5 Towards Creation of a Communications Support Environment

5-1 Barrier-free Communications

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This paper describes the research on the barrier-free communication focusing on the information communication technology that it should realize in aging society in the twenty-first century. To begin with, the research of the information barrier-free in which the elderly and the disabled would not be covered with the disadvantage in reception and transmission of information is described. Especially, robustness of the system and utilization of non-verbal information are important in the technology of sign language and voice interpretation that support the communication between deaf people and normal listener. Next, robotic communication terminals which supports the mobility such as free and easy strolls of the elderly and the disabled is described. It is important that the system would be able to correspond to dynamism of the real world and diversity of the elderly and the disabled.

Keywords
elderly, disabled, barrier-free, sign language, translation, mobility support, robot

1 Introduction

Computerization has recently made rapid progress, with the massive development of information communication technology. A large amount of information now enters homes, enterprises, and administrative agencies, and is exchangeable at any time between anyone anywhere. This has been made possible through optical-cable, mobile communication, digital broadcasting, and large-capacity global networks. This flow of information will continue throughout the early 21st century.

At the same time, Japan is rapidly aging and the Japanese are having fewer children, leading to an extremely rapid rate of demographic change with in Japan. The National Institute of Population and Social Security Research estimated that the elderly should represent one in five of the population in the year of 2006, one in four in 2015, and one in three in 2050. White Paper on the Disabled produced by the Prime Minister's Office[1] reported that officially registered (holding impaired-persons handbooks) visually impaired, hearing- and speech-impaired, and physically impaired now number 350,000, 360,000, and 1,550,000, respectively. The hearing- and speech-impaired, including those who became so at an old age, are said to total six million. The increasingly accepted concept of "normalization" has provided the disabled with equal rights and allowed them to live and work together with the non-disabled without being obliged to move from their home towns. This concept has resulted in gradual progress toward barrier-free environment, but barriers have still not been adequately eliminated. One normally thinks of such barriers as those involving transportation and roads but, in an advanced information society, in addition to such a physical environment, information must also be barrier-free.

In 1998, the Ministry of Posts and Telecommunications created the guidelines "Accessibility to Telecommunication Facilities," in order to realize a barrier-free information environment[2]. These guidelines are intended to help create an environment in which everyone, including the non-disabled, the disabled, and the elderly, can enjoy the benefits of the growing information society. In the developing advanced information society, it is urgent that telecommunication technology that helps create a barrier-free information society for the elderly, the disabled, and all other people be developed, in order to allow information to be sent and received and to increase the overall health and safety of all of the country's citizens.

This paper describes a study on barrier-free communication. With a focus on telecommunication technology, we continue this study in an effort to realize such communication in the aging society of the 21st century, in which fewer and fewer children are being born. Specifically, this paper focuses on a barrier-free information society that allows the elderly and disabled to easily send and receive information, and on a robotic communication terminal (RCT) that helps enable such people to move comfortably.

2 Barrier-free information

The "digital divide" is a major problem. Depending on their location, income, and educational level, some have access to Internet information and others do not. This is a particularly serious problem for the elderly and disabled. Many countries have attempted to eliminate such a divide[3].

As a barrier-free communication terminal for the visually impaired, a screen reader has been developed for input and output (or output only) using the voice (or the sense of touch) [4][5]. This device, however, leaves many problems for conveying information using graphical user interfaces (GUI) to the visually impaired unsolved, because GUIs are developed for sighted people. For example, text can be vocalized, but it is difficult explaining an illustration to the visually impaired. Describing a photo may be a problem in the future, but it should be possible to communicate information contained in a chart, table, or graph. However, the screen reader is a revolutionary invention in the sense that it requires no other person to assist in accessing the Internet. It is also useful for the elderly with poor eyesight. More advanced voice-recognition technology is expected to be developed, enabling widespread use by those who cannot see the screen clearly while traveling.

Those who become hearing-impaired over the course of their lifetime require a different approach. As they have already acquired the ability to understand the Japanese language, it is preferable to provide text rather than sign language. Teletext is used widely today in TV news broadcasts[6]. In the future, when the technology advances to such a level that the communication terminal can handle general speaker's voices, the postnatal hearing-impaired may be able to view a text translation and communicate with those around them.

