URAII 2009
The 6th International Conference on Ubiquitous Robots and Ambient Intelligence

Kimdeajung Convention Center, Gwangju, Korea
October 29–31, 2009

Final Program

Secretariats:
• Ji Yeong Lee (Hanyang Univ., Korea) e-mail: jyeongl@hanyang.ac.kr Tel: +82-31-400-5253
• Kate Lim (KROS, Korea) e-mail: iknf@kros.org Tel: +82-2-783-0306 / Fax: +82-2-783-0307
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On behalf of the organizing and program committees, I would like to welcome all of you to URAI 2009, the 6th International Conference on Ubiquitous Robots and Ambient Intelligence, to be held at Kimdaejoong Convention Center, Gwangju, Korea, on October 29-31, 2009. As the General Chair, it is my great pleasure and honor to host URAI 2009, cosponsored by KROS (Korea Robotics Society) and Gwangju City, and technically-cosponsored by IEEE RAS, RSJ, and RST. Although URAI began as a small workshop focusing on ubiquitous robotics 6 years ago, it has grown into the international conference which covers both ubiquitous robotics and various types of intelligent robotic systems. The aim of this conference is to bring together researchers, engineers and practitioners to present their ideas and recent works.

URAI 2009 is highlighted by 4 plenary talks by renowned researchers, 18 regular presentation sessions, 3 work in progress sessions, and one video session of 209 contributed papers. A series of exciting social events are to be provided for the participants, including welcoming reception, conference banquet, as well as a robotics lab tour at Gwangju Institute of Science and Technology and a specialized culture tour of southwestern areas of Korea.

I would like to take this opportunity to thank all the organizing and program committee members who work hard to make URAI 2009 a success. My special appreciation should be directed to Dr. Sang-Ju Kwon and Prof. Tatsuo Arai, the program chairs for their invaluable contributions.

Gwangju has been historically playing political, economic, and cultural center of southwestern area of Korea. Variety of magnificent historical places is nearby. Famous traditional dishes are enjoyable along with beautiful landscapes. Specially, we prepare a culture tour as one of conference activities to provide all participants with a chance of enjoying variety of amazing landscape, traditional culture, and world-famous Koryo porcelain village. Please, enjoy your stay in Gwangju.

Sincerely,

Byung-Ju Yi
General Chair of URAI 2009
Professor, Hanyang University
Conference Organization

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Conference Organizers & Sponsors

- **Conference Organizer**
  - Korea Robotics Society

- **Conference Sponsors**
  - IEEE Robotics & Automation Society
  - Robotics Society of Japan
  - Robotics Society of Taiwan
  - Ministry of Knowledge Economy
  - National IT Industry Promotion Agency
  - Korea Tourism Organization
  - Ubiquitous Sensor Networks GRRC
  - Gwangju International Photonics EXPO Foundation
  - Gwangju Convention & Visitors Bureau
  - Aldebaran Robotics
  - Hokuyo Automatic
  - KIST- Cognitive Robotic IMM
  - NI
  - NT Research
  - SimLab
  - YUJIN TOBOT
Name of Company: Yujin Robot Co., Ltd
President: Kyung Chul Shin

Address: #1214, Namsung Plaza, 345-30, Gasan-dong, Guemcheon-gu, Seoul, Country: Korea
Tel: 82-2-2026-1400
Fax: 82-2-2026-1440
E-mail: insung@yujinrobot.com
Web-site: www.yujinrobot.com

Contents of Exhibit: Network education Robot "iRobi Q"

Introduction

We had started a business from 1988, and since that time we have been continuously developing and manufacturing various robotic products for cleaning, home care, educational and Industrial robots etc. In this line of business we enjoy an especially advantageous position as the leading company in Korea. During those 20 years period, we obtained several R&D certificates from government authorities and received good reputations from our customers and buyers over the world.

We employ the leading edge technology and make things real in practical robots. Those seamless efforts on R&D and venturous trial resulted in such business successes with several oversea and domestic buyers.

Now, we are ready to take a new challenge and we are going to take it soon over the world.

Name of Company: Hokuyo Automatic Co., Ltd.
President: Mr. Hitoshi Ozaki

Address: 1-10-9, Niitaka, Yodogawa-ku, Osaka 532-0033
Country: Japan
Tel: +81-6-6394-2102
Fax: +81-6-6394-2339
E-mail: foreign-trade@hokuyo-aut.co.jp
Web-site: http://www.hokuyo-aut.jp/

Contents of Exhibit: Laser scanners: URG-04LX, URG-04LX-UG01, UTM-30LX, UTM-30LX

Introduction

Hokuyo, founded in Osaka, Japan in 1946, is a recognized leading manufacturer of automatic control devices for advanced technology industries. We have been manufacturing a broad range of factory automation systems in production process and material handling facilities. In robotics industry, we are the top supplier of laser scanners which are the tool of mapping for autonomous robots such as service robots, rescue robots, security robots and so on. Most of our laser scanners have light weight and compact size, power consumption is also very low. Hokuyo is continuous working on its product for customer to have the best option in terms of cost, perform ace and flexibility. Please feel free to contact us if you are interested in our technology and service.

Name of Company: SimLab Co., Ltd.
President: Kyong-Sok Chang

Address: TaeSeung Bldg 4th Fl #402,15-9 Jamwon-dong, Seocho-gu, Seoul 137-902, Korea
Country: Korea
Tel: +82-2-3471-2014
Fax: +82-2-6280-9931
E-mail: info@simlab.co.kr
Web-site: www.simlab.co.kr

Contents of Exhibit: RoboticsLab

Introduction

RoboticsLab is "Robotics Software Development Environment including Dynamics and Control Engines". It provides realistic and effective simulation for robotic manipulation tasks and mobile robot navigation. It is developed to support Rapid-prototyping, Customizing and Testing Reusable Robotic Algorithms. Robotics engineers and researchers can get help in a variety of fields such as robot/environment modeling, dynamic simulation, controller development, and educations.
**National Instrument**

**Name of Company**: NATIONAL INSTRUMENTS  
**President**: Michael Chu Kim  
**Address**: 8th floor, Daewha Building, 169, Samsung-Dong, Kangnam-Ku, Seoul, Korea. 135-882  
**Country**: USA  
**Tel**: 02-3451-3400  
**Fax**: 02-3451-2997  
**E-mail**: Seokyong.choi@ni.com  
**Web-site**: Ni.com/korea

**Contents of Exhibit**: LabVIEW, a intelligent robot BIGEYE

**Introduction**

National Instrument will showcase LabVIEW, a graphical programming language that will help robotics engineer to design, prototype, and deploy all in same platform. Along with this powerful S/W, prototyping H/W such as CompactRIO and SingleBoard-RIO will be shown that is embedded inside a intelligent robot, co-developed with PIRO.

BIDGE

"Development of Robot Aided Education for Robotics Tutorials" project is one of the attempts to develop, apply and evaluate robots as a context for robotics education. This is a joint effort between PIRO (Pohang Institute of Intelligent Robotics) and NI (National Instruments, Korea). In this project, we create two products: a robot kit and a textbook. The robot (called BigEye) was developed for use in our curriculum is now available. Today, we will introduce a robot platform for “Robot Aided Education”.

**Aldebaran Robotics**

**Name of Company**: Aldebaran Robotics  
**President**: Bruno Maisonnier  
**Address**: 170 rue Raymond Losserand  
**Country**: France  
**Tel**: +33 1 77 37 17 59  
**Fax**: +33 1 77 35 22 68  
**E-mail**: qlelay@aldebaran-robotics.com  
**Web-site**: www.aldebaran-robotics.com

**Contents of Exhibit**: Nao, Humanoid Robot

**Introduction**

Nao is a humanoid robot developed and manufactured by Aldebaran Robotics, a French company based in Paris, France. The demonstration will show how the robot interacts autonomously and the capacities of high level programming through Choregraphe software.

Nao stands tall in all points amongst its robotic brethren. Platform agnostic, it can be programmed and controlled using Linux, Windows or Mac OS. The hardware has been built from the ground up with the latest technologies providing great fluidity in its movements and offering a wide range of sensors. Nao contains an open framework which allows distributed software modules to interact together seamlessly. Depending on the user’s expertise, Nao can be controlled via Choregraphe®, our user friendly behaviour editor, by programming C++ modules, or by interacting with a rich API from scripting languages.

In addition to the high level API, advanced users can take advantage of low level access to sensors and actuators and can, if they wish, replace our code with custom adaptations. In order to allow users to validate motion sequences, simulators are available for Microsoft Robotics Studio and Webots.

ALDEBARAN ROBOTICS was founded in 2005 in Paris to develop and market humanoid home robot companions. Since May 2008, Aldebaran is shipping its first generation robot. Nao is a 58cm tall friendly robot that includes a computer and networking capability at its core. Delivered with a full set of development tools, NAO addresses the needs of universities including RoboCup players and research labs around the world. It’s an evolving platform, which is unique in its ability to handle multiple applications. Today Aldebaran’s regroups more than 80 people including +35 first class engineers and PhDs involved in R&D and production.
**T-Hive**

A new 6DOF bilateral haptic device, which provides a spatial sensation on the handle using vibrotactile display, is proposed in this research. The sphere-shape handle is specially designed to be covered with several pieces of vibrating panels. When a specific panel is activated, the user perceives the spatial location of the vibrotactile stimulus during an input operation. This research introduces the design of the proposed device, including the selection guide of the dimension, location, and number of vibrotactile panels.

**T-Vision**

The developed tactile display system successfully conveyed texture information such as ridges, grooves, and surface roughness according to the position information acquired from the touch screen. To handle the texture information, a graphic-to-tactile conversion method based on the gray scale level of the image was adopted. Additionally, tactile impulses can be generated through feedback with a low latency to prevent users from being distracted from their focus on the touch-screen based virtual museum.

**Variable Stiffness Joint (VSJ)**

The variable stiffness joint (VSJ) is designed for a robot manipulator for safer use in the operating space shared by human. The stiffness is generated by leaf springs and two actuators are used to control the position and stiffness of the joint. Changing effective length of the spring results in changes in stiffness. The position of the joint is controlled via rotating two actuators at the same speed in the same direction. The stiffness is controlled when the two actuators rotate at the different speed.

**Spring Clutch**

The Spring-Clutch is a simple passive mechanism that consists of a coil spring and a CAM mechanism. When a torque is applied that is less than a threshold value, Spring-Clutch functions as a rigid joint between the input and the output. However, when an applied torque exceeds the threshold, angular displacement occurs between the input and output to reduce the collision force. If the applied torque is removed, Spring-Clutch immediately returns to its nominal position without the need for additional operations.
General Information

- **Conference Location**
The conference will be held at Kimdaejung Convention center located at Gwangju. Kimdaejung Convention center was established in 2003 to play the role of holding variety of international activities. The center is equipped with multi-media center, meeting rooms, auditorium, exhibition hall, and VIP room. With its spacious exhibition hall and auditorium, the center is able to accommodate everything from small and medium sized symposiums to international conferences. The center is close to Gwangju airport and several accommodation facilities are also located at a nearly town called Sangmu district.

  Kimdaejung Convention Center
  Gwangju, Korea

- **Registration Desk**
The registration desk will be open at the lobby of Atrium on the 2nd floor of Kimdaejung convention center in the period of the following times:
  
  08:15 - 18:30 Thursday, October 29
  08:15 - 16:30 Friday, October 30

- **Information/Message Board**
The Information/Message Board will be located near the Registration Desk. Messages will be posted in this area throughout the conference.

- **Name Badges**
All attendees must wear their name badges at all times to gain admission to all conference sessions, exhibits and receptions.

- **CD-ROM Proceedings**
A full manuscript of each paper presented at the conference has been published on CD-ROM Proceedings. Your registration fee includes a copy of IEEE CD-ROM Proceedings.

- **Official Language**
The official language of the conference is English and will be used for all presentations and printed materials.

- **Currency and Credit Cards**
The unit of Korean currency is Won. Foreign currency and traveler's checks can be exchanged into Korean Won at foreign exchange banks and other authorized money exchangers. Credit cards, including VISA, American Express, Diners Club, Master Card and JCB, are accepted at major hotels, department stores, and large restaurants. The exchange rate is subject to fluctuation.

- **Electricity**
In Korea, outlets for 220 volts 60 Hz are dominant. Always check the power supply before using your equipment.

- **Internet Access**
You can get easy access to the internet services inside the Kimdaejung convention center. Also, wireless internet is available in the conference venue.

- **Refreshment Break**
Coffee and fresh beverage will be served at the conference site.

- **Climate**
Gwangju temperature is expected to range 0 to 12°C (32~54°F) during the conference. It is sunny and bright, but sometimes isolated shower in Gwangju. The weather is subject to change.

- **Restaurants**
There is a cafeteria inside Kimdaejung convention center and several private cafeterias near the center. A leaflet of restaurant information will be provided on-site.
Technical Tour

Gwangju Institute of Science and Technology Lab. Tour

Date & Time: Oct. 30 (Fri.), 15:30 - 17:30 (2 hr) Fee: Free

Dynamics and Control (Robotics and Haptics) Laboratory
(Prof. Jeha Ryu), Tel +82-62-970-2389, 2425, http://haptics.gist.ac.kr

The objective of the Dynamics and Control (Robotics and Haptics) Laboratory is to create novel mechatronic systems based on the advanced information technology, mechanical engineering, and electrical engineering. Specifically, the human interfaces with robots, vehicles, and virtual environments are the main research topics of the laboratory, which require dynamics, control, mechanical component, system design, computer graphics, programming, and electronic engineering. The recent research focus is on the haptic interaction with real, virtual, and remote environments, which has potential for various applications, such as remote/surgical/rehabilitation robots, vehicle telematics, and haptic broadcasting, game, and education.

In this technical tour, a bilateral teleoperation system, Sil-Gam book, a virtual calligraphy training system, and other haptics-related systems will be demonstrated.
A Platform for Bio-insect and Artificial Robot Interaction

This project Bio-insect and artificial Robot Interaction based on Distributed Systems (BRIDS) aims to make new intelligent architecture using cooperative reinforcement learning for dragging or driving a bio-insect towards a desired goal point without any help from human. For this project, we installed a hardware platform consisting of a main computer for control and image processing, camera, Bluetooth access point, and revised e-puck robots. Using this hardware platform, we can find location and heading angle of each robot and bio-insect. For verification of our hardware platform, we made simple algorithm that can make formations of G, I, S, T using 10 e-puck robots, as visualized in above figures.

Wireless localization networks for indoor mobile robots

- A wireless localization network (WLN) based on a chirp spread spectrum technique (CSS) helps indoor mobile robots track a pedestrian around them in a ubiquitous robot space (URS).
- The CSS shows improved performance for localization compared to the latest technique in terms of propagation capability and noise sensitivity.
- The WLN consists of mobile tags that are carried on human and reference tags that are attached on walls or ceiling.
- The position of the pedestrian is estimated from distance between the mobile tag and the reference tag, calculated by symmetric double-sided two-way ranging (SDS-TWR) algorithm.
Tour program

- Laser scanner (LIDAR) for robot navigation
- 3D measurement for shipbuilding industry
- Robot navigation with collision avoidance
Culture Tour

Date & Time: Oct. 31(Sat)
Fee: Free (Including lunch)

Site 1] Cheongja Doyoji
Site 2] Soonchonman Reed Field
Site 3] Nakaneupsung Folk Village

Reservation : URAI2009 Desk

[Schedule]
08 : 00 depart Gwangju in front of Kimdaejung convention center
08 : 10 pick up participants in front of Lamada Plaza Hotel
09 : 40 arrive at Sunchunman
11 : 00 depart Sunchunman
12 : 00 arrive at Nakaneupsung food festival
14 : 00 depart Nakaneupsung
15 : 00 arrive at Gangjin Koryo Porselin village
17 : 00 depart Gangjin
18 : 00 arrive at Lamada Plaza Hotel

[Note]
It could be cancelled if the number of applicants is less than 15.
Access

By Airplane
Gimpo — 55 min
Jeju — 50 min — Gwangju
Gwangju Airport ↔
By taxi - 10 min
By city bus[No.] - 1000

By Express bus
Seoul — 3:30min
Pusan — 3:30min — Gwangju
Daegu — 3:40min — Gwangju
Daejeon — 2:30min
Express Bus Terminal ↔
By taxi - 15 min
By city bus - Ilgok38, Sangmu64,
[No.] Daechon69, 518, 1000

By KTX
Yong — 2:40min
Songjeong, Gwangju
San
Seoul — 3:55min

By Train
(Gwangju)
By taxi - 30 min
By city bus[No.] - 518
Gwangju Songjeong Station ↔
By subway - 10 minutes
By taxi - 20 minutes
By city bus[No.] - 518

By Car
Seoul — Gyeongbu Highway
Daegu — 88 Highway — Honam Highway — Donglim IC
Busan — Southern sea Highway
City hall — Sangmu incineration place
Go through come out Donglim IC. Follow the traffic sign says
Gwangju City hall. You will see the sign of Kimdaejung Convention
Center(Approx. 10 minutes)

By Subway
Three-minute walk from Kimdaejung Convention Center Station, Exit 5

By City Bus
Sangmu02, Sangmu62, Sangmu64, Songjeong19, Ilgok38, Songam73,
Daechon69, Daechon270, Cheomdan20, 518, 1000

Information
Gwangju Airport (8262)940-0312
Korean Air Gwangju Office (8262)942-0111
Asiana Airline Gwangju Office (8262)943-2626
Gwangju Station (8262)514-7788 / Songjeongli Station (8262)942-3376
Express Bus Terminal (8262)360-8114

Kimdaejung Convention Center
Kimdaejung Convention Center

• 151, Sangmu Pyeonghwa-gil, Seo-gu, Gwangju, 502-828, Korea Tel. (8262)611-2000 Fax. (8262)611-2099
• Dongwoo Kukje Building #1101, Yeouido-dong 13-4, Yeongdeungpo-gu, Seoul, 150-870, Korea,
  Tel.(822)576-2198 Fax.(822)576-2090
Robotics is one of the challenging technologies which are evolving worldwide. Many nations including USA, Japan, Germany, and many other European countries are investing and developing robotics technology. In Korea, robot industry is considered as one of the most promising fields for future economy. The Ministry of Knowledge and Economy of Korea is in charge of the research and development of robot technology.

Gwangju, Korea, as the hub of home appliance robots pursues robots with emotion, warmth, and friendliness. In order to achieve technologies for home appliance robot, we provide a workshop for presentation, lectures, and discussions on innovative robot technology. The workshop gathers robotists from industry, research institute, university, and government from all around the world. Especially, the workshop concentrates on the emerging issue of systematic integration and fusion of components of robot technologies for coherence and compatibility.

We, the committee of the 2009 International Workshop on Robot Integration Technology, wish the robotists to come to the workshop and enjoy the heart of robot technology.

■ Date: Thursday, October 29, 2009
■ Place: Kimdaejung Convention Center, 2nd floor, room 210, Gwangju, Korea
■ Administration: Robotics Institute of Redone Technologies, Co. LTD.
■ Sponsor: Kimdaejung Convention Center
■ Contact: Professor Yongseon Moon,
   Suncheon National Univ., 062-373-2024, 011-607-0888

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<td>09:00 ~ 09:30</td>
<td>Opening</td>
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<td>09:30 ~ 11:00</td>
<td>Robot Hand Technology</td>
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<td>- China: HIT, Prof. Jin Minghe</td>
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<td>11:00 ~ 12:30</td>
<td>The introduction of Tsukuba Challenge, in which, the autonomous mobile</td>
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<td>robots try to navigate 1 km of usual pedestrian street in Tsukuba</td>
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<td>city autonomously</td>
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<td>- Japan: University of Tsukuba, Prof. YUTA</td>
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<td>Lunch</td>
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<td>14:00 ~ 15:30</td>
<td>Robotics Research at HIT: From Industrial Robotics to Advanced Robotics</td>
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<td>- China: HIT Robotics Institute, Prof. Fu Yi-Li</td>
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<td>15:40 ~ 17:10</td>
<td>Next Generation Robots: From Robotic Co-Workers to Intrinsic Compliance</td>
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<td>- German: Aerospace Center (DLR), Sami Haddadin</td>
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<td>17:10 ~ 18:00</td>
<td>Computer aided functional neurosurgery and robotics of neurosurgery</td>
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<td>- Korea: Korean Society of Medical Robotics, Young Soo Kim</td>
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1. **IRONC 2009 will be held on October 29-30, 2009, at Kimdaejung Convention Center, Gwangju, Korea.**
   (1) There will be a preliminary meeting of the participants on October 29, 2009.
   (2) The competition begins at 10AM October 30, 2009. Each team has 30 minutes of time allowed for the navigation.

2. **The purposes of the IRONC 2009 is**
   (1) to provide an opportunity to exchange, share, and promote the knowledge on robot outdoor navigation,
   (2) to promote the development of new technologies for outdoor navigation of a robot, and
   (3) to induce young students to engage in robotics research.

3. **This competition evaluates the capability of outdoor navigation of a mobile robot: move the robot autonomously to the goal location through an outdoor path while avoiding obstacles within the shortest possible time period.**

4. **A team shall be comprised of a team leader and 10 or less team members.**

5. **The participants can use their own robot or the robot provided by the supporting company of the competition, the Redone technologies, Inc.**

6. **This year, 17 teams have applied for the participation of the competition.**

7. **This is the first year of the competition. It will be held annually.**

8. **Sponsors and supporters of the IRONC 2009 are as the followings.**
   (1) Sponsors: The Ministry of Knowledge Economy of Korea, Government of Gwangju Metropolitan City
   (2) Co-sponsor: Gwangju Technopark
   (3) Technical co-sponsors: Kimdaejung Convention Center, Korea Robotics Society, Korea Association of Robot Industry, Korea Institute of Industrial Technology
   (4) Supporter: Redone Technologies, Inc.

9. An example of the path through which a robot travels is shown below.

10. **For further details on the IRONC 2009, please contact Prof. Nak Yong Ko.**

    Prof. Nak Yong Ko
    Dept. Control, Instrumentation, and Robot Eng., Chosun Univ., Korea
    +82-62-230-7108.
Plenary Speakers

Professor Hideo Fujimoto Nagoya Institute of Technology, Japan
(Co-presented by Yoshihiro Tanaka, Jumpei Arata)

Haptic technology and medical robotics

[Biography]
Hideo FUJIMOTO
1970 graduated from Department of Mechanical Engineering, Faculty of Engineering Nagoya University.
Doctor of Engineering
Currently, Professor of Nagoya Institute of Technology graduate school engineering course. Additional posts as Director of Institute of Medical Engineering Intelligent Surgical Instrument Research, of Advanced Manufacturing Techno Institute, and of TOYOTA Robotics Haptics Institute.
He is interested in the research fields such as medical engineering, intellectualization of robot, force tactile sense technology, and tradition of skills. General leader of large-scaled national project of medical-engineering collaboration.
He won many prizes such as Excellent Paper Award of Society of Instrument and Control Engineers, Best Paper Award of JUSFA, 2004 Good Design Award, etc.
He successively held various posts such as President of Scheduling Society, standing Director and Manager of Chubu District of Society of Instrument of Control Engineers, a member of Technology and Science Council of Ministry of Education, Culture, Sports, Science and Technology.
Currently, he is in charge of various posts such as Director of Robotics Society of Japan, standing Director of NPO Automation Promoting Association, Director of Scheduling Society, Chair of Aichi Prefecture Manufacturing Personnel Training Council, fellow of Japan Society of Mechanical Engineers, etc.

[Abstracts of Plenary Talk]
Haptic devices are now being developed in fields of virtual reality or robotics. Haptic interface is the technology to realize the operation by human intuition, and tactile sensor, replaced by the human tactile perception, is the technology that is available for diagnosis or product inspection at medical and manufacturing sites and for human sensitivity evaluation, etc. "Haptic technology" related to these technology is the technology concerned with human skills and sensitivity following bio-technology or nano-technology. And it is the growing field to create high value-added products with competitive power or innovative technology in the future.

In our lecture, we will introduce the haptic study we have carried out so far for the first time. Tactile sense cannot be perceived until we touch something. You can actually experience the wonder of human tactile perceptive phenomena through demonstration of "TouchLens", the tactile amplification appliance, and Haptic Illusion. Then, we introduce the project on medical robot development that we have studied recently with a part of these work background.
In neurosurgery, it is known that the removal rate of brain tumor is a key parameter of clinical outcome. Motivation of the project is improvement of removal rate of brain tumor. We developed a neurosurgical robot by introducing master-slave technology. The developed neurosurgical robot can be mounted on a conventional head-frame device on surgical bed for the accuracy of patient-robot coordinates. Advanced surgical tools, such as a 3D endoscope, a tactile sensor, and a sensor-feedback suction tube are embedded in a manipulator. In addition, we are working on haptic sensor development, surgeon-device interface software and training system. Therefore, the collaboration system of these "intelligent surgical instruments" is a key technology of this project. The concept, prototype implementation, and collaborative demonstration of these devices will be presented in the talk by using visual materials.
Professor In So Kwon, KAIST, Korea

Robust Vision Techniques for Intelligent Robots

[Biography]

Education
1985. M.S., Dept. of Mechanical Design and Production Engineering, Seoul National University
1983. B.S, Dept. of Mechanical Design and Production Engineering, Seoul National University

Experience
1992~current, Professor, School of Electrical Engineering and Computer Science, KAIST
1998~1999, Visiting professor, Department of Engineering, Cambridge University
1983~1984, Researcher, NC Center, KIMM, Korea.

Prize
Oct. 2008 , Student Paper Award (with Jungho Kim)
2006. International Conference on Ubiquitous Robots and Ambient Intelligence 2008 (URAI 2008), Outstanding
Poster Award (with K. Sung)
2001. SPIE Photonics Conference, Poster Paper Award, Boston, USA (with K. Yoon)
KAIST Research Award.

[Abstracts of Plenary Talk]

Research in KAIST Robotics and Computer Vision (RCV) Lab. has been focused on developing robust methods
concerning important robot vision problems: 3D mapping, localization and object recognition. In this talk, we first
present robust methods for finding feature correspondences from an image pair with significant deformation.

We then introduce a new theory to model the sensor noise of CCD cameras for low-level feature extraction,
such as edge and corner detection. The robustness against illumination variations will be demonstrated by extensive
experiments. Finally, we will present a graphical model based object recognition framework for recognizing objects
under strong cluttered backgrounds. The framework is designed to resemble the characteristics of the human vision
system. Experimental results using the standard DBs and real images show the feasibility of the proposed method
for real-world applications, such as intelligent service robots.
Professor Shin’ichi YUTA, Professor, University of Tsukuba, Japan

Autonomous navigation of a Mobile Robot
Integration of Sensing, Planning and Control

[Biography]

Professor Shin’ichi YUTA received his Bachelor, Master and Doctoral degrees in Electrical Engineering from Keio University, in 1970, 1972, and 1975 respectively. From 1975 to 1978, he was a Research Associate at Tokyo University of Agriculture and Technology in department of Electronics. From 1978, he has been at University of Tsukuba. He was as a lecturer at first, in Institute of Information Science and Electronics, and promoted to be a full professor in 1992. In 1999 he moved into Institute of Engineering Mechanics and Systems. In 2000-2002, he was a dean of College of Engineering Systems, and in 2002-2004, he worked as a chairman of the Institute and leads 60 faculty members. In 2004-2006, Professor Shin’ichi Yuta was appointed to be a vice-president of University of Tsukuba. The role of his vice-presidency was for, research, industrial cooperation, community service and international relationship. In 2006 April, he completed his term of vice president and stepped down to be a professor of the graduate school of systems and information engineering, and was also appointed to be a director of the Industrial Liaison and Cooperative Research Center.

He is an expert in robotics, and heading the Intelligent Robot Laboratory. He has been conducting an autonomous mobile robot research project, since 1980. He has published more than 500 technical papers in this field. He has been keeping close relationship and collaboration with many industries, into which, his several research results were transferred. He has also organized and chaired many international and domestic academic conferences in Robotics. He has received several awards from IEEE (Institute of Electrical and Electronic Engineers), RSJ (Robotics Society of Japan) and other academic societies. He is a fellow of IEEE and RSJ.

[Abstracts of Plenary Talk]

At University of Tsukuba, we have been researching to realize the autonomous mobile robots which can navigate in real indoor and outdoor environments, based on the experimental and task oriented approach.

The biggest characteristic of the mobile robot is the size of the working space, in which the robot lives. The mobile robots are requested to work in the thousand times bigger area of the robot body. So the most important issue for the mobile robot is the ability to cope with wide range of environmental situations.

In this lecture, our experiences on the experimental mobile robotics research of sensing, planning and control will be shown, as well as the system architecture and integration of functions.
Professor Sunil K. Agrawal, PhD, Professor, University of Delaware

Robotic Exoskeletons for Gait Assistance and Training of the Motor Impaired

[Biography]

Sunil K. Agrawal received a Ph.D. degree in Mechanical Engineering from Stanford University in 1990. He is currently the Director of Mechanical Systems Laboratory. He has published close to 250 journal and conference papers. Dr. Agrawal is a Fellow of the ASME and his other honors include a Presidential Faculty Fellowship from the White House in 1994, a Bessel Prize from Germany in 2003, and a Humboldt US Senior Scientist Award in 2007. He has served on editorial boards on numerous journals published by ASME and IEEE.

