OVERVIEW OF THE NATIONAL PROJECT "FRIENDLY NETWORK ROBOTICS"

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ABSTRACT

The Agency of Industrial Science and Technology of the Ministry of International Trade and Industry has started the feasibility study on the new project "Friendly Network Robotics" in 1996. This project is conducted under the Industrial Science and Technology Frontier Program. The project aims at developing technologies to construct human friendly robots that can provide various useful services to human beings in their daily lives. Research agenda include human friendly robot mechanisms, human-robot collaboration control methods, distributed intelligence technologies and network tele-robot technologies with the future advancement of communication network technology in mind.

1. INTRODUCTION

The Agency of Industrial Science and Technology (AIST) of the Ministry of International Trade and Industry (MITI) has been conducting the Industrial Science and Technology Frontier Program and is promoting several research and development projects in order to achieve the objectives of the creation and promotion of new industries, the vitalization of the economy and the improvement of the quality of life based on the novel results of science and technologies. Before starting a new research and development project in this scheme a two-year feasibility study is usually conducted to evaluate the project. The two-year feasibility study on the Friendly Network Robotics has been approved and started in 1996. In this paper the main concept and key technologies of the project will be discussed.

2. OBJECTIVES

The rapid and enormous increase of the number of the elderly people toward the 21st century is becoming a big social problem in Japan. In the beginning of the 21st century, the aged people over 65 years old will occupy 20 percent. We will live in the society where at least one out of five people is over 65 years old. In such a society it will be highly required to improve the productivity in the offices and in the service industries as well as in the manufacturing industries, and the needs for medical care and welfare services will greatly increase. Highly advanced robots are expected to be an answer to solve these problems. One of the expected applications of this kind of robots is to work in places where human beings exist in various fields as well as in construction sites. Another application is to take care of patients and elderly people in their daily lives to improve the quality of life.

The "Friendly Network Robotics" project has been proposed to develop technologies to construct an intelligent robot that is able to work in actual human societies to offer various kinds of services with its gentle actions and behaviors. This purpose of the project will meet the needs the aged society inevitably requires.

The current robots are mainly used to release workers from dangerous tasks by automating processes in manufacturing industries. In this case these industrial robots are used in the limited areas, such as manufacturing factories and large scale plants, where the robots are entirely separated from human daily life. The project aims to develop key technologies for the robot that will be used in our daily lives, such as at homes and in offices and hospitals as well as in the industries.

The project is also expected to create new industries like car and TV set industries which are large consumer product industries. If technologies to construct daily-life-use robots are developed in the project, the project will trigger the creation of a large robot market, and may create a new robot industry, which will be comparable to car and TV set industries.

3. TECHNOLOGICAL CONCEPTS AND PROSPECTED APPLICATION AREAS

Conventional robots have been developed as automation devices. Today a lot of industrial robots are used mainly in factories in order to increase the productivity and to release human workers from hard, dangerous and dirty jobs. These industrial robots work in the environment separated from human beings. This situation developed the image that the robots work in a space isolated from human beings. Actually, current industrial robots are heavy and hard compared with human beings and can further surpass them in output power. In order to secure the human safety the robots are used employing absolute safety

countermeasure, for example, setting up a fence between the robots and human beings.

Different from the industrial robots, the daily-life-use robots must coexist with human beings in the common working space. Such robots are required to act coordinating with human actions and to be harmless to delicate human bodies. Many technological problems must be tackled to establish technologies to realize human friendly daily-life-use robot.

From the historical point of view, it is apparent that the related technologies to the robotics have greatly contributed to the realization of new robot functions. For instance, the progress of servo control techniques, computer science and micro electronics largely contributed to the recent advancement of the robotics and its practical use in various production lines. High speed computer network technology for information and telecommunication fields is drawing the attention recently. In Japan the information super highway utilizing fiber optics is planed to be constructed in the beginning of the 21st century. This infrastructure will enable high speed information exchanges among various places throughout Japan. The super highway is expected to be an infrastructure of multi-media communication in the information technological field. It is also an important technological infrastructure to add new functions to an advanced robot. For example, powerful computer network is predicted to stimulate the advance of new network-based robotics by integrating distributed intelligence through the network as well as by facilitating the tele-operation of remote robots located far away in the network.

With the two key words, "Human friendly robotics" and "network based robotics", we aim at establishing a new technology paradigm for robotics, utilizing both robot technology which allows coexistence of robot and human, and network technology of information and telecommunication fields.

Figure 1 shows the possible application areas imaged in this project where new robots are expected to work for and with human beings. Construction is one of the promising application fields where the robot is able to work effectively with human workers.

4. KEY TECHNOLOGIES

As mentioned above, the "Friendly Network Robotics" project is planned under two concepts: human friendliness and network-based. Individual research topics currently under consideration are the followings.

(1) SOFT ROBOTICS
"Soft robotics" means new robot technology suitable for coexistence with human beings. Most of the present robots are made of hard metal and work at higher speed with higher power than human beings because they have been designed without considering coexistence

with human beings. Soft robot structures and control methods as well as sensors make robots safe to human beings in case of unexpected collision and are also friendly to human beings. One of the ideal models is the structure of a human body which consists of hard bones and soft tissue, that is, skin and muscle.