In the following, we describe a study on an advanced dialog system between sign language and voice, to support communication between a person of normal hearing and a hearing-impaired person (a deaf person) who uses sign language on a daily basis.

2.1 Advanced interpretation system between sign language and voice

A deaf person has more difficulty in everyday communication than in the use of a communication terminal. The general use of lip reading, written communication, and sign-language interpreters cause the speaker to feel stress and expose the privacy of the disabled person to the interpreter. To avoid these problems, studies are underway to develop a technology for recognizing and converting sign language into voice, and vice versa, as shown in Fig. 1[7][8].

At the Communications Research Laboratory, we have been working since 1995 to

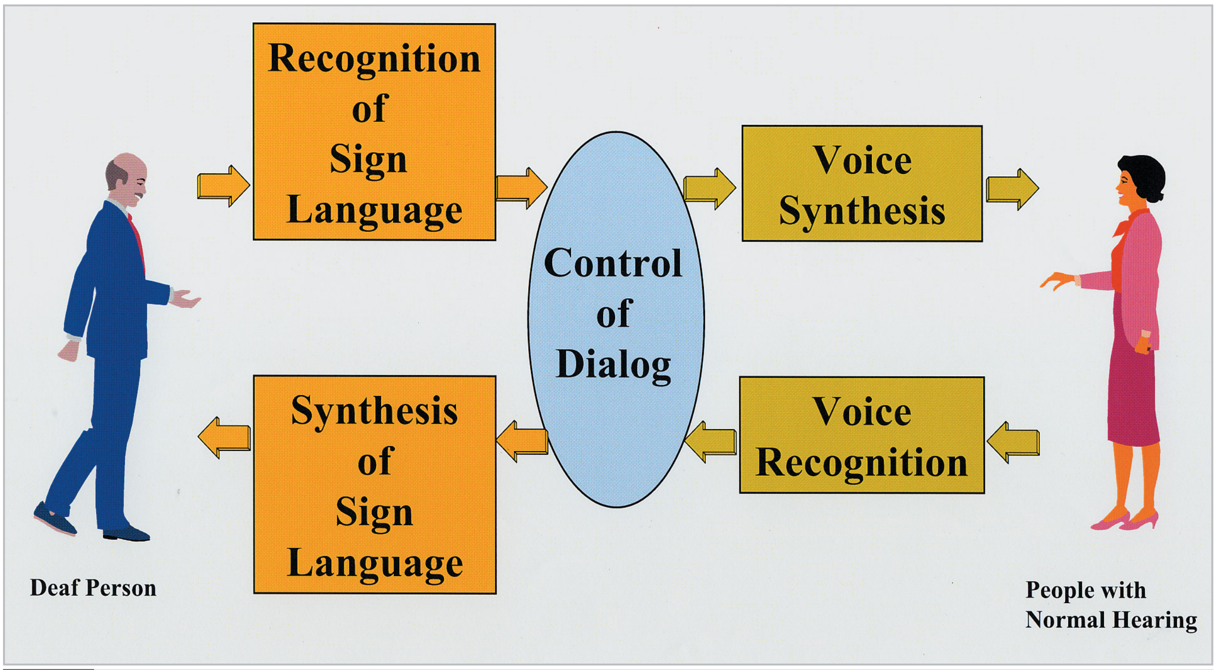

Fig. 1 *Technology for interpreting sign language and voice*

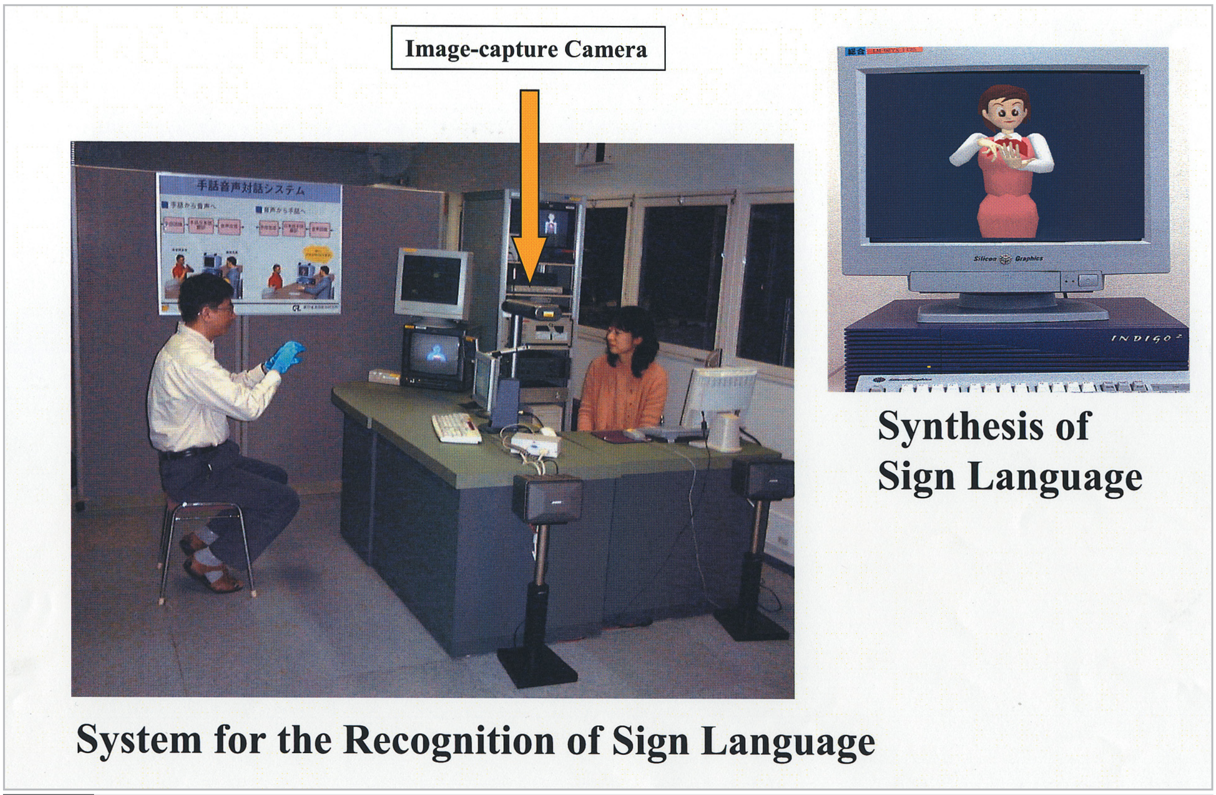

Fig. 2 *Dialog system between sign language and voice*

develop a system for the recognition and synthesis of sign language as a barrier-free technology for the disabled. Upon completion of Phase 1 in 1999, we developed a dialog system between sign language and voice[7] (as shown in Fig. 2), and a video database for sign language[9]. The system for the synthesis of sign language allows the generation of sign-language animation upon input of spoken Japanese, and is close to being put into practical use[10]. However, the translation system involves practical difficulties in the recogni-