[Abstracts of Plenary Talk]

Robotics is emerging as a promising tool for training of human functional movements. The talk will describe novel designs of lower extremity exoskeletons, intended for gait assistance and training of motor-impaired patients. The exoskeletons have undergone tests on healthy and chronic stroke survivors to assess their potential. GBO is a Gravity Balancing un-motorized Orthosis which can alter the gravity acting at the hip and knee joints during swing. ALEX is an Actively driven Leg Exoskeleton which can modulate the foot trajectory using motors at the joints. This research was supported by NIH through a BRP program.

http://www.udel.edu/udaily/2009/nov/nihgrant111908.html

References:


The technical program consists of 4 plenary sessions, 1 workshop, 4 parallel oral sessions, and 1 video session of contributed papers.

- **Plenary Sessions**
The plenary sessions will be held at Convention Hall on the 2nd floor of Kimdaejung convention center.

- **Technical Sessions**
All technical sessions will be held at the 2nd floor of Kimdaejung convention center at Room (201), Room (202-204), Room (206-207), and Room (210).

- **Guide to Understanding Session Numbering**
Each session in the technical program is assigned a unique number which clearly indicates when and where the paper is presented. A typical number is shown below:

  **Typical Session Number: TA1**
  
  The first letter (e.g., T) indicates the day of the conference.
  
  T = Thursday, F = Friday
  
  The second letter (i.e., A) indicates the time of the day.
  
  A, B = Morning,
  
  C, D = Afternoon

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**Social Program Information**

- **Welcome Reception**
  Thursday, October 29, 19:20~20:30, Convention Hall (4th floor of Kimdaejung convention center)

  URAI 2009 invites all conference attendees to enjoy an evening with colleagues and friends. Beverage and snacks will be served for all the registrants.

- **Banquet**
  Friday, October 30, 19:00~21:00, Convention Hall (4th floor of Kimdaejung convention center)

  You are welcomed to the banquet to be held on October 30. Please make sure to bring the banquet ticket. In the banquet, the URAI 2009 Best Paper Awards will be presented.
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<td>TA2 Sensors and actuators</td>
<td>TA3 Intelligence and learning</td>
<td>2009 International Workshop on Robot Integration Technology</td>
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<tr>
<td>10:30~12:00</td>
<td>TB1 Medical robot</td>
<td>TB2 Control architecture and Middleware</td>
<td>TB3 Human-robot interaction</td>
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<td>15:40~16:55</td>
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<td>TC2 Open Innovation Technology for RT Market</td>
<td>TC3 Robot Vision for Ubiquitous Robot Services</td>
<td>2009 International Workshop on Robot Integration Technology</td>
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※ Robot Forum (room 208-209, 4:30~6:30)
## Friday, October 30

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<td>FA2 Service robot</td>
<td>FA3 Robot vision I</td>
<td>FA4 Navigation/Localization I</td>
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<td>10:30~12:00</td>
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<td>FB2 USN technology</td>
<td>FB3 Robotic mechanisms and design I</td>
<td>VD1 Video</td>
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<td>13:30~14:20</td>
<td>Plenary Talk3: Shin’ichi Yuta</td>
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<td>15:40~17:10</td>
<td>FC1 Artificial Evolution of Robots in Software and Hardware</td>
<td>FC2 Design and Control of Quadruped Walking Robot</td>
<td>FC3 Robotic mechanisms and design II</td>
<td>FC4 Navigation/Localization II</td>
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<td>17:25~18:25</td>
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<td>FD2 Robot vision II</td>
<td>FD3 Intelligent space/ environment technologies</td>
<td>FD4 Navigation/Localization III</td>
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<td>19:00~21:00</td>
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※ Outdoor navigation (Square of Kimdaejung convention Center) : 10:00~18:00  
※ KROS Member’s Meeting (6pm at room 206-207), KROS Board Meeting (12~1:30 pm at Hwangbo Restaurant)
Thursday, October 29

[TA1] Autonomous Vehicles, Room 201

Chairs: Sungshin Kim, Pusan National University, Korea
        Byoung-Ho Kim, Kyungsung University, Korea

09:00~09:15 TA1-1 Road Detection and Obstacle Avoidance using a Single Laser Range Finder for Outdoor Navigation
Youjin Shin, Woojin Chung
Korea University, KOREA

09:15~09:30 TA1-2 Fuzzy Inference System for Autonomous Navigation on Forklift AGV
Jungje Park, Taeryong Jeon, Jungmin Kim, Sungshin Kim
Pusan National University, KOREA

09:30~09:45 TA1-3 Performance Index for Effective Multi-Legged Robotic Walking
Byoung-Ho Kim
Kyungsung University, KOREA

09:45~10:00 TA1-4 Surveillance Robot with Emailing and Telephoning functions
Aneesh N. Chand, Shin’ichi Yuta
University of Tsukuba, JAPAN

10:00~10:15 TA1-5 Time-Optimal Straight-Line Trajectory of Three-Wheeled Omni-Directional Mobile Robots with Multi-Objective
Ki Bum Kim, Byung Kook Kim
Korea Advanced Institute of Science and Technology, KOREA

[TA2] Sensors and actuators, Room 202-204

Chairs: Toshihiro Mori, Hokuyo Automatic Co., Japan
        Jongsuk Choi, KIST, Korea

09:00~09:15 TA2-1 Analytic Sound Source Localization with Triangular Microphone Array
Byoung-ki Lee, Jongsuk Choi
KIST, KOREA
09:15~09:30  **TA2-2**  Splitting Overlapped Reflected Laser Waveforms for Hokuyo Laser Range Finder (SOKUIKI Sensor) - Architecture and Implementation -
Suparerk Premvuti, Hirohiko Kawata, Toshihiro Kamitani, Toshihiro Mori
_Hokuyo Automatic Co., JAPAN_

09:30~09:45  **TA2-3**  3D SOKUIKI Sensor Module by Roundly Swinging Mechanism and SCIP-3D Interface
Mitsuhiro Matsumoto, Shin’ichi Yuta
_University of Tsukuba, JAPAN_

09:45~10:00  **TA2-4**  A Torque Controller Design of Flexible Joint Robot Arm Using Disturbance Observer
Hosun Lee¹, Yonghwan Oh², Jae-Bok Song¹
¹_Korea University, KOREA, ²Korea Institute of Science and Technology, KOREA_

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**[TA3]  Intelligence and learning, Room 206-207**

Chairs: **Lee Sandberg**, University of Skövde, Sweden  
**Sungchul Kang**, KIST, Korea

09:00~09:15  **TA3-1**  Extending a self-learning landmark navigation system for behavior based mobile robots
Lee Sandberg
_University of Skövde, SWEDEN_

09:15~09:30  **TA3-2**  Segmentation of Continuous Human Gestures for Imitative Learning
Hyoungnyoun Kim, Kyungwha Park, Kyungkoo Kim, Ji-Hyung Park
_KIST, KOREA_

09:30~09:45  **TA3-3**  Development of a Remote-Controlled Mobile Robot for Foreign Language Education
Sungon Lee¹, Doik Kim¹, Youngsu Cha¹, Bum-jae You¹, Heungjae Cho²
¹_KIST, KOREA, ²SAMIL CTS Co., KOREA_

09:45~10:00  **TA3-4**  Solving Geometrical Uncertainty of Mobile Manipulation by Natural Actor-Critic
Byungchan Kim¹, Changmook Chun¹, Sungchul Kang¹, Dongseok Ryu²
¹_KIST, Korea, ²Texas A&M University-Corpus Christi, USA_

10:15~10:30  **Break Time**
### [TB1] Medical robot, Room 201

**Chairs:** Sunil Agrawal, University of Delaware, U.S.A.  
Jaesung Hong, Kyushu University, Japan

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<th>Time</th>
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| 10:30~10:45 | TB1-1   | Open MRI Guided Surgical Navigation for Liver Tumor Ablation Therapy | Jaesung Hong, Morimasa Tomikawa, Kozo Konish, Makoto Hashizume  
Kyushu University, JAPAN |
| 10:45~11:00   | TB1-2   | Haptic Modeling of a Suction Process for a Surgery Training System  | Hyung Wook Kim, Jumpei Arata, Hideo Fujimoto  
Nagoya Institute of Technology, JAPAN |
| 11:00~11:15   | TB1-3   | Robot Console System for Neuroendoscopic Surgery                   | Kento Nishibori¹, Atsushi Yamada¹, Yuichiro Hayashi², Junichi Tokuda³, Nobuhiko Hata³, Kiyoyuki Chinzei⁴, Hideo Fujimoto¹  
¹Nagoya Institute of Technology, JAPAN, ²Nagoya University, JAPAN, ³Harvard Medical School, USA, ⁴Science and Technology (AIST), JAPAN |
| 11:15~11:30   | TB1-4   | EMG-based Real-Time Joint Angle Extraction Method for Human Elbow: Pre-processing and Optimization Process | Hyeon-Jae Yu¹, Youngjin Choi²  
¹LS MTRON, KOREA, ²Hanyang University, KOREA |
| 11:30~11:45   | TB1-5   | Compact Hand Exoskeleton Robot for the Disabled                    | Hyun-Ki In, Kyu-Jin Cho  
Seoul National University, KOREA |
| 11:45~12:00   | TB1-6   | Mechanical Design of a Wearable Robot(RoboWear) for Power Augmentation | Changyong Song, Kyunghwan Kim  
NT Research Inc., KOREA |

### [TB2] Control architecture and Middleware, Room 202-204

**Chairs:** Jyh-Ching Juang, National Cheng-Kung University, Taiwan  
Jee-Hwan Ryu, Korea University of Technology and Education, Korea

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| 10:30~10:45 | TB2-1   | Maneuver Control of Tricycle Mobile Robot Based on Backstepping Approach | Shun-Hung Chen, Jyh-Ching Juang, Tsung-Hui Huang  
National Cheng-Kung University, TAIWAN |
| 10:45~11:00   | TB2-2   | Efficient UPnP SOAP Transmission using IP Matching                | Ki-Woong Lim¹, Sang Chul Ahn¹, Kwanghoon Sohn²  
¹KIST, KOREA, ²Yonsei University, KOREA |
11:00~11:15  TB2-3  A QoS-Aware Component Model for Service Robots
Min-kyu Sin¹, Ji Chan Maeng¹, Choulsoo Jang², Sunghoon Kim², Minsoo Ryu¹
¹Hanyang University, KOREA, ²Electronics and Telecommunications Research Institute, KOREA

11:15~11:30  TB2-4  State Test Methodology for Robot Software Component Architecture
Sang-Woo Maeng, Hong-Seong Park
Kangwon National University, KOREA

11:30~11:45  TB2-5  A Fault-Tolerant Architecture for Component-based Service Robot Software Platforms
Hyejune Ahn¹, Byung Wook Choi¹, Sang Chul Ahn²
¹Seoul National University of Technology, KOREA, ²KIST, KOREA

11:45~12:00  TB2-6  Novel Robust Control Algorithm of DC Motors
Ba-Hai Nguyen, Hai-Bac Ngo, Jee-Hwan Ryu
Korea University of Technology and Education, KOREA

10:30~10:45  TB3-1  Laser based leg detection with experimental attributes for human robot interaction
Hoyeon Kim, Woojin Chung
Korea University, KOREA

10:45~11:00  TB3-2  A Wrist-type Heart Rate Monitor for the Elderly Care
Chankyu park¹, Jaehong kim¹, Ho-jin choi²
¹ETRI, KOREA, ²KAIST, KOREA

11:00~11:15  TB3-3  VOR Based Target Tracking System with an Accelerometer for Mobile Robots
Hyun Kyu Ouh¹, Wook Bahn¹, Jaehong Park¹, Wonsang Hwang¹, Hyun-il Kwon¹, Kwangsoo Kim², Dong-il "Dan" Cho¹
¹Seoul National University, KOREA, ²Hanbat National University, KOREA

11:15~11:30  TB3-4  Adaptive Weighting Probabilistic Model for Human Tracking with a Mobile Robot Using Laser Range Finder
Chen-Tun Chou, Chi-Pang Lam, Li-Chen Fu
National Taiwan University, TAIWAN

11:30~11:45  TB3-5  A Gender Classification Method using the External Features
Ho-Sub Yoon, Young-Woo Yoon, Jae-Yeon Lee
ETRI, KOREA
11:45~12:00 TB3-6 A Vibrotactile Maze Game with a Portable Haptic Mouse
Seong-Man Cho, Jae-Oh Kim, Mi-Jeong Park, Sang-Youn Kim
Korea University of Tech. & Edu., KOREA

12:00~12:15 TB3-7 Two-Wheel Mobile Platform with Active Assistant Wheels for Expressive Service Robot
Oh-Hun Kwon¹, Seong-Yong Koo², Nam-Su Yuk², Dong-Soo Kwon¹
¹KAIST, KOREA, ²Technology center Samsung Electronics Co.LTD, Korea

12:00~13:30 Lunch

13:30~13:40 Opening Ceremony

**Plenary Talk 1, Convention Hall, 4th floor of Kimdaejung Convention Center**

Chairs: Dongsoo Kwon, KAIST, Korea

13:40~14:30 Haptic Technology and Medical Robotics
Professor Hideo Fujimoto, Nagoya Institute of Technology, Japan

**Plenary Talk 2, Convention Hall, 4th floor of Kimdaejung Convention Center**

Chairs: Chang-Hwan Kim, KIST, Korea

14:30~15:20 Robust Vision Technique for Intelligent Robots
Professor In So Kwon, KAIST, Korea

15:20~15:40 Break Time

**[TC1] Wheelchairs and smart spaces, Room 201**

Chairs: Chung-Hsien Kuo, National Taiwan University of Science and Technology, Taiwan

15:40~15:55 TC1-1 The RFID-based Object Location and Live Camera Spotting
Han-Yen Yu, Jiann-Jone Chen
National Taiwan University of Science and Technology, TAIWAN

15:55~16:10 TC1-2 Robot Navigation using Image Sequences
Yu Fu, Tien-Ruey Hsiang, Sheng-Luen Chung
National Taiwan University, TAIWAN
16:10~16:25  **TC1-3**  Development of the Integrated Moving and Turning Mechanism for an Electric Wheelchair  
Wei-chen Lee, Jyun-An Yao, Yue-Ying Lyu  
*National Taiwan University of Science and Technology, TAIWAN*

16:25~16:40  **TC1-4**  Development of an Automatic Battery Exchange Station with Image Positioning  
Chi-Ying Lin, Sheng-Chang Liang  
*National Taiwan University of Science and Technology, TAIWAN*

16:40~16:55  **TC1-5**  Innovative Wheelchair Manipulation Interface with Collision Avoidance and Heart Beat Monitoring  
Chung-Hsien Kuo, Yi-Chang Chan, Kuo-Wei Chiou, Jia-Wun Siao  
*National Taiwan University of Science and Technology, TAIWAN*

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**[TC2] Open innovation technology for RT market, Room 202-204**

**Chairs:** Tamio Tanikawa, AIST, Japan

15:40~15:55  **TC2-1**  Smart Home for Security and Low Power Consumption Based on Ubiquitous Robotics  
Tamio Tanikawa¹, Kenichi Ohara², Hiroyuki Nakamoto³, Masato Iijima⁴, Noriaki Ando⁵, Takeshi Sakamoto⁶, Tetsuo Kotoku⁷, Kohtaro Ohba⁸, Tatsuo Arai²  
¹AIST, JAPAN, ²Osaka University, JAPAN, ³Systems Engineering Consultants (SEC) Co., Ltd, JAPAN, ⁴Misawa Homes Institute of Research and Development Co., LTD, JAPAN, ⁵Technologic Arts Incorporated, JAPAN

15:55~16:10  **TC2-2**  An Intelligent Ambience that can lead Robot's Actions -Development and Experimental Evaluation of a Device Developed for an Intelligent Ambience-  
Takeshi Sakaguchi¹, Shinichi Tsunoo², Eiji Kubo², Kazuhito Yokoi³, Kazuyoshi Wada²  
¹AIST, JAPAN, ²Tokyo Met. University, JAPAN

16:10~16:25  **TC2-3**  Smart RT Device with Easy Replaceability in Ubiquitous Robot Environment  
Kenichi Ohara, Shinji Yonesaka, Tomohito Takubo, Yasushi Mac, Tatsuo Arai  
*Osaka University, JAPAN*

16:25~16:40  **TC2-4**  Robot Total Management System for Robots in Daily Life Environments  
Bong Keun Kim¹, Hideyuki Tanaka¹, Yasushi Sumi¹, Hirohiko Onda¹, Tamio Tanikawa¹, Kohtaro Ohba¹, Tetsuo Tomizawa²  
¹AIST, JAPAN, ²University of Electro-Communications, JAPAN

16:40~16:55  **TC2-5**  Development and Control of Omni-directional Mobile System with Active Casters  
Jae Hoon Lee¹, Youhei Hukumoto¹, Shingo Okamoto¹, Bong Keun Kim², Tamio Tanikawa², Ohba Kohtaro²  
¹Ehime University, JAPAN, ²AIST, JAPAN
[TC3] Robot vision for ubiquitous robot services, Room 206-207

Chairs: Yasushi Mae, Osaka University, Japan

15:40~15:55 TC3-1 Layered Structure on Module-Based Robot Control System for Service Robots
Yasushi Mae, Hideyasu Takahashi, Jaeil Choi, Kenichi Ohara, Tomohito Takubo, Tatsuo Arai
Osaka University, JAPAN

15:55~16:10 TC3-2 Implementation and Evaluation of the Scale-Invariant Feature Transform on GPU
Jaeil Choi, Yasushi Mae, Kenichi Ohara, Tomohito Takubo, Tatsuo Arai
Osaka University, JAPAN

16:10~16:25 TC3-3 Object Pose Estimation by Multi-Surfaces SIFT Matching for Manipulation
Amr Almaddah, Yasushi Mae, Tatsuo Arai, Kenichi Ohara ,Tomohito Takubo
Osaka University, JAPAN

16:25~16:40 TC3-4 Action Indication System in Emergency using Audio and Visual Presentation
Kotaro Morikawa, Yasushi Mae, Kenichi Ohara, Tomohito Takubo, Tatsuo Arai
Osaka University, JAPAN

16:55~17:10 Break Time

[WP1] Work-in progress I, Room 201

Chairs: Chang-Hwan Kim, KIST, Korea
Woon Chul Ham, Chunbuk National University, Korea

17:10~17:13 WP1-1 Object Extraction using Blur Magnification and Analysis
Sungheum Kim, Kapje Sung, Inso Kweon
KAIST, KOREA

17:13~17:16 WP1-2 Converting Night-time Image to Day-time Image for Night Surveillance System
Si Jong Kim, Kwang Ho An, Yeon Geol Ryu, Myung Jin Chung
Korea Advanced Institute of Science and Technology, KOREA

17:16~17:19 WP1-3 Diff RGB: A Novel Constant Intensity Color Space
Sunglok Choi, Wonpil Yu
ETRI, KOREA

Soolwan Kim¹, Ju-Hong Park², Sung-Kee Park¹
¹Korea Institute of Science and Technology, KOREA, ²MtekVision Co, Ltd., KOREA
17:22~17:25 WP1-5 Approaching to Charging Station for Outdoor Mobile Robot using Visual Information
Ji Hoon Joung, M. S. Ryoo, Jaeyeong Lee, Wonpil Yu
Electronics and Telecommunications Research Institute, KOREA

17:25~17:28 WP1-6 Making Robots Take an Elevator: Detection and Recognition of Elevator Buttons
Youngwoo Yoon, Hosub Yoon, Jaeyeon Lee
ETRI, KOREA

17:28~17:31 WP1-7 3D Pose Estimation of Robot by Vanishing Points in Single Catadioptric Image
Hyun-Deok Kang¹, Jae-Hyuk Kwak², Heon-Young Lim², Su-Young Jeong², Yeon-Sik Kang², Cheol-Hyu Park¹, Chang-Hwan Kim²
¹DMI, KOREA, ²KIST, KOREA

17:31~17:34 WP1-8 Discriminative Common Vectors in DCT domain for Face Recognition
Ji Sung Kim, Kwang Ho An, Won Hwa Kim, Myung Jin Chung
Korea Advanced Institute of Science and Technology, KOREA

17:34~17:37 WP1-9 Precise Welding Line Detection for Automatic Robot Welding using a Single Camera with Two Vertical Structured Lights
Seung Hun Lee, Jae Byung Park, Woon Chul Ham
Chonbuk National University, KOREA

17:37~17:40 WP1-10 Dense Stereo Matching using Texture-less Region Extraction in the Urban Environment
Woo Hyun Kim, Jung Won Kang, Myung Jin Chung
Korea Advanced Institute of Science and Technology, KOREA

17:40~17:43 WP1-11 Real Time Posture Estimation of Human Hand Considering Class Error
Takanobu Tanimoto, Kiyoshi Hoshino
University of Tsukuba, JAPAN

17:43~17:46 WP1-12 Video Stabilization with Reinitialization on Sudden Scene Change
Sunglok Choi, Wonpil Yu
ETRI, KOREA

17:46~17:49 WP1-13 Design of Micro Force Sensor using Strain Gauges
Y. C. Kim¹, Y. S. Ihn¹, H. R. Choi¹, J. C. Koo¹, S. M. Lee²
¹Sungkyunkwan University, KOREA, ²Korea Institute of Industrial Technology, KOREA

17:49~17:52 WP1-14 Development of Active Skin Base on Dielectric Elastomer
Huu Lam Vuong Nguyen, Huu Chuc Nguyen, DukSang Kim, Kuang Chun An, Ja Choon Koo, Hyouk Ryeol Choi, Youngkwan Lee, Jae Do Nam
Sungkyunkwan University, KOREA
17:52~17:55 **WP1-15** In-Network Processing Based Lighting Control System using WSN
Muhammad Shoaib Khalid
*Hanyang University, KOREA*

17:55~17:58 **WP1-16** The Study of Train Tilting Control of Conventional Curve Line
Su Gil Lee
*Korea Railroad Research Institute, KOREA*

17:58~18:01 **WP1-17** A Study on Train Management System Running Test of Conventional Line
Su Gil Lee
*Korea Railroad Research Institute, KOREA*

18:01~18:04 **WP1-18** Head Pose Detecting System using Thermal Camera
Sewoong Jun, Bong-Seok Kim
*Korea Electronics Technology Institute, KOREA*

18:04~18:07 **WP1-19** An Infrared Laser Scanner for Mobile Robot Navigation using Multiple Step Phase Demodulation Method
Heesun Yoon, Hajun Song, Kyihwan Park
*GIST, KOREA*

18:07~18:10 **WP1-20** A New Obstacle Avoidance Method by Making a Decision of the Turning Point
Jinpyo Hong, Kyihwan Park
*GIST, KOREA*

18:10~18:13 **WP1-21** Measurement System Development for On-Line Test of Electric Vehicle
Youngjae Han, Sugil Lee, Jeongmin Cho, SeongHo Han
*Korea Railroad Research Institute*

18:13~18:16 **WP1-22** Collision Avoidance of a Mobile Robot Using Potential Field Algorithm
Yeong Geol Bae, Hyun Wook Kim, Sunsoo Choi, Sang Hoon Suh, Dae Young Byun, Seul Jung
*Chungnam National University, KOREA*

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**[WP2] Work-in progress II, Room 202-204**

**Chairs:** Nakju Lett Doh, Korea University, Korea
Wonpil Yu, ETRI, Korea

17:10~17:13 **WP2-1** Design of Single Positive-Rule and Dual Negative-Rule Fuzzy Controller for Robot Obstacle Avoidance
Jinwook Kim, Yoon-Gu Kim, Young-Duk Kim, Won-Seok Kang, Jinung An
*Daegu Gyeongbuk Institute of Science and Technology (DGIST), KOREA*

17:13~17:16 **WP2-2** Fast Obstacle Avoidance for Mobile Robots using Bearing-only Information
Hae Kwan Jeong, Soo Hyun Kim, Yoon Keun Kwak
*KAIST, KOREA*
17:16~17:19 **WP2-3** A Sampling Strategy for RBPF-SLAM in Non-Static Environments
Jung-Suk Lee, Wan Kyun Chung
*POSTECH, KOREA*

17:19~17:22 **WP2-4** Outdoor Localization System for Advertisement Robot
Christiand, Heesung Chae, Wonpil Yu
*ETRI, KOREA*

17:22~17:25 **WP2-5** Qualitative Mapping based on Local Triangulated Map
Minyong Choi, Wan Kyun Chung
*POSTECH, KOREA Electronics and Telecommunications Research Institute, KOREA*

17:25~17:28 **WP2-6** Jerk-Bounded Trajectory Generation Method Using Digital Convolution
Geon Lee¹, Youngjin Choi¹, Jinhoon Kim², Suk-Joong Kim³
¹*Hanyang University, KOREA,²Seoul National University of Technology, KOREA,³ED Co. KOREA*

17:28~17:31 **WP2-7** Plane Extraction from 3D point clouds of Indoor Environments
Changjoo Nam, Nakju Lett Doh
*Korea University, KOREA*

17:31~17:34 **WP2-8** Robust Data Estimation for Simultaneous Localization and Mapping: a hybrid approach of $H_{\infty}$ and Extended Kalman Filter
Seo-Hyun Jeon¹, Nakju Lett Doh²
¹*ETRI, KOREA,²Korea University, KOREA*

17:34~17:37 **WP2-9** Comparison between Two Motion Models in EKF Localization
Sunglok Choi, JaeYeong Lee, Christiand, Wonpil Yu
*ETRI, KOREA*

17:37~17:40 **WP2-10** Guided Path Planning for Proximity Location Sensors
Sunglok Choi, JaeYeong Lee, Yu-Cheol Lee, Seung-Hwan Park, Wonpil Yu
*ETRI, KOREA*

17:40~17:43 **WP2-11** Multi-level Deceleration Scheme for Accurate Goal Arrival
Sunglok Choi, JaeYeong Lee, Wonpil Yu
*ETRI, KOREA*

17:43~17:46 **WP2-12** Comparison between Position and Posture Recovery in Path Following
Sunglok Choi, JaeYeong Lee, Wonpil Yu
*ETRI, KOREA*

17:46~17:49 **WP2-13** Visual Path Following and Obstacle Avoidance Using Multiple Cameras for Outdoor Environments
Heon-Cheol Lee, Tae-Seok Lee, Seung-Hwan Lee, Gyu-Ho Eoh, Beom-Hee Lee
*Seoul National University, KOREA*
17:49~17:52 WP2-14 Study about a Path Planning of an Autonomous Mobile Robot along an Obstacle Pattern
Sung-Ha Kim, Sung-Min Ryu, Chi-Sung Park, Jung-Myung Lee
Pusan National University, KOREA

17:52~17:55 WP2-15 Experimental Construction and Comparison of a Motion Model of a Wheeled Mobile Robot
Yoonkyu Yoo, Woojin Chung
Korea University, KOREA

17:55~17:58 WP2-16 Motion Control and Obstacle Avoidance for Outdoor Patrol Robots
Chang-bae Moon, Woojin Chung
Korea University, KOREA

17:58~18:01 WP2-17 A Practical Approach of an Indoor Mobile Robot Local Navigation Using the 2.5D Elevation Map
Chang-bae Jung, Woojin Chung
Korea University, KOREA

18:01~18:04 WP2-18 A Lane Based Navigation of Outdoor Robot for IRONC 2009
Nak Yong Ko, Taegyun Kim
Chosun University, KOREA

18:04~18:07 WP2-19 Refinements of 3D Reconstruction using Laser Range Finder
Si Jong Kim, Kwang Ho An, Chang Hun Sung, Myung Jin Chung
Korea Advanced Institute of Science and Technology, KOREA

18:07~18:10 WP2-20 Vision-based Track Running Mobile Robot
Jungtae Kim, Daijin Kim
POSTECH, KOREA

18:10~18:13 WP2-21 A Simulation Tool for Outdoor Navigation of Mobile Robots
M. Yousaf Ali Khan, Eui-jung Jung, Byung-Ju Yi
Hanyang University, KOREA

Gon-Woo Kim, Yun-oh Choi
Wonkwang University, KOREA

18:16~18:19 WP2-23 Study on Sensor Fusion Outdoor Autonomous Driving Based on Lane Method using NRLAB-04 Robot
Seung-Min Park, Min-Woo Lee, Jung-Youn Lee, Min-Ho Song, Sang-Min Han, Kwee-Bo Sim
Chung-Ang University, KOREA
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<td>WP3-1</td>
<td>Speech Enhancement Using Geometric Source Separation in POMI Robot</td>
<td>Hye-Jin Kim, H. Leung, Ho-sub Yoon, J.-Y. Lee</td>
<td>ETRI, KOREA, Calgary University, CANADA</td>
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<td>17:13-17:16</td>
<td>WP3-2</td>
<td>Force Sensorless Control of Two Planar Robots</td>
<td>Jae Yeon Choi, Byung-Ju Yi</td>
<td>Hanyang University, KOREA</td>
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<td>17:16-17:19</td>
<td>WP3-3</td>
<td>A Robot Simulator ‘FRESi’ for Dynamic Facial Expression</td>
<td>Jeong Woo Park, Won Hwa Kim, Won Hyung Lee, Myung Jin Chung</td>
<td>KAIST, KOREA</td>
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<td>Motion Prediction of the Human Based on the Statistically Extracted Paths</td>
<td>Jungho Park, Jeong-Sik Choi, Jimin Kim, Beom-Hee Lee</td>
<td>Korea Military Academy, KOREA, Seoul National University, KOREA</td>
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<td>WP3-5</td>
<td>Grasping Algorithm for Varied Objects</td>
<td>Ho-Yul Lee, Byung-Ju Yi, Youngjin Choi</td>
<td>Hanyang University, KOREA</td>
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<td>Changhyun Cho</td>
<td>Chosun University, KOREA</td>
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<td>WP3-7</td>
<td>Optimal Position Control of a Surgical Illumination System</td>
<td>Eui-jung Jung, Byung-Ju Yi</td>
<td>Hanyang University, KOREA</td>
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<td>17:31-17:34</td>
<td>WP3-8</td>
<td>Stiffness modeling of a 3 DOF soft finger mechanism</td>
<td>Hyo Jung Cha, Byung-Ju Yi</td>
<td>Hanyang University, KOREA</td>
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<td>17:34-17:37</td>
<td>WP3-9</td>
<td>Nonlinear Optimal Control of a Two-Wheeled Inverted Pendulum Mobile Robot</td>
<td>Sangtae Kim, SangJoo Kwon</td>
<td>Korea Aerospace University, KOREA</td>
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<td>17:37-17:40</td>
<td>WP3-10</td>
<td>Introducing the Developing Platform OPRoS: The Open Software Platform for Robotics Services</td>
<td>Hong Seong Park, Soo Hee Han, Mi Sook Kim</td>
<td>Kangwon University, KOREA</td>
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17:40~17:43 WP3-11 New Robotic Foot Design with Toes and Heel Joints
Hyunsool Kim, Jinhee Park, SangJoo Kwon
Korea Aerospace University, KOREA