(2) HIGH LEVEL COMMUNICATION

Daily-life-use robots need to be easily operated so that any untrained people including aged people can handle them as easily as they use household electrical apparatus. "Human-robot interface technology" is required to be developed. This technology includes the functions of measuring human behavior, recognizing it, understanding its intention, and high performance tele-operation using virtual reality. One of the goals of this interface is to enable a user to control a robot without manuals.

(3) HYPER AUTONOMY

Autonomous control and collaboration. control technology among robots and human beings should be studied. Components of these technologies seem to be multi-robot control technologies based on the distributed intelligence and the behavior-based intelligence so that a robot can decide its action according to the observation of surrounding robots' behaviors.

(4) DISTRIBUTED NETWORK INTELLIGENCE

Though high level intelligence is needed for human friendly robots, the robots can not have all intelligence required. By integrating the various types of robot intelligence distributed in a network and by activating them as a group, higher intelligence of a robot seems to be realized.

(5) NETWORK TELE-ROBOTICS TECHNOLOGY

The future advancement of communication network technology will provide useful tools to the development of network tele-robot technologies. The research agenda of this subject includes tele-operation technology, cooperation technology for multiple tele-robots, cooperation technology between human and tele-robot, tele-experience technology, and tele-communication technology.

(6) NETWORK MECHATRONICS TECHNOLOGY

The future advancement of communication network technology will enable the connection of various mechatronics systems including robots to the computer communication network and the control of them efficiently through the network. This technology includes network interface apparatus, compression/extension method of huge

information and ATM (Asynchronous Transfer Mode) method.

Figure 2 shows a schematic presentation of the key technologies of "Friendly Network Robotics Project". The technologies developed in this project will have a wide range of applications from home use to construction works.