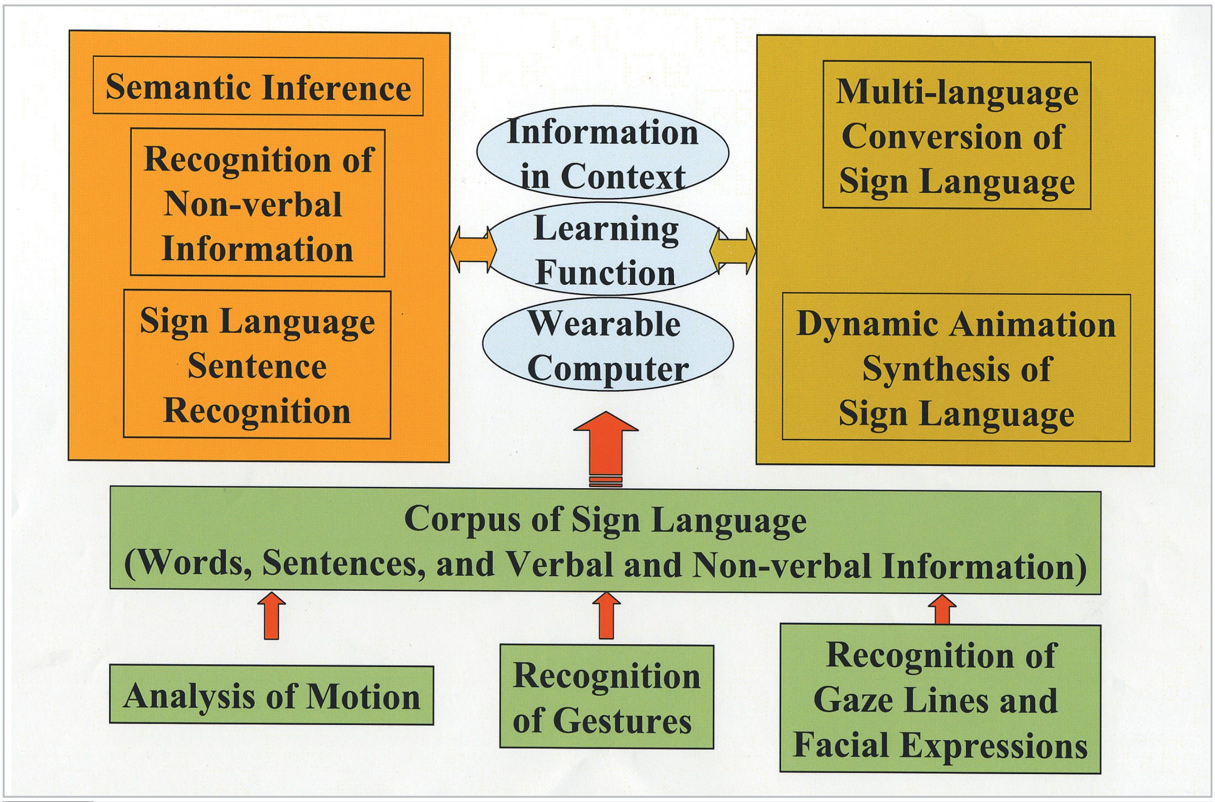

Fig.3 *Advanced interpretation technologies between sign language and voice*

tion of sign language, leaving many problems unsolved.

Fig. 3 describes the future studies. These studies will be intended, in particular, to develop robust systems for general speakers. To make possible sign language sentence recognition, it is necessary to automatically detect the end of each word in video images of sign language, and to divide each sign-language sentence into meaningful units. The Japanese language and sign language are linguistically different. Thus, to solve the problems involved in the treatment of a natural language, it is necessary to break a spoken sentence down into sign-language words, and to rearrange those words in accordance with the sign language grammar. It is also necessary to reconstruct a complicated structure into a simple one. We plan on developing an advanced interpretation system between sign-language and voice by recognizing non-verbal information and converting it into a dynamic natural sign language. Such information includes the shape of the lips, gaze lines, gestures, and other non-verbal information. In the future, it will be necessary to further improve translation technology by analyzing the context and inferring the intention of the information sender. We plan on applying the sign-language synthesis technology to foreign sign languages, particularly Korean, in cooperation with Korean researchers. We will also consider developing an application in American sign language at a later date.

2.2 Communication between those with different types of disabilities

In the future, as shown in Fig. 4, it will be necessary to develop 1) an interface that allows elderly or disabled users to operate a communication terminal using natural voices and gestures, without being conscious of the terminal; 2) an information filter that allows effective access to needed information; 3) a communication agent; and 4) media conversion technology. Once the above development is achieved, we should be able to provide a system for communication between persons with different types of disabilities.

