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Development of Common Platform Technology for Next-Generation Robots

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1. Introduction

Various research and development projects for robots have been carried out by a large number of research groups. However, many research groups spend a lot of time and money to develop the basic robotic hardware and software for each application field, which might be used as common infrastructure. In addition, apart from the market for industrial robots, markets for service robots are few and tiny.

The application-independent common technology for robots of any kind, which can be used by most robot developers and engineers, is defined as "common platform technology." In order to increase the efficiency of future robot research and development, the establishment of the common platform technology is a matter of urgency. The common platform is relevant to recent topics in robotics, including robotics structured environment, networked robot, robot middleware, reorganized dynamic simulator, and so on.

In order to develop next-generation robots capable of working in complex and dynamic environments, and not just in factories, the "information-structured environment" is a key technology. For example, the position information of the robots, objects and the humans in the working environment are required for any robotic application and might make the working environment closer to the structured environment, such as those in factories, using information technology (IT). In the information-structured environment, the robots can work as if they were in factories well organized in terms of the working environment for robots. If this position information can be acquired on the basis of a common infrastructure, then research or development of the next-generation robots can be executed more efficiently. Although Smart Room (Pentland, 1995), Aware Home (Kidd et al., 1999), Intelligent Space (Lee & Hashimoto, 2002; Lee et al., 2004), and Robotic Room (Sato et al., 2004) related to the information-structured environment have been developed, they are not considered as the robotic infrastructure.

On the other hand, software technology applied as the common platform technology, such as a robot simulator, is also an important issue. Although there is a lot of robot software developed in the world and several robot simulators (Gerkey et al., 2003; Michel, 2004; Nesnas et al., 2006; Gates, 2007; Lee et al., 2007), there are few simulators that guarantee the consistency of software modules. The simulator would be able to simulate the performance

of a robot synthetically using developed software modules, to guarantee their connectivity, reusability and would be extendable.
In Japan, information-structured environments as an environmental platform and a robot world simulator as a software platform are ongoing projects within the framework of the common robot platform technology for robotics applications of any kind. These projects are the first challenge to arrange the robot research and development infrastructure in the world. Here, we introduce these projects (Izawa, 2006; Tanie et al., 2006).

2. The next-generation robot coordination program

First of all, the background of these projects is explained. In Japan, the Council for Science and Technology Policy defines themes of national and social importance worthy of promotion, and coordinates related ministries in reconsideration of the conventional separate measures of individual ministries. The Coordination Program of Science and Technology Projects was established in 2005 to promote these themes, in order to strengthen coordination while eliminating duplication of related measures (Izawa, 2006; Tanie et al., 2006). The following eight themes were addressed initially: post-genome, emerging and re-emerging infectious diseases, ubiquitous networks, next-generation robots, biomass utilization technology, hydrogen & fuel cell, nano-bio-technology, and local science & technology clusters. In 2007, six new themes were added to these eight themes. Focusing on "common platform technology for next-generation robots," the core missions of the Next-Generation Robot Coordination Program are to promote the robot research and development of each ministry and to provide society with basic infrastructure technology for robots, thus enabling the development of services to be provided by various robots. Additionally, the stated objective to "lead the world in developing core robot technology useful in everyday life, both in the home and in urban environments" is a strategically important concern of the "3rd Term Science and Technology Basic Plan of Japan" for 2006-2010. Developing robots useful to society is also a concern of "INNOVATION 25," a governmental long-term strategy indicator.

3. Common platform technology

There have been various research and development projects of robots in individual ministries. After examination of these projects, it was found that required research and development were conducted for every application, and that certain ministries have clearly indicated technology that might be used as a common infrastructure. It follows that the technology capable of common use by robot developers and engineers when conducting research and development of robots was defined as application-independent "common platform technology." It was raised as an issue to be urgently addressed through the Next-Generation Robot Coordination Program in order to increase the efficiency of future robot development. Specifically, there are two aspects; namely, "information-structured environment" and "basic software for robot development," which are each discussed below (Izawa, 2006; Tanie et al., 2006).

3.1 Information-structured environment as an environmental platform

Although a robot's working environment will change depending on its application, technology using sensors to measure a robot's own position in relation to its environment is

required for any application. Various developments are underway in regard to such technology. If position information can be acquired on the basis of a common structure, then research and development of robot systems for specific applications can be executed more efficiently.

Furthermore, in the near future, robots themselves are not only expected to be equipped with intelligence and software, but also to utilize knowledge of their environment through integration with other technologies such as IT, ubiquitous computing, network communication technology, and use of GPS and RFID tags. These technologies have been developed as "networked robotics." The importance of "environmental information structuring technology" (that is, the embedding of programs, information, and knowledge for robots in the environments in which they operate as common infrastructure technology for developing various robots) is expected to increase. Therefore, in utilizing IT and similar technologies from this point onwards, it becomes necessary to research and develop standard models for information-structured environments. Two questions arise to be discussed: firstly, how should communication among embedded apparatus and robots, both indoors and outdoors, be standardized? Secondly, what kind of equipment (such as RFID tags) and information (such as environmental maps) should be embedded in the environment? The concept of the information-structured environment is shown in Fig. 1.

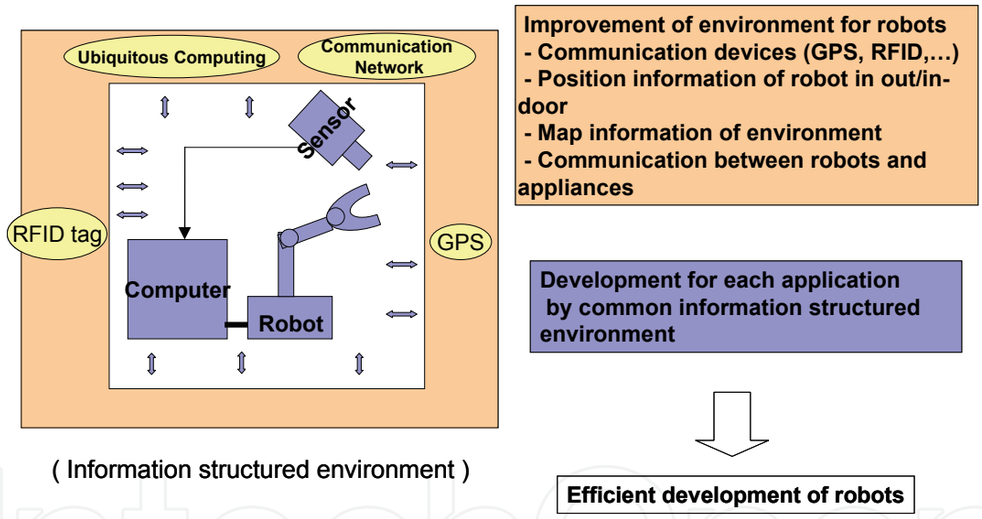


Fig. 1. Concept of Information-Structured Environment

3.2 Basic software for robot development as a software platform

At the same time, various types of software are needed in order to develop robots. Since an effective mechanism enabling robot researchers and engineers to share such software has not been established, they have each developed their own software independently in different research projects and research organizations. However, similar software is often developed over multiple projects and a considerable amount of shared software exists. Moreover, there has been no means of evaluating the performance of a developed robot in comparison to that of other robots in the same program environment. It is therefore essential to build social infrastructure that enables the provision of software for shared use. To that end, research and development of a robot world simulator to serve as a common management system for robot software are needed. Based on distributed object technology,

such a simulator would be able to simulate the performance of a robot synthetically in terms of its hardware, sensors and sensing functions, control structure, and other functions, including work environment, environmental objects, etc. Furthermore, it would be necessary for the simulator to guarantee the connectivity and reusability of various kinds of developed robot software, as well as its ability to accumulate functions and to be expandable. The concept of a robot world simulator is shown in Fig. 2.