17:43~17:46 WP3-12 An Image-guided Robotic System for Cochlear Implant Surgery
Hoon Lim¹, Young-Soo Kim¹, Byung-Ju Yi¹, Jaesung Hong², Nozomu Matsumoto², Makoto Hashizume²
¹Hanyang University, KOREA, ²Kyushu University, JAPAN

17:46~17:49 WP3-13 A Registration Method between Robot and Image Coordinates Using Least Square Fitting
Hyun-Soo Yoon, Byung-Ju Yi
Hanyang University, KOREA

17:49~17:52 WP3-14 Backward-Motion Control of Multiple Passive Trailers Using a Car-Like Mobile Robot
Kwanghyun Yoo, Woojin Chung
Korea University, KOREA

17:52~17:55 WP3-15 Examination of the Backward Motion Control Performance of a Car with a Passive Trailer
Jae-il Roh, Woojin Chung
Korea University, KOREA

17:55~17:58 WP3-16 Walking Pattern Generation using Approximate Unstable Zero Cancelation and Its Compensation Method
Giho Jang, Youngjin Choi
Hanyang University, KOREA

17:58~18:01 WP3-17 A Biologically Inspired Image Sequence Stabilization System for Humanoid Eyes
Yeon Geol Ryu, Kwang Ho An, Si Jong Kim, Hyun Chul Roh, Myung Jin Chung
KAIST, KOREA

18:01~18:04 WP3-18 A Study of Rolling and Sliding Condition for Micromanipulation System
Y. S. Ihn¹, Y. C. Kim¹, H. R. Choi¹, J. C. Koo¹, S. M. Lee²
¹Sungkyunkwan University, KOREA, ²Korea Institute of Industrial Technology, KOREA

18:04~18:07 WP3-19 Deriving a Generalized Policy from Interactive Demonstrations
C. Y. Park, D. H. Kim, I. C. Kim
Kyonggi University, KOREA

18:07~18:10 WP3-20 Context based Programming-Learning of Robots
Andrey V. Gavrilov
Novosibirsk State Technical University, RUSSIA
18:10~18:13 WP3-21 Development of OPRoS Software Components
Eun-Cheol Shin, Soo-Kyung Son, Byung-Wook Choi, Byung-Hun Hwang, Dong-Hoon Lee
Korea Institute of Industrial Technology, KOREA

18:13~18:16 WP3-22 Research on Complex Equipment Fault Diagnosis based on Weighted Fuzzy Logic Petri Nets
Lixia Liu
Engineering College of Armed Police Force, CHINA

18:16~18:19 WP3-23 A new Direct Adaptive Fuzzy Control for a Class of Nonlinear Systems
Y. Alinejad-Beromi\textsuperscript{1}, Morteza Moradi\textsuperscript{2}, Ahmad Ahmadi\textsuperscript{1}
\textsuperscript{1}Semnan University, IRAN, \textsuperscript{2}Islamic Azad University, IRAN

18:20~19:10 Poster (1st floor of Kimdaejung Convention Center)

19:20~20:30 Welcome reception (Convention Hall, 4th floor of Kimdaejung Convention Center)
Friday, October 30

[FA1] Smart space technology and its application in Japan, Room 201

Chairs: Kenichi Ohara, Osaka University, Japan

09:00–09:15 FA1-1 iMec: Sensor Embedded Medicine Case for Dosing Monitoring
Takuo Suzuki, Yasushi Nakauchi
University of Tsukuba, JAPAN

09:15–09:30 FA1-2 Investigation of User RT-Service Generation System Design for Ubiquitous Space
Ken Ukai, Makoto Mizukawa, Yoshinobu Ando
Shibaura Institute of Technology, JAPAN

09:30–09:45 FA1-3 Object Manipulation Service applying Spatially Distributed Function Model
Takayoshi Hanji, Takuya Mizuno, Tadashi Hosoya, Ken Ukai, Makoto Mizukawa, Yoshinobu Ando
Shibaura Institute of Technology, JAPAN

09:45–10:00 FA1-4 A Representation of Object Information Based on Interactions between Humans and Objects in Intelligent Space
Mihoko Niitsuma1, Hideki Hashimoto2
1Chuo University, JAPAN, 2University of Tokyo, JAPAN

10:00–10:15 FA1-5 Position Estimation Method Using RSSI Measurement Sensors
Yuji Abe1, Kenichi Ohara1, Tomohito Takubo1, Yasushi Mae1, Tamio Tanikawa2, Tatsuo Arai1
1Osaka University, JAPAN, 2National Institute of Advanced Industrial Science and Technology, JAPAN

[FA2] Service robot, Room 202-204

Chairs: Jae-Bok Song, Korea University, Korea
Seul Jung, Chungnam National University, Korea

09:00–09:15 FA2-1 Endtip Design for Stable Jumping Motion in Various Ground Conditions
Ki-Seok Kim, Byeong-Sang Kim, Jae-Bok Song
Korea University, KOREA

09:15–09:30 FA2-2 Abnormal Sound Detection System using Sound Localization and Sound Classification
Dohyeong Hwang1, Byoung-Gi Lee1, Jongsuk Choi1, Mignon Park2
1KIST, KOREA, 2Yonsei University, KOREA

09:30–09:45 FA2-3 A Practical Grasp Quality Measure Based on Object Wrench Space Under Unit Normal Disturbances
Hyunhwan Jeong, Joono Cheong
Korea University, KOREA
09:45~10:00  FA2-4  Development of Robot Education Program of Creative Robot School for Children
Seul Jung, Jaekook Ahn, Seungjun Lee, Junhyung Park
Chungnam National University, KOREA

10:00~10:15  FA2-5  Real-time Motion Imitation Control of a Humanoid Robot with Non-real-time Motion Data
Sung-Kyun Kim, Syungkwan Ra, Doik Kim, Bum-Jae You, Sang-Rok Oh
KIST, KOREA

[FA3]  Robot vision I, Room 206-207

Chairs: Kang-Hyun Jo, University of Ulsan, Korea
Qian Chen, Wakayama University, Japan

09:00~09:15  FA3-1  Fast Face Detection and Tracking using Stereo-camera and Adaptive Color Model
Kazumasa Suzuki, Haiyuan Wu, Toshikazu Wada and Qian Chen
Wakayama University, JAPAN

09:15~09:30  FA3-2  Robust Lane Recognition Technique for Vision-Based Navigation with Multiple Detection Clues
SeungBeum Suh, Yeonsik Kang, Chiwon Roh, Sung-Chul Kang
KIST, KOREA

09:30~09:45  FA3-3  Camera Motion Estimation based on Edge Structure Analysis
Andrey Vavilin, Kang-Hyun Jo
University of Ulsan, KOREA

09:45~10:00  FA3-4  Outdoor Scene Objects Detection Using Context Information
My-Ha Le, Hoang-Hon Trinh, Kang-Hyun Jo
University of Ulsan, KOREA

[FA4]  Navigation/Localization I, Room 210

Chairs: Gun-Woong Bae, Han Dong University, Korea
Shun-Feng Su, National Taiwan University of Science and Technology, Taiwan

09:00~09:15  FA4-1  Vision-based Track Running Mobile Robot
Jungtae Kim, Dajjin Kim
POSTECH, KOREA

09:15~09:30  FA4-2  Development of Intelligent Hospital Service Robot with Neural Image Identification
Kuo-Ho Su1, Yih-Young Chen1, Shun-Feng Su2
1 Chinese Culture University, TAIWAN, 2 National Taiwan University of Science and Technology, TAIWAN
09:30~09:45 **FA4-3** A Visual Compass based on UKF SLAM
Je Seong Han¹, Sang Hoon Ji², Woo Hyun Ko², Sang Moo Lee², Kyung Tae Nam², Woong Hee Sho³
¹University of Science and Technology, KOREA, ²Korea Institute of Industrial Technology, KOREA

09:45~10:00 **FA4-4** Real Time Object Recognition Algorithm with Embedded Linux Using 2D Laser and Vision
Yu Min Jung, Gun Woong Bae
Han Dong University, KOREA

10:00~10:15 **FA4-5** A Mobile Robot Localization Method Using Monte Carlo Localization Approach
Nak Yong Ko, Tae Gyun Kim
Chosun University, KOREA

10:15~10:30 **Break Time**

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**[FB1] Cutting Edge of the Japanese RT, Room 201**

**Chairs:** Tatsuo Arai, Osaka University, Japan

10:30~10:45 **FB1-1** Maintenance Planning for Individual Houses Based on Cause-and-effect Relationship
Eiji Arai, Hidefumi Wakamatsu, Eiji Morinaga
Osaka University, JAPAN

10:45~11:00 **FB1-2** Robot Town Project: Robotized Structurization of Daily Human Life Environment
Tsutomu Hasegawa
Kyushu University, JAPAN

11:00~11:15 **FB1-3** 3D Dynamic Active Sensing of Human Eye
Kenji Yamada¹, Takumi Gosho¹, Mituru Higashimori¹, Makoto Kaneko¹, Yoshiaki Kiuchi²
¹Osaka University, JAPAN, ²Hiroshima University, JAPAN

11:15~11:30 **FB1-4** A Telesurgery Experiment between Japan and Thailand
Mamoru Mitsuishi¹, Makoto Hashizume³, Patpong Navicharem², Yuichi Fujino⁴, Kazushi Onda¹, Shigen Yasunaka¹, Naohiko Sugita¹, Jumpei Arata¹, Hideo Fujimoto¹, Keiji Tanimoto¹, Kazuo Tanoue², Satoshi Ieiri², Kozo Konishi², Yoshihiro Ueda⁷
¹University of Tokyo, JAPAN, ²Kyushu University, JAPAN, ³Chulalongkorn University, THAILAND, ⁴NTT Corporation, JAPAN, ⁵Nagoya Institute of Technology, JAPAN, ²CORETEC INC., JAPAN, ⁷NTT Communications Co., JAPAN

11:30~11:45 **FB1-5** Identification of Types of Obstacles and Obstacle Map Building for Mobile Robots
Yusuke Tamura, Yu Murai, Hiroki Murakami, Hajime Asama
University of Tokyo, JAPAN
11:45~12:00  FB1-6  Automated Cloning System Using Micro Robotics
Tatsuo Arai¹, Tamio Tanikawa², Fumihito Arai³, Osamu Sato⁴, Hiroshi Aso⁵, Satoshi Akagi⁶
¹Osaka University, JAPAN, ²AIST, JAPAN, ³Tohoku University, JAPAN, ⁴KHI, JAPAN, ⁵FHK, JAPAN, ⁶NILGS, JAPAN

[FB2]  USN technology, Room 202-204

Chairs: Chankil Lee, Hanyang University, Korea
Youngchul Bae, Chonnam National University, Korea

10:30~10:45  FB2-1  Scheduling of RAPIEnet Switch using Edge-Coloring of Conflict-Multigraph
Syed Hayder Abbas, Seung Ho Hong
Hanyang University, KOREA

10:45~11:00  FB2-2  Optimized Mobile Sink Trajectory for Efficient Energy Consumption in WSNs
Farrukh Salim, Jong Kyu Lee
Hanyang University, KOREA

11:00~11:15  FB2-3  Design of Low Cost 2-D Scanning Sensor Modules
Jong Tae Seo, Byung Ju Yi
Hanyang University, KOREA

11:15~11:30  FB2-4  Development of Embedded Software for Wireless Networked Lighting Control System using UML
Seung Mo Jung, Ju Hyung Yoo, Joung Han Lee, Dong Jin Lim
Hanyang University, KOREA

11:30~11:45  FB2-5  RtEML: Real-time EtherCAT Master Library
Yongseon Moon¹, Tuan Anh Vo Trong¹, Nak Yong Ko², Kwangjin Kim², Youngchul Bae³
¹Sunchon National University, KOREA, ²Chosun University, KOREA, ³Chonnam National University, KOREA

11:45~12:00  FB2-6  An Ambient Air Quality Monitoring System Based on ZigBee Network
Sang Eon Bac, Chankil Lee
Hanyang University, KOREA

[FB3]  Robotic mechanisms and design I, Room 206-207

Chairs: Whee Kuk Kim, Korea University, Korea
Takeshi Morishita, Toin University of Yokohama, Japan

10:30~10:45  FB3-1  Synthesis of Foldable Spatial 3-DOF Parallel Mechanisms
Jaehoon Chung¹, Byung Ju Yi¹, Whee Kuk Kim²
¹Hanyang University, KOREA, ²Korea University, KOREA
<table>
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<th>Time</th>
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<tr>
<td>10:45~11:00</td>
<td>FB3-2</td>
<td>A New 3T+2G Parallel Module</td>
<td>Hyun-koo Kwak(^1), Wheeuk Kim(^1), Jaheon Chung(^2), Byung-Ju Yi(^1)</td>
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<td>(^1)Korea University, KOREA, (^2)Hanyang University, KOREA</td>
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<td>11:00~11:15</td>
<td>FB3-3</td>
<td>Design of a New 3T1R Type 4-DOF Mechanism</td>
<td>Hyun-koo Kwak(^1), Wheeuk Kim(^1), Jaheon Chung(^2), Byung-Ju Yi(^1)</td>
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<td>11:15~11:30</td>
<td>FB3-4</td>
<td>Real-Time Variable Stiffness Joint for Robotic Applications</td>
<td>Saul Opie, Woosoon Yim</td>
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<td>University of Nevada, U.S.A.</td>
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<td>11:30~11:45</td>
<td>FB3-5</td>
<td>Compact Autonomous Robot with Inverse Kinematics Algorithm</td>
<td>Osamu Tojo, Takeshi Morishita</td>
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<td>Toin University of Yokohama, JAPAN</td>
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<td>11:45~12:00</td>
<td>FB3-6</td>
<td>Development of an Active Walker with Easy Maneuverability</td>
<td>Takanori Ohnuma, Geunho Lee, Nak Young Chong</td>
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**[VD1] Video session, Room 210**

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<tr>
<td>10:30~10:35</td>
<td>VD1-1</td>
<td>Design of a Multi-wheeled Pipeline Inspection Robot</td>
<td>Young-sik Kwon, Byung-Ju Yi</td>
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<td>Hanyang university, KOREA</td>
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<td>10:35~10:40</td>
<td>VD1-2</td>
<td>Robot Control with Infrared Based Gesture Recognition System</td>
<td>Daeha Lee, Jaehong Kim, Jaeyeon Lee</td>
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<td>10:40~10:45</td>
<td>VD1-3</td>
<td>OPROS Component Development Environment</td>
<td>Byoungyoul Song, Seungwoog Jung, Choulsoo Jang, Sunghoon Kim</td>
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<td>10:45~10:50</td>
<td>VD1-4</td>
<td>A Dynamic, Modularized Plugin Programming for Robots</td>
<td>Seung-Ik Lee, Rockwon Kim, JunYung Sung, SungHoon Kim</td>
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10:55~11:00 **VD1-6** Intelligent Control of CNU GYROBO  
Seul Jung, Pil Kyo Kim  
*Chungnam National University, KOREA*

11:00~11:05 **VD1-7** Locomotion of Microrobot using Stationary Two-Pair EMA Coil System  
Jongho Choi, Hyunchul Choi, Kyoungrae Cha, Jongoh Park, Sukho Park  
*Chonnam National University, KOREA*

11:05~11:10 **VD1-8** Target Classification System using 24GHz Microwave Radar  
Seongkeun Park, Euntai Kim  
*Yonsei University, KOREA*

11:10~11:15 **VD1-9** Design of a Robotic Air-Powered Hand with Elastic Ligaments  
Dennis W. Hong, Colin Smith, Alex McCraw, Carlos Guevara, Kyle Cothern  
*Virginia Tech. University, U.S.A.*

11:15~11:20 **VD1-10** Motivation-based Action Selection Mechanism using Quadruped Robot  
Sang Hyoun Lee, Il Hong Suh  
*Hanyang University, KOREA*

12:00~13:30 **Lunch**

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**Plenary Talk 3, Convention Hall, 4th floor of Kimdaejung Convention Center**

Chairs: **Sungchul Kang**, KIST, Korea

13:30~14:20 **Autonomous Navigation of a Mobile Robot Integration of Sensing, Planning and Control**  
Professor Shin’ichi Yuta, University of Tsukuba, Japan

14:20~14:30 **Break Time**

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**Plenary Talk 4, Convention Hall, 4th floor of Kimdaejung Convention Center**

Chairs: **Kyu-Jin Cho**, Seoul National University, Korea

14:30~15:20 **Robotic Exoskeletons for Gait Assistance and Training of the Motor Impaired**  
Professor Sunil K. Agrawal, University of Delaware, U.S.A.

15:20~15:40 **Break Time**
[FC1]  Artificial evolution of robots in software and hardware, Room 201

Chairs: Hyungpil Moon, Sungkyunkwan University, Korea
       Jin-Woo Jung, Dongguk University, Korea

15:40~15:55  FC1-1  A Robot Clustering Scheme with Fault Tolerance
    Young-Sik Hong, Jun-Ho Jeong, Hyun-Woo Koo, Jin-Woo Jung
    Dongguk University, KOREA

15:55~16:10  FC1-2  R-Object Model Simulator for Evolutionary Robots
    Yun-Sik Son, Ji-Woo Park, Jin-Woo Jung, Se-Man Oh
    Dongguk University, KOREA

16:10~16:25  FC1-3  Iterative Fuzzy Clustering from Data with Missing Features
    Kwang-Hyun Park¹, Hyong-Euk Lee², Sang Wan Lee³
    ¹Kwangwoon University, KOREA, ²SAIT, KOREA, ³KAIST, KOREA

16:25~16:40  FC1-4  A Design of Cooperative Robots Using Spatial Mechanisms
    Dongmin Choi¹, Jae Hoon Park¹, DooYoung Na², Yong-Tae Kim², Jin-Woo Jung³, Hyouk Ryeol Choi¹, Hyungpil Moon¹
    ¹Sungkyunkwan University, KOREA, ²Hankyong National University, KOREA, ³Dongguk University, KOREA

16:40~16:55  FC1-5  Peer-to-Peer Interaction among Intelligent Robots
    Mee Hwa Park, Jin Hyun Park, Yong Kyu Lee
    Dongguk University, KOREA

16:55~17:10  FC1-6  Localization for Mobile Robot Using Sensor Fusion and Landmark
    Yong Min Tai, Ji Sung Kim, Yeon Geol Ryu, Si Jong Kim, Myung Jin Chung
    KAIST, KOREA

[FC2]  Design and control of quadruped walking robot, Room 202-204

Chairs: Sangdoek Park, Korea Institute of Industrial Technology, Korea
        Hyouk Ryeol Choi, Sungkyunkwan University, Korea

15:40~15:55  FC2-1  Dynamic Stability of Quadruped Walking Robot
    Duc Trong Tran, Ig Moo Koo, Gia Loc Vo, Ho Moon Kim, Se-gon Roh, Hyungpil Moon, Hyouk Ryeol Choi
    Sungkyunkwan University, KOREA

15:55~16:10  FC2-2  Body Movement and Ability of Quadruped Robot in 3D Rough Environment
    Vo Gia Loc¹, Ig Mo Koo¹, Tran Duc Trong², Ho Moon Kim³, Se-gon Roh¹, Hyungpil Moon¹, Hyouk Ryeol Choi¹, Sangdoek Park²
    ¹Sungkyunkwan University, KOREA, ²Korea Institute of Industrial Technology, KOREA
16:10~16:25 **FC2-3** Development of Biomimetic Quadruped Walking Robot: AiDIN-II
Ig Mo Koo¹, Tran Duc Trong¹, Vo Gia Loc¹, Ho Moon Kim¹, Se-gon Roh¹, Hyungpil Moon¹, Hyouk Ryeol Choi¹, Sangdoek Park²
¹Sungkyunkwan University, KOREA, ²Korea Institute of Industrial Technology, KOREA

16:25~16:40 **FC2-4** Virtual Sensor Feasibility Verification using the 1-Leg Robot
Kwang Jin Ko, Wan Soo Kim, Chang Soo Han
*Hanyang University, KOREA.*

16:40~16:55 **FC2-5** A Comparative Study on the Position Control of Electro-Hydraulic Actuator
Wonhee Kim¹, Donghoon Shin¹, Dong Gyu Gang¹, Dahee Won², Chung Choo Chung¹
¹Hanyang University, KOREA, ²Korea Institute of Industrial Technology, KOREA

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**[FC3] Robotic mechanisms and design II, Room 206-207**

Chairs: Dennis Hong, Virginia Tech, U.S.A.
       Kyu-Jin Cho, Seoul National University, Korea

15:40~15:55 **FC3-1** Residual Vibration Reduction of an Industrial Robot under Linux/RTAI Environment
Chul-Goo Kang, Kyo-Sik Woo, Jin-Woo Kim
*Konkuk University, KOREA*

15:55~16:10 **FC3-2** Development of Anthropomorphic Robot Hand: SKKU HAND III
Jooyoung Chun, Hansang Chae, Byungjune Choi, Segon Roh, Hyungpil Moon, Hyouk Ryeol Choi
*Sungkyunkwan University, KOREA*

16:10~16:25 **FC3-3** Design and Fabrication of Inchworm Robot Using Smart Composite Microstructures (SCM)
Je Sung Koh, Kyu Jin Cho
*Seoul National University, KOREA*

16:25~16:40 **FC3-4** Motion Characteristics for the Kinematic Topologies of the IMPASS Robot
Ya Wang, Dennis Hong
*Virginia Tech. University, U.S.A.*

16:40~16:55 **FC3-5** A Study on The Drilling Characteristics of Micro-Machine with Precessional Motion
Juhyun Kim, Hyunchul Choi, Kyoungrae Cha, Jongoh Park, Sukho Park
*Chonnam National University, KOREA*
16:55~17:10  **FC3-6**  Distantly Controlled Robot for Radiation-free Operation of the CT-guided Biopsy  
Soo-Hyun Kim¹, Kwang-Gi Kim¹, Chang Min Park²  
¹National Cancer Center, KOREA, ²Seoul National University Hospital, KOREA

[**FC4**]  Navigation/Localization II, Room 210

**Chairs:** Sooyong Lee, Hongik University, Korea  
Haruhiko Niwa, Waseda University, Japan

15:40~15:55  **FC4-1**  Position Estimation of GPS based on Spherical Geometry  
Heesung Chae, Jaeyeong Lee, Wonpil Yu  
ETRI, KOREA

15:55~16:10  **FC4-2**  Indoor Pedestrian Localization System for Location based Service  
Huisung Kim, Minyoung Lee, Sooyong Lee  
Hongik University, KOREA

16:10~16:25  **FC4-3**  Cycle-slip Reduction Method with Multiple Receivers  
- A Practical Application of Indoor GPS-  
¹Haruhiko Niwa, ¹Kenri Kodaka, ²Takuji Ebinuma, ³Yoshihiro Sakamoto, ¹Shigeki Sugano  
¹Waseda University, JAPAN, ²Tokyo University of Marine and Science Technology, JAPAN, ¹Knowledge Services Co., JAPAN

16:25~16:40  **FC4-4**  Localization using a Chirp Spread Signal and Symmetric Double Sided-Two Way Ranging  
Seok Yeon Kim, Chankil Lee  
Hanyang University, KOREA

16:40~16:55  **FC4-5**  Gait Estimation based Pedestrian Localization  
Huisung Kim, Minyoung Lee, Sooyong Lee  
Hongik University, KOREA

17:10~17:25  Break Time

[**FD1**]  Ambient intelligence, Room 201

**Chairs:** Gaetano Ciaravella, SSSA, Italy  
Dietmar Bruckner, Vienna University of Technology, AUSTRIA

17:25~17:40  **FD1-1**  Ubiquitous Robotics Application for Improving Quality of Life  
Gaetano Ciaravella¹, Sungon Lee², Sang Rok Oh², Bum Jae You², Paolo Dario¹  
¹SSSA, ITALY, ²KIST, KOREA
17:40~17:55  **FD1-2**  Rule-based Approach for Automatic Service Composition in Ubiquitous Environment
K. Tari¹, Y. Amirat¹, A. Chibani¹, A. Yachir¹, ²
¹University of Paris Est-Paris 12 Val de Marne, FRANCE, ²Military Polytechnic School, ALGERIA

17:55~18:10  **FD1-3**  Network Configuration in Artificial Pheromone System by Considering Exploration and Exploitation
Herianto, Daisuke Kurabayashi
Tokyo Institute of Technology, JAPAN

18:10~18:25  **FD1-4**  Perception and Modeling of Scenarios in Ambient Automation Networks with Hidden Markov Models
Dietmar Bruckner¹, Josef Mitterbauer¹, Rosemarie Velik²
¹Vienna University of Technology, AUSTRIA, ²Tecnalia – Fatronik, SPAIN

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### [FD2]  Robot vision II, Room 202-204

**Chairs:** Liang-Chia Chen, National Taipei University of Technology, Taiwan
Moon-Hong Baek, KITECH, Korea

17:25~17:40  **FD2-1**  Improvement of Object Recognition for Grasping Task using SURF and Background Subtraction
La Tuan Anh, Jae-Bok Song
Korea University, KOREA

17:40~17:55  **FD2-2**  Real-time Fourier Transform Profilometry with Reference Reconstruction for 3-D Robot Vision
Liang-Chia Chen, Xuan Loc Nguyen, Wei-Shung Dai
National Taipei University of Technology, TAIWAN

17:55~18:10  **FD2-3**  Genetic Particle Filter (GPF) for Online Non-Linear / Non-Gaussian Bayesian Tracking
Md. Zahidul Islam, Chi-Min Oh, Chil-Woo Lee
Chonnam National University, KOREA

18:10~18:25  **FD2-4**  Extraction the 3D Spatial Features from 3D Range Data using the 2D Image Local Descriptors
Kyung-Wook Park, Jae-Han Park, Yong-Duck Shin, Seung-Ho Baeg, Moon-Hong Baeg
Korea Institute of Industrial Technology (KITECH), KOREA
[FD3] Intelligent space/environment technologies, Room 206-207

Chairs: Yong-Moo Kwon, KIST, Korea

17:25~17:40  FD3-1  u-Metaverse: Extension of Virtual URS (Ubiquitous Robotic Space)  
Muhammad Rusdi Syamsuddin, Yong-Moo Kwon  
KIST, KOREA

17:40~17:55  FD3-2  Shape Based Position Measurement Method Using Laser Range Finders  
Hajime Tamura¹, Takeshi Sasaki¹, Hideki Hashimoto¹, Fumihiro Inoue²  
¹University of Tokyo, JAPAN, ²Obayashi Corp, JAPAN

17:55~18:10  FD3-3  Exploration of Floor Surface for the Blind  
Huisung Kim, Minyoung Lee, Sangcheol Park, Sooyong Lee  
Hongik University, KOREA

18:10~18:25  FD3-4  Multi-Object Tracking Using Ultrasonic Sensors  
Dong-Jin Moon, Zhong-Soo Lim, Sung-Mo Kang, Hwang-Ryol Ryu  
RIST (Research Institute of Industrial Science & Technology), KOREA


Chairs: JangMyung Lee, Pusan National University, Korea  
Woojin Chung, Korea University, Korea

17:25~17:40  FD4-1  Path Planning Using Modified Gradient Method for Small-Sized Robots  
Seo-Yeon Hwang, Jae-Bok Song  
Korea University, KOREA

17:40~17:55  FD4-2  Localization Algorithm of Multiple Robots  
TaeKyung Yang, WonSeok Jang, WonYeon Choi, JangMyung Lee  
Pusan National University, KOREA

17:55~18:10  FD4-3  Development of Mobile Robot Based on Differential Drive Integrated with Accelerometer  
Surachai Panich, B. Bhawinee, Thanapol Asvalapsil, Puttiporn Paksupho  
Srinakharinwirot University, THAILAND

18:10~18:25  FD4-4  Experimental Evaluation of the Performance of Mobile Robot Navigation Using Different Localization Sensors  
Jaewan Ahn, Woojin Chung  
Korea University, KOREA

19:00~21:00  Banquet (Convention Hall, 4th floor of Kimdaejung Convention Center)
Thursday, October 29

**Autonomous Vehicles (TA1, Oct. 29, 09:00~10:15, Room 201)**

**TA1-1 (09:00~09:15)**

*Road Detection and Obstacle Avoidance using a Single Laser Range Finder for Outdoor Navigation*

Youjin Shin, Woojin Chung

*Korea University, KOREA*

In the case of outdoor mobile robots, there are a lot of difficulties in the navigation of outdoor environments. This research presents a method for detecting road surfaces and finding the drivable region through a single laser sensor. For the motion-control component, we basically used the Vector Field Histogram (VHF) algorithm. Finally, through an actual outdoor experiment, we upheld the efficacy of our outdoor navigational system.