5. CONCLUSIONS

The feasibility study has started in 1996. More concrete research themes are being proposed and screened based on the two concepts, that is, "human friendliness" and " network-based". Individual research themes, application areas, and the way of project formation will be further discussed and refined by experts from industries, universities and the government in this feasibility study to launch the project.
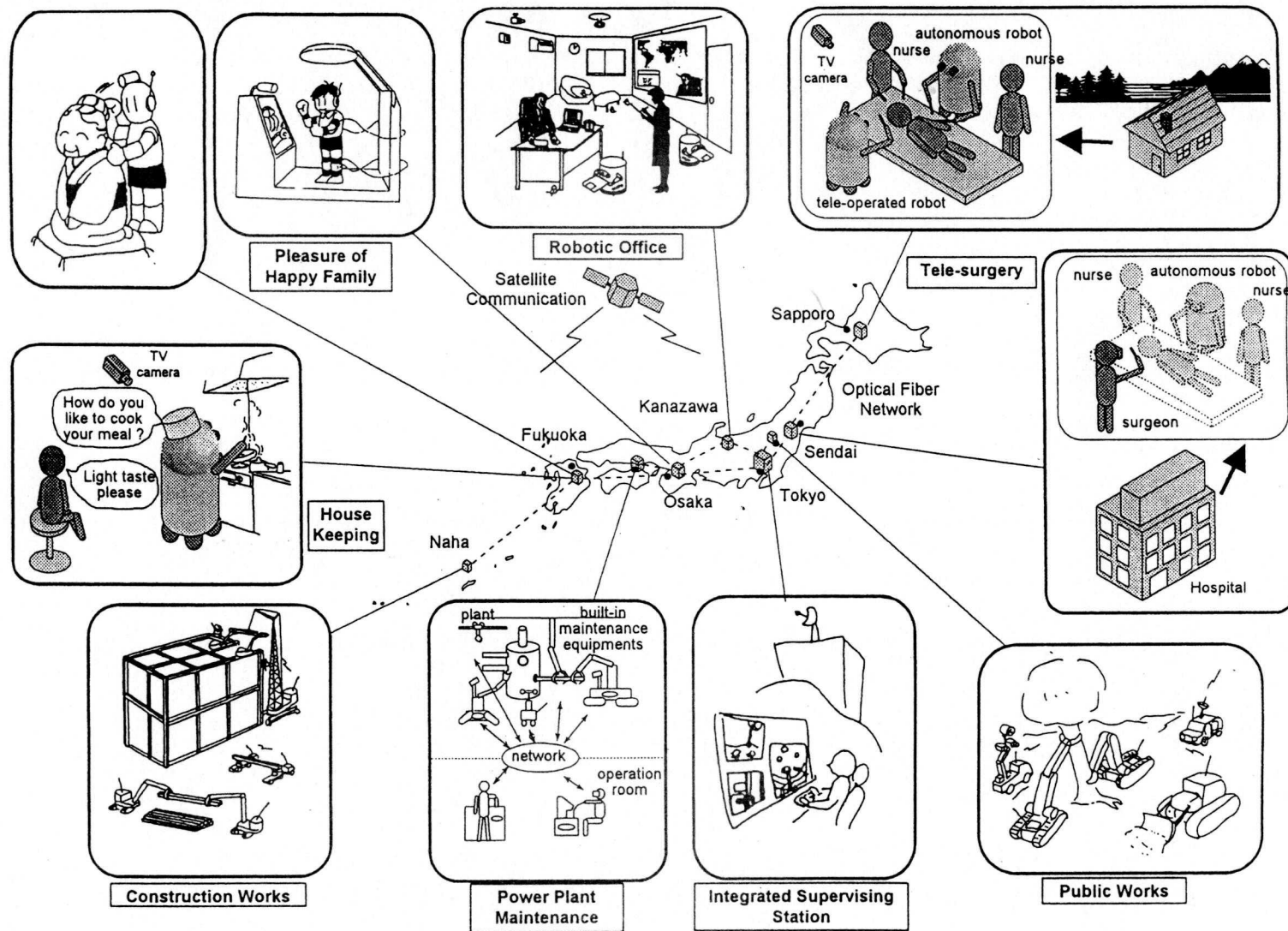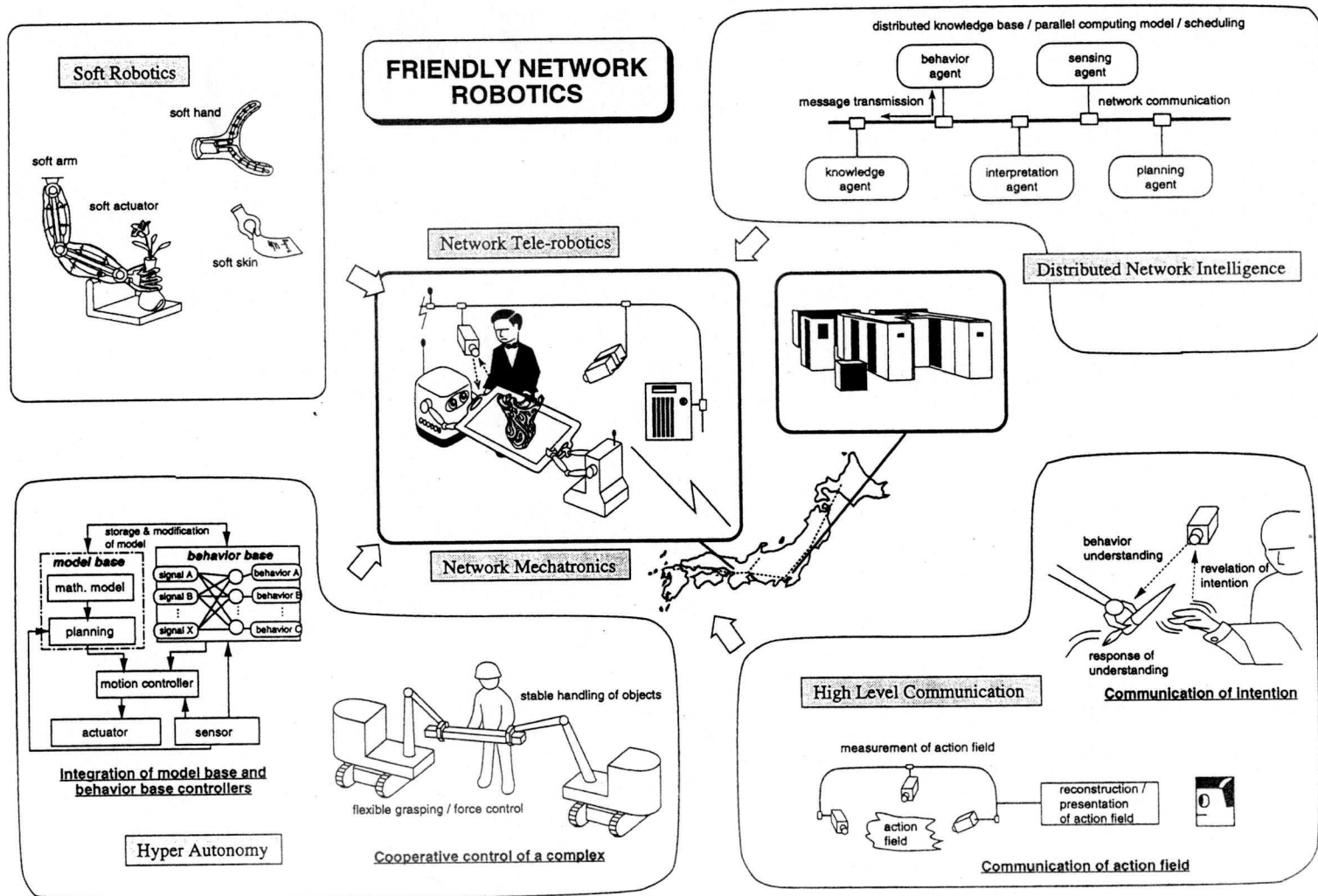
Figure 1   Application areas of Friendly Network Robotics

Figure 2 Key technologies of "Friendly Network Robotics Project"