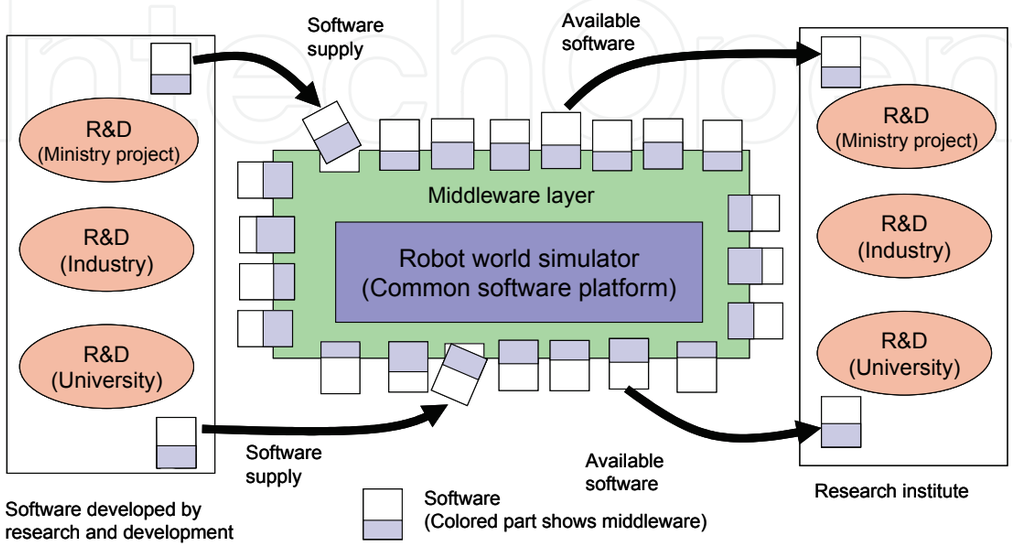


Fig. 2. Concept of Robot World Simulator (Software Platform)

4. Toward realization of a common platform

Aimed at the "effective and efficient promotion of coordination programs for science and technology projects" as supported by the special coordination fund for Promoting Science and Technology from the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT), and toward further development of a common platform technology, the four three-year projects described below are being implemented starting from 2005 and 2006. (The organization responsible for each project is indicated in parentheses.)

4.1 Structuring Robot Town 2005-2007 (Kyushu University)

The objective of the Robot Town Project is to develop a common platform enabling robots to work in the ordinary environments encountered in everyday life. In the platform, sensors and RFID tags are embedded and connected with a network to support robotic activities (Hasegawa et al., 2006, 2007; Kurazume et al., 2007). Fig. 3 depicts a conceptual diagram of the robot town. Fig.4 illustrates the daily life support by robots in/out of a house in the robot town.

To achieve autonomous robotic activities in such an environment, distributed sensors such as cameras and laser range finders (LRFs), and RFID tags connected with a network are distributed in the environment. Real-time data from the sensors and the robots are integrated by the Town Management System (TMS) together with GIS and other databases as shown in Fig.5. Robots in the platform can obtain miscellaneous information required for their activities from the TMS. The information includes the positions and the motions of

humans, cars, robots and obstacles in the platform. This platform is built in Fukuoka Island City and is opened in 2008.