**TA1-2 (09:15~09:30)**

*Fuzzy Inference System for Autonomous Navigation on Forklift AGV*

Jungje Park, Taeryong Jeon, Jungmin Kim, Sungshin Kim

*Pusan National University, KOREA*

This paper is represented to research of driving control for the forklift AGV (autonomous ground vehicle). The related works that were studied about AGV as transportation vehicle used two methods which are magnet-gyro and wire guidance. But they have weaknesses that are cost, maintenance and reconstruct according to change of working environment. Therefore, in this paper, we develop localization system through sensor fusion with laser navigation system and encoder, gyro sensors for robustness. Also we design driving controller using fuzzy control and proportional control. It considers distance and angle of difference between position of forklift AGV and pallet for engaging work. To analyze performance of the proposed control system, we experiment same work over 10 times. In the results, the average error was presented with 54.16mm between simulation of control navigation and real control navigation. Consequently, experimental result shows that the performance of proposed control system is effective.

**TA1-3 (09:30~09:45)**

*Performance Index for Effective Multi-Legged Robotic Walking*

Byoung-Ho Kim

*Kyungsung University, KOREA*

One of fundamentals for multi-legged robots is to make a stable and balanced walking. For a multi-legged robot to walk stably, each footstep of the robot is to be determined carefully. A performance index is proposed for this purpose. To deal with effective multi-legged robotic walking, we consider a quadruped robotic walking model and try to estimate the trend of the proposed performance index in a quadrupedal walking. Simulation studies show that effective foot configuration in a quadrupedal walking can be planned by adopting the proposed performance index. Finally, we discuss on optimal motion planning for legged mobile manipulations.

**TA1-4 (09:45~10:00)**

*Surveillance Robot with Emailing and Telephoning Functions*

Aneesh N. Chand, Shin’ichi Yuta

*University of Tsukuba, JAPAN*
In this work, we have designed an email controlled personal surveillance robot for patrolling in domestic environments with a focus on active intruder reporting capabilities with autonomous telephone calling and emailing. First, we command a mobile robot to patrol a surveillance area by sending it an email. The robot captures images of the surveillance area during patrolling and applies the Viola-Jones algorithm of face detection for intruder detection. Moreover, in the event an intruder is detected, the robot uses autonomous emailing and telephoning functions to alert the house owner. These functions are achieved by using Internet-based applications that makes such a robot suitable for deployment in domestic environments.

TA1-5 (10:00~10:15)

**Time-Optimal Straight-Line Trajectory of Three-Wheeled Omni-Directional Mobile Robots with Multi-Objective**  
Ki Bum Kim, Byung Kook Kim  
*KAIST, KOREA*

We focus on the time-optimal straight-line trajectory generation of three-wheeled omni-directional mobile robots. Our studies are based on the dynamics of mobile robot actuated with battery, which has a finite voltage. We formulate a multi-objective problem which has both translational and rotational cost for time-optimality. To analyze our problem, we use the concept of the switching functions derived by maximum principle for each battery input component. Through the introduction of Level K and its trajectory in heading domain, we propose three combinations of optimal candidates as the time-optimal solution.

**Sensors and actuators (TA2, Oct. 29, 09:00~10:00, Room 202–204)**

TA2-1 (09:00~09:15)

**Analytic Sound Source Localization with Triangular Microphone Array**  
Byoung-gi Lee, Jongseuk Choi  
*KIST, KOREA*

Sound source localization is one of important parts of acoustic signal process. Especially, it is essential for intelligent robot audition system. Many of sound source localizer make use of the relation of TDOA (time delay of arrival) among microphones with the source position to estimate the direction of sound source. We have developed a sound source localizer with a triangular microphone-array in a free field. However, we have focused on only source’s azimuth estimation and the elevation estimation has been out of our interest so far. In this paper, we will analyze the TDOA of the triangular microphone-array, derive explicit equations for the source direction, not only the azimuth but also the elevation, and verify it effective through simulations and experiments.

TA2-2 (09:15~09:30)

**Splitting Overlapped Reflected Laser Waveforms for Hokuyo Laser Range Finder (SOKUIKI Sensor) - Architecture and Implementation -**  
Suparek Premvuti, Hirohiko Kawata, Toshihiro Kamitani, Toshihiro Mori  
*Hokuyo Automatic Co., JAPAN*

The Hokuyo’s UTM-30LX (Top-URG) ASIC architecture has been modified to accommodate ability to detect multiple or overlapped reflected laser waveforms. The width and peak of detected waveforms are also measured. The added information is used to detect objects under outdoor environment with precipitation, e.g. rain, fog or snow.

TA2-3 (09:30~09:45)

**3D SOKUIKI Sensor Module by Roundly Swinging Mechanism and SCIP-3D Interface**  
Mitsuhiro Matsumoto, Shin’ichi Yuta  
*University of Tsukuba, JAPAN*

We designed and implemented a modularized three dimensional scanning laser range sensor (3D SOKUIKI sensor) using the roundly swinging mechanism. The sensor module is aimed to use for the mobile robot in the real environment and on the irregular ground. It can measure the wide view angle in zonal area around the sensor module. For the easy use of this sensor module, we defined and implemented the SCIP-3D mini command system as the user interface protocol of this
sensor which is a minimal set of the SCIP-3D interface specification, so that the user program can get the X-Y-Z coordinate of the laser reflecting points easily.

TA2–4 (09:45~10:00)

**A Torque Controller Design of Flexible Joint Robot Arm Using Disturbance Observer**

Hosun Lee¹, Yonghwan Oh², Jae-Bok Song³

¹Korea University, KOREA, ²KIST, KOREA

In this paper, we propose a robust torque controller method for a flexible joint robot arm. Considered flexible joint robot arm can measure the joint torque by the torque sensor. In this robot arm system, there are undesirable effects e.g., parameter variation, errors in parameter identification and external disturbances as well as disturbance. To reduce the disturbance effects on the system performance, the disturbance observer scheme is used, and the system dynamics is reformulated to apply the disturbance observer. Using simulations of one degree of freedom flexible joint robot arm, we have demonstrated the performance of the proposed controller.

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**★ Intelligence and learning 〈TA3, Oct. 29, 09:00~10:00, Room 206~207〉**

TA3–1 (09:00~09:15)

**Extending a self-learning landmark navigation system for behavior based mobile robots**

Lee Sandberg

University of Skövde, SWEDEN

Navigation by piloting is when we navigate with respect to external landmarks. The course to a location is determined by identifying landmarks or a sequence of landmarks and follows the landmarks in a specific order with respect to the world, rather than to an internal frame of reference. This paper suggests an extension to such a landmark based navigation system originally develop by Ulrich Nehmzow and Tim Smithers [1]. Nehmzow system is capable of navigating rooms using a right-hand side wall following behavior. Nehmzow’s system couldn't reuse what it had learn from the right-hand side wall following and apply it to left-hand side wall following. We propose adding a parallel system by introducing a virtual robot that believes its moving in the opposite direction and use them both at all times regardless of direction, making it possible for both systems to learn and recognize landmarks together and thereby solving the problem of matching the systems recognized landmarks.

TA3–2 (09:15~09:30)

**Segmentation of Continuous Human Gestures for Imitative Learning**

Hyoungnyoun Kim, Kyungwha Park, Kyungkoo Kim, Ji-Hyung Park

KIST, KOREA

Imitative learning, which teaches human gestures to robots by demonstration, is an active field of research in humanoid robotics. In this paper, in order to allow robots to learn complex/continuous gestures, we propose a method for segmenting and recognizing such gestures based on predefined basic motions. Since each elemental gesture has ambiguous data ranges in a sequential gesture, we combined both Dynamic Time Warping and Kullback-Leibler divergence to increase the accuracy of gesture segmentation. We have achieved about 80 percent accuracy in segmenting continuous gestures, and applied our approach to a small humanoid robot to demonstrate that imitative learning is possible.

TA3–3 (09:30~09:45)

**Development of a Remote-Controlled Mobile Robot for Foreign Language Education**

¹Sungon Lee, ¹Doik Kim, ¹Youngsu Cha, ¹Bum-jae You, ²Heungjae Cho

¹KIST, KOREA, ²SAMIL CTS Co., KOREA

We have developed a mobile robot for a foreign language education. This robot, VANI is remotely controlled through the internet. A teacher in the remote site can talk with a student in front of the robot, simultaneously moving the robot. Compared with typical study through a phone, this improved presence turned out to increase students’interests, expecting better educational performance. Another point we tried to get in the development is to make the robot with minimum cost for early commercialization. In order to do so, we drastically removed the unnecessary parts and used the cheapest
components in building the robot. As a result, this robot has been successfully commercialized and some are now being used in private institutes for foreign language study. This paper will explain the hardware and software system of the developed robot.

**TA3-4 (09:45~10:00)**

**Solving Geometrical Uncertainty of Mobile Manipulation by Natural Actor-Critic**

Byungchan Kim\(^1\), Changmook Chun\(^1\), Sungchul Kang\(^1\), Dongseok Ryu\(^2\)
\(^1\)KIST, KOREA, \(^2\)Texas A&M University-Corpus Christi, U.S.A.

This paper is a study on an adaptive method for opening a door using a mobile manipulator. Opening a door has been regarded as a geometry-oriented problem. This work treats the door opening as a force-oriented problem. Not assuming a door’s exact trajectory, only compliance control is executed with a simple command which directs a pulling direction. Then, the mobile manipulator adapts itself to the door trajectory, with bounded force condition. The main challenge of this research is to find an optimum compliance gain at each configuration of the manipulator with position error of the mobile base. To resolve this problem, we employed an adaptive method based on modern reinforcement learning. We simulated the learning process for a door opening task, then adopted the learned compliance gain policy to the opening a door execution using real mobile manipulator. The experimental results prove that the proposed adaptive strategy was successful.

**Medical robot (TB1, Oct. 29, 10:30~12:00, Room 201)**

**TB1-1 (10:30~10:45)**

**Open MRI Guided Surgical Navigation for Liver Tumor Ablation Therapy**

Jaesung Hong, Morimasa Tomikawa, Kozo Konish, Makoto Hashizume
Kyushu University, JAPAN

An open MRI guided surgical navigation system designed for percutaneous abdominal therapies was proposed. MRI-based 3-D display of the needle and tumour can help physicians intuitively understand the positional relationship between the needle and tumour. Using a reference marker to track the patient movement, Motion compensation and 3-D real-time update was accomplished. Open MRI assisted in immediate confirmation of cured area and complications after intervention. 42 clinical applications indicated that the proposed method can combine the advantages of both MRI and ultrasound.

**TB1-2 (10:45~11:00)**

**Haptic Modeling of a Suction Process for a Surgery Training System**

Hyung Wook Kim, Jumpei Arata, Hideo Fujimoto
Nagoya Institute of Technology, JAPAN

This paper presents a haptic modeling method of a suction process for a brain surgery simulation. When a suction tool touches and moves the surface of a virtual model, the reaction force is calculated and displayed to an operator using a haptic device, while the surface of the model is being deformed. At the same time, mesh structure around the removed tissue of the model are rearranged and updated for realistic visualization.

**TB1-3 (11:00~11:15)**

**Robot Console System for Neuroendoscopic Surgery**

Kento Nishibori\(^1\), Atsushi Yamada\(^1\), Yuichiro Hayashi\(^2\), Junichi Tokuda\(^3\), Nobuhiko Hata\(^3\), Kiyoyuki Chinzei\(^4\), Hideo Fujimoto\(^1\)
\(^1\)Nagoya Institute of Technology, JAPAN, \(^2\)Nagoya University, JAPAN, \(^3\)Harvard Medical School, U.S.A., \(^4\)AIST, JAPAN

We developed a robot console program that featured two-windows version of image workstation program "3D Slicer". The robot system is for image/sensor integrated neuroendoscopic surgery. The design challenges were 1) balancing the amount of information provided to the surgeon to keep him/her concentrating on the robotic surgery, while maintaining the demand of rich and complicated functions of intra-operative image processing, 2) binding the sensor signal and its spatial information so that the sensor signal and information of surgical instruments are integrated to image data. We added a
subwindow(s) to the image workstation program “3D Slicer”. The sub-window is for surgeon to display the image from the endoscope and other minimal information from the sensors. The main window of 3D Slicer is for radiologists to do complicated image processing and surgical planning. To bind the sensor signal and spatial information, we designed a mixer program that took a stream of scalar value as the sensor signal and a stream of 4x4 transformation matrix as the spatial information. Firstly, we demonstrated necessary information to surgery which was displayed on sub-window(s). The main window and sub-window(s) are operated independently. Secondly, we bound sensor signal and their positions for image guided surgery to integrate image data precisely.

TB1-4 (11:15~11:30)

**EMG-based Real-Time Joint Angle Extraction Method for Human Elbow: Pre-processing and Optimization Process**

Hyeon-Jae Yu¹, Youngjin Choi²

¹LS MITRON, KOREA, ²Hanyang University, KOREA

This paper proposes a real-time joint angle extraction method of human elbow by processing the biomedical signal of surface EMG (electromyogram) measured at the center point of biceps brachii. Actually, the EMG is known as nonstationary signal, but we assume that it is quasi-stationary because a physical or physiological system has limitations in the rate at which it can change its characteristics. Based on the assumption, a pre-processing method to obtain pre-angle values from raw EMG signal is firstly suggested, and then a optimization method to minimize the error between the preangle and real joint angle is proposed in this paper. Finally, we show the effectiveness of the suggested algorithm through experimental results.

TB1-5 (11:30~11:45)

**Compact Hand Exoskeleton Robot for the Disabled**

Hyun-Ki In, Kyu-Jin Cho

Seoul National University, KOREA

Exoskeleton robots can enable the disabled to perform the daily tasks that they were not able to do by using their own bodies. Hand is an important part of the body for the disabled to perform their daily tasks. Compared to the legs or the arms, the degree of freedom is much higher, which makes it hard to build a compact exoskeleton robot. In this paper, we propose a concept for a hand assistive device for the disabled that is lightweight and compact. Instead of using rigid frames and linkages, it is made of a glove with tendons driving each finger. Just like the many compact robotic hands, it is under-actuated. The proposed concept is suitable for a hand exoskeleton device that requires a large number of joints but does not need a large force.

TB1-6 (11:45~12:00)

**Mechanical Design of a Wearable Robot(RoboWear) for Power Augmentation**

Changyong Song, Kyunghwan Kim

NT Research Inc., KOREA

This paper proposes three types of wearable robots for the purpose of power augmentation in human muscles. The wearable robots called as RoMAN consist of a upper body, a lower body and a backpack for a controller. The magnitude of power augmentation exceeds muscular power of a male adult. Thus, safety for robot’s malfunction in mechanism and control has been considered much more important in power augmentation than in power assistance. In addition, the wearable robots must not restrict human’s normal motion a lot. We propose a hybrid mechanism that passive and active joints are collaborated together to form complex power augmented motions. In addition, we propose a muscle stiffness sensor to detect human intention of movement on the clothes. It has much advantage over the EMG that is detected on skin surface.

★ Control architecture and Middleware 〈TB2, Oct, 29, 10:30~12:00, Room 202–204〉

TB2-1 (10:30~10:45)

**Maneuver Control of Tricycle Mobile Robot Based on Backstepping Approach**

Shun-Hung Chen, Jyh-Ching Juang, Tsung-Hui Huang
This paper describes the backstepping control method using sum of squares (SOS) technique to design the nonlinear controller for a trajectory tracking problem of tricycle mobile robot. The backstepping recursive structure and Lyapunov method are used to eliminate the error so that the stability of control systems can be guaranteed. Furthermore, the sum of squares conditions constraint the performances such that the backstepping controller is optimal. All states of tricycle mobile robot match the behavior of nominal robot include the control energies. Computer simulation results show the effectiveness of the backstepping control strategy.

Efficient UPnP SOAP Transmission using IP Matching

Ki-Woong Lim¹, Sang Chul Ahn³, Kwanghoon Sohn²

¹KIST, KOREA, ²Yonsei University, KOREA

In the future, robots will be more intelligent and complex. Accordingly, their services will be composed of modular S/W components. Hence, it is important to provide efficient communication between S/W components. The UPnP (Universal Plug and Play) is a middleware that has many advantages for future robot in dynamic distributed computing environment such as ubiquitous computing environments. We improve the UPnP engine for the robot and are developing a UPnP based robot middleware platform for easy integration of robot S/W components. Since UPnP is based on TCP/IP, however, data are unnecessarily transmitted through TCP/IP layer in a SBC(Single Board Computer). In this paper, we propose the efficient UPnP SOAP transmission using IP matching to avoid it. We also show that it is efficient to transmit data for robot using multiple SBCs.

A QoS-Aware Component Model for Service Robots

Min-kyu Sin¹, Ji Chan Maeng¹, Choulsoo Jang², Sunghoon Kim², Minsoo Ryu¹

¹Hanyang University, KOREA, ²ETRI, KOREA

QoS is becoming a more important issue for service robots as their main job is to provide services directly to end users. However, although QoS has been an active research topic in network and software areas, it is difficult to find useful results that are applicable to service robots. In this paper, we attempt to develop an effective method to achieve QoS guarantees in service robot applications. Specifically, we first present metamodels needed for specifying QoS and then extend the OPRoS component model based on the metamodels.

State Test Methodology for Robot Software Component Architecture

Sang-Woo Maeng, Hong-Seong Park

Kangwon National University, KOREA

We are developing an automated component state testing architecture in order to find faults in component for stability. In this paper, we present state testing methodology for robot software component which has regulated interface using OPRoS component model. This methodology can be applied other component system if the platform or middleware support specific control interface for a component. Our approach is easy to automate testing process and requires less effort of tester or developer.

A Fault-Tolerant Architecture for Component-based Service Robot Software Platforms

Heejune Ahn¹, Byung Wook Choi¹, Sang Chul Ahn²

¹Seoul National University of Technology, KOREA, ²KIST, KOREA

This paper presents a fault tolerant architecture for OPRoS platform. The proposed architecture follows OPRoS system model hierarchy; the fault tolerant measures of detection, isolation, and recovery are mapped onto ports, components, tasks, and containers of OPRoS system. This hierarchical approach minimizes the fault handling time and fault containment area. Also, the fault handling is customized using XML descriptors by the component developers and system integrators who well understand the constraints of components and robot’s operating environment. Test results using robot navigation service verify the flexibility and the real-time performance of the proposed fault tolerant architecture.
In this paper, a novel speed control algorithm of DC motors is presented. The key contribution here is a simple speed controller only with speed feedback and without an inner current control loop. This is possible by adjusting the reference speed based on a certain rule. Therefore, the proposed speed controller here becomes simpler while maintaining the control performance. Moreover, with the proposed controller, the system response can be tuned with less complexity. This proposed control method is investigated both mathematically and experimentally.
Adaptive Weighting Probabilistic Model for Human Tracking with a Mobile Robot Using Laser Range Finder
Chen-Tun Chou, Chi-Pang Lam, Li-Chen Fu
National Taiwan University, TAIWAN

Human tracking has received tremendous amount of attention while human-robot interaction is getting more and more important nowadays. In this paper we use adaptive weighting probabilistic model (AWPM) to associate previous and present sensed data by laser range finder (LRF). First, we collect the geometric information from LRF, and this laser measurement vector is used to decompose into several human legs sectors after human detecting system. Second, we use AWPM to do the data association, and then integrate this model into a particle-filter-based human tracking system to predict and update the people’s leg states. This system will be evaluated through experiment with the mobile robot platform in the indoor environment.

A Gender Classification Method using the External Features
Ho-Sub Yoon, Young-Woo Yoon, Jae-Yeon Lee
ETRI, KOREA

This paper presents a gender classification method using external gender features taken from facial images. There have been a number of studies that have performed gender classification using internal features, such as skin colour, wrinkle textures, shape features and so on, from human faces. Even if internal features have dominant information for gender classification, but for the case of people aged 1-25 years and over 60 years, the hairstyle is an additional feature as external features for gender classification. Often, occlusion from hairstyles, for instance, renders useful information gathering difficult if not impossible. In our approach, we adapt the active appearance model fitting method to precisely detect facial features. The test results indicate that external features are very useful for gender classification.

A Vibrotactile Maze Game with a Portable Haptic Mouse
Seong-Man Cho, Jae-Oh Kim, Mi-Jeong Park, Sang-Youn Kim
Korea University of Tech. & Edu., KOREA

In this paper, we presents a haptic maze game where a game player can sense the moving direction of a virtual object. We already proposed a new vibrotactile rendering method which is achieved by controlling the input voltage and the actuation time for multiple vibration motors in order to haptically simulate the object’s motion. To provide the vibrotactile feedback to users, a portable haptic mouse system was also developed. This paper proposes haptic maze game application and furthermore evaluate that the vibration flow is suitable for game application in which an object is moving.

Two-Wheel Mobile Platform with Active Assistant Wheels for Expressive Service Robot
Oh-Hun Kwon1, Seong-Yong Koo1, Nam-Su Yuk2, Dong-Soo Kwon1
1KAIST, KOREA, 2Technology center Samsung Electronics Co.LTD, Korea

This paper proposes a new type of two-wheel mobile robot platform for stability and various gesture generations with the help of two active assistant wheels. The assistant wheels are located in both the front and rear of the mobile platform and are activated during gesture generation. Four gestures were modeled and generated with tilting of the body and independent wheel control. Each gesture’s expressiveness is tested in a simulated, restaurant-like environment. Our preliminary performance evaluation revealed that the proposed active assistant wheels can be helpful in creating various dynamic gestures for Human-Robot Interaction.

★ Wheelchairs and smart spaces (TC1, Oct. 29, 15:40~16:55, Room 201)★

The RFID-based Object Location and Live Camera Spotting
Han-Yen Yu, Jiann-Jone Chen
National Taiwan University of Science and Technology, TAIWAN
The RFID space location identification becomes one of the most popular research topics. Previous research proposed to deploy regular spaced reference tags to perform location identification. It can effectively estimate the object location, but this system setup is not easy to reduce estimation error. We proposed to utilize more than one RFID readers and control the reading power to perform location identification. It effectively utilizing deploying tags array and location algorithm to improve the accuracy of object location. Experiments show that the proposed method can largely reduce the estimation error from 69 cm to be under 15 cm. To intuitively render this location information, it controls the parameters of PTZ camera to spot the target object to provide context-awareness services. By integrating RFID-based location identification function with smart camera system, many smart space applications can be developed.

TC1–2 (15:55~16:10)

Robot Navigation using Image Sequences
Yu Fu, Tien-Ruey Hsiang, Sheng-Luen Chung
National Taiwan University, TAIWAN

In this paper, we propose an image sequence based method for a robot to navigate with an appearance-based map. A planned path is separated into several steps, and reference image sequences are first taken at positions, such as the intermediate positions or the final destination in that path. In each step, the robot performs visual homing to navigate, or in other words, trying to minimize the magnitude of optical flows of matched features between each observed image and the previously accorded reference image. During the minimization, the robot gradually moves to the homing position. Consequently, after several visual homing procedures, the robot is able to reach the final destination. With our method, the robot navigates more accurately and our experimental results prove the stability of this method under different illuminations and occlusions.

TC1–3 (16:10~16:25)

Development of the Integrated Moving and Turning Mechanism for an Electric Wheelchair
Wei-chen Lee, Jyun-An Yao, Yue-Ying Lyu
National Taiwan University of Science and Technology, TAIWAN

An integrated moving and turning mechanism for an electrical wheelchair is proposed in this paper. The mechanism uses only one small DC servo motor to reduce the weight of the whole mechanism, which further makes it less power consumption. The integrated mechanism can also allow the wheelchair to move in any direction directly to provide maximum maneuverability. The weight of the complete integrated mechanism is 2259 grams and can carry a load of 40 kgw running at the speed of 56 mm/sec. Further weight reduction will be performed to make the mechanism more compact and lightweight.

TC1–4 (16:25~16:40)

Development of an Automatic Battery Exchange Station with Image Positioning
Chi-Ying Lin, Sheng-Chang Liang
National Taiwan University of Science and Technology, TAIWAN

This study focuses on building an automatic battery exchange system for intelligent vehicle systems such as home care wheelchairs. A 3-DOF robot manipulator, similar to a toggle style mechanism, has been designed and fabricated to perform the battery exchange motion within a self-built battery holder station. A theoretical analysis based on forward/inverse kinematics was performed to calculate the required motion of servo motors and to avoid the dead point positions. The motion of the robot manipulator was simulated by MATLAB Simulink and the functionality of the whole system was successfully verified through experiments. Furthermore, the whole system is designed with an image positioning feature and a stereo vision-based approach with a pair of images will be applied to transfer the 3D information of a target object (battery slot on the wheelchair) to appropriate motor commands.

TC1–5 (16:40~16:55)

Innovative Wheelchair Manipulation Interface with Collision Avoidance and Heart Beat Monitoring
Chung-Hsien Kuo, Yi-Chang Chan, Kuo-Wei Chiou, Jia-Wun Siao
National Taiwan University of Science and Technology, TAIWAN

This paper presents an innovative wheelchair manipulation interface. The proposed wheelchair manipulation interface is developed using two independent translational position sensors instead of a conventional joystick. Especially, two
translational position sensors are placed on two arm rests of the wheelchair to measure the wheelchair manipulation commands. Therefore, the proposed manipulation solution performs more easy and straightforward. To avoid collision during driving the wheelchair, infrared (IR) sensor array is used to collect the distance of obstacles in front of the wheelchair. At the same time, a collision avoidance algorithm is developed according to the distances measured from five IR sensors. Because of simultaneously using two hands to manipulate the two translational position sensors on two arm rests, it is possible to place two surface electrodes on the translational position sensor modules to collect the user’s electrocardiography (ECG) when driving the wheelchair. Therefore, the proposed innovative wheelchair manipulation architecture does not only perform straightforward and safe drive solution, but also monitor the user’s heart beats.

★ Open innovation technology for RT market (TC2, Oct. 29, 15:40~16:55, Room 202–204)

TC2~1 (15:40~15:55)
Smart Home for Security and Low Power Consumption Based on Ubiquitous Robotics
Tamio Tanikawa¹, Kenichi Ohara², Hiroyuki Nakamoto³, Masato Iijima⁴, Noriaki Ando¹, Takeshi Sakamoto⁵, Tetsuo Kotoku¹, Kohtaro Obara¹, Tatsuo Arai²
¹AIST, JAPAN, ²Osaka University, JAPAN, ³Systems Engineering Consultants (SEC) Co., Ltd, JAPAN, ⁴Misawa Homes Instituted of Research and Development Co., LTD., JAPAN, ⁵Technologic Arts Incorporated, JAPAN

The robot technology parts (RT parts) can be arranged on environment. The RT parts are controlled through the network. The concept of Ubiquitous Robotics is to support human life by RT parts on the environment. Smart home for secure and ecology has been built by corportive control of RT parts and common network on the national project “Open Innovation Promotion by Utilizing Basic Robotic Technology” in New Energy and Industrial Technology Development Organization (NEDO). In this paper, the concept of the smart home with distributed RT parts will be introduced. The smart home has two main functions. One is intelligent window. Another one is intelligent air condition system. The intelligent window works to guard a home and support human. The intelligent air condition system works temperature and humidity control in the home with low power consumption. In above functions, the common home network is important. In order to connect Any RT parts, the common network device was developed with RT middleware architecture.

TC2~2 (15:55~16:10)
An Intelligent Ambience that can lead Robot's Actions
-Development and Experimental Evaluation of a Device Developed for an Intelligent Ambience-
Takeshi Sakaguchi¹, Shinichi Tsunoo², Eiji Kubo³, Kazuhiro Yokoi¹, Kazuyoshi Wada²
¹AIST, JAPAN, ²Tokyo Met. University, JAPAN

In order to execute several tasks in offices and houses, robots need a large amount of information. If each item that is part of the ambience is endowed with some intelligence, robots can simply change the state of the item as requested by the ambience itself. We refer to such an ambience as an "Intelligent Ambience (IA)."In this paper, we constructed an IA model that comprised three types of doors, a device developed specially for this IA, and a humanoid robot. We also verified the effectiveness of the IA experimentally.

TC2~3 (16:10~16:25)
Smart RT Device with Easy Replaceability in Ubiquitous Robot Environment
Kenichi Ohara, Shinji Yonesaka, Tomohito Takubo, Yasushi Mae, Tatsuo Arai
Osaka University, JAPAN

We are attention to Ubiquitous Robotics, which provide informational and physical service. In this environment, distributed module is needed to have Robot Technology(RT). To let this distributed module, which we call RT device, work independently and widely providing such services, function analysis and design of hardware and software architecture are needed. In this paper, based on this concept, "Module Design" of Ubiquitous Robot is proposed by using RTC-Lite, which is framework of light wight RT component. Moreover, we show simple home network, which is an example of Ubiquitous Robot environment, by using smart RT devices based on proposed module design.
Robot Total Management System for Robots in Daily Life Environments
Bong Keun Kim¹, Hideyuki Tanaka¹, Yasushi Sumi¹, Hiromu Onda¹, Tamio Tanikawa¹, Kohtaro Ohba¹, Tetsuo Tomizawa²
¹AIST, JAPAN, ²University of Electro-Communications, JAPAN
In this paper, a robot total management system is proposed for various types of robots in daily life environments. The proposed system was designed for two different robot systems in a daily life space and evaluated by considering a particular scenario.