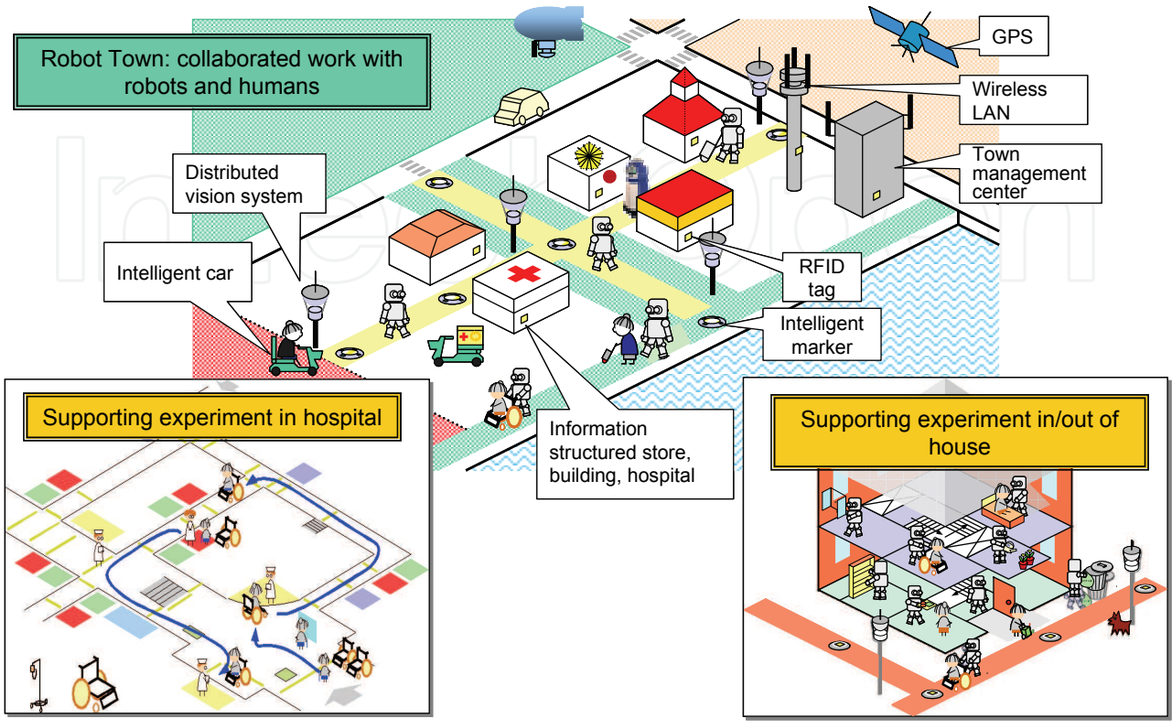


Fig. 3. Concept of Robot Town

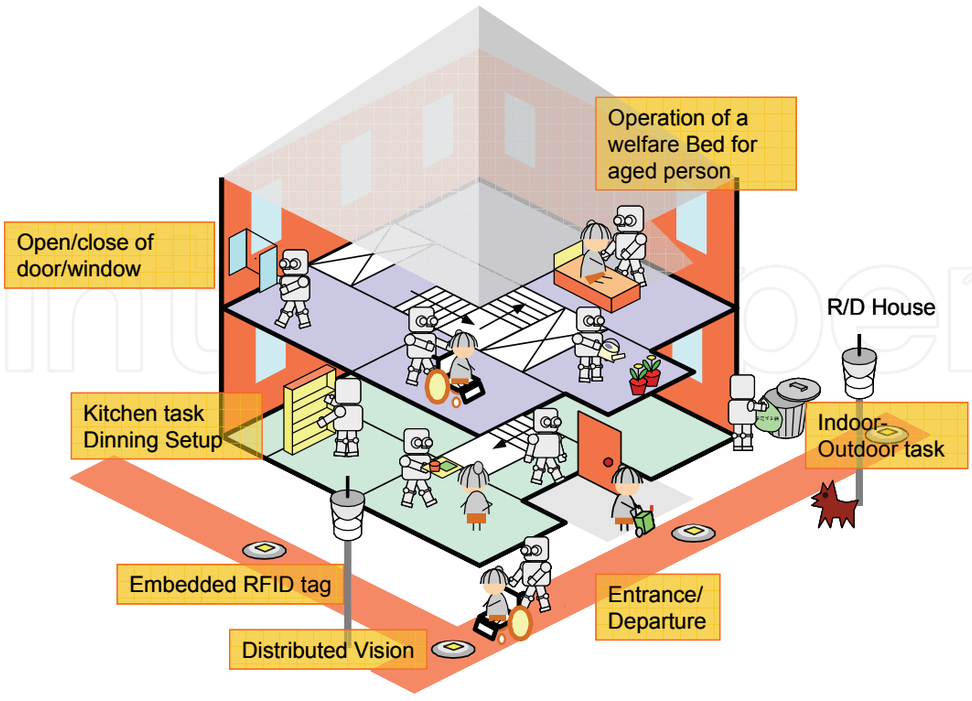


Fig. 4. Daily Life Support by Robots in/out of a house in Robot Town

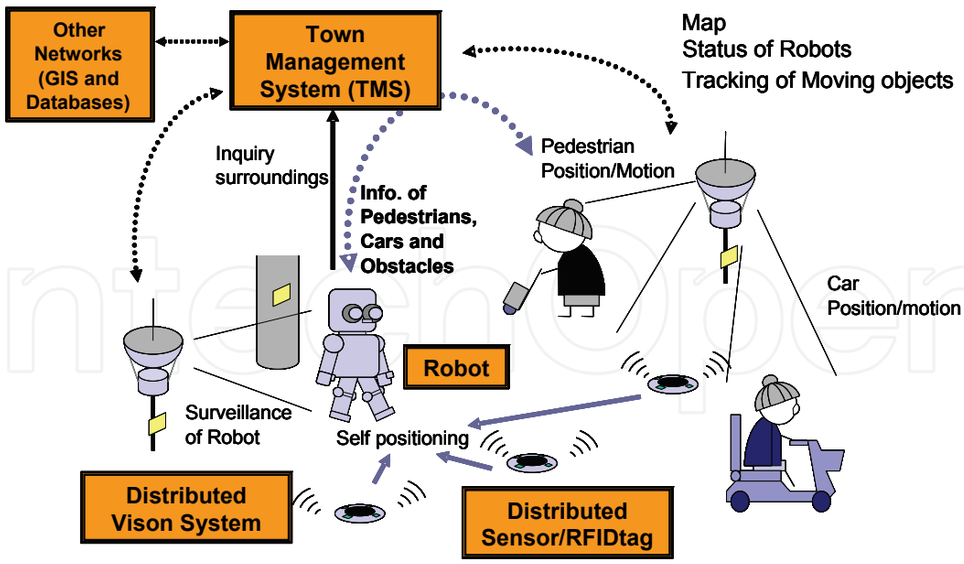


Fig. 5. Information Structuring of Robot Town



Fig. 6. Experimental House and Its Surroundings in Robot Town

Fig. 6 shows the experimental house and its surroundings. A number of open experiments have been conducted since January 2007. In the experiment in January 2007, when the parked car was detected by the sensor mounted on the house, the event of the arrival of the car was transmitted to the TMS and the TMS directed the command to the wheelchair robot to go to the parking area to bring the baggage automatically using RFID tags shown as cards mounted on the road as shown in Fig. 7. In the experiment in January 2008, when the wheelchair robot was called at the experimental bus stop, the robot went automatically to the person demanding the robot, using camera image from distributed vision system and RFID tags on the road as shown in Fig.8. Inside the house, two types of robots carried out the object-handling from the handling robot to the porter robot using the TMS as shown in

Fig. 9 (a). The TMS knows the position of the robots from distributed sensors and each object with tags. Fig. 9 (b) shows the real-time positions of the human and robots in the house.



(a) Start from the Base (b) Carry the Baggage

(c) Move along the Road (d) Return to the Entrance of the House

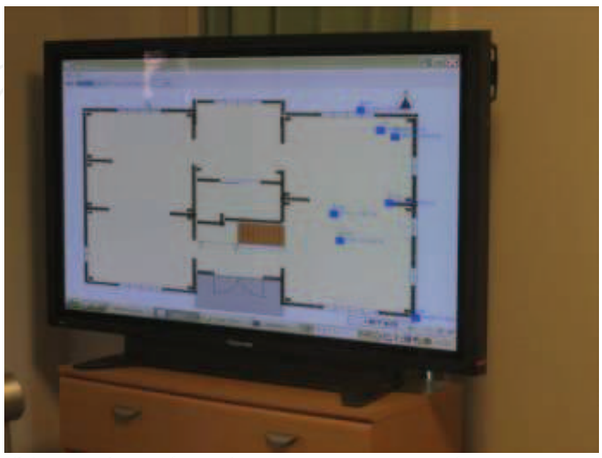
Fig. 7. Scenes of the Experiment of Wheelchair Robot in January 2007



Fig. 8. Scenes of the Experiment for Demanding the Wheelchair Robot in January 2008



(a) Dual Arm Robot and Porter Robot



(b) Display of Real-Time Positions of Humans and Robots

Fig. 9. Scenes of the Experiment in the Experimental House

4.2 Structuring of human behavior measurement 2006-2008 (Advanced Telecommunications Research Institute International (ATR))

A new framework for structuring environmental information based on humans' positions will be proposed. Structuralizing environmental information based on precise positions of humans who move in and out of buildings is one of the most important issues for realizing robots capable of providing various services (Kanda et al., 2007; Oike et al., 2007; Glas et al., 2007). For acquiring such information, the framework consists of three fundamental technologies: "Real-time robust measuring and recording of humans' positions," "Structuring environmental information based on the relationship between obtaining spatial information and the history of humans' positions," and "Constructing a common platform to provide the structured environmental information." The robotic service applications utilize the structured environmental information as shown in Fig. 10. It has the four-layered model, consisting of sensor, segment, primitive and service-and-application layers, to give the meanings in terms of space and behaviour for the robot services such as guidance, navigation and introduction. Fig. 11 shows the human position measurement system of the platform.

This platform is to be built in the Kansai area. There are two platforms planned; one is located at the lobby of the NICT (National Institute of Information and Communications Technology) Keihanna Building and another is UCW (Universal City Walk, Osaka). The former is named the Keihanna platform. The later is named the UCW platform. Fig. 12(a) shows the outside of the Keihanna platform. Fig. 12(b) shows the equipment of the platform.

Since the UCW is located at the front of Universal Studio Japan (USJ), many people walk through there. Fig. 13(a) and Fig. 13(b) show the outside of the UCW platform and the equipment of the platform, respectively. The sensing system composed of several cameras and laser rangefinders (LRFs) was set around the open space, and more than ten people were detected simultaneously by the sensing system and their behaviour was labelled as shown in the display. In the experiment in January 2008, the shop guidance by the robot was carried out in the UCW as shown in Fig. 14.