Development and Control of Omni-directional Mobile System with Active Casters
Jae Hoon Lee¹, Youhei Hukumoto¹, Shingo Okamoto¹, Bong Keun Kim², Tamio Tanikawa², Ohba Kohtaro²
¹Ehime University, JAPAN, ²AIST, JAPAN
A novel mobile device for transportation of objects is investigated. Based on the idea of distributed actuation, double-wheel-type active caster which can endow objects with mobility is designed. Control architecture with embedded processor and wireless communication to connect distributed caster modules is suggested. Kinematic model of omni-directional mobile system which consists of multiple double-wheel-type active casters is utilized to the controller. Models for each caster module and for the whole system were employed in the embedded controller and host computer, respectively. The test-bed of active caster with XBee RF module is also developed.

★ Robot vision for ubiquitous robot services 〈TC3, Oct. 29, 15:40~16:40, Room 206-207〉

Layered Structure on Module-Based Robot Control System for Service Robots
Yasushi Mae, Hideyasu Takahashi, Jaeil Choi, Kenichi Ohara, Tomohito Takubo, Tatsuo Arai
Osaka University, JAPAN
Recently, each system developers has became to make functions for robots as software modules on middleware platform. These functions for the robots control systems, for example, manipulate the object and estimate pose of the object, are applied to other robot control systems. But, when the concepts of creation for modules and hardware structure are not allow desired robot control system, it is difficult to use function modules for the robot on other robots. In this paper, we present layered structure on module-based robot control system with hardware dependency. Our structure consists of Sensing modules, Action modules and Management modules on module-based robot control system. In addition, we show example which is implementation of grasping motion using vision on our structure with RT-Middleware.

Implementation and Evaluation of the Scale-Invariant Feature Transform on GPU
Jaeil Choi, Yasushi Mae, Kenichi Ohara, Tomohito Takubo, Tatsuo Arai
Osaka University, JAPAN
SIFT (Scale-Invariant Feature Transform) features have been used very successfully in many research fields in computer vision and robotics. These features help to find very robust local correspondences between two different images, but the algorithm for the feature extraction is somewhat time consuming on CPU, restricting its use in on-line and real-time robot applications. In this paper, we discuss several technical aspects of the implementation of SIFT on GPU. Our implementation is based on the CUDA framework provided by NVIDIA, and up to ten times faster than the CPU-based algorithm. For comparison, we also provide quantitative measures from the experiments of our GPU implementation of SIFT.

Object Pose Estimation by Multi-Surfaces SIFT Matching for Manipulation
Amr Almaddah, Yasushi Mae, Tatsuo Araï, Kenichi Ohara, Tomohito Takubo
Osaka University, JAPAN
For a robot working in a dynamic environment visual robust perception is a key for any successful grasping and manipulation function. This paper describes a vision system design for objects detection and robot manipulation process.
using a Multi-Surfaces SIFT features matching using GPU. In the Multi-Surfaces technique we define different target patterns for each camera in the stereo vision system so that we will be able to detect the objects from any different point of view during real time operation.

TC3–4 (16:25~16:40)

**Action Indication System in Emergency using Audio and Visual Presentation**
Kotaro Morikawa, Yasushi Mae, Kenichi Ohara, Tomohito Takubo, Tatsuo Arai
Osaka University, JAPAN
In this paper we propose an action indication system to human in emergency situations. Immediately after emergency situation occurs, people may be in panic and they cannot do appropriate actions to avoid danger. The proposed system gives indication of appropriate actions to human based on recognition of human actions and situations by multiple sensors. And for basic experiment system, Basic presentation methods using audio and/or visual indications are evaluated by experiments.

★ Work-in progress I [WP1, Oct. 29, 17:10~18:16, Room 201]

WP1–01 (17:10~17:13)

**Object Extraction using Blur Magnification and Analysis**
Sungheum Kim, Kapje Sung, Inso Kwon
KAIST, KOREA
In this paper, we present a framework for extracting foreground objects based on an estimated blur map. The blur is modeled by spectrum components, spatial gradients and variance of mixed light rays. A blurry background can be effectively generated by summing up rays along a path where camera moves. Using the magnified, synthetic blur due to the camera motion, the proposed method optimizes the initial cost, and segments the interested region from its background planes. The detailed analysis establishes a practical foundation for more general situations with a single hand-held camera.

WP1–02 (17:13~17:16)

**Converting Night-time Image to Day-time Image for Night Surveillance System**
Si Jong Kim, Kwang Ho An, Yeon Geol Ryu, Myung Jin Chung
KAIST, KOREA
This paper describes a method that converts night-time images to day-time images. We call it ‘denight method’. Denight method is useful for surveillance applications. Its applications include night-time traffic monitoring, security camera and so on. To convert night-time images to day-time images, we present a sequential procedure method. Our approach is specified in three subsections dealing with background extraction, foreground extraction, and denight process. It has been tested in several different environments.

WP1–03 (17:16~17:19)

**Diff RGB: A Novel Constant Intensity Color Space**
Sunglok Choi, Wonpil Yu
ETRI, KOREA
A novel color space, Diff RGB, is compared with popular normalized RGB. It keeps similar intensity in spite of intensity variation as like the normalized RGB. However, its transformation is much faster than the normalization, and it does not have any exceptional case in its transformation. Two applications of Diff RGB, landmark detection and skin color detection, are briefly explained.

WP1–04 (17:19~17:22)

**Preliminary Development for Vision-based Human Augmented Mapping: Human Robot Interaction and Human Following**
Soohwan Kim\textsuperscript{1}, Ju-Hong Park\textsuperscript{2}, Sung-Kee Park\textsuperscript{1}
\textsuperscript{1}KIST, KOREA, \textsuperscript{2}MtekVision Co., Ltd., KOREA

Human augmented mapping is a semi-autonomous map building approach for mobile robots. Among many prerequisites for human augmented mapping, human robot interaction and human following are the most fundamental ones, since the main concept is a guided tour. In this paper, we only employ a stereo camera and assume that the user has no background knowledge on robotics so that the robot should provide an easy interaction method. For that, we suggest an intuitive HRI method using virtual buttons and vision-based human following using Haar-like visual features. We implemented these preliminary developments on a real mobile robot. The experimental results show that our system is applicable to human augmented mapping using a stereo camera particularly for naive users.

\textbf{WP1–05 (17:22~17:25)}

\textbf{Approaching to Charging Station for Outdoor Mobile Robot using Visual Information}

Ji Hoon Joung, M. S. Ryoo, Jaeyeong Lee, Wonpil Yu

ETRI, KOREA

In this paper, we present the method of finding the direction of an outdoor charging station using visual information. We find the direction of the charging station with the local feature based object recognition using SURF (Speed Up Robust Feature) and sliding windows method. We plan to adaptively change the size of window by considering the distance between the robot and the charging station, in order to reduce computation time.

\textbf{WP1–06 (17:25~17:28)}

\textbf{Making Robots Take an Elevator: Detection and Recognition of Elevator Buttons}

Youngwoo Yoon, Hosub Yoon, Jaeyeon Lee

ETRI, KOREA

We developed an elevator number and symbol recognition system. In this paper, we described the button area detection, number and symbol area detection, and number and symbol recognition parts. The edge detection, morphology operations, blob analysis techniques are used. This is our first step to make robots and unmanned vehicles take an elevator by themselves.

\textbf{WP1–07 (17:28~17:31)}

\textbf{3D Pose Estimation of Robot by Vanishing Points in Single Catadioptric Image}

Hyun-Deok Kang\textsuperscript{1}, Jae-Hyuk Kwak\textsuperscript{2}, Heon-Young Lim\textsuperscript{2}, Su-Young Jeong\textsuperscript{2}, Yeon-Sik Kang\textsuperscript{2}, Cheol-Hyu Park\textsuperscript{1}, Chang-Hwan Kim\textsuperscript{2}
\textsuperscript{1}DMI, KOREA, \textsuperscript{2}KIST, KOREA

Catadioptric imaging system is able to provide a complete view that aids to know the navigational capabilities of robots, alertness in surveillance and in many panoramic imaging applications. Catadioptric imaging system consists of reflective quadric mirror and lens. In navigational process of functional ability in autonomous robot, it is important to know his geometric attitude for effective control of robot motion. This paper proposes one of solution which can utilize the pose information by using the geometric properties from the central catadioptric camera. The geometric properties in the central catadioptric camera permit the perspective projection from the original catadioptric image. We show that projection in the equivalent unit sphere provides a proper coordinates to detect parallel lines as a great circles. Using these interesting conditions, we present the experimental results both synthetic and real image.

\textbf{WP1–08 (17:31~17:34)}

\textbf{Discriminative Common Vectors in DCT domain for Face Recognition}

Ji Sung Kim, Kwang Ho An, Won Hwa Kim, Myung Jin Chung

KAIST, KOREA

In this paper, we will apply discriminative common vectors(DCV), which is a linearly subspace based face-recognition method using reduced dimension, in a frequency domain using discrete cosine transform. First of all we show that a result from DCV in a frequency domain is the same as a result from DCV in a spatial domain, then present an experiment result using ORL data base. This method reduces computational burden than the previous linear subspace-based face recognition methods in two aspects, by using DCV and eliminating DCT coefficients with less information since JPEG DCT coefficients can be used directly for face recognition such that the inverse DCT transform can be skipped.
Precise Welding Line Detection for Automatic Robot Welding using a Single Camera with Two Vertical Structured Lights
Seung Hun Lee, Jae Byung Park, Woon Chul Ham
Chonbuk National University, KOREA
For assembling numerous huge steel plates into a ship in shipbuilding, each steel plate should be carried to its predetermined position in accordance with a ship blueprint. Since the steel plate is too huge to carry as is, a handle is needed to carry such a huge steel plate, where the handle is called a lug. In this study, a precise welding line detection method is proposed for automatic robot welding of a lug to a huge steel plate. For welding line detection, a single camera and two laser line diodes are used. First, two vertical structured laser lights are projected on the lug and the steel plate, and then are detected by the camera. From the structured lights, the feature points of the welding line is obtained by the vertical threshold, thinning and Hough transform algorithms robust to illumination changes. Next, for obtaining the initial welding position on the welding line, a premeasured lookup table (LUT) about the lug shape is used. For verifying the feasibility and effectiveness of the proposed welding line detection method, experiments were carried out 100 times. As a result, the average error and the maximum error of the initial welding positions are 0.29cm and 0.36cm. The obtained initial welding position is precise enough for automatic robot welding.

Dense Stereo Matching using Texture-less Region Extraction in the Urban Environment
Woo Hyun Kim, Jung Won Kang, Myung Jin Chung
KAIST, KOREA
In this paper, we have proposed a new stereo matching algorithm based on the texture-less region extraction algorithm and the searching algorithm for the most reliable pixel. This approach has two distinct features. First, it uses line segments to extract texture-less regions in an urban image. While color segmentation based on the mean-shift method has much computational loads and the sensitivity to parameters, the proposed algorithm has segmented urban images robustly and quickly. Second, it uses reliable pixels to estimate correct disparities in the texture-less region. The reliable pixel has a distinct correction value, compared with other pixels. From this approach, we could assign correct disparities to the texture-less region without any optimization procedure. We conducted some experiments using 20 samples of urban stereo images. In order to speed up the algorithm, we implemented the stereo matching algorithm on both CPU and GPU (Graphics Processing Unit). In the experiments, we confirmed that the texture-less region extraction algorithm could enhance the accuracy of the dense stereo matching algorithm and reliable pixels play an important role to estimate correct disparities. We have achieved that overall algorithm processed stereo images of resolution 320x240 and 32 depth hypotheses at 5 frames per second using an NVIDIA Geforce 9800GTX graphics card and an Intel Pentium IV 3.4GHz CPU.

Real Time Posture Estimation of Human Hand Considering Class Error
Takanobu Tanimoto, Kiyoshi Hoshino
University of Tsukuba, JAPAN
The authors propose a universal robot hand interface by the system for human hand posture estimation in real time and with high accuracy. This method searches similar image quickly from a large volume of previously-sorted image database containing complicated shapes and self-occlusions of the hand. But if the past research system missed select classes at high level, estimation error was too high. So we proposed hand posture estimation system considering class error with multi-resolution images.

Video Stabilization with Reinitialization on Sudden Scene Change
Sunglok Choi, Wonpil Yu
ETRI, KOREA
The core step of video stabilization is to estimate global motion from locally extracted motion clues. Optical flow and feature matching have been utilized as local motion clues between adjacent image sequence. However, sudden scene change causes the motion clues totally wrong, which entails wrong global motion. Adaptive RANSAC, authors’ previous work, is applied to solve this problem with reinitialization. The proposed method resets its states when motion estimation
is difficult. The difficulty is quantified as the ratio of probably correct motion clues among overall clues. An experiment using real image sequence verifies effectiveness of the proposed method.

WP1-13 (17:46~17:49)
**Design of Micro Force Sensor using Strain Gauges**
Y. C. Kim1, Y. S. Ihn1, H. R. Choi1, J. C. Koo1, S. M. Lee2
1Sungkyunkwan University, KOREA, 2Korea Institute of Industrial Technology, KOREA

The Main issues with micro scale mechanics system have been realized with strict fidelity complex shaped devices. Micro-electro mechanical systems (MEMS) have currently constrained to complex fabrication and inadequate robustness. Therefore the force to actualize more precise is a matter of interest force sensing with micro or nano-scale range on high precision robot system. Presenting measurement system is constructed two semiconductor strain gauges that are using to know the information about applied force and distance from discretionary position. The sensing system is adopt to new architecture and moreover it is developed algorithm that has be located sensors at best optimized position to increase sensitivity and accuracy more than before. In this study, we have developed a system precisely measuring a contact force and position by making a probe used controlling and moving micro parts in the assembly line or production process using industrial robots. And we have focus on the system used a low price sensor that has be considered the changed structure design issue to measuring micro force sensing and analyzed a case in points happened at materializing and accomplishing procedure.

WP1-14 (17:49~17:52)
**Development of Active Skin Base on Dielectric Elastomer**
Huu Lam Vuong Nguyen, Huu Chuc Nguyen, DukSang Kim, Kuang Chun An, Ja Choon Koo, Hyouk Ryeol Choi, Youngkwon Lee, Jae Do Nam
Sungkyunkwan University, KOREA

In this study, we present "the active skin", which can provide tactile sensing and stimulation simultaneously. The active skin is configured with a flexible polymer substrate embedded with multiple tactile cells, which can respond actively and generate various tactile stimulation according to the touch. The active skin is based on dielectric elastomer as a functional polymer. Since the active skin is conformable, it can be worn, wrapped or covered onto any curved surface and utilized as an innovative tactile interface for a wide variety of applications.

WP1-15 (17:52~17:55)
**In-Network Processing Based Lighting Control System using WSN**
Muhammad Shoaib Khalid
Hanyang University, KOREA

Recently, wireless sensor networks (WSN) have been widely discussed in many applications. In this paper, we propose in-network processing based lighting control system for home and building. Wireless sensors nodes are responsible for measuring current illuminations. Two kinds of lighting devices, namely direct lighting devices and external lighting device, are used to provide illumination level maintaining and day light modeling, respectively. We consider processing information within network rather than sending data to an external network or system for processing, for which we use computation and communication power of wireless sensor node and propose in-network processing based decision algorithm to determine desired illumination level to achieve energy savings. First we model the decision algorithm for single sensor node by using Simplex algorithm. Finally we model in-network processing based decision algorithm to control and balance the illumination for two sensor nodes in room.

WP1-16 (17:55~17:58)
**The Study of Train Tilting Control of Conventional Curve Line**
Su Gil Lee
Korea Railroad Research Institute, KOREA

Tilting trains are now an established feature of railway operations throughout the world. For intercity traffic, tilt provides operators with increasing speeds, and therefore enhanced competitiveness, on existing routes where insufficient traffic or a lack of funds precludes the construction of a dedicated new high-speed railway. Applying the tilting train, we can expect 30% of speed up on existing lines, but the stability of the electric current would be low because of tilting the train. Also,
the spark between the centenary and pantograph cause environmental problems such as noise, radio wave malfunction. Therefore, the tilting on pantograph for the power suppling device is very essential for stable electric power supply.

WP1-17 (17:58~18:01)

A Study on Train Management System Running Test of Conventional Line
Su Gil Lee
Korea Railroad Research Institute, KOREA

The main transformer of the train is the equipment that receives the AC 25KV power from the trolley wire and transforms it to an adequate voltage that can be used by the traction control system of the train. The primary winding side is the trolley wire voltage; the secondary winding side is the load side that supplies power to the main motor through the traction control system (Converter/ Inverter); the third winding side is the load side that supplies power to SIV that provides the service units of the train with power, which includes loads such as train air conditioning and ventilators, composed of multiple winding transformer. The main circuit system of the secondary winding is 2 parallel and 1 serial. Mcpl car and M cars have one traction control system which has 2 sets of converter/inverter to which the main transformer supplies power.

WP1-18 (18:01~18:04)

Head Pose Detecting System using Thermal Camera
Jun Sewoong, Kim Bong-Seok
Korea Electronics Technology Institute, KOREA

This paper presents a new system to estimate the head pose of human in interactive indoor environment that has dynamic illumination change and large working space. The main idea of this system is to suggest a new morphological feature for estimating head angle from Thermal Camera. When a thermal camera shows distribution of face heat, there are obviously some morphological distributions. Applying a threshold to the heat distribution, we also obtain the different morphology image from different head yaw pose. Therefore, we can obtain the morphological shape of heat distribution of face. Through the analysis of this morphological property, the head pose can be estimated. It is simple and significantly invariant from illumination in comparison with other algorithm which adopts normal camera as a sensor. Our system can automatically segment and estimate head pose in a wide range of head motion without manual initialization like other optical flow system. As the result of experiments, we obtained the reliable head orientation data under the real-time performance.

WP1-19 (18:04~18:07)

An Infrared Laser Scanner for Mobile Robot Navigation using Multiple Step Phase Demodulation Method
Heesun Yoon, Hajun Song, Kyihwan Park
GIST, KOREA

Making a map by using global sensor is a mainstream tool in a mobile robot’s navigation. It requires specific vision system such as a CCD camera, range finding system such as laser scanner, and many other things. A laser scanner has highly collimated beams that can be obtained easily, thus achieving high lateral resolution. For the signal processing, the multiple step phase demodulation method is addressed in this paper. To have higher resolution of distance in the laser scanner using the phase demodulation method, signal should be modulated with a high frequency. However, it is not easy to amplify the high frequency since the amplifying gain is restricted by the frequency bandwidth. It is advantageous to demodulation using an intermediate frequency in which high gain amplification as well as less contaminated signal are obtained. Analytical and experimental results are presented to show how the multiple step phase demodulation method works in laser scanner for robot navigation.

WP1-20 (18:07~18:10)

A New Obstacle Avoidance Method by Making a Decision of the Turning Point
Jinpyo Hong, Kyihwan Park
GIST, KOREA

When the robot goes from the initial position to the goal position in the unknown environment, we need an obstacle avoidance method considering the path for effective control. There are many navigation methods to reach the goal position in the unknown environment. However, vector field histogram, artificial potential field, nearness diagram and so on focus
on avoiding the obstacle and moving safely to the goal position without considering the shortest path. In this paper, we propose a new obstacle avoidance algorithm that avoids the obstacle and generates the shortest path to the goal position by making decision of the turning point. In our proposed method, we divide the robot motion into turning motion, straight motion, and local minimum motion. And we explain about searching for the turning point for the motions respectively. Finally, we verify that the mobile robot moves to the goal position on the shortest path by showing the experimental result.

WP1–21 (18:10～18:13)
Measurement System Development for On-Line Test of Electric Vehicle
Youngjae Han, Sugil Lee, Jeongmin Cho, SeongHo Han
Korea Railroad Research Institute, KOREA
Presently, as the feasibility study shows that trans-Korea railway and trans-continental railway are advantageous, interest in high-speed railway system is increasing. Because railway vehicle is environment-friendly and safe compared with airplane and ship, its market-sharing increases gradually. TTX (Tilting Train eXpress) has been developed by KRRI(Korea Railroad Research Institute) for last 6 years to satisfy the need. An electric railway system is composed of high-tech subsystems, among which main electric equipment such as transformer and converter are critical components determining the performance of rolling stock. We developed a measurement system for on-line test and performances evaluation of TTX network line.

WP1–22 (18:13～18:16)
Collision Avoidance of a Mobile Robot Using Potential Field Algorithm
Yeong Geol Bae, Hyun Wook Kim, Sunsoo Choi, Sang Hoon Suh, Dae Young Byun, Seul Jung
Chungnam National University, KOREA
This paper presents a collision avoidance method using potential field of force for the mobile robot to avoid obstacles without collision. When obstacles exist between the mobile robot and the goal position, the path of mobile robot is planned by an attractive force and a repulsive force. Also, for the mobile robot to follow the shortest path toward to the goal position, a direction decision algorithm is added to the potential filed algorithm. For simulation studies, kinematics and dynamics of the mobile robot platform derived. Simulation confirms the performance of the proposed collision avoidance algorithm.

★ Work-in progress II 〈WP2, Oct, 29, 17:10~18:19, Room 202~204〉

WP2–01 (17:10～17:13)
Design of Single Positive-Rule and Dual Negative-Rule Fuzzy Controller for Robot Obstacle Avoidance
Jinwook Kim, Yoon-Gu Kim, Young-Duk Kim, Won-Seok Kang, Jinung An
Daegu Gyeongbuk Institute of Science and Technology (DGIST), KOREA
Fuzzy controller method provides intuitive method for non-linear system such as robot obstacle avoidance systems. A P/N (Positive/Negative) fuzzy controller method makes fuzzy rules simpler by utilizing negative-rules which are not present in general fuzzy systems. Because the P/N fuzzy controller uses positive-rules for target position and negative-rules for obstacle positions, the controller can be more intuitive system. However, previous P/N fuzzy controller design has a problem on avoiding obstacles near to the current robot position. The controller cannot avoid obstacles exactly because negative-rule degrees of each direction (right or left) cancel out each other. To solve this problem, single positive-rule and dual negative-rule fuzzy controller method is suggested. When obstacles are near to the robots, the proposed fuzzy controller method separates inputs of fuzzy controller by two directions and performs fuzzy operations independently with utilization of dual-negative rules. In this paper, single positive-rule and dual negative-rule fuzzy controller method which gives enhanced obstacle avoiding method for autonomous robots is proposed. Also, hardware design of the fuzzy controller is presented. Optimal hardware design can be applied to real-time mobile robots which require high performance and low-power consumption.
Fast Obstacle Avoidance for Mobile Robots using Bearing-only Information
Hae Kwan Jeong, Soo Hyun Kim, Yoon Keun Kwak
KAIST, KOREA
This paper is to provide a new obstacle avoidance algorithm for autonomous mobile robots. The name of algorithm is ELA\(^*\) whose key concept is based on bearing-only information. This means that a robot does not have to recognize its relative location in order to reach a goal with obstacle avoidance. Therefore, the robot make an approach to the goal by ELA\(^*\) even if knowing the direction to the goal only. ELA\(^*\) consists of two behaviors: motion-to-goal and boundary-following. This is very similar with Bug2 algorithm, but ELA\(^*\) is more effective due to dynamic m-line. In the stage of development, it is concluded that ELA\(^*\) would be useful in emergency operations such as rescue where a prior information is absent or no use because ELA\(^*\) is able to guarantee fast obstacle avoidance with little knowledge.

A Sampling Strategy for RBPF-SLAM in Non-Static Environments
Jung-Suk Lee, Wan Kyun Chung
POSTECH, KOREA
The mobile robot must estimate its pose to operate given tasks, and the information about the environment is needed for accurate pose estimation, simultaneously, even if the environment is non-static. The sensor observations corrupted by environmental changes disturb data association between registered features and the newly observed features, and make pose estimation and mapping fail. To solve this problem, we propose a sampling strategy for RBPF-SLAM that makes the pose estimation in SLAM process robust to environmental changes. We also show the plan for solving related problems, which include sampling intermediate poses, map update and map management methods.

Outdoor Localization System for Advertisement Robot
Christiand, Heesung Chae, Wonpil Yu
ETRI, KOREA
This paper deals with the localization for the mobile robot working in the outdoor environments. In this works, Bayesian framework filter (particle filter) is used to estimate the robot position from gathered information in the form of odometer and GPS data. The main goal is to provide reliable position information for the mobile robot operating in outdoor environment. To show the feasibility of the particle filter algorithm, we have implemented an experimental system with the common GPS. Experimental results show that the proposed particle filter has improved the localization performance of GPS in the outdoor environments.

Qualitative Mapping based on Local Triangulated Map
Minyong Choi, Wan Kyun Chung
POSTECH, KOREA
Qualitative mapping algorithm based on a local triangulated map is proposed. An environment is modeled as a global topological map comprised of the local triangulated maps. The local triangulated map is obtained using Delaunay triangulation based on local geometric feature map. The acquired local triangulated map represents configurations between landmarks in the environment. In order to build the local geometric feature map, extended Kalman filter based SLAM is used. The proposed method is insensitive to sensor noise if the sensor noise doesn’t ruin a configuration of landmarks. As constructing the qualitative map, we can represent the environment compactly and the map could be used in path planning efficiently.

Jerk-Bounded Trajectory Generation Method Using Digital Convolution
Geon Lee\(^1\), Youngjin Choi\(^1\), Jinhuy Kim\(^2\), Suk-Joong Kim\(^3\)
\(^1\)Hanyang University, KOREA, \(^2\)Seoul National University of Technology, KOREA, \(^3\)ED Co. KOREA
This paper proposes a jerk-bounded trajectory generation method using a digital convolution. The suggested jerk-bounded trajectory is able to reduce unexpected damages for a robot motion control system and to improve a tracking accuracy/speed of the control system. Also, it can be implemented in real-time because it requires low computational loads. The effectiveness of the suggested method is shown through numerical simulations for a point-to-point (PTP) motion generation application.
Plane Extraction from 3D point clouds of Indoor Environments
Changjoo Nam, Nakju Lett Doh
Korea University, KOREA

This paper presents a method of corner detection from 3D point clouds of an indoor environment. The detected corner can be used as a reference to clustering point clouds. The clustered points are extracted to a plane through following process: eliminate outliers by RANSAC and extract a plane by PCA. The extracted plane has the least square error sum. Reconstruction of 3D indoor environment can be achieved by this work.

Robust Data Estimation for Simultaneous Localization and Mapping: a hybrid approach of $H_\infty$ and Extended Kalman Filter
Seo-Hyun Jeon\textsuperscript{1}, Nakju Lett Doh\textsuperscript{2}
\textsuperscript{1}ETRI, KOREA, \textsuperscript{2}Korea University, KOREA

Research about Simultaneous Localization and Mapping (SLAM) has been actively researched among many scientists around the world. Generally applied algorithm of SLAM is Extended Kalman Filter (EKF-SLAM), and further researches are in the progress for Rao-Blackwellized particle filters (FastSLAM) and Unscented Kalman Filter (UKF) [1-3]. We are introducing a new algorithm in this paper by applying $H_\infty$ filter (HF) to SLAM. HF is well known for its robustness in nonlinear estimation since it minimizes the maximum probable error with certain characteristic factor ($\gamma$). By adjusting the factor ($\gamma$), it is possible to limit the error within the inverse of the factor. This is the special feature of HF algorithm, which will be explained in section 2.1. While no previous approach has been done so far, we are in the progress of adapting HF into SLAM. The current result shows that HF, in part, performs better in certain conditions. The simulation result will be shown in section 3. However, there are several limitations of this algorithm which will be explained later in this paper.

Comparison between Two Motion Models in EKF Localization
Sunglok Choi, JaeYeong Lee, Christiand, Wonpil Yu
ETRI, KOREA

Localization is one of the most important tasks for mobile robots. Bayesian filters (e.g. Kalman filter and particle filter) are common localization technique in robotics. The Bayesian filters predict location of robot using a motion model and control input, and they correct the estimation using an observation model with sensor measurements. Thrun et al. enumerated two kinds of motion models in their book [1]: the velocity motion model and odometry motion model. The velocity model uses linear and angular velocity as control input. In contrast, the odometry model utilizes odometer measurements directly. This paper tries to analyze and compare two motions models in EKF localization. Simulation with a virtual robot was performed in two different noise configurations. An experiment with a real robot also verified the comparison on their performance.

Guided Path Planning for Proximity Location Sensors
Sunglok Choi, JaeYeong Lee, Yu-Cheol Lee, Seung-Hwan Park, Wonpil Yu
ETRI, KOREA

A robot can estimate its position by detecting RFID or barcode tags. The tags and their reader have small detecting range less than 0.3 meters, and provide position of the robot through proximity. It is difficult to distribute the tags all over the space, so a path planner needs to guide paths toward tags to hit the tags more frequently. This paper enumerates methods to generate the guided path on the road map and grid map. Especially, two approaches on the grid map were described in detail and analyzed in experiments.