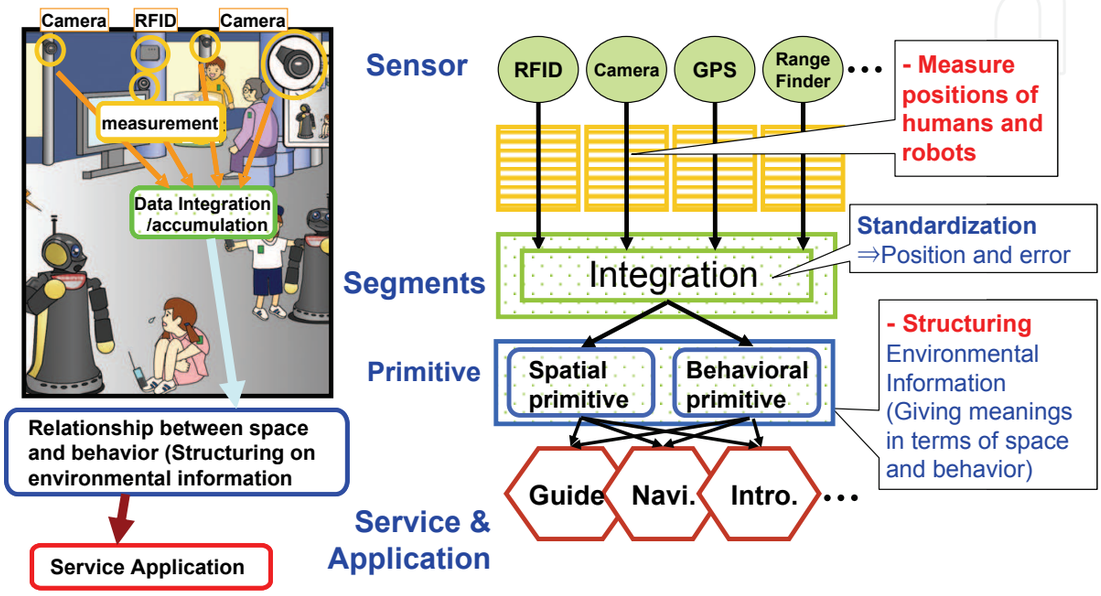


Fig. 10. Four-Layer Model for Structuring Environmental Information

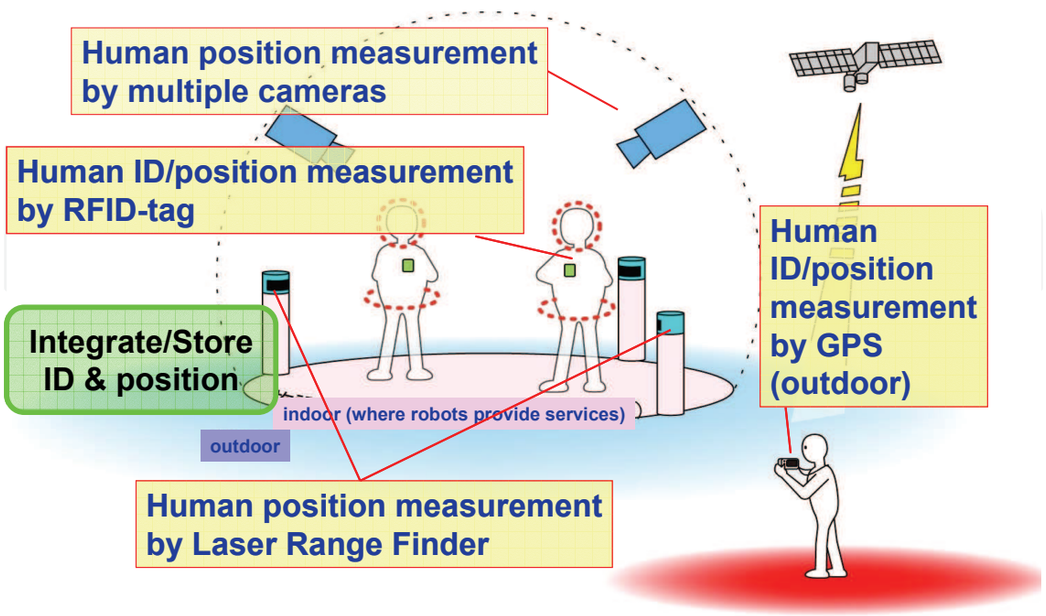
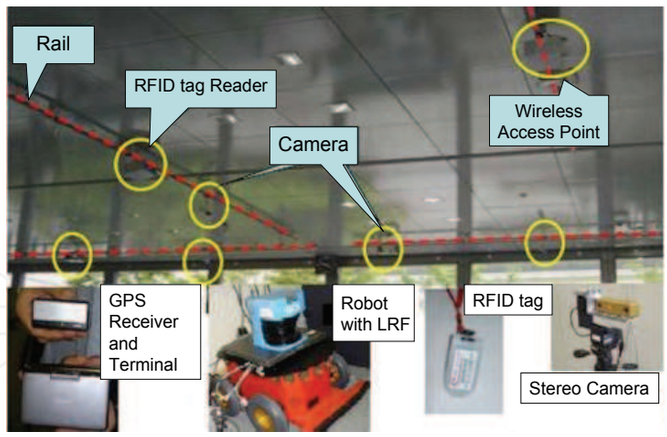


Fig. 11. Human Positioning System



(a) NICT Keihanna Building

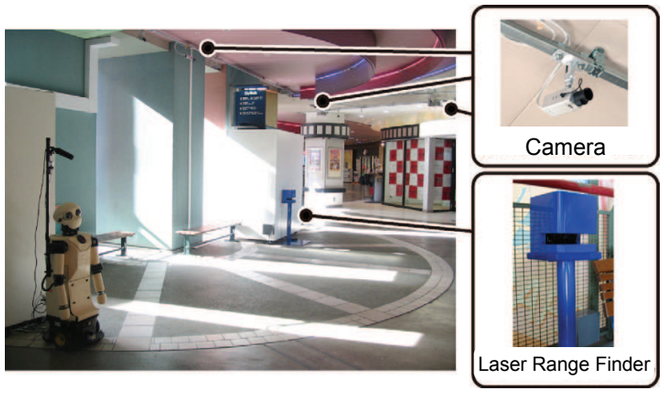


(b) Lobby of NICT Keihanna

Fig. 12. Keihanna Platform



(a) Outside UCW



(b) Equipment of UCW Platform

Fig. 13. UCW Platform



(a) Communication Robot talking to a Person



(b)Display of Real-time Positions of Humans and Robots

Fig. 14. Scenes of the Experiment in UCW Platform

4.3 Structuring of robot task 2006-2008 (AIST)

The goal of this project is to establish a common platform for robot infrastructure, i.e. universal design for next-generation robots, enabling various tasks in different environments by different robots (Ohara et al., 2008; Kamol et al., 2007; Sugawara et al., 2007). Fig. 15 illustrates the conceptual diagram of the universal design. To construct the robot platform, an environmental and robot manipulation framework is to be developed. The framework will be considered in terms of its physical level and intelligence level. This platform is to be built in the Tsukuba and Kanagawa areas. The prototype of the platform is built in AIST, Tsukuba.

The prototype platform is equipped with RFID tags, cameras and LRFs. Furthermore, Pseudlite, i.e. indoor GPS, Starlite, i.e. infrared LED transmitter, and other sensors are integrated into the platform (Ohara et al., 2008; Kamol et al., 2007; Sugawara et al., 2007). Fig. 16. illustrates the distributed sensors for robot localization in the platform.