Multi-level Deceleration Scheme for Accurate Goal Arrival
Sunglok Choi, JaeYeong Lee, Wonpil Yu
ETRI, KOREA
When we stop our car in front of the stop line, we step on the brake many times. It is referred as multi-level deceleration. This paper applies this idea into a mobile robot, which needs to arrive the goal accurately. Simulation results demonstrate effectiveness of multi-level deceleration.

WP2-12 (17:43~17:46)
**Comparison between Position and Posture Recovery in Path Following**
Sunglok Choi, JiaeYeong Lee, Wonpil Yu
*ETRI, KOREA*
Path following is one of the most basic function of a mobile robot. It is a series of trials to attain its state to the target state. Its objective state determines the type of path followers: position, pose, and posture recovery. This paper compares performance of two path followers via experiments. One of them makes the robot proceed to position on the path, which is position recovery. The other tries to follow position incorporated with orientation and velocity, which is posture recovery. Comparison presents that posture recovery makes the robot more shaking when a location sensor has noise.

WP2-13 (17:46~17:49)
**Visual Path Following and Obstacle Avoidance Using Multiple Cameras for Outdoor Environments**
Heon-Cheol Lee, Tae-Seok Lee, Seung-Hwan Lee, Gyu-Ho Eoh, Beom-Hee Lee
*Seoul National University, KOREA*
This paper addresses an autonomous robot guidance problem which combines path following and obstacle avoidance in outdoor environment. To solve the problem, a vision system which consists of two monocular cameras for path following and a stereo camera for obstacle avoidance is proposed. For more robust obstacle avoidance, the vision system is aided by range sensors. The experiments showed that the proposed system was capable of performing on-line visual path following and obstacle avoidance.

WP2-14 (17:49~17:52)
**Study about a Path Planning of an Autonomous Mobile Robot along an Obstacle Pattern**
Sung-Ha Kim, Sung-Min Ryu, Chi-Sung Park, Jang-Myung Lee
*Pusan National University, KOREA*
To move automatically for a brainiest mobile robot to the designated goal, the robot should estimate a circumference environment and decide the path to the goal. The robot should do avoiding action about an obstacle in the moving path and continuously move to the goal. The Algorithm of the mobile robot automatic navigation that has high reliability would be shown in this paper and the algorithm includes a pattern matching method for efficient movement and a path creating using GPS sensor.

WP2-15 (17:52~17:55)
**Experimental Construction and Comparison of a Motion Model of a Wheeled Mobile Robot**
Yoonkyu Yoo, Woojin Chung
*Korea University, KOREA*
Motion and sensor models are crucial components in algorithms for the pose estimation of a wheeled mobile robot. Nowadays, two or more different items of pose data are used to obtain reliable data for pose estimation. It is important to improve the accuracy of results from data fusion. However, if data fusion is applied properly depending on the environment, we can obtain more accurate pose data. In this paper, from simulation, it is clear that motion model uncertainty varies across navigational paths depending on the sensor model uncertainty. Further, this approach is useful and applicable when we construct a real motion model.

WP2-16 (17:55~17:58)
**Motion Control and Obstacle Avoidance for Outdoor Patrol Robots**
Chang-bae Jung, Woojin Chung
*Korea University, KOREA*
This paper demonstrates the application of a proper motion-control method and obstacle-avoidance algorithms for outdoor patrol robots so that these robots can safely navigate roads and avoid static and a few dynamic obstacles in the Seosan
Petroleum Reserved Basement. Utilizing mobile robot odometry and LRF sensors, we improved path-tracking and collision-avoidance algorithms with lane changes. The outdoor mobile robots were controlled through remote control systems. Reflecting on the navigational environment and tasks of the outdoor patrol robots in the Seosan Basement, we verified that the suggested control systems are appropriate for the autonomous mobile robots.

WP2-17 (17:58~18:01)
A Practical Approach of an Indoor Mobile Robot Local Navigation Using the 2.5D Elevation Map
Chang-bae Moon, Woojin Chung
Korea University, KOREA
In this paper, we generate a robot-coordinate centered local map using 2.5D elevation map. By using this 2.5D elevation map, we extracted obstacle information. Nearness diagram (ND) and the extracted obstacle information was used for navigation in the local area. By using the proposed method, the mobile robot was able to successfully navigate in a practical environment while detecting the ground plane located obstacles with minimum height 5cm.

WP2-18 (18:01~18:04)
A Lane Based Navigation of Outdoor Robot for IRONC 2009
Nak Yong Ko, Taegyun Kim
Chosun University, KOREA
This paper presents a local obstacle avoidance method for outdoor navigation of a mobile robot. Especially the method is useful for navigation where a robot follows a track while avoiding obstacles in the track. The lane method divides robot workspace into lanes which are directed in the direction of the track path. The lane method is revision of the LCM(Lane Curvature Method) which incorporates the concept of lane into the CVM(Curvature Velocity Method). The proposed method only adopts lane concept and obtains translational velocity and rotational velocity by a heuristic method. The proposed method is simpler than the LCM and CVM. Though the CVM and LCM is better in general cases, the proposed method works well because the robot follows a track in this research. The method will be used for robot navigation in the International Robot Outdoor Navigation Competition which will be held on October 2009 at Gwangju, Korea(IRONC 2009).

WP2-19 (18:04~18:07)
Refinements of 3D Reconstruction using Laser Range Finder
Si Jong Kim, Kwang Ho An, Chang Hun Sung, Myung Jin Chung
KAIST, KOREA
This paper describes a method that improves 3D reconstruction result using an LRF (Laser Range Finder) disparity image. We can project LRF 3D points onto image pixel coordinates using extrinsic calibration matrixes of a camera−LRF (Φ, Δ) and a camera calibration matrix ( K ). The LRF disparity image can be generated by interpolation of projected LRF points. Using the LRF disparity image, we can detect invalid points in stereo reconstruction and refine multi-sensor 3D reconstruction based on stereo vision and LRF. Refinements of 3D reconstruction using LRF disparity image is specified in three subsections dealing with projection of LRF 3D points, LRF disparity image generation, and invalid points detection. It has been tested by synchronized stereo image pair and LRF data.

WP2-20 (18:07~18:10)
Vision-based Track Running Mobile Robot
Jungtae Kim, Daijin Kim
POSTECH, KOREA
To make a mobile robot run following a playground track, in this paper we introduce a method, how to extract a line from a camera image. First we separate the image into track line regions and other regions using color similarity. Then we extract a line information from the track line regions. From the line information we find out the relation between the location of a robot and line curvature error. The error information gives us not only the location but also the turning direction of a robot.
WP2–21 (18:10~18:13)

A Simulation Tool for Outdoor Navigation of Mobile Robots
M. Yousaf Ali Khan, Eui-jung Jung, Byung-Ju Yi
Hanyang University, KOREA
This paper presents a simulation tool for the outdoor navigation of mobile robots. Basically in this tool we make a virtual environment of the path provided to us. We test the mobile robot in this virtual environment, and then finally we perform the same experiments by using the actual mobile robot in real environment. We are using camera vision to detect the borders of the track by detecting the colors at the borders and obstacles are detected by using laser range finder.

WP2–22 (18:13~18:16)

Gon-Woo Kim, Yun-oh Choi
Wonkwang University, KOREA
This paper presents the architecture of an outdoor mobile robot of navigating structured environments autonomously. Using multi-sensor fusion, the robot is able to follow a predetermined route, avoid static obstacles, and estimate its location concurrently without any manual operation. The methodology and the on-going process are mainly mentioned.

WP2–23 (18:16~18:19)

Study on Sensor Fusion Outdoor Autonomous Driving Based on Lane Method using NRLAB-04 Robot
Seung-Min Park, Min-Woo Lee, Jung-Youn Lee, Min-Ho Song, Sang-Min Han, Kwec-Bo Sim
Chung-Ang University, KOREA
It recognizes an obstacle and it evades the method which it embodies. In addition it affixes the sensor modules (supersonic waves and web cam) in basic module (GPS, IR-PSD and BLDC motors) of NRLAB-04 platform. Main algorithm uses Lane Method that navigate recognizing obstacle and do feedback to an escaping following again alternative center by the shortest while travel to alternative central. In this paper, we propose system that recognize obstacle and describes about method in addition in about application method of the module. And we verify about the method through an experiment and simulation.

★ Work—in progress III <WP3, Oct. 29, 17:10~18:19, Room 206~207>

WP3–01 (17:10~17:13)

Speech Enhancement Using Geometric Source Separation in POMI Robot
Hye-Jin Kim¹, H. Leung², Ho-sub Yoon¹, J-Y Lee¹
¹ETRI, KOREA, ²Calgary University, CANADA
For intelligent robots, speech processing such as speech recognition and speaker recognition is essential to interact with human-beings. This, however, is hard to guarantee its capability because of noise, reverberation etc. In this paper, we propose a speech enhancement system based on Geometric Source Separation and Bark Filter. We do experiment in POMI robot, developed by ETRI 2008.

WP3–02 (17:13~17:16)

Force Sensorless Control of Two Planar Robots
Jae Yeon Choi, Byung-Ju Yi
Hanyang University, KOREA
This paper deals with a sensorless interaction force control in a cooperative task for two robots. In tightly coupled cooperative task of two robots, interaction force control is required. In this work, two cooperative robots not fixed to the ground are considered. A closed form interaction force and ZMP control algorithm is proposed. Each planar robot can be visualized as a kinematically redundant robot, where the number of joints are more that the required degree of freedom. In the motion planning, a sequential redundancy resolution algorithm is proposed. The primary task is to control the ZMP of each robot and the secondary task is to control the interaction force and the cooperative motion between the two
robots. The concept of virtual joints is employed to represent the constrained degrees, which include the interaction force and the cooperative task between the two robots. Through the simulation, we show that the proper cooperative task can be accomplished by using the suggested interaction force model without any force sensor.

WP3–03 (17:16~17:19)

A Robot Simulator ‘FRESi’ for Dynamic Facial Expression
Jeong Woo Park, Won Hwa Kim, Won Hyung Lee, Myung Jin Chung
KAIST, KOREA

Most of the robots are nowadays evolving and imitating human social skills to achieve sociable interaction with humans. Socially interactive robots require different characteristics rather than conventional robots. Likewise human-human interaction, human-robot interaction is also accompanied with emotional interaction. Therefore, the robot's emotional expression is very important for human, especially facial expressions play an important role among the whole part of the human body. In this paper, we introduce a facial robot expression simulator ‘FRESi’.

WP3–04 (17:19~17:22)

Motion Prediction of the Human Based on the Statistically Extracted Paths
Junghee Park1, Jeong-Sik Choi2, Jimin Kim2, Beom-Hee Lee2
1Korea Military Academy, KOREA, 2Seoul National University, KOREA

This paper gives a novel approach for predicting the human motion. It was based on the feature that the human with an intention moves to its corresponding goal and there are statistically typical paths in the environment. By inferring the goal and the path to it, the motion of the human could be predicted. We applied the fuzzy inference system to matching the current movement with statistically extracted paths and predicting the future moving direction.

WP3–05 (17:22~17:25)

Grasping Algorithm for Varied Objects
Ho-Yul Lee, Byung-Ju Yi, Youngjin Choi
Hanyang University, KOREA

To connect the robot with human life, we need an effective grasping algorithm. The robot should be able to grasp varied object in varied environment. The elements necessary for grasping algorithm are as follows: First, when grasping the object with diverse sizes and shapes, the fingers have to contact with them as widely as possible. Second, the robot should be able to control the force imposed on the object by finger knuckles. Third, if the size and position of object are not known accurately, the robot should be able to grasp it effectively. In this paper, we propose a grasping algorithm that can satisfy these conditions, showing the efficiency of this algorithm through the simulation.

WP3–06 (17:25~17:28)

Multirate Wave Transform with delayed reflections
Changhyun Cho
Chosun University, KOREA

This paper investigates effects of an unit time delay in the multirate wave transform (MWT). The MWT has been proven to be passive regardless of update rates of a haptic device and VE, and wave impedance. For practical system, however, an unit time delay is inevitably imposed on the feedback in MWT, since MWT is conducted at a digital system (e.g., PC). A practical model of MWT considering unit time delays was provided in this paper. The proposed model was evaluated by investigating energy behaviors and norms of the scattering matrix.

WP3–07 (17:28~17:31)

Optimal Position Control of a Surgical Illumination System
Eui-jung Jung, Byung-Ju Yi
Hanyang University, KOREA

Most surgical illumination systems have been developed as a passive system. However, sometimes it is inconvenient to relocate the position of the illumination system whenever the surgeon changes his pose. To cope with such a problem, this study develops an auto illumination system that autonomously tracks the surgeon's movement. A 5-DOF serial type
A manipulator system that can control its position and rotation (X, Y, Z, roll, and pitch) is developed. By using one ultrasonic sensor, the surgeon's position can be detected. The measured data are sent to the main control system so that the robot can move to the optimal position that depends on the surgeon's position. Finally, performance of the developed auto-illuminating system was verified through experiment.

WP3-08 (17:31~17:34)
Stiffness modeling of a 3 DOF soft finger mechanism
Hyo Jung Cha, Byung-Ju Yi
Hanyang University, KOREA.
This paper presents the design and stiffness modeling of a 3 DOF soft finger. First, the design is briefly introduced and kinematics of the finger, the length of wires, and Jacobian are derived. Secondly, the stiffness modeling of the finger is conducted to measure the softness of the finger mechanism as well as estimate the actuator size. Finally, the stiffness model of the finger is verified through experimental work.

WP3-09 (17:34~17:37)
Nonlinear Optimal Control of a Two-Wheeled Inverted Pendulum Mobile Robot
Sangtae Kim, SangJoo Kwon
Korea Aerospace University, KOREA
This paper describes a nonlinear optimal control method for a two-wheeled inverted pendulum mobile robot. First, the three degrees of freedom dynamic model for the balanced mobile robot is derived in state-space form. Then, the SDRE (State-Dependent Riccati Equation) nonlinear control method is adopted to improve the balancing and driving performance and it is compared with linear control performance. The simulation results show that the SDRE control is advantageous to LQR in the respect of transient performance and required maximum torque of driving wheels.

WP3-10 (17:37~17:40)
Introducing the Developing Platform OPRoS: The Open Software Platform for Robotics Services
Hong Seong Park, Soo Hee Han, Mi Sook Kim
Kangwon University, KOREA, Kon Kuk University, KOREA
Developing robot software takes a great deal of time and effort to implement robot algorithms and functionalities. Since there are no standards for robot software, the software parts that worked in one company's product are not necessarily compatible with those of other companies. In Korea, several research institutes have joined to develop a robot software platform funded by the government. It is the "Open Software Platform for Robotics Services (OPRoS).” The OPRoS provides an easy to use, comprehensive development environment and extensive functions that provide great benefits to broaden the robot market.

WP3-11 (17:40~17:43)
New Robotic Foot Design with Toes and Heel Joints
Hyunsool Kim, Jinhee Park, SangJoo Kwon
Korea Aerospace University, KOREA
In some researches, it was proved that adopting a foot with toe joints consist of torsion springs is advantageous in making humanoid robot walk smoother and faster. In this paper, we suggest a new robotic foot design to consider the energy efficiency by adding more degrees of freedom of toes and heels consist of pillars, where the three toes are helpful for making humanoid robot walk smoother and the two heel joints is to absorb the landing impact force, so we can decreased the total energy consumption of the humanoid robot. The arrangement of springs reduced the frequency of system. The simulation results will show the effectiveness of the new foot design.

WP3-12 (17:43~17:46)
An Image-guided Robotic System for Cochlear Implant Surgery
Hoon Lim, Young-Soo Kim, Byung-Ju Yi, Jaesung Hong, Nozomu Matsumoto, Makoto Hashizume
Hanyang University, KOREA, Kyushu University, JAPAN
The cochlear implant requires a high accuracy so that it avoids the damage of a facial nerve. Thus, it depends entirely
upon the ability of a skilled surgeon. In this work, an image-guided robotic surgery system is proposed, which monitors the surgery state in real-time and avoid the mistake due to trembling hand so that the accuracy and stability of the surgery can be enhanced.

WP3–13 (17:46~17:49)
A Registration Method between Robot and Image Coordinates Using Least Square Fitting
Hyun-Soo Yoon, Byung-Ju Yi
Hanyang University, KOREA

A registration in medical areas is to establish a relationship between two different coordinates. This work deals with a registration method required in image guided surgical robotic system. Using a bi-planar fluoroscopy, 3D points of the surgical area are registered to the image coordinates located at the center of the fluoroscopy. Next, a surgical robot employed for precise positioning of surgical tools is registered to the image space. Specifically, a rotation matrix and a position vector of the robot coordinate system with respect to the image coordinate system are found by using an analytic least square fitting method for nine data sets.

WP3–14 (17:49~17:52)
Backward-Motion Control of Multiple Passive Trailers Using a Car-Like Mobile Robot
Kwanghyun Yoo, Woojin Chung
Korea University, KOREA

It is difficult to find a practical solution for the backward-motion control of a car-like mobile robot with n passive trailers. In this paper, we propose a quantitative valuation index for evaluating the performance of the backward-motion control of a car-like mobile robot with multiple passive trailers. Moreover, we propose a reversely-connected car with trailers that can improve the performance of the backward-motion control of n passivetrailers by the use of a general car instead of a specialized mobile robot. Theoretical verification and simulations show that the backward-motion control of a general car with n passive trailers can be successfully carried out by using the proposed approach.

WP3–15 (17:52~17:55)
Examination of the Backward Motion Control Performance of a Car with a Passive Trailer
Jae-il Roh, Woojin Chung
Korea University, KOREA

A trailer system is composed of one vehicle and several passive trailers. Therefore, it seems that one driver can control many vehicles; thus, a trailer is an efficient method of transportation. However, trailer systems have disadvantages. Backward motion control is difficult. Many researchers have explored solutions for this problem. Most research focuses on backward motion control through an automatic control system. However, such a system also has limitations. Problem of who take responsibility of traffic accident. Further, the exact position of passive trailers always has to be known. The difficulty in the backward motion control of a trailer lies in the difference in the control input between the vehicle and the trailer-system. Therefore, a change in the control input can enable the driver to control the trailer easily. The driver secures rear vision for maneuvering the trailer and input control, such as for driving the vehicle in the forward direction.

WP3–16 (17:55~17:58)
Walking Pattern Generation using Approximate Unstable Zero Cancelation and Its Compensation Method
Giho Jang, Youngjin Choi
Hanyang University, KOREA

This paper suggests a walking pattern generation method using an approximate unstable zero cancelation and its compensation. Basically, there exists an error in the walking pattern generation method for humanoid robots using both a pole-zero cancelation by series approximation (PZCSA) and a linear quadratic regulator (LQR) method suggested in [12]. This error is caused by the approximate pole-zero cancelation for removing an unstable zero. As an alternative of this problem, firstly, we construct an estimator for position/acceleration errors of Center of Mass (CoM) and a position of Zero Moment Point (ZMP), and then they are used for compensating the ZMP error and the CoM error using a low pass filter. Through these simple procedures, finally, we show that both the ZMP and CoM errors can be removed through numerical simulations.
WP3-17 (17:58~18:01)

A Biologically Inspired Image Sequence Stabilization System for Humanoid Eyes
Yeon Geol Ryu, Kwang Ho An, Si Jong Kim, Hyun Chul Roh, Myung Jin Chung
KAIST, KOREA

When a humanoid robot walks or runs, image sequences from its eyes can be displeased to tele-operator and decrease a performance of the vision analysis – tracking, recognition and perception. We have been solving this problem through the image sequence stabilization (ISS) technique which is aimed at removing unintentional motion from image sequences. In this paper we propose a novel fast image sequence stabilization system based on KLT tracker and Kalman filter. Furthermore, we adopted vestibulo ocular reflex of humans for developing humanoid eyes. Therefore our ISS system is suitable to humanoid eyes. The effectiveness of our system is confirmed by many experiments over a variety of image sequences.

WP3-18 (18:01~18:04)

A Study of Rolling and Sliding Condition for Micromanipulation System
Y. S. Ihn1, Y. C. Kim1, H. R. Choi1, J. C. Koo1, S. M. Lee2
1Sungkyunkwan University, KOREA, 2Korea Institute of Industrial Technology, KOREA

Due to development of micro/nano technology for last few years, micromanipulation system are required in order to handle a micro/nano device. As a result usage of various micromanipulation systems become norm in the industry. Normally the micromanipulation system consists of precision staging system, small scale manipulation system, and highly sensitive sensing system. One of the most popular micromanipulation tasks might be handling of a micro-scale particle on a surface. When a manipulation tip handle a micro particle, micro particle could translate with rolling or sliding. In the present work, micro phenomena is modeled using contact mechanism.

WP3-19 (18:04~18:07)

Deriving a Generalized Policy from Interactive Demonstrations
C. Y. Park, D. H. Kim, I. C. Kim
Kyonggi University, KOREA

Within learning from demonstration (LfD), a robot learns a policy from examples, or demonstrations, provided by a user. We define examples as sequences of state-action pairs that are recorded during the user’s demonstration of the desired robot behavior. Our LfD framework utilizes this dataset of examples for k-Nearest Neighbor (k-NN) learning, to derive a generalized policy that reproduces the demonstrated behavior.

WP3-20 (18:07~18:10)

Context based Programming-Learning of Robots
Andrey V. Gavrilov
Novosibirsk State Technical University, RUSSIA

In this paper architecture of hybrid control system of robot based on context and learning by natural language is suggested.

WP3-21 (18:10~18:13)

Development of OPRoS Software Components
Eun-Cheol Shin, Soo-Kyung Son, Byung-Wook Choi, Byung-Hun Hwang, Dong-Hoon Lee
Korea Institute of Industrial Technology, KOREA

This paper presents a new way of developing the robot software components based on the open source platform, OPRoS (Open Platform for Robotic Services). The robot software architecture is proposed along with the OPRoS Component Interface, and the OPRoS based software components are applied to a mobile robot and a mobile service robot, respectively. Finally, the paper shows that the OPRoS based software components have the nearly same performance as those developed based on the commonly used software.

WP3-22 (18:13~18:16)

Research on Complex Equipment Fault Diagnosis based on Weighted Fuzzy Logic Petri Nets
Lixia Liu
Engineering College of Armed Police Force, CHINA
Currently, using intelligent information technology to improve the accuracy and efficiency of fault diagnosis has become the development trend of fault diagnosis technology. The fault diagnosis technology character of current complex devices was analyzed firstly in the paper. Then, aim at the uncertain reasoning problem in the fault diagnosis, a weighted fuzzy logic reasoning algorithm that is more suitable for practical engineering application was brought out. At the same time, to improve the fault diagnosis efficiency, a formalize algorithm for diagnosis reasoning by use of the parallel process capability of Petri nets was also provided. Finally, an example was used to verify the proposed methods in the paper.

WP3–23 (18:16~18:19)

**A new Direct Adaptive Fuzzy Control for a Class of Nonlinear Systems**

Y. Alinejad-Beromi¹, Morteza Moradi², Ahmad Ahmadi¹

¹Semnan University, IRAN, ²Islamic Azad University, IRAN

In this paper, a direct self structure adaptive fuzzy control for a class of nonlinear systems with unknown dynamical model is presented. The control action is produced by proposing an adaptive fuzzy system with a fix number of rules and adaptive membership functions. The reference signal and state errors are used to tune the membership functions and updating them instantaneously. Lyapunov synthesis method is used to guarantee the stability of close loop system. The proposed control scheme implemented to an invert pendulum system and its effectiveness is shown on the simulation results.
FA1–1 (09:00~09:15)

iMec: Sensor Embedded Medicine Case for Dosing Monitoring
Takuo Suzuki, Yasushi Nakauchi
University of Tsukuba, JAPAN

Recently, the number of senior citizens who are living alone and taking medicine has been increasing due to population aging. Since they have many risks for incorrect dosing and their caretakers are concerned about their health, we propose iMec system which composed by ubiquitous sensors and an iMec (interactive medicine case). This system assists senior citizens in taking medicines correctly and also their caretakers in monitoring their condition of dosing. Ubiquitous sensor, which is an inexpensive sensor embedded in house, is used to estimate the living state of a senior citizens in order to confirm the timing of dosing (e.g. after breakfast). iMec is a medicine case developed by us that recognizes medicines in it using camera in order to confirm the amount of dosing. We confirmed iMec can recognize medicines by experiments.

FA1–2 (09:15~09:30)

Investigation of User RT-Service Generation System Design for Ubiquitous Space
Ken Ukai, Makoto Mizukawa, Yoshinobu Ando
Shibaura Institute of Technology, JAPAN

In this research, we propose the robot technology (RT) Ontology for Kukanchi (Interactive Human-Space Design and Intelligence) to make robot provide appropriate services according to situations. For this, we propose to define that "Main task" as a task that the user explicitly requests and "Tsuide task" as an essential task accompanied with the "Main task" to complete it. We focus on the development of the system for identifying and defining "Tsuide task" that is changed by the intention of user and the main task. We name the proposing technique as "RT Ontology" which can be used for the infrastructure technology for structuring space information. In this paper, we describe the outline of RT Ontology and experiments of five cases.

FA1–3 (09:30~09:45)

Object Manipulation Service applying Spatially Distributed Function Model
Takayoshi Hanji, Takuya Mizuno, Tadashi Hosoya, Ken Ukai, Makoto Mizukawa, Yoshinobu Ando
Shibaura Institute of Technology, JAPAN

Object manipulation is one of the common and important tasks for robots to provide services in intelligent space. In this paper, we proposed and tested the technique adopting Kukanchi to realize object manipulation. At first, with the environmental sensors, we get the approximate position information of the target object using ucode-reading system. The ucode is unique ID system that assigns IDs to all objects to distinguish objects and places. Then, we acquire position, posture, and shape of the target object with higher accuracy from the camera attached on the wrist of the robot arm using the image marker. Size and patterns are registered with the image marker beforehand. Therefore, we can calculate relative distance and posture with the camera. Based on information of environmental sensors, we perform object manipulation with the robot arm.

FA1–4 (09:45~10:00)

A Representation of Object Information Based on Interactions between Humans and Objects in Intelligent Space
Mihoko Niitsuma1, Hideki Hashimoto2
1Chuo University, JAPAN, 2University of Tokyo, JAPAN

Intelligent Space (iSpace) we propose as an intelligent environment provides information and physical services to users via intelligent agents such as mobile robots, computer devices, and digital equipment. To provide suitable services corresponding with situations of the users, iSpace observes the space, extracts useful information from the observation and actuates suitable iSpace agents to deal with the situation. Especially, the observation function of iSpace is considered as a basic requirement for realization of iSpace. We then focus on obtaining information about the state of the space, and describing it in computer-processable form. In this paper, we present a system to observe everyday objects that people use
to accomplish their activities with the aim of involving the object information in describing human activities in iSpace. The system represents the observation in the form of 4W1H (who, what, when, where, how). Overview of the system and procedures to obtain the object information will be presented.

FA1–5 (10:00~10:15)

Position Estimation Method Using RSSI Measurement Sensors
Yuji Abe¹, Kenichi Ohara¹, Tomohito Takubo¹, Yasushi Mae¹, Tamio Tanikawa², Tatsuo Arai¹
¹Osaka University, JAPAN, ²National Institute of Advanced Industrial Science and Technology, JAPAN

Recently, sensor network is one of the key technologies in robotic field. Especially, position estimation of devices is important technology on sensor network. Position estimation method by using Received Signal Strength Indication (RSSI) is approached in indoor environment because of facility of installation. However, in indoor environment, estimation accuracy on this method is affected by multipath fading. In this paper, to solve this problem and take the advantage of RF communication, we propose RSSI measurement sensor using radio signal which is based on 125kHz, which is less affected by multipath fading. In this paper, we do RSSI measurement experiment with this sensor, and comparison experiment with Zigbee. And we show results of position estimation experiment by using RSSI measurement sensor.

FA2–1 (09:00~09:15)
Endtip Design for Stable Jumping Motion in Various Ground Conditions
Ki-Seok Kim, Byeong-Sang Kim, Jae-Bok Song
Korea University, KOREA

A portable guard robot should be able to overcome relatively high obstacles to cope with different situations. To satisfy this requirement, a small jumping robot based on a conical spring and a variable length endtip based on a nut-screw mechanism, is proposed in this paper. If an obstacle obstructs the designated path, the robot jumps up from the ground to overcome it. However, the robot fails to jump in some cases because the jump is affected by several factors such as the endtip material and shape and the ground conditions. Various experiments demonstrate that the jump performance can be improved by selecting the appropriate endtip material and shape for different ground conditions.

FA2–2 (09:15~09:30)
Abnormal Sound Detection System using Sound Localization and Sound Classification
Dohyeong Hwang¹, Byoung-gi Lee¹, Jong suk Choi¹, Mignon Park²
¹KIST, KOREA, ²Yonsei University, KOREA

In this paper, we introduce sound detection system. This system has two main technologies: sound source localization classification. In the sound source localization used four microphones to find direction azimuth and elevations of sound source (Time Delay Of Arrival) method. We a classifier to distinguish abnormal sound plied cepstral-based features such as Cepstral Coefficient since they provide cation accuracy than other features [1].