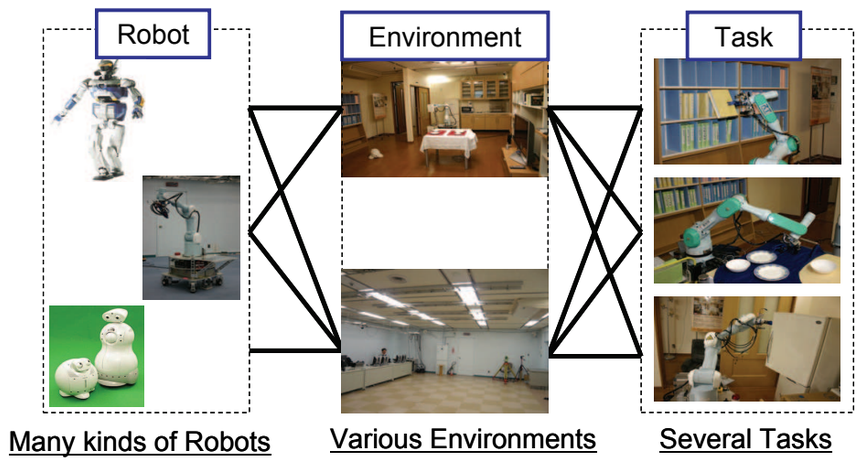


Fig. 15. Concept of Universal Design for Next-Generation Robots

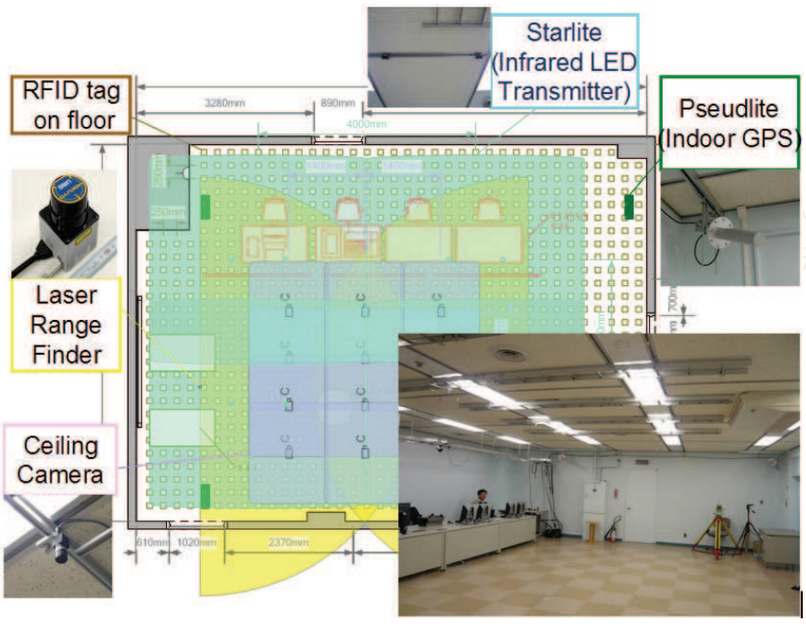


Fig. 16. Distributed Sensors in the Prototype of the Platform in Tsukuba

The interface of each sensor is standardized by RT (Robot Technology) middleware that has been proposed as a standard middleware for robotic technologies. The RT middleware is described in Section 4.4. The fine structure of a sensor is held as a profile. Each robot in the platform can obtain its position information in the same manner. It should be noted that the project is related to the standardization of the robotic localization service (Object Management Group, 2007).

For robotic tasks, distributed RFID tags, which have links to the knowledge database for robotic tasks, and visual markers indicating the knowledge are developed. Fig. 17 shows the concept of the knowledge storage distributed in the information-structured environment. To perform manipulation tasks, fine positioning within 5 mm and knowledge of the object to be handled are necessary. So, sensing strategy is changed depend on the distance and the knowledge is obtained through RFID tags and visual markers. A matrix code, also known as a 2D barcode, is utilized as the marker. The position and orientation of the matrix code is utilized for the visual servo of the robotic arm as shown in Fig. 18(a). The marker is named Coded Landmark for Ubiquitous Environment (CLUE). Since the matrix code of the CLUE is invisible under ordinary lighting, the CLUE has no effect on the design of the object, to which the CLUE is attached. The code emerges in ultraviolet lighting as shown in Fig.18(a). As a physical interface, the universal handle shown in Fig. 18(b) is developed so that a robot is able to handle miscellaneous doors easily. Furthermore, structuring of typical robotic tasks is conducted based on the pick and place task since most robotic tasks are divided into the pick and place tasks.

The experiment was carried out in October 2007. The demonstration task was carried out in which the robot opens the door of the refrigerator, picks up the package and places it on the electric range, and finally places the package on the table.

Fig. 19 shows some scenes of the robotic experiments.

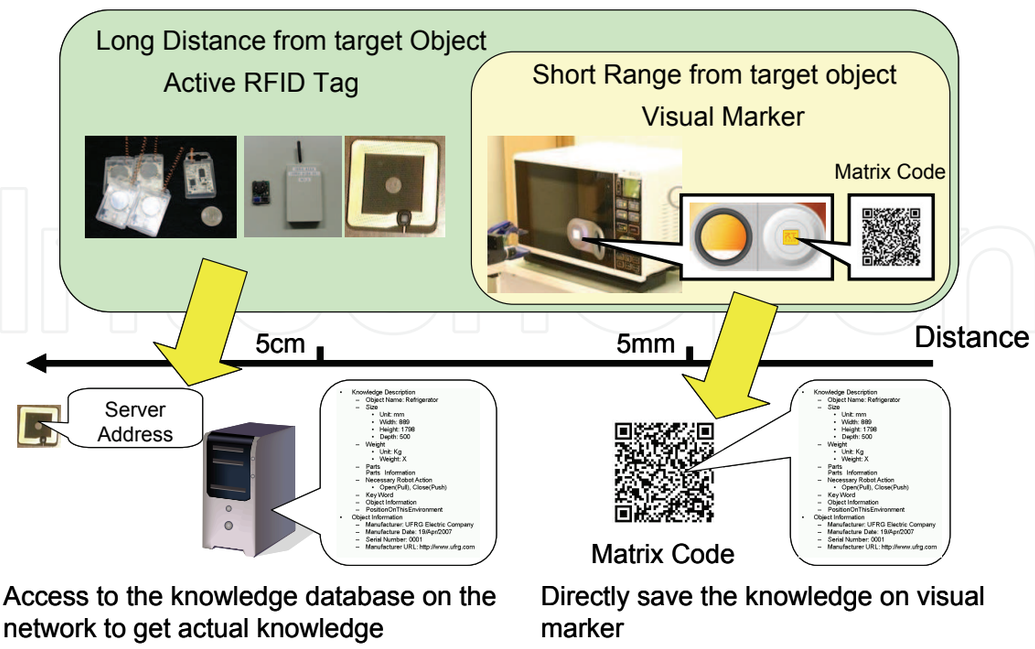


Fig. 17. Distributed Knowledge Storage in Information-Structured Environment



(a) Matrix Code Emersion by Ultraviolet Lighting (Left Image) (b) Door Opening by Universal handle

Fig. 18. Universal Handle with CLUE (Coded Landmark for Ubiquitous Environment)



(a) Dish Handling (b) Book Handling (c) Container Handling with Universal Handle

Fig. 19. Scenes of Experiments

4.4 Robot World Simulator 2005-2007 (National Institute of Advanced Industrial Science and Technology (AIST))

The objective of this project is to develop a robot simulator composed of distributed object modules (Nakaoka et al., 2007). The distributed object modules are implemented by RT Middleware (RTM). RTM is intended to establish a common platform based on the distributed object technology that would support the construction of various networked robotic systems by the integration of various network-enabled robotic elements called RT Components (RTCs) (OpenRTM-aist, 2007). RTM was adopted as a draft version of International Standard by the OMG in Oct. 2006. Fig. 20 shows the conceptual diagram of the simulator, the real robot and the RTCs. The RTC is a sharable robotic software module. The conceptual diagram of RTM and RTC is shown in Fig. 21.

The name of the simulator is OpenHRP3 (Open architecture Human-centred Robotics Platform 3). OpenHRP3, based on the humanoid robot simulator OpenHRP2 developed by AIST (Kanehiro, 2004), was partially open for limited users from 2007. The simulator will be open for unlimited users from April 2008. The robot world simulator OpenHRP3 will also be open to robot developers as a result of a "distributed-component robot simulator." Fig. 22 shows the user interface of OpenHRP3.

To enhance the dynamics simulation, a forward dynamics algorithm is to be developed and implemented by efficient O(n) and O(log n) algorithms, utilizing parallel computing (Yamane et al., 2006a, 2006b, 2007a, 2007b). Fig. 23 shows the simulation result and the experimental result of the humanoid robot made by OpenHRP3. The tendency of the motion

is almost the same. The simulation results were confirmed by a number of experiments using real robots. This is one of the advanced properties of OpenHRP3 as a robot dynamics simulator. Fig.24 shows a closed loop linkage mechanism, multi-transporter robots, a humanoid robot, a wheelchair and a robot arm as samples of simulations.