FA2–3 (09:30~09:45)
A Practical Grasp Quality Measure Based on Object Wrench Space Under Unit Normal Disturbances
Hyunhwan Jeong, Joono Cheong
Korea University, KOREA

In this paper, we present a practically useful grasp quality measure that takes account of the torque limits of finger actuators and the shapes of object geometries. The measure value means the maximally resistable external disturbance when the value is positive (i.e., force-closure), while it implies the minimally required external force to recover a force-closure grasp when the value is negative (i.e., non-force-closure). The proposed grasp quality measure is defined by the distance between the convex hulls of the extended grasp wrench space (e-GWS) and the object wrench space (OWS), where e-GWS and OWS are, respectively, created by the active wrenches from the robot fingers and the uniform distribution of unit normal forces on the polyhedral object surface. The validity of the proposed measure is verified through numerical examples.
Development of Robot Education Program of Creative Robot School for Children
Seul Jung, Jaekook Ahn, Seungjun Lee, Junhyung Park
Chungnam National University, KOREA

This paper presents program development of robot education for elementary school children. The purpose of this education program is to spread scientific knowledge to young children to draw their interests in science as well as engineering fields for future career. Since the robot is a popular and amusing tool for getting attention of children, program related with robots is developed for one day education. College students are also involved in helping children to build robots within a given time. As a robot demonstration resulting from previous research, BoxingBot is presented and controlled. Experiences and evaluations from previously held creative robot schools at Chungnam National University are presented to share with.

Real-time Motion Imitation Control of a Humanoid Robot with Non-real-time Motion Data
Sung-Kyun Kim, Syungkwon Ra, Doik Kim, Bum-Jae You, Sang-Rok Oh
KIST, KOREA

In this paper, we propose an on-line human-humanoid robot motion imitation control method using non-real-time human motion data from inertial measurement units or infra-red optical sensors. A virtual spring-damper system is applied to prevent an abrupt motion of robot joint, although the input motion data are non-real-time. Torque control method for position-control motor system is also provided. As a validation of the proposed method, an experiment was conducted with Mahru-III, a humanoid robot developed in KIST, and the result is discussed.

Fast Face Detection and Tracking using Stereo-camera and Adaptive Color Model
Kazumasa Suzuki, Haiyuan Wu, Toshikazu Wada and Qian Chen
Wakayama University, JAPAN

This paper describes a video rate system for detecting and tracking faces that uses an active stereocamera. By making use of the depth information obtained from a stereo camera, the number of sub-image regions to be classified for detecting faces can be greatly reduced. This not only makes the face detection fast, but also reduces the false positive rate. When a face has been detected, the system tracks it by investigating the skin color distinctiveness of the pixels in the search area. The initial skin color model of the face is trained online from the image where the face is detected, and it is updated whenever a new face has been detected. The system can work at video-rate and can follow the illumination changes automatically.

Robust Lane Recognition Technique for Vision-Based Navigation with Multiple Detection Clues
SeungBeum Suh, Yeonsik Kang, Chi-won Roh, Sung-Chul Kang
KIST, KOREA

Lane detection is crucial function in autonomous navigation. Vision system is the most popular sensing modality used in detection. However, there exist many formidable challenges for detecting the lane with vision system under poor or high illumination, shadows, and road markings. Especially mosaic shadow produced by high illumination and surrounding environments cause the false detection frequently. This paper proposes a novel method called filtration algorithm to detect the lane using multiple clues for threshold of all edge points based on the Bayesian rules. Data association is carried out for diminishing the false detection rate under extended Kalman filter (EKF).

Camera Motion Estimation based on Edge Structure Analysis
Andrey Vavilin, Kang-Hyun Jo
In this paper we present an approach for recovering graph-based structures from the images. This structure is then used for estimating planar camera motion. Our approach is based on detecting straight line segments. After several prefiltering operations such as bilateral filtering a Hough transform preceding by edge detection is applied. Then a result of transformation analyses in order to detect local maximums. Reverse transform of these maximums gives us a several straight lines presented in the image. We use an intersection of these analytical lines with detected edges in order to find straight line segments. On this step we also detect intersections between line segments. For each intersection point we compute rank based on number of connected points. After transforming image into graph we search for similar structural elements in the graph of previous frame. This process is based on searching subgraphs consists of vertexes with similar ranks. After finding correspondence points camera motion is estimated as a combination of translation and rotation.

Outdoor Scene Objects Detection Using Context Information
My-Ha Le, Hoang-Hon Trinh, Kang-Hyun Jo
University of Ulsan, KOREA
This paper describes an approach to detect the ground surface for outdoor intelligent mobile robots. The proposed method includes two steps. Firstly, the pre-process is used for analyzing the information of buildings and trees. The context information is used to separate four mains regions such as buildings, trees, sky and a ground surface. The candidate regions of the ground surface include roads, courts, shadows, bushes or ornament, etc. Secondly, the ground surface is identified with other objects. The process is performed with a large database images including structured/unstructured roads and courts.

Vision-based Track Running Mobile Robot
Jungtae Kim, Daijin Kim
POSTECH, KOREA
To make a mobile robot run following a playground track, in this paper we introduce a method, how to extract a line from a camera image. First we separate the image into track line regions and other regions using color similarity. Then we extract line information from the track line regions. From the line information we find out the relation between the location of a robot and line curvature error. The error information gives us not only the location but also the turning direction of a robot.

Development of Intelligent Hospital Service Robot with Neural Image Identification
Kuo-Ho Su1, Yih-Young Chen1, Shun-Feng Su2
1Chinese Culture University, TAIWAN, 2National Taiwan University of Science and Technology, TAIWAN
This project is to develop a novel architecture for intelligent hospital service robot. In the control scheme, the technologies of CCD vision image and FRID are combined to provide the environmental information to the fuzzy navigation controller and fuzzy tracking controller. In the navigation mode, the robot is designed to proceed according to the information of guiding lines. However, since the robot utilizes continuous images from the fixed angle of depression, a warning area is planned in this project to detect the obstacle and to decide whether obstacle avoidance action should be done. In the tracking mode, the fuzzy tracking controller is triggered to track specified image. Some salient features exist in this developing project: (1) the passive RFID modules and tags are utilized simultaneously to provide auxiliary environment information and to construct therobotic localization system. (2) Under the conditions of insufficient light, masked object or detection angle difference, the BAM neural network is joined into the image identification after the image reconstruction to decrease the identification error. (3) To reduce the chattering phenomena of robot, the translation width is embedded into fuzzy navigation and tracking controllers. The hardware of whole system includes an embedded industrial computer (LinCon8000), microcontroller (ET44210: containing RISC CPU, AD channels and PWM outputs), CCD camera/image grabber card, RFID module/tag, infrared sensors, driving circuits, motor encoders, two autonomous controlled DCBLMs, audio module and mechanical chassis.
FA4–3 (09:30~09:45)

A Visual Compass based on UKF SLAM
Je-Seong Han, Sang-Hoon Ji, Woo-Hyun Ko, Sang-Moo Lee, Kyung-Tae Nam, Woong-Hee Sho
University of Science and Technology, KOREA, Korea Institute of Industrial Technology, KOREA

In this paper, we present a visual compass based on the UnscentedKalman Filter Simultaneous Localization and Mapping (UKF SLAM) using a low-cost camera. The Extended Kalman Filter (EKF) based visual compass has been proposed. However, the output of the UKF is more accurate than the EKF for nonlinear system. In this work, the UKF is applied to the visual compass to improve the accuracy of the output.

FA4–4 (09:45~10:00)

Real Time Object Recognition Algorithm with Embedded Linux Using 2D Laser and Vision
Yu-Min Jung, Gun-Woong Bae
Han Dong University, KOREA

It is difficult to recognize objects with a moving mobile robot. When we use vision camera, there are some problems such as noise and inaccuracy errors from sensors, long image processing time and etc. To overcome problems, we designed a faster algorithm using combined data from laser sensors and vision camera. After calibration of camera and laser sensor, angles of near range measured by laser sensor can be matched location of camera pixels. By using result of process only around the matched pixels, we could reduce processing time. Also we could estimate localization of mobile robot by using combined data and grid method. The grid method is a simple algorithm. Each grid expresses whether it is occupied or not. The algorithm is designed based on real time embedded Linux system. Kernels and device drivers in Linux were designed for this process.

FA4–5 (10:00~10:15)

A Mobile Robot Localization Method Using Monte Carlo Localization Approach
Nak Yong Ko, Taegyun Kim
Chosun University, KOREA

This paper describes a Monte Carlo Localization(MCL) based localization method for a mobile robot. The research uses ultrasonic range data for localization. The ultrasonic signal is generated and radiated from a beacon whose location is given a priori. The method uses several beacons, theoretically over three. Then the receiver located on board a robot detects the range from the beacon. The method proposes a sensor model for the range sensing based on statistical analysis of the sensor output. The experiment uses commercialized beacons and detector which are used for trilateration localization. The performance of the proposed method is verified through real implementation. Though the method requires exact location of the beacons, it doesn’t require geometrical map information of the environment. Also, it is possible to estimates the location of both the beacon and robot.

FB1–1 (10:30~10:45)

Maintenance Planning for Individual Houses Based on Cause-and-effect Relationship
Eiji Arai, Hidefumi Wakamatsu, Eiji Morinaga
Osaka University, JAPAN

Houses in Japan are maintained with periodic inspections by house builders or maintenance agencies, but it is not effective enough for all houses because deterioration of each house depends on conditions of its location or lifestyle of its inhabitants. In this paper, a maintenance planning method adapted to individual houses is proposed. First, the cause-and-effect relationship with respect to deterioration of a house is modeled as a directed graph arrows/nodes of which correspond to states/conditions. The structure of a directed graph depends on construction method of each house, its room layout, and the location of equipments or furniture in it. Then, monitoring states with sensors to prevent deterioration corresponds to making a cut set of the graph. By calculating the cut set with the minimum weight of cut arrows which corresponds to cost of sensors and repair, an appropriate maintenance plan can be derived.
FB1-2 (10:45~11:00)

Robot Town Project: Robotized Structurization of Daily Human Life Environment
Tsutomu Hasegawa
Kyushu University, JAPAN

This paper describes a new concept of robotized structurization of daily human life environment. Three different robotic functions have been developed: 3D geometric modeling of daily life environment, calibration system of widely distributed vision, and localization system of distributed and embedded RFID tags.

FB1-3 (11:00~11:15)

3D Dynamic Active Sensing of Human Eye
Kenji Yamada1, Takumi Gosho2, Mituru Higashimori1, Makoto Kaneko1, Yoshiaki Kiuchi2
1Osaka University, JAPAN, 2Hiroshima University, JAPAN

In early diagnosis of glaucoma, intraocular pressure measurement is one of an important method. Non-contact method has measured eye pressure through the deformation of cornea during the increase of the force due to air puff. The deformation is influenced by the cornea stiffness as well as the eye internal pressure. Since the cornea stiffness is unknown in general, it is difficult to evaluate the true eye pressure. The dynamic behavior of cornea under air puff may provide us with a good hint for evaluating the cornea stiffness appropriately. For this purpose, we develop the sensing system composed of a high speed camera, a mirror for producing a virtual camera, a non-contact tonometer and a slit light source. This system enables us to measure the cornea deformation under concave shape. We show the experimental data for human eyes as well as an artificial eye made by transparent material.

FB1-4 (11:15~11:30)

A Telesurgery Experiment between Japan and Thailand
Mamoru Mitsuishi1, Makoto Hashizuma2, Patpong Navicharern3, Yuichi Fujino4, Kazushi Onda5, Shigen Yasunaka1, Naohiko Sugita1, Jumpei Arata1, Hideo Fujimoto5, Keiji Tanimoto6, Kazuo Tanoue2, Satoshi Ieiri2, Kozo Konishi2, Yukihiro Ueda7
1University of Tokyo, JAPAN, 2Kyushu University, JAPAN, 3Chulalongkorn University, THAILAND, 4NTT Corporation, JAPAN, 5Nagoya Institute of Technology, JAPAN, 6CORETEC INC., JAPAN, 7NTT Communications Co., JAPAN

The authors conducted a telesurgery experiment between Thailand and Japan using a newly developed slave manipulator. A laparoscopic cholecystectomy and a laparoscopic Nissen fundoplication were successfully performed on a pig using the developed system. The measured control signal and image transmission time delays and the estimated sensible time delay were 57.1 ms, 151.2 ms and 278.3 ms, respectively. The sensible time delay was decreased greatly over previous experiments by the reduction in the image transmission time delay provided by employing a low latency CODEC.

FB1-5 (11:30~11:45)

Identification of Types of Obstacles and Obstacle Map Building for mobile Robots
Yusuke Tamura, Yu Murai, Hiroki Murakami, Hajime Asama
University of Tokyo, JAPAN

For service robots coexisting with humans, both safety and working efficiency are very important. In order for robots to avoid collisions with surrounding obstacles, the robots must recognize obstacles around them. In this paper, three types of obstacles, such as stationary, movable and moving are defined, and a method to identify the type of obstacles is proposed. The experiments were conducted to evaluate the usefulness of the method.

FB1-6 (11:45~12:00)

Automated Cloning System Using Micro Robotics
Tatsuo Arai1, Tamio Tanikawa2, Fumihito Ara1, Osamu Sato4, Hiroshi Aso5, Satoshi Akagi6
1Osaka University, JAPAN, 2AIST, JAPAN, 3Tohoku University, JAPAN, 4KHI, JAPAN, 5FHK, JAPAN, 6NILGS, JAPAN

The cloning is one of the most promising biotechnologies today. The project aims to automate every process required in the cloning, i.e. supplying, cutting, removing, filtering, assembling and fusing, on the basis of micro robotics technology. The processes are performed on a micro chip consisting of micro channels and chambers in which oocytes and membranes flow and are manipulated. A whole system would be small and compact enough to be fit on desk top to meet various demands in biotechnology. The objectives, the overview and the current progress will be introduced.
FB2-1 (10:30~10:45)

Scheduling of RAPIEnet Switch using Edge-Coloring of Conflict-Multigraph
Syed Hayder Abbas, Seung Ho Hong
Hanyang University, KOREA

This paper presents a top-down approach to obtain a synchronized schedule for RAPIEnet (Real-time Automation Protocol for Industrial Ethernet) switches. Each port of the switch is considered as an exclusive networking resource thus ensuring concurrent communication. Offline schedules are obtained for each switch with a full-duplex connection. The inputs of the system are network infrastructure and directed communication lines. Based on the inputs, the Bipartite Multigraph and schedules for each switch is generated. Finally an algorithm to synchronize the schedules of adjacent switches will be presented.

FB2-2 (10:45~11:00)

Optimized Mobile Sink Trajectory for Efficient Energy Consumption in WSNs
Farrukh Salim, Jong Kyu Lee
Hanyang University, KOREA

Wireless Sensor network is emerging very rapidly due to its vast number of applications in every field of human life. The network is usually composed of energy constrained sensor nodes and resource unlimited sink node. The sensor nodes collect data from the environment and send data to sink via multi-hopping. Thus, the nodes around the vicinity of sink feels great burden of relaying all the sensor nodes' data, as well as sending their own data. This creates hotspot problem causing some sensor nodes to deplete their energies earlier, network lifetime is reduced and network becomes disconnected. To eliminate this problem, sink is made to move. A number of mobile sink strategies have already been proposed, but the need of good optimum strategy is still needed. In this paper, we propose an optimized Mobile Sink Trajectory in order to collect the data form sensors in an energy efficient manner. We propose the spiral movement of the mobile sink and argue that it provides proficient results in balancing load consumption fairly. We compare our spiral movement strategy with two other strategies; (1) when mobile sink moves along the periphery of the network, and (2) when the sink is statically placed at the centre of the network. Simulation results confirm that our proposed approach outperforms the others.

FB2-3 (11:00~11:15)

Design of Low Cost 2-D Scanning Sensor Modules
Jong-Tae Seo, Byung-Ju Yi
Hanyang University, KOREA

Most display units such as advertising panels and mannequins in Exhibition halls or Big Shopping Malls are static. The aim of this study is development of an active display system that provides a clear screen view to customers. For this, two types of low cost 2-D scanning sensor modules are proposed. The first type is a sensor unit using a crank slider. The second type uses a cycloid gear. The reciprocating motion created by these sensor mounting units allows a periodic scanning at the 2-D environment. Thus, these sensor modules can be used for 2-D scanning task to locate an object in the 2-dimensional space. An automatically rotating TV is chosen as an example device.

FB2-4 (11:15~11:30)

Development of Embedded Software for Wireless Networked Lighting Control System using UML
Seung-Mo Jung, Ju-Hyung Yoo, Joung-Han Lee, Dong-Jin Lim
Hanyang University, KOREA

In this paper, a lighting control system application based on ZigBee is developed using UML. Conventional development procedure for an application using ZigBee stack requires a tremendous effort, since a developer has to study programming interfaces and analyze sample code to modify and add necessary code. Inthis study, ZigBee application for lighting control system is modeled using UML and embedded software code is generated using automatic code generation tool. If the application development using UML proposed in this paper is used, it is possible for a user to easily develop an application using powerful notations of UML diagrams without paying attention to the details of complex programming code.
FB2–5 (11:30~11:45)
RtEML: Real-time EtherCAT Master Library
Yongseon Moon1, Tuan Anh Vo Trong1, Nak Yong Ko2, Kwangjin Kim2, Youngchul Bae3
1Sunchon National University, KOREA, 2Chosun University, KOREA, 3Chonnam National University, KOREA
This paper describes a real-time EtherCAT master library called RtEML. RtEML controls EtherCAT slaves under EtherCAT protocol in real-time. It provides a simple programming interface which is useful in developing robot application in C/C++ or C#. To achieve deterministic, hard real-time control in Microsoft Windows environment without additional hardware, INtime is used. INtime is designed especially to take advantage of the powerful capabilities of the x86 processor architecture, and the proposed RtEML achieves micro-seconds of real-time performance.

FB2–6 (11:45~12:00)
An Ambient Air Quality Monitoring System Based on ZigBee Network
SangEon Bae, Chankil Lee
Hanyang University, KOREA
This paper presents an ambient air quality monitoring system based on ZigBee network. To realize the reliable network, sensor nodes mounting various sensors such as carbon dioxide, dust, VOC, temperature and humidity, are configured by ZigBee mesh network. Two QoS parameters, transmission delay and packet error rate, are evaluated by varying the hopping number. Experimental results show that an appropriate hopping number is to be chosen to guarantee the required network performances.

FB3–1 (10:30~10:45)
Synthesis of Foldable Spatial 3-DOF Parallel Mechanisms
Jaeheon Chung1, Byung-Ju Yi1, Whee Kuk Kim2
1Hanyang University, KOREA, 2Korea University, KOREA
This paper deals with synthesis of foldable spatial 3-DOF parallel mechanisms with two rotations and one translation. Advantages of a foldable structure are portability and compactness. The foldable structure can be achieved by combination of several chains. Five foldable mechanisms are selected and characteristics of these mechanisms are compared. Effectiveness of the foldable mechanism is shown through applications of the mechanisms.

FB3–2 (10:45~11:00)
A New 3T+2G Parallel Module
Hyun-koo Kwak1, Wheekuk Kim2, Jaeheon Chung2, Byung-Ju Yi2
1Korea University, KOREA, 2Hanyang University, KOREA
A new 3T+2G type 5-DOF parallel module having 3-DOF translational motion and 2-DOF grasping motion is proposed. It consists of a base plate, a top plate, two grasping links, and four sub-chains connecting the base plate to the top plate and grasping links. Each of sub-chains has two proximal revolute joints, one parallelogram, and one distal revolute joint. Each of three sub-chains has one active joint on the base plate but one sub-chain has two active joints driven through a transmission from the ground. Firstly, closed-form inverse and forward position solutions are derived. Then, after driving the first-order kinematic model of the proposed mechanism, its workspace and its kinematic characteristics are examined. Lastly, its emulation program is developed to confirm its object-grasping and object-moving motion capability.

FB3–3 (11:00~11:15)
Design of a New 3T1R Type 4-DOF Mechanism
Hyun-koo Kwak1, Wheekuk Kim1, Jaeheon Chung2, Byung-Ju Yi2
1Korea University, KOREA, 2Hanyang University, KOREA
A new 4-DOF mechanism having Schonflies motions (3-DOF translational motions and 1-DOF rotational roll motion) is proposed. It consists of a moving plate, a base plate, and three sub-chains connecting those two plates. Each of three sub-chains has a proximal revolute joint on the base plate, followed by another revolute joint, a planar parallelogram, and
FB3-4 (11:15~11:30)
**Real-Time Variable Stiffness Joint for Robotic Applications**

Saul Opie, Woosoon Yim  
*University of Nevada, U.S.A.*

It is well known that human hands have variable compliance in their joints due to their muscle articulation. Like human hands, the adaptability and efficiency of control technology can be improved by utilizing the intrinsic dynamics of passive elements, and it can lead to a well-balanced coupling between control and mechanical design. In this research, the development of a real-time variable compliance passive joint is studied for applications such as robotic grasping and biped walking as well as shock and vibration isolation. In the proposed design, a Biased-Magneto rheological Elastomer (B-MRE) is the central component of the variable compliance joint, and its effectiveness is experimentally evaluated for real-time control of its joint compliance, which can be effectively used for mitigating shocks and vibrations common in the robotic joints in contact with dynamically changing environments.

FB3-5 (11:30~11:45)
**Compact Autonomous Robot with Inverse Kinematics Algorithm based on Fuzzy Control Model**

Osamu Tojo, Takeshi Morishita  
*Toin University of Yokohama, JAPAN*

In this paper, we propose a multijoint control reduction method for small self-contained autonomous robots. This method reduces the inverse kinematics operation. Furthermore, this method enables the development of an easy control system, because the use of the fuzzy logic enables the linguistic modeling of the joint angle. By carrying out an experiment on horizontal coplanar points using the arm of a small humanoid robot, we confirmed that the robot can perform the same movements as humans. In addition, we achieved fast information sharing applying the control algorithm of an all-integer arithmetic algorithm in a low-cost and low-power microprocessor.

FB3-6 (11:45~12:00)
**Development of an Active Walker with Easy Maneuverability**

Takanori Ohnuma, Geunho Lee, Nak Young Chong  
*Japan Advanced Institute of Science and Technology, JAPAN*

This paper presents physical design and hardware/software realization issues of a novel assistive robotic walker that we call JAIST active robotic walker (JAROW). The JAROW is developed to provide potential users with sufficient ambulatory capability in all directions and easy-to-use features. Special focus is placed on how to allow easier maneuverability through an intelligent user interface. For the purpose, we develop the dual rotating infrared (DRIr) sensor detecting a specific location of the user’s lower limbs, as well as the motion control algorithm for the walker. Our on-going experimental investigations confirmed that the JAROW can autonomously adjust its motion direction and velocity according to the user’s walking behavior without any extra devices.

★ Video session 〈VD1, Oct. 30, 10:30~11:20, Room 210〉

VDI-1 (10:30~10:35)
**Design of a Multi-wheeled Pipeline Inspection Robot**

Young-sik Kwon, Byung-Ju Yi  
*Hanyang university, KOREA*

Recently, many pipeline inspection robot systems have been developed. We develop a new type of reconfigurable robot that can be used for 80~100mm pipeline. The mechanism consists of three multi-wheeled chains, each of which is operated by a micro DC motor. The robot is designed foldable when each chain contacts the wall of pipelines. Thus, the
robot can be operated in various sizes of pipeline. This work uses the closed-form Jacobian of a pipeline inspection robot driven by three multi-wheeled chains. The Robot is controlled by a Joystick interface. It can go through elbow and T-branch. The robot system has been developed and the validity of this mechanism was proved by experimentation.

VD1-2 (10:35~10:40)
Robot Control with Infrared Based Gesture Recognition System
Dae-ha Lee, Jae-hong Kim, Jae-yeon Lee
ETRI, KOREA
Gesture based techniques have been applied in various part. In robot environment, pointing and command gestures are mainly used. But it is difficult to extract character or digit from gesture action. In this paper we introduce infrared based gesture recognition system which can extract character/digit/figure data from user gesture, and we applied this system to robot control.

VD1-3 (10:40~10:45)
OPROS Component Development Environment
Byoungyoul Song, Seungwoog Jung, Choulsoo Jang, Sunghoon Kim
ETRI, KOREA
OPRoS(Open Platform for Robot Services) is a specification and implementation model of networked intelligent robots which provides software component reusability, device interoperability, heterogeneous network interconnectivity. The goal of OPRoS technology is to establish a specification and provide an implementation model of networked intelligent robots in order to develop complex and various robot applications more easily. In this paper, we will introduce the OPRoS component development environment and applied robots.

VD1-4 (10:45~10:50)
A Dynamic, Modularized Plugin Programming for Robots
Seung-Ik Lee, Rockwon Kim, JunYung Sung, SungHoon Kim
ETRI, KOREA
This paper presents a dynamic, modularized approach to robot programming by applying plugin technology to robotics. With this plugin framework, programming robots can become pretty much easier than the conventional approach. Modularized development, dynamic deployment, dynamic loading & unloading, seamless multiple team support and increased portability are expected to obtain by using this robot plugin technology. To show the usability, a simulated robot is controlled with three pluggable objects.

VD1-5 (10:50~10:55)
srLib: The Next Standard in Robotics Physics Engines
Jeongseok Lee, Frank C. Park
Seoul National University, KOREA
In video game simulation, speed is more important than accuracy. For this reason, physics engines in video games lower their level of accuracy so that their calculations can be simplified and performed in real-time. Unfortunately, video game simulation is not suitable for robotics research because of the requirement for an extremely high level of accuracy. In that case the required physics engine must perform a highprecision dynamic simulation. Recently, a lot of physics engines for simulations have been developed and offered to users for free. PhysX [1], Bullet [2] and Open Dynamics Engine (ODE) [3] are currently the most well-known physics engines but they are only useful in the development of video games. Unfortunately, they are not satisfying the demand for a physics engine that can perform high-quality scientific simulations. In order to fill this need, srLib was developed as an open source physics engine for simulating rigid multi-body dynamics. Because of its strong benefits, srLib has the potential to become the standard for robotics physics engines.

VD1-6 (10:55~11:00)
Intelligent Control of CNU GYROBO
Seul Jung, Pil Kyo Kim
Chungnam National University, KOREA
This paper presents implementation of a single wheel robot system called GYROBO. The GYROBO has one wheeled system that balances itself by gyro effect. Intelligent control technique using neural network along with PD control method is used to balance the GYROBO. The reference compensation technique(RCT) has been implemented on DSP hardware. Experimental results of neural network control are demonstrated.

VDI-7 (11:00~11:05)

**Locomotion of Microrobot using Stationary Two-Pair EMA Coil System**

Jongho Choi, Hyunchul Choi, Kyoungrae Cha, Jongoh Park, Sukho Park

Chonnam National University, KOREA

Two-dimensional electromagnetic actuation system was developed which consists of two pairs of Helmholtz and Maxwell coils to manipulate microrobot for intravascular therapy. We analyzed the locomotive mechanism and validated the performance of the movement of microrobot by various experiments.

VDI-8 (11:05~11:10)

**Target Classification System using 24GHz Microwave Radar**

Seongkeun Park, Euntai Kim

Yonsei University, KOREA

In this paper, we propose a pedestrian classification system using 24GHz microwave radar. In order to classify the pedestrian and vehicle, we use multi-layer perceptron neural network. Real world experiments show the validity of our methods.

VDI-9 (11:10~11:15)

**Design of a Robotic Air-Powered Hand with Elastic Ligaments**

Dennis W. Hong, Colin Smith, Alex McCraw, Carlos Guevara, Kyle Cothorn

Virginia Tech. University, U.S.A.

This video presents the development of a dexterous robotic hand powered by compressed air and demonstrates its capability to grasp different types of objects. The Robotic Air-Powered Hand with Elastic Ligaments, or RAPHaEL, uses a novel actuator in the shape of an accordion like corrugated tubing. Each finger of the hand is actuated by three segments of the actuator connected to a single compressed air line. As compressed air enters the actuator triggered by a solenoid, all three segments of the finger moves by rotating about their joints. When the compressed air is turned off by the solenoid, the finger returns to its original position by elastic members attached to the finger. The force and compliance of the actuation is changed by the air pressure from a central air pressure control valve. This mechanism significantly simplifies the design, control, and implementation of a dexterous hand and dramatically lowers the cost. The video demonstrates several grasping experiments including grasping a delicate light bulb to holding a heavy can of food. Our preliminary experiments show the capability of RAPHaEL and effectiveness of the new approach. This enables it to be a cost effective practical solution for use in prosthesis and as a general research and education robot hand.

VDI-10 (11:15~11:20)

**Motivation-based Action Selection Mechanism using Quadruped Robot**

Sang Hyung Lee, Il Hong Suh

Hanyang University, KOREA

An intelligent robot must be able to select sequential and goal-oriented behaviors to achieve given goals. For this, we had proposed motivation-based action selection architecture using behavioral motivations. A behavioral motivation is first generated with association between sensors and behaviors. The architecture constructs a network of behavioral motivations to achieve given goals using the shortest reinforcement learning method. The constructed network can be operated as fully connected finite state machine. To show the validity of our proposed method, experimental results of a quadruped robot that is called by AIBO will be illustrated.
FC1-1 (15:40~15:55)
A Robot Clustering Scheme with Fault Tolerance
Young-Sik Hong, Jun-Ho Jeong, Hyun-Woo Koo, Jin-Woo Jung
Dongguk University, KOREA
Grouping robots is one of the most important issues in multi robot systems. Most studies on grouping have the objective of realizing cooperation and coordination between robots for solving specific problems. This set of robots is called a robot cluster. In this paper, we will propose an approach for handling faults in communication while clustering robots for cooperation and coordination in multi-robot systems. We will also discuss a fault tolerance scheme for the procedure.