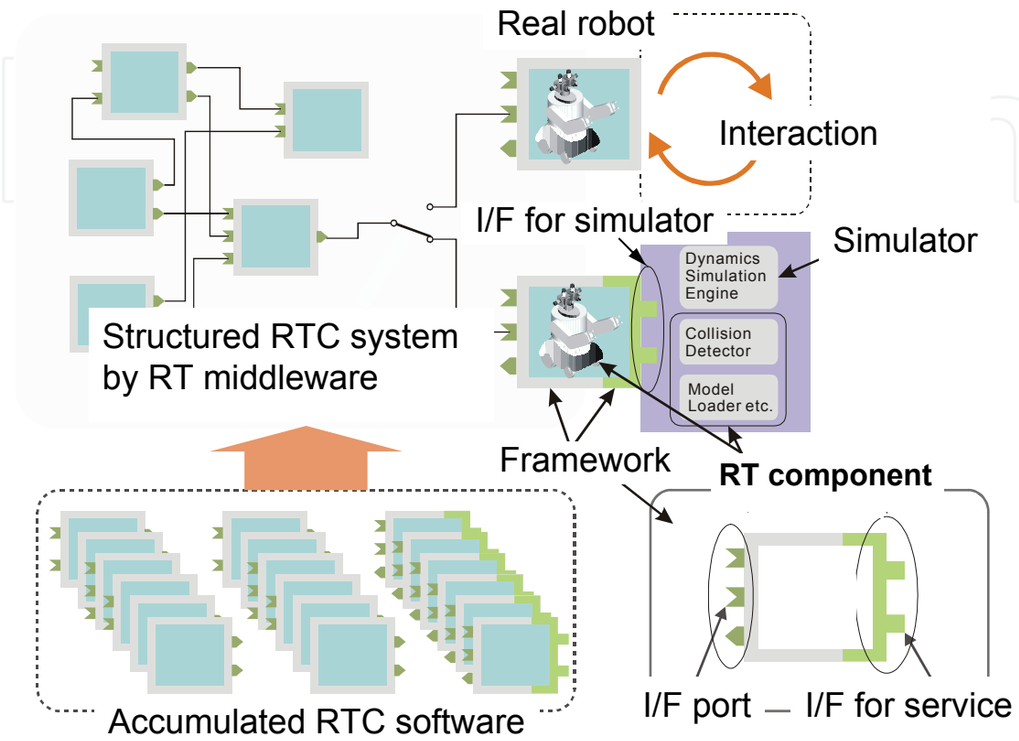


Fig. 20. Simulator, Real Robot and RT Components

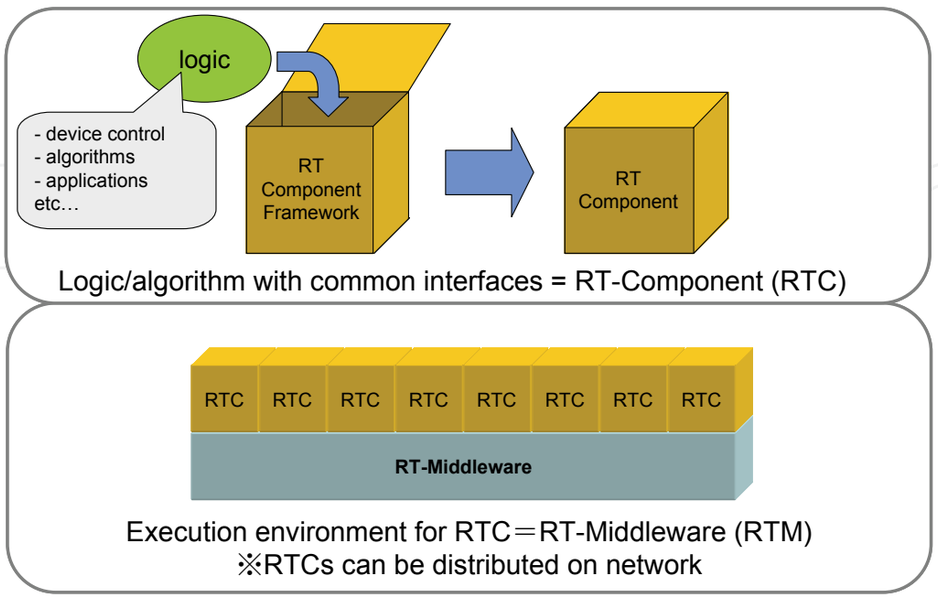


Fig. 21. Conceptual Diagram of RTM and RTC

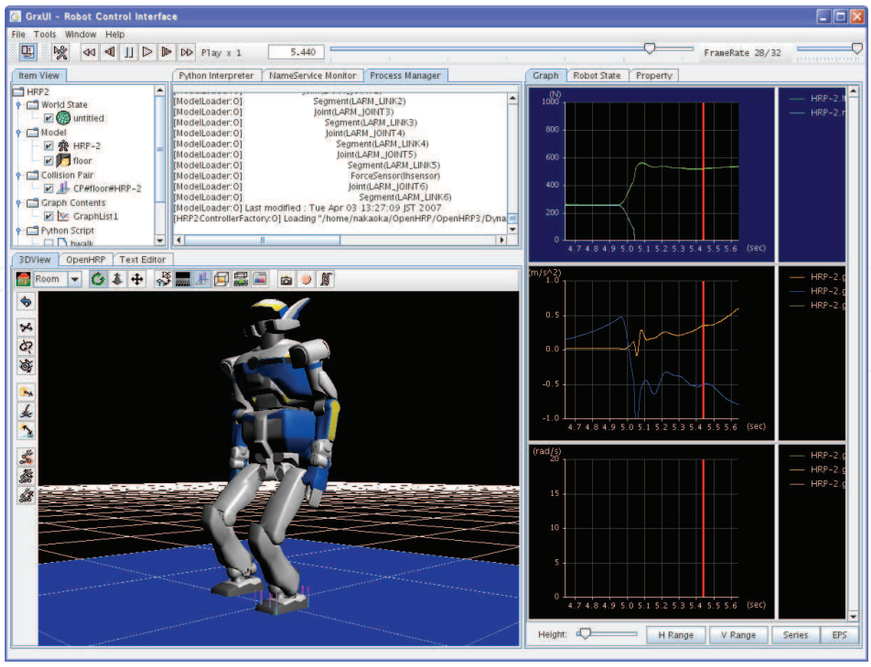


Fig. 22. GUI of OpenHRP3

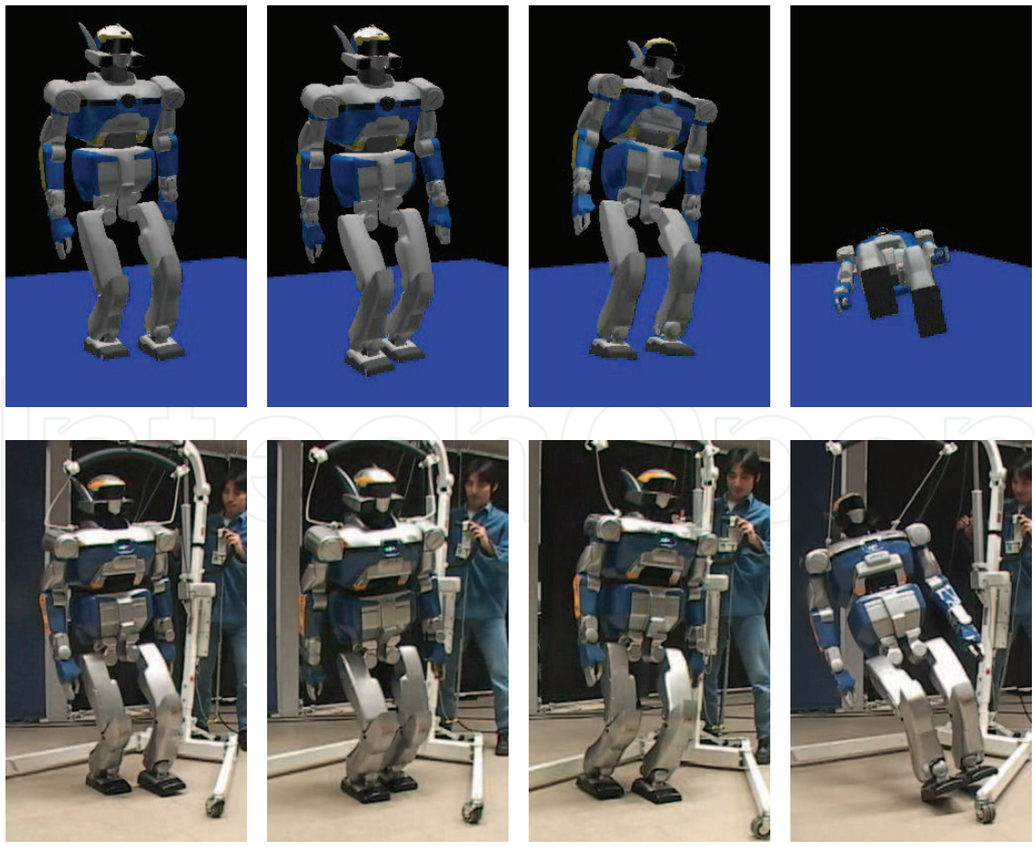
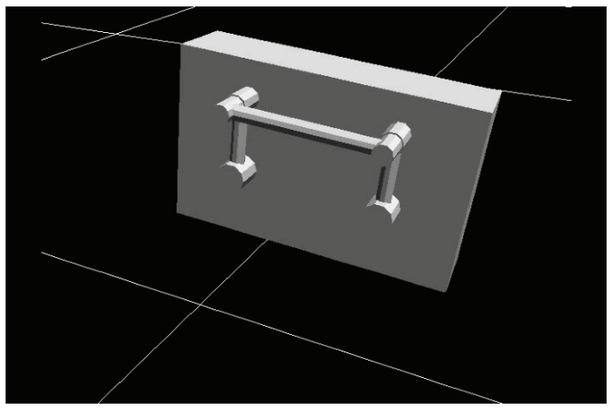
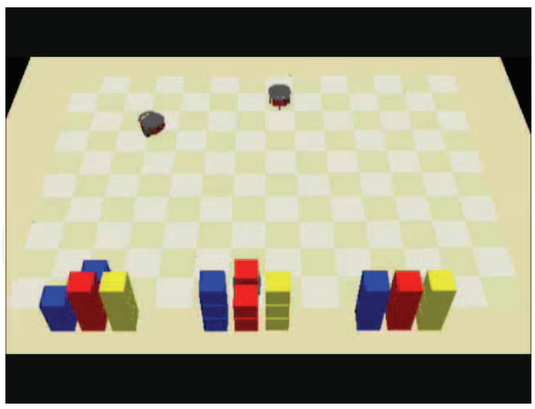


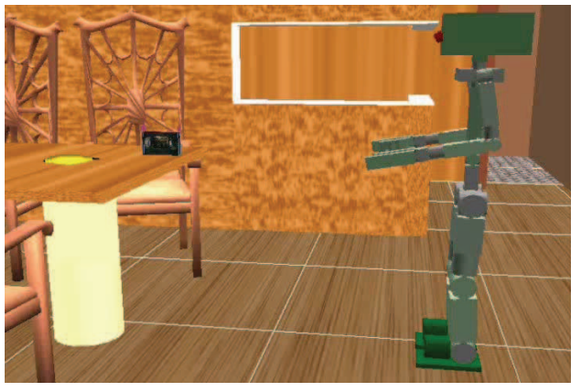
Fig. 23. Simulation Result and Experimental Result



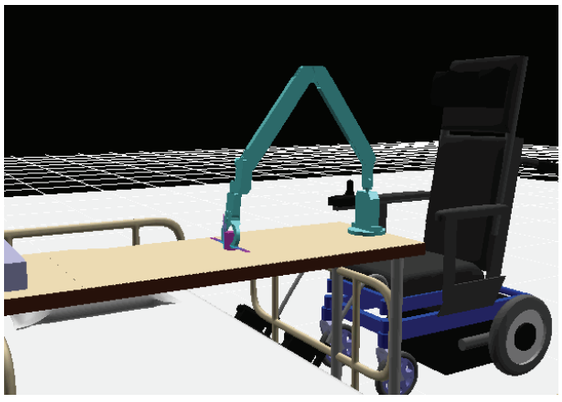
(a) Closed Loop Linkage Mechanism



(b) Multi-Transporter Robots



(c) Humanoid Robot



(d) Wheelchair and Robot Arm

Fig. 24. Various Simulation Tasks

4.5 General remarks on the platforms

As indicated above, the aim of these projects is to enable development and construction of a diverse range of environmental information structured platforms, ranging from the structure of a town to the structure of a work-space on a desk. Furthermore, a working environmental platform is to be built and installed, after research is completed, for common use by numerous robot researchers and engineers in the Fukuoka, Kansai, and Kanagawa areas. Additionally, the robot simulator is intended for public release in order to promote the sharing of software. These trials provide robot developers with a tool set which not only provides software usable solely for robot development, but also includes the environment in which a robot works. The overview of the common platforms project is shown in Fig. 25. Table 1 shows the specifications of the three environmental platforms.

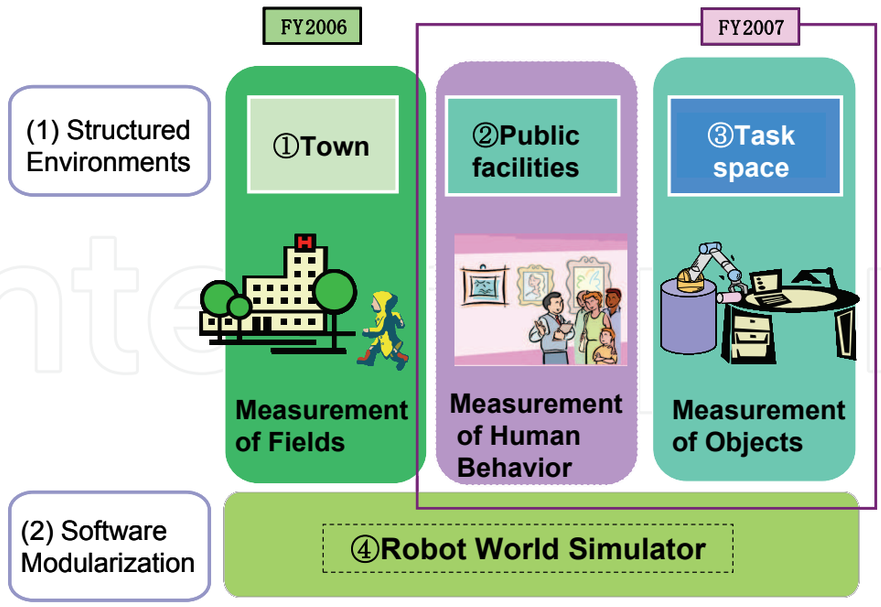


Fig. 25. Overview of Common Platform

PJ	Robot town by Kyushu Univ.	Human behavior measurement by ATR	Robot task by AIST
Measurement accuracy	Same as other Platforms	50 mm	50 mm 5 mm (for manipulation)
Embedded devices	RFID Cameras (distributed camera system) LRF GPS	RFID Cameras LRF GPS	RFID Cameras LRF iGPS (psudo-light)
Middleware	RT-middleware	Cross ML	RT-middleware
Provided function	-Position; robot, moving object -ID information -API	-Position; robot, humans -ID information -API	-Position; robot, objects -API including RT-components
Demonstration	Convey baggage & clothes, Guidance	Human support, e.g., Guidance	Clear the table & book return to the shelf
Open site	Experimental house and roads in Fukuoka Island City	NICT lobby and UCW in Kansai	Experimental house in Kanagawa Robot Park

Table 1. Specifications of Environmental Platforms (not final version)

5. Conclusions

In this paper, the outline of the "common platform technology for next-generation robots" promoted in the coordination program of science and technology projects for next-generation robots were introduced. Two projects, the robot town project and the world

robot simulator project, were completed by the end of March 2008 and some projects will be utilized in the new robotic project on robot intelligence of Ministry of Economy, Trade and Industry (METI). Standardization of information-structured environments and utilization of these platforms are to be discussed. The collaboration among ministries toward international standardization such as RT middleware and robot localization has started. Thus, collaborative robotic activities among ministries are becoming widespread. It is envisaged that robotics research will be accelerated by means of this core platform provided throughout society, which will work to disseminate services utilizing robots and will therefore spur development of the robot industry.