FC1-2 (15:55~16:10)
R-Object Model Simulator for Evolutionary Robots
Yun-Sik Son, Ji-Woo Park, Jin-Woo Jung, Se-Man Oh
Dongguk University, KOREA
In the classical robot motion paradigm, robots make it difficult to respond efficiently to the dynamically variable environment such as disaster area. In order to handle such a situation that may be changed dynamically, a technology that allows a dynamic execution of data transmission and physical/logical connection between multiple robots based on scenarios is required. In this paper, we deal with evolutionary robots that adapt to any given environment and execute scenarios, specially focused on the development of a simulator to verify and experiment R-Object model for the evolutionary robots.

FC1-3 (16:10~16:25)
Iterative Fuzzy Clustering from Data with Missing Features
Kwang-Hyun Park¹, Hyong-Euk Lee², Sang Wan Lee³
¹Kwangwoon University, KOREA, ²SAIT, KOREA, ³KAIST, KOREA
To reveal regularities in input/output (I/O) relationships from data patterns with missing features, we construct an interpretable probabilistic fuzzy rule-based system that requires less human intervention and less prior knowledge than other state-of-the-art methods. Specifically, we present a new iterative fuzzy clustering algorithm that incorporates a supervisory scheme into an unsupervised fuzzy clustering process. The learning process starts in a fully unsupervised manner using fuzzy c-means (FCM) clustering algorithm and a cluster validity criterion, and then gradually constructs meaningful fuzzy partitions over the input space. Missing features in given data are estimated by using an expectation-maximization method. The corresponding fuzzy rules with probabilities are obtained through an iterative learning process of selecting clusters with supervisory guidance based on the notions of cluster-pureness and class-separability.

FC1-4 (16:25~16:40)
A Design of Cooperative Robots Using Spatial Mechanisms
Dongmin Choi¹, Jae Hoon Park¹, DooYoung Na², Yong-Tae Kim², Jin-Woo Jung³, Hyouk Ryeol Choi¹, Hyungpil Moon¹
¹Sungkyunkwan University, KOREA, ²Hankyong National University, KOREA, ³Dongguk University, KOREA
In this paper, a design of mobile-manipulators and a methodology of their cooperative operations to overcome and navigate cluttered environments. We designed mobile robots with 3 DOF robotic arms in order to cooperate together by docking between the two robots. We consider the spatial properties of the docked robotic arms and propose a control method to overcome obstacles in a cooperative way. As an initial result, we present a scenario and simulation that illustrates two mobile-manipulators make docking and overcome obstacles using the spatial mechanism.

FC1-5 (16:40~16:55)
Peer-to-Peer Interaction among Intelligent Robots
Mee Hwa Park, Jin Hyun Park, Yong Kyu Lee
Dongguk University, KOREA
In this paper, we design and implement an interaction framework among intelligent search robots in a P2P wireless network environment without a central server. Peer to peer interaction is essential in such a dynamic environment to
exchange required information such as geographic map data among autonomous search robots. In order to maintain information about dynamically joining and leaving robots in the mobile environment, we use a dynamic peer list and a dynamic routing table. For data exchange, we present a packet structure and a novel addressing scheme based on the signature method, which can reduce the message size especially during data multicasting. Experimental results are described showing that our scheme is feasible.

FC1–6 (16:55~17:10)

Localization for Mobile Robot Using Sensor Fusion and Landmark
Yong Min Tai, Ji Sung Kim, Yeon Geol Ryu, Si Jong Kim, Myung Jin Chung
KAIST, KOREA
In this paper, we present the method of localization system that uses iGPS (indoor GPS) sensor and Omni-directional vision sensor in the environment involving landmark. The indoor GPS (iGPS) is a simple and cheap localization sensor in the indoor environment. However, the error range of iGPS is too wide to be used in a small size robot. This paper presents a more accurate method of localization system that uses the iGPS sensor and Omni-directional vision sensor. We use the relative angle of robot estimation method and the linear position estimation. Then, we fuse the data from two sensors to get the accurate position.

★ Design and control of quadruped walking robot (FC2, Oct. 30, 15:40~16:55, Room 202~204)

FC2–1 (15:40~15:55)

Dynamic Stability of Quadruped Walking Robot
Duc Trong Tran, Ig Moo Koo, Gia Loc Vo, Ho Moon Kim, Se-gon Roh, Hyungpil Moon, Hyouk Ryeol Choi
Sungkyunkwan University, KOREA
This paper presents a simple analysis study of dynamic stability of quadruped walking robot with dynamic gait. The total force and moment distribution exerted on the robot body are used to conduct a final criterion cost function which can directly describe the stability of the robot. The dynamic supporting and swinging lines are used for calculating current state and next phase state of robot behavior. Finally, dynamic simulations on several environments are performed to validate the efficiency of the idea.

FC2–2 (15:55~16:10)

Body Movement and Ability of Quadruped Robot in 3D Rough Environment
Vo Gia Loc1, Ig Mo Koo1, Tran Duc Trong1, Ho Moon Kim1, Se-gon Roh1, Hyungpil Moon1, Hyouk Ryeol Choi1, Sangdoek Park2
1Sungkyunkwan University, KOREA, 2Korea Institute of Industrial Technology, KOREA
Determination of orientation and location of the body of quadruped robots in rough terrain is studied in this work. The workspace of the body is determined in advance by inspiring knowledge from parallel manipulator. Then, the region of the body that allows the robot to reach the next desired foothold is analyzed. The intersection of the workspace and the region ensures the existence of inverse kinematic solution as well as the reachable of the next swing leg to the desired foothold. Therefore, the algorithm only has to find a suitable position and posture of the body of the robot in next step inside the intersected region. Since determination of the region is done with pure geometric calculation, the algorithm runs fast in real-time. The effectiveness of the proposed algorithm is confirmed by walking over a rough terrain of MRWALLSPECT IV robot in simulation environment.

FC2–3 (16:10~16:25)

Development of Biomimetic Quadruped Walking Robot: AiDIN-II
Ig Mo Koo1, Tran Duc Trong1, Vo-Gia Loc1, Ho Moon Kim1, Se-gon Roh1, Hyungpil Moon1, Hyouk Ryeol Choi1, Sangdoek Park2
1Sungkyunkwan University, KOREA, 2Korea Institute of Industrial Technology, KOREA
In this research, a comprehensive study is performed on the design and control of a quadruped walking robot. In advance, the walking posture and skeletal configuration of the vertebrate are analyzed to understand quadrupedal locomotion, and
the roles of limbs during walking are investigated. In addition, with the study if the, design criteria and control method for a quadruped walking robot are derived. The proposed controller, through it is simple, provide a usefull framework for controlling a quadruped walking robot. In particular, introduction of a new biomimetic reflex controller based on the quadruped animal behavior. Finally, the proposed method is implementing in a quadruped walking robot, called AiDIN-II (Artificial Digitigrade for Natural Environment Version II).

**FC2-4 (16:25~16:40)**

**Virtual Sensor Feasibility Verification using the 1-Leg Robot**
Kwang Jin Ko, Wan Soo Kim, Chang Soo Han  
*Hanyang University, KOREA*

The sensor data measured by a walking robot are used to recognize the physical environment or information that controls the robot's posture. Therefore, a robot's walking can be advanced with the use of such sensing information. For the precise control of a robot, highly accurate sensor data are required, but most highly accurate sensors are expensive and are exposed to excessive load operation in the field. The seriousness of these problems will be seen if the prototype's practicality and mass productivity, which are closely related to the unit cost of production, preservation, and maintenance, will be considered. In this paper, the use of a virtual sensor technology was suggested to address the aforementioned problems, and various ways of applying the theory to a walking robot through the use of virtual sensor information obtained through training with an actual sensor, and of various hardware information, were presented. Towards this end, the back propagation neural-network theory was used. Finally, the possibility of the replacement of the ground reaction force sensor with a leg joint encoder and torque-cell sensor of the 1-leg robot was verified.

**FC2-5 (16:40~16:55)**

**A Comparative Study on the Position Control of Electro-Hydraulic Actuator**
Wonhee Kim1, Donghoon Shin1, Dong Gyu Gang1, Dahee Won2, Chung Choo Chung1  
1*Hanyang University, KOREA, 2*Korea Instituteof Industrial Technology, KOREA*

In this paper we present a comparative study on the position control of electro-hydraulic actuator. Investigated are four control laws including (Proportional and Integral (PI), Linear Quadratic Gaussian (LQG), backstepping, and passivity based control to evaluate position tracking performance. High gain observer is designed to estimate the state and the load torque used in the nonlinear control methods. Simulation results show that the passivity based controller has the best position tracking performance among them.

**★ Robotic mechanisms and design II (FC3, Oct. 30, 15:40~17:10, Room 206~207)**

**FC3-1 (15:40~15:55)**

**Residual Vibration Reduction of an Industrial Robot under Linux/RTAI Environment**
Chul-Goo Kang, Kyo-Sik Woo, Jin-Woo Kim  
*Konkuk University, KOREA*

Residual vibration of material handling robots results in increasing tact time, and thus decreasing productivity significantly. In this paper, we describe residual vibration reduction due to input shaping technique that is applied to a mechanical system under Linux/RTAI environment. Experimental results show that reduction of residual vibration is significant at point-to-point motion, and is well prepared to apply to actual commercial robot controllers.

**FC3-2 (15:55~16:10)**

**Development of Anthropomorphic Robot Hand: SKKU HAND III**
Joo-young Chun, Hansang Chae, Byungjuene Choi, Segon Roh, Hyungpil Moon, Hyouk Ryeol Choi  
*Sungkyunkwan University, KOREA*

In this paper, an anthropomorphic robot hand called SKKU Hand III is presented. Different from the previous gripper-type robot hands, the thumb is designed as one part of the palm and provides the mobility of the palm. The driving circuits for the SKKU Hand III are embedded in the hand, and each driving circuit communicates with others using CAN protocol. The SKKU Hand III is manufactured and feasibility of the hand is validated through preliminary experiments.
Design and Fabrication of Inchworm Robot Using Smart Composite Microstructures (SCM)
Je-Sung Koh, Kyu-Jin Cho
Seoul National University, KOREA
This paper presents a robot based on the motion of the ascotis selenaria, a type of inchworm with a locomotion that has an omega shape bending motion in between the extension motions. This type of inchworm can travel approximately at a body length per stroke on a rough surface, leaf edges and branches of trees. The robot is built with smart composite microstructures, a fabrication method that uses laser micromachining to cut composites and assemble them into micro structures. The robot is actuated with a single shape memory alloy coil actuator. This robot can be used for search and rescue or gathering useful information in an area where only small scale robots can penetrate.

Motion Characteristics for the Kinematic Topologies of the IMPASS Robot
Ya Wang, Dennis Hong
Virginia Tech. University, U.S.A.
This paper presents the motion characteristics for the different kinematic topologies of a novel mobile robot that uses two actuated spoke wheels. The mobile robot, IMPASS (Intelligent Mobility Platform with Actuated Spoke System) utilizes a unique locomotion concept of stretching in or out individually actuated spokes to combine the benefits of the wheels and legs. Due to this unique motion strategy, IMPASS goes through a number of different kinematic topologies while moving. With the non-slip constraints at the foot, the changing topology brings out various case problems which show various motion characteristics, expressed by the mathematical model based on kinematics analysis. The motion characteristics are deduced for each kinematic topology in the way of three important parameters describing the steering characters: the turning angle, the heading angle, and the turning radius of curvature. Additionally, the general sequence-evolution expression of the foot position with orientation at each time-step is concluded using of the shifting angle and the step length, which satisfies all the kinematic topology cases. The motion characteristics for different kinematic topologies, the primary focus of this paper, lay the foundation for the future path and motion planning of the IMPASS robot.

A Study on The Drilling Characteristics of Micro-Machine with Precessional Motion
Juhyun Kim, Hyunchul Choi, Kyoung Rae Cha, Jongoh Park, Sukho Park
Chonnam National University, KOREA
This study proposed a new driving and drilling mechanism for micro-machine which is driven by rotational magnetic field. The machine holds no power supply cables, no batteries, and no controlling systems on the body itself. The rotational magnetic field was generated by 3 pairs of Helmholdz coils. The spiral shaped micro-machine has the function of locomotion, revolution and drilling in the liquid or gel [1]. The micro machine was able to run through agar, but the drilling into the boundaries of agar is very difficult for the micro-machine. In order to solve the problem, the precessional motion of the machine was proposed in this paper. The efficiency of the precessional motion of the micro-machine was evaluated by the various drilling experiments.

Distantly Controlled Robot for Radiation-free Operation of the CT-guided Biopsy
Soo-Hyun Kim1, Kwang-Gi Kim1, Chang Min Park2
1National Cancer Center, KOREA, 2Seoul National University Hospital, KOREA
The biopsy operation, especially in lungs, is essential to inspect whether some detected tumors are malignant or benign. But it requires a series of precise and careful actions which is time-consuming and the operator is easy to be exposed to over-radiation. We developed a distantly controlled robot of the CT-guided biopsy which is radiation-free. The robot system is easily and precisely controlled in distant from the radiation source and most actions of the biopsy operation can be automated. Also this robot has a specially designed needle injection device which does less pain to the patient.
Position Estimation of GPS based on Spherical Geometry

Heesung Chae, Jaeyeong Lee, Wonpil Yu
ETRI, KOREA

Most of the outdoor localization is based on GPS for the mobile robot. In this paper a new GPS simulation approach based on the simple spherical geometry theory is introduced for the efficient evaluation to estimate the area covered by GPS. This proposed simulation algorithm can provide the possibility to estimate the area to get position prior to using GPS devices.

Indoor Pedestrian Localization System for Location based Service

Huisung Kim, Minyoung Lee, Sooyong Lee
Hongik University, KOREA

Localization is the key technology for location-based service; an information and entertainment service utilizing the ability to make use of the geographical position of the user. The service provider gets the location based on the radio signal delay of the closest cellular phone towers and/or using GPS for outdoor use. Indoor localization is developed widely for mobile robots. One of the localization methods is using the artificial landmarks; however, it cannot be applied without modification to the localization of the pedestrian because the pedestrian may walk differently from the mobile robot especially when we are interested in localizing the elderly and the handicapped. This paper presents newly developed pedestrian localization system using the artificial landmarks and inertial measurement unit. New method of landmark recognition and inertial measurement unit based dead reckoning are described.

Cycle-slip Reduction Method with Multiple Receivers -A Practical Application of Indoor GPS-

Haruhiko Niwa, Kenri Kodaka, Takaji Ebinuma, Yoshhiro Sakamoto, Shigeki Sugano
Waseda University, JAPAN, Tokyo University of Marine and Science Technology, JAPAN, Knowledge Services Co., JAPAN

Wabot-House Laboratory has been working on an indoor GPS. Extending the GPS to indoor space will enable us to seamlessly track the position of a mobile robot or machine that moves between indoor and outdoor spaces. In past studies, we had already demonstrated that our basic system of indoor GPS could work well in that it could track the robot with centimeter-level resolution inside the laboratory room. However, there was a fatal problem of a cycle slip that led a critical positioning error and occurred where a radio wave condition was bad. This problem is being a major obstacle to put the indoor GPS system into practical use. Then, we established a new method for reducing the occurrence of the cycle slip, using multiple GPS receivers and also increasing the number of pseudolite transceivers. We were able to lessen the frequency of the cycle-slip occurrence by about 25 percent in our laboratory.

Localization using a Chirp Spread Signal and Symmetric Double Sided-Two Way Ranging

Seok Yeon Kim, Chankil Lee
Hanyang University, KOREA

Chirp Spread Spectrum (CSS) module with an extended range and Symmetric Double Sided-Two Way Ranging (SDS-TWR) protocol are designed and implemented. Employing this technique, 1-D at outdoor and 2-D experiments in indoor environment are accomplished. The measurement results show the reasonable accuracy, measured by standard variation of locating error, to be used for various applications. Some mismatches between the theoretical bound and experimental results are also explained.

Gait Estimation based Pedestrian Localization

Huisung Kim, Minyoung Lee, Sooyong Lee
Hongik University, KOREA
Pedestrian localization is the key technology for caring the elderly, the visually impaired and the handicapped in health care districts. It also becomes essential for the emergency responders where the GPS signal is not available. Indoor localization has been studied for mobile robots. One of the localization methods is using the internal encoder sensors and extra sensors such as the camera, the accelerometer, etc. However, it cannot be applied to the localization of the pedestrian because the pedestrians do not have the dead reckoning sensors and may move differently from the mobile robot. This paper presents newly developed pedestrian localization system using the gyro sensors. Instead of using the accelerometer, the pedestrian gait is estimated from the gyro sensor measurement and the travel distance is estimated based on the gait kinematics. New method of fusing the gyro information and the magnetic compass information is developed and used in the proposed localization.

★ Ambient intelligence (FD1, Oct. 30, 17:25~18:25, Room 201)

FD1-1 (17:25~17:40)

Ubiquitous Robotics Application for Improving Quality of Life
Gaetano Ciaravella¹, Sungon Lee², Sang Rok Oh², Bum Jae You², Paolo Dario¹
¹SSSA, ITALY, ²KIST, KOREA
In this paper a brief review on Ubiquitous Robotics Application for improving the quality of life and its applications has been introduced. The field of application and the approaches are several and for different task, but for each of these approaches it is possible to divide the system in three main domains: a software domain, an embedded domain and a mobile domain.

FD1-2 (17:40~17:55)

Rule-based Approach for Automatic Service Composition in Ubiquitous Environment
K. Tan¹, Y. Amirat¹, A. Chibani¹, A. Yachir¹,²
¹University of Paris Est-Paris 12 Val de Marne, FRANCE, ²Military Polytechnic School, ALGERIA
The issue of service composition intended to offer seamless access to a variety of high level services has received widespread attention lately. Recent research efforts have dealt with the service composition problem in ubiquitous environment. Due to the dynamic and uncertain nature of this environment, the service composition should take into account the dynamic recomposition of services. In this paper, we propose a layered design approach for flexible and failure-tolerant service composition. It generates automatically flexible plans by optimizing both the number of services and parameters that appear in the composition. The plan is constructed in an abstract way, using rule-based technique, in order to fit to the changes occurring on the services and the context of use. It allows optimizing the time of the recomposition in large-scale environment by removing the phase of redisclosure. The obtained results show the feasibility and the scalability of our approach and a better reactivity to the dynamic and uncertain nature of the ubiquitous environment.

FD1-3 (17:55~18:10)

Network Configuration in Artificial Pheromone System by Considering Exploration and Exploitation
Herianto, Daisuke Kurabayashi
Tokyo Institute of Technology, JAPAN
In this paper, we present a study how to construct a network in the artificial pheromone system composed of data carriers and autonomous robots. Inspired by the creatures, such as ant community that establish and maintain expected path in the network by using pheromone, we investigate the effect of putting pheromone in the system. First, we assume that an environment is a two-dimensional finite region with distributed data carriers on it. Agents do not have any map. Therefore, we introduce intelligent node (IN) for localization and has ability as mediator between agents. In this system, IN gathers information and makes suggestions to the robot. We focus on the process of the mobile robot to put or not the pheromone for network configuration. Then we optimize the network construction by arranging time duration of the robot for putting the pheromone based on the IN suggestion. The artificial pheromone potential field network constructed using our proposed model can be used for the navigation of autonomous robots.
Perception and Modeling of Scenarios in Ambient Automation Networks with Hidden Markov Models
Dietmar Bruckner\(^1\), Josef Mitterbauer\(^1\), Rosemarie Velik\(^2\)
\(^1\)Vienna University of Technology, AUSTRIA, \(^2\)Tecnalia–FATRONIK, SPAIN

This paper presents and summarizes methods for machine perception, specifically scenario recognition. Hidden Markov models are used as a mathematical framework. There emission and transition probability distributions are created and updated according to the application-specific algorithms. Tests have been conducted in a senior’s home and at a kitchen test bed at the Institute of Computer Technology. Results show that the model is capable of distinguishing various scenarios of the users and that it allows for prediction of future behavior.

★ Robot vision II 〈FD2, Oct. 30, 17:25~18:25, Room 202–204〉

FD2–1 (17:25~17:40)
Improvement of Object Recognition for Grasping Task using SURF and Background Subtraction
La Tuan Anh, Jae-Bok Song
Korea University, KOREA

In service robotic applications grasping the daily objects is an essential requirement. In that context object and obstacle detection are used to find the object and to plan an obstacle-free path for the robot in order to manipulate the object. In this paper, an efficient object recognition and obstacle detection methods based on the background subtraction and speeded-up robust features (SURF) algorithms are proposed. Instead of performing tracking the object in full image, we search and match features in the window of attention which contains only the object. Therefore, the tracked interest points are more repeatable and robust to noise. In addition, the background subtraction helps to monitor the workspace and detect the appearance of obstacles. Various experiments show that objects can be grasped safely and stably in the dynamic environment using the proposed method.

FD2–2 (17:40~17:55)
Real-time Fourier Transform Profilometry with Reference Reconstruction for 3-D Robot Vision
Liang-Chia Chen, Xuan-Loc Nguyen, Wei-Shung Dai
National Taipei University of Technology, TAIWAN

This article presents a 3-D image acquisition method for autonomous robot vision using Fourier transform profilometry (FTP). Based on the spectral information of a captured fringe pattern, the method is proposed for reconstructing a reference surface which is essential for FTP method to obtain 3-D surface profiles. By doing so, the developed vision system can be employed to capture 3-D profiles of surrounding objects by one-shot imaging with a frame speed up to 60 Hz. The method can achieve high-speed 3-D image acquisition for robot and is capable of capturing moving targets such as human and vehicles. Experimental results verify the feasibility of applying the developed vision system to autonomous robots.

FD2–3 (17:55~18:10)
Genetic Particle Filter (GPF) for Online Non-Linear / Non-Gaussian Bayesian Tracking
Md. Zahidul Islam, Chi-Min Oh, Chil-Woo Lee
Chonnam National University, KOREA

The dynamic state estimation problems can be efficiently solved by Bayesian methods. The Bayesian approach is to construct the probability density function (pdf) of the state vector based on all available information. This pdf plays an important role to approximate the current state location of knowledge about the state vector. In the state-space approach to model a non-linear dynamic system, for the target tracking problem, the particle filtering has been successfully proven. In the standard particle filter, a resampling scheme is used to reduce the degeneracy problem and improve the estimation performance. But this resampling introduces some problem which is called sample impoverishment or particle deprivation. Genetic Particle Filter (GPF) can overcome this problem in standard particle filter by using some genetic operators like crossover, mutation in prediction steps and roulette-wheel sampling in genetic algorithm.

FD2–4 (18:10~18:25)
Extraction the 3D Spatial Features from 3D Range Data using the 2D Image Local Descriptors
In mobile robot research, it is of enormous importance to build the 3D metric representations of the 3D real-space for basic robot tasks such as localization, navigation, and path planning. In this paper, we propose a novel method to extract the 3D spatial features from the 3D range data with well-known 2D image local descriptors. First, we make the 2D range image from the 3D range data. And then, we extract the 3D spatial features corresponding to 2D image features detected by applying image local descriptors to 2D range images. Finally, to evaluate our proposed method, we observe the results of the matching between two frames.

★ Intelligent space/environment technologies (FD3, Oct. 30, 17:25~18:25, Room 206~207)

FD3-1 (17:25~17:40)

u-Metaverse: Extension of Virtual URS (Ubiquitous Robotic Space)
Muhammad Rusdi Syamsuddin, Yong-Moo Kwon
KIST, KOREA

This paper presents a concept of u-Metaverse. The motivation of this research is towards integration of ubiquitous robotic space and metaverse. First, this paper introduces our previous researches on virtual robotic space. Second, this paper describes briefly the trends of metaverse research, especially in view of virtual world and mirror world. Finally, this paper presents a concept of u-Metaverse. As a first step towards u-Metaverse, the integration demonstration of sensor and Metaverse is shown.

FD3-2 (17:40~17:55)

Shape Based Position Measurement Method Using Laser Range Finders
Hajime Tamura¹, Takeshi Sasaki¹, Hideki Hashimoto¹, Fumihiro Inoue²
¹University of Tokyo, JAPAN, ²Obayashi Corp, JAPAN

In this paper, an accurate and precise long-distance position measurement method for cylindrical objects using laser range finders (LRFs), which can be used for surveys in a construction fields, is proposed. The data acquired from the LRF is nothing more than the contours of the objects. Therefore, this research aims to estimate the accurate center positions of the objects by applying the least square method or the maximum likelihood estimation to their contours based on the shape information of the objects. We adopted cylindrical shaped objects since a circle is invariant against rotation. If we know the object’s radius in advance, the aforementioned two methods become non-linear problems. So we applied the Newton-Raphson method to solve these two non-linear equations. Experimental results reveal that the maximum likelihood estimation can give us the most accurate center position.

FD3-3 (17:55~18:10)

Exploration of Floor Surface for the Blind
Huisung Kim, Minyoung Lee, Sangcheol Park, Sooyong Lee
Hongik University, KOREA

Most of the blind or vision-impaired people use white cane or get help from the guide dog for walking. The white cane helps the user to perceive the environment simply identifying the existence of nearby obstacles. The conventional white cane is a stick and the user feels whether it is moving freely in space or is hit by an obstacle. In this paper, three infrared range sensors are used in order to detect uneven surface. The sensor system is installed on the user’s belt. Three sensors are configured radially and the design parameters are selected based on the sensor characteristics. The main difference from the conventional range sensor system for the blind is that it provides three discrete state information; even surface, ascending stair, descending stair.

FD3-4 (18:10~18:25)

Multi-Object Tracking Using Ultrasonic Sensors
Dong-Jin Moon, Zhong-Soo Lim, Sung-Mo Kang, Hwang-Ryol Ryu
RIST (Research Institute of Industrial Science & Technology), KOREA

In this paper we have studied the possibility of the multiple object tracking using 5 ultrasonic receivers and 1 transmitter.
The multiple echoes from the multiple ultrasonic receivers are used to reconstruct the local environment in which the mobile robot and the multiple objects are located. The distance, the bearing angle, and the object type (cylinder or plane) for two objects were derived from a new algorithm, which was proposed by the current authors. It can be extended to multiple objects other than two with ultrasonic sensors more than three.


FD4-1 (17:25~17:40)
Path Planning Using Modified Gradient Method for Small-Sized Robots
Seo-Yeon Hwang, Jae-Bok Song
Korea University, KOREA
This paper deals with the path planning method for small-sized robots in an indoor environment where the activity is limited. In mobile robotics, the gradient method has been the most popular path planning method. The purpose of the gradient method is to generate an optimal path which has no collision with obstacles. However, in case of the small-sized robots, the robot might pass through the limited areas under the tables and chairs. The conventional gradient method assigned the costs around the obstacles in order to calculate the intrinsic cost to make collision-free paths. This method provides an optimal path for the robots in wide areas. On the other hand, the robot in the narrow areas cannot figure out an optimal path because the high intrinsic costs hinder from generating gradient paths. This paper proposes a novel scheme how the robots figure out a path in narrow areas. It assigns the intrinsic costs simultaneously during the adjacency cost assignment step. Then the robot can figure out a safe path in narrow areas. The proposed method reduces the computational time significantly by assigning the costs to the minimum area. The intrinsic cost is also used to control the robot’s velocity. The results show that the proposed method successfully works in various environments.

FD4-2 (17:40~17:55)
Localization Algorithm of Multiple Robots
TaeKyung Yang, WonSeok Jang, WonYeon Choi, JangMyung Lee
Pusan National University, KOREA
The multi block localization method for multiple robots using iGS-UR is proposed in this paper. iGS-UR means indoor global localization using ultrasonic and RF. To measure the distance of a mobile robot from a beacon at a known position, the mobile robot wakes up one beacon to send out the RF signal to measure the traveling time from the beacon to the mobile robot. As the number of robots is increasing, the sampling time of localization also rises. Because during each sampling time, only one robot can localize its own position calling beacons one by one. This paper proposes an efficient localization algorithm for the multiple robots in the multiblocks. Slave beacons and robots are synchronized by the master beacon. Each beacon in a block sends a RF signal with the fixed time interval. The robots which already know the interval can catch the signal and calculate the location. In this method, all the robots simultaneously get the distance from each beacon to estimate their positions.

FD4-3 (17:55~18:10)
Development of Mobile Robot Based on Differential Drive Integrated with Accelerometer
Surachai Panich, B. Bhawinee, Thanapol Asvalapsil, Puttiporn Paksupho
Srinakharinwirot University, THIALAND
This paper proposed mainly a fusion between encoders and accelerometer for distance increment with Kalman filter to estimate robot’s position and heading. A developed differential encoder system with integrated accelerometer is analyzed and experimental tested in square shape. Applying the Kalman filtering theory, we successfully fused differential encoders and accelerometer to obtain improved position and heading angle estimation. Finally, the experimental result and simulation present the different trajectory generated by only differential encoders and differential encoders integrated with accelerometer.

FD4-4 (18:10~18:25)
Experimental Evaluation of the Performance of Mobile Robot Navigation Using Different Localization Sensors
Jaewan Ahn, Woojin Chung
The conditions and environments of the motion of mobile robots are very diverse. Various combinations of sensors enable different aspects of robotic motion. It is not clear that the improvement in the performance of an individual sensor module improves the performance of the overall system. It is necessary to consider various sensor combinations to search for those factors that help to improve the overall system performance. This paper presents an experimental study of the navigational performance of mobile robots using two kinds of localization sensor. From the experimental test, we can ascertain the improvement in the navigational performance for each sensor module. Moreover, using each individual sensor, we can analyze the pattern of motion of a mobile robot.
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