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7. References

Kidd, C.D.; Orr, R.; Abowd, G. D.; Atkeson, C. G.; Essa, I. A.; Blair MacIntyre; Mynatt, E.; Starner, T. E. & Newstetter, W. (1999). The Aware Home: A Living Laboratory for Ubiquitous Computing Research, *Proceedings of the 2nd International Workshop on Cooperative Building 1999 (CoBuild'99)*.

Gates, B. (2007). A Robot in Every Home, *Scientific American*, January 2007.

Glas, D. F.; Miyashita, T.; Ishiguro, H. & Hagita, N. (2007). Laser Tracking of Human Body Motion Using Adaptive Shape Modelling, *Proceedings of IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2007)*, pp.602-608.

Gerkey, B.; Vaughan, R. T. & Howard, A. (2003). The Player/Stage Project: Tools for Multi-Robot and Distributed Sensor System, *Proceedings of the 11th International Conference on Advanced Robotics (ICAR 2003)*, pp. 317-323.

Hasegawa, T. & Muarkami, K. (2006). Robot Town Project: Supporting Robots in an Environment with Its Structured Information, *Proceedings of The 3rd International Conference on Ubiquitous Robots and Ambient Intelligence (URAI2006)*, pp. 119-123.

Hasegawa, T.; Murakami, K.; Kurazume, R.; Senta, Y.; Kimuro, Y. & Ienaga, T. (2007). Robot Town Project: Sensory Data Management and Interaction with Robot of Intelligent Environment for Daily Life, *Proceedings of The 4th International Conference on Ubiquitous Robots and Ambient Intelligence (URAI2007)*.

Izawa, I. (2006). The National Promoting Policy for Robot Technology, *2006 Annual Conference of the Robotic Society of Japan (RSJ2006). (in Japanese)*

Kamol, P.; Nikolaidis, S.; Ueda, R. & Arai, T. (2007). RFID Based Object Localization System using Ceiling Cameras with Particle Filter, *Proceedings of The 2nd International Symposium on Smart Home (SH'07)*.

Kanda, T.; Shiomi, M.; Perrin, L.; Nomura, T.; Ishiguro, H. & Hagita, N. (2007). Analysis of People Trajectories with Ubiquitous Sensors in a Science Museum, *Proceedings of IEEE International Conference on Robotics and Automation (ICRA2007)*, pp.4846-4853.

Kanehiro, F.; Hirukawa, H. & Kajita, S. (2004). OpenHRP: Open Architecture Humanoid Robotics Platform, *International Journal of Robotics Research*, Vol.23, No.2, pp.155-165.

Kawaji, K.; Wang, Q.; Sasaki, T.; Hashimoto, H. (2007). Multiple Objects Localization in Intelligent Space - Utilizing User Hands Position Information from Position Server - , *Proceedings of The 4th International Conference on Ubiquitous Robots and Ambient Intelligence (URAI2007)*, pp.389-394.

Kurazume, R.; Tobata, Y.; Iwashita, Y. & Hasegawa, T. (2007). 3D Laser Measurement System for Large Scale Architectures Using Multiple Mobile Robots, *Proceedings of The 6th International Conference on 3-D Digital Imaging and Modelling*.

Lee, J. & Hashimoto, H. (2002). Intelligent Space -concept and centents-, *Advanced Robotics*, Vol.16, No.3, pp.265-280.

Lee, J.; Morioka, K. Ando ,N. & Hashimoto, H. (2004). Cooperation of Distributed Intelligent Sensors in Intelligent Environment, *IEEE/ASME Transactions on Mechatronics*, Vol.9, No.3, pp.535-543.

Lee, K.; Kim K.; Shim, H. & Lee, J. (2007). Unified S/W Platform for Ubiquitous Robot, AnyRobot Studio, *Proceedings of The 4th International Conference on Ubiquitous Robots and Ambient Intelligence (URAI2007)*.

Michel, O. (2004). Cyberbotics Ltd - WebotsTM: Professional Mobile Robot Simulation, *International Journal of Advanced Robotic Systems*, Vol.1, No.1, pp. 39-42.

Nakaoka, S.; Hattori, S.; Kanehiro, F.; Kajita, S. & Hirukawa, H. (2007). Constrained-based Dynamics Simulator for Humanoid Robots with Shock Absorbing Mechanisms, *Proceedings of IEEE/RSJ International Conference on Intelligent Robots and Systems 2007 (IROS 2007)*, pp.3641-3647.

Nesnas, I. A.; Simmons, R.; Gaines, D.; Kunz, C.; Diaz-Calderon, A.; Estlin, T.; Madison, R.; Guineau, J.; McHenry, M.; Shu, I.. & Apfelbaum, D. (2006). CLARAty: Challenges and Steps Toward Reusable Robotic Software, *International Journal of Advanced Robotic Systems*, Vol. 3, No.1, pp. 23-30.

Object Management Group (2007). Request for Proposal: Robotic Localization Service, OMG document robotics/07-06-25.

Ohara, K.; Sugawara, T.; Lee, J. H.; Tomizawa, T.; Do, H. M.; Liang, X.; Kim, Y. S.; Kim, B. K.; Sumi, Y.; Tanikawa, T.; Onda, H.; Ohba, K. (2008). Visual Mark for Robot Manipulation and Its RT Middleware Component, *Advanced Robotics*, Vol.22, No.3.

Oike, H.; Wada, T.; Iizuka, T.; Wu, H.; Miyashita, T. & Hagita, N. (2007). Detection and Tracking using Multi Color Target Models, *Proceedings of SPIE Optics East 2007*.

OpenRTM-aist (2007). http://www.is.aist.go.jp/rt/OpenRTM-aist/html-en/

Pentland, A. (1995). Machine Understanding of Human Action, *Proceedings of 7th International Forum Frontier of Telecommunication Tech*.

Sato, T.; Harada, T. and Mori, T., Environment-type Robot System "Robotic Room" Featured by Behavior Media, Behavior Contents, and Behavior Adaptation, *IEEE/ASME Transactions on Mechatronics*, Vol. 9, No. 3, pp.529-534, 2004.

Sugawara, T.; Tomokuni, N.; Lee, J.; Tomizawa, T.; Ohara, K.; Kim, B. K. & Ohba, K. (2007). Development of Ubiquitous Mobile Manipulator System with RT-Middleware, *Proceedings of the International Conference on Control, Automation and Systems 2007 (ICCAS2007)*, pp. 2473-2476.

Tanie, K. & Matsuhira, N. (2006). Common Platform Technology for Next Generation Robots, 2N12, DS15, *Proceedings of Annual Conference of Robotics Society of Japan (RSJ2006). (in Japanese)*

Yamane, K. & Nakamura, Y. (2006). Stable Penalty-Based Model of Frictional Contacts, *Proceedings of International Conference on Robotics and Automation (ICRA2006)*, pp. 1904-1909.

Yamane, K. & Nakamura, Y. (2006). Parallel O(logN) Algorithm for Dynamics Simulation of Humanoid Robots, *Proceedings of IEEE-RAS International Conference on Humanoid Robotics*, pp. 554-559.

Yamane, K. & Nakamura, Y. (2007). Automatic Scheduling for Parallel Forward Dynamics Computation of Open Kinematic Chains, *Robotics: Science and Systems*.

Yamane, K. & Nakamura, Y. (2007). Robot Kinematics and Dynamics for Modelling the Human Body, *Proceedings of International Symposium on Robotics Research*, pp. 77-88.

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This book consists of 18 chapters about current research results of service robots. Topics covered include various kinds of service robots, development environments, architectures of service robots, Human-Robot Interaction, networks of service robots and basic researches such as SLAM, sensor network, etc. This book has some examples of the research activities on Service Robotics going on around the globe, but many chapters in this book concern advanced research on this area and cover interesting topics. Therefore I hope that all who read this book will find lots of helpful information and be interested in Service Robotics. I am really appreciative of all authors who have invested a great deal of time to write such interesting and high quality chapters.

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