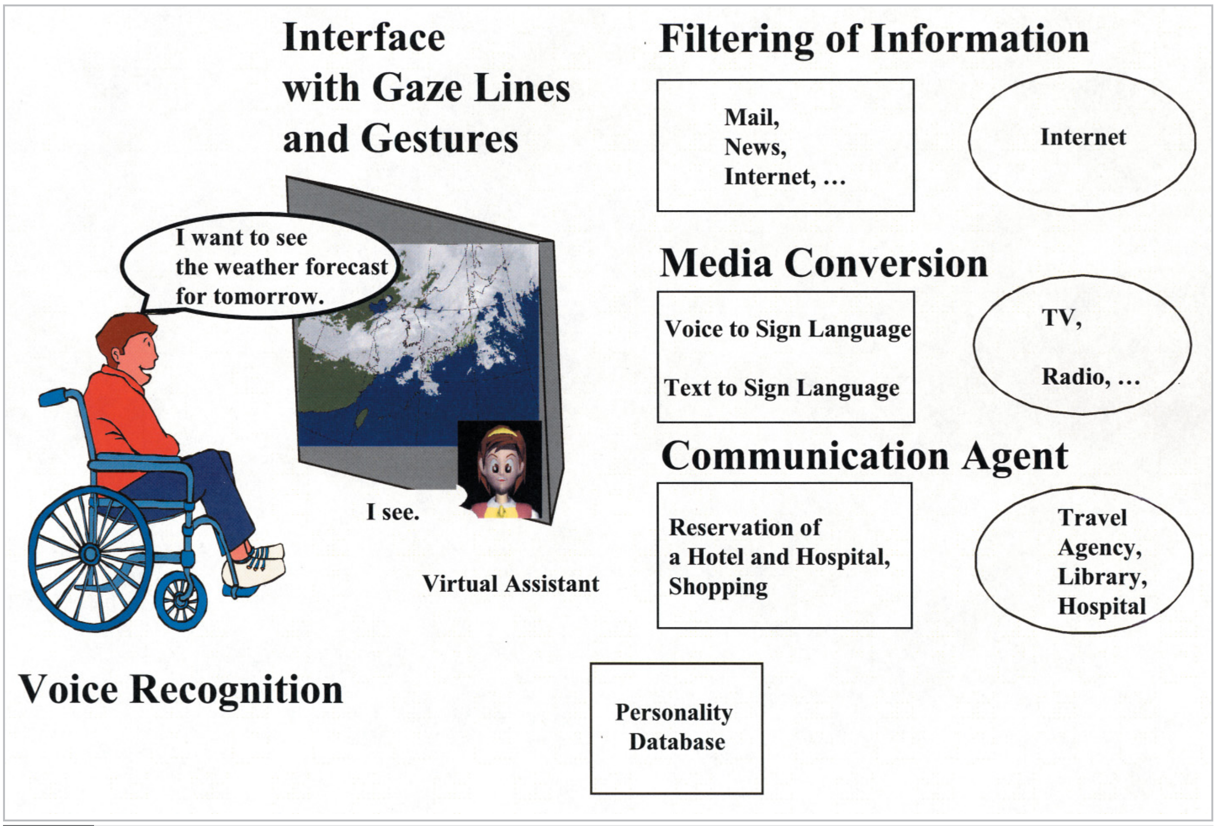

Fig.4 *Multi-modal communication system for the disabled*

3 Robotic communication terminal (RCT)

Outdoor walking is a major problem for the elderly and disabled. A mobility support system created through the use of information communication technology could allow such people to live more productive lives. Such a system will serve as a substitute for the ears and eyes, to allow the elderly and disabled to enjoy a more active and pleasant life, including walking and shopping, without the help of others. Studies have been conducted on technologies for specific disabilities, such as a navigation system using PHS and GPS [11], and an intelligent wheelchair for the physically disabled[12]. In the following section, we describe a robotic communication terminal (RCT) that has been in development since 1999[13], a comprehensive mobility support system for a variety of elderly and disabled persons.

3.1 RCT

Fig. 5 is an illustration showing three types of systems to be developed. They will increase the mobility of the elderly and disabled by providing, through the computer network during travel, information on the ever-changing environment around the user, as well as on alternate routes to the destination in the event of an accident that obstructs traffic. As the users of a terminal for such systems are the elderly or disabled, the terminal should be sufficiently intelligent to help users on the street avoid danger. It must increase the user's mobility by helping him/her to recognize a problem, to move, and to obtain information. The support system consists of an environment-embedded system having distributed terminals and a mobile system traveling with the user (either a user-carried mobile system or a user-carrying mobile system). To realize such a system, we plan to study (1) an environment-embedded system for detecting road-surface conditions, obstacles, and moving bodies; (2) a mobile system for monitoring a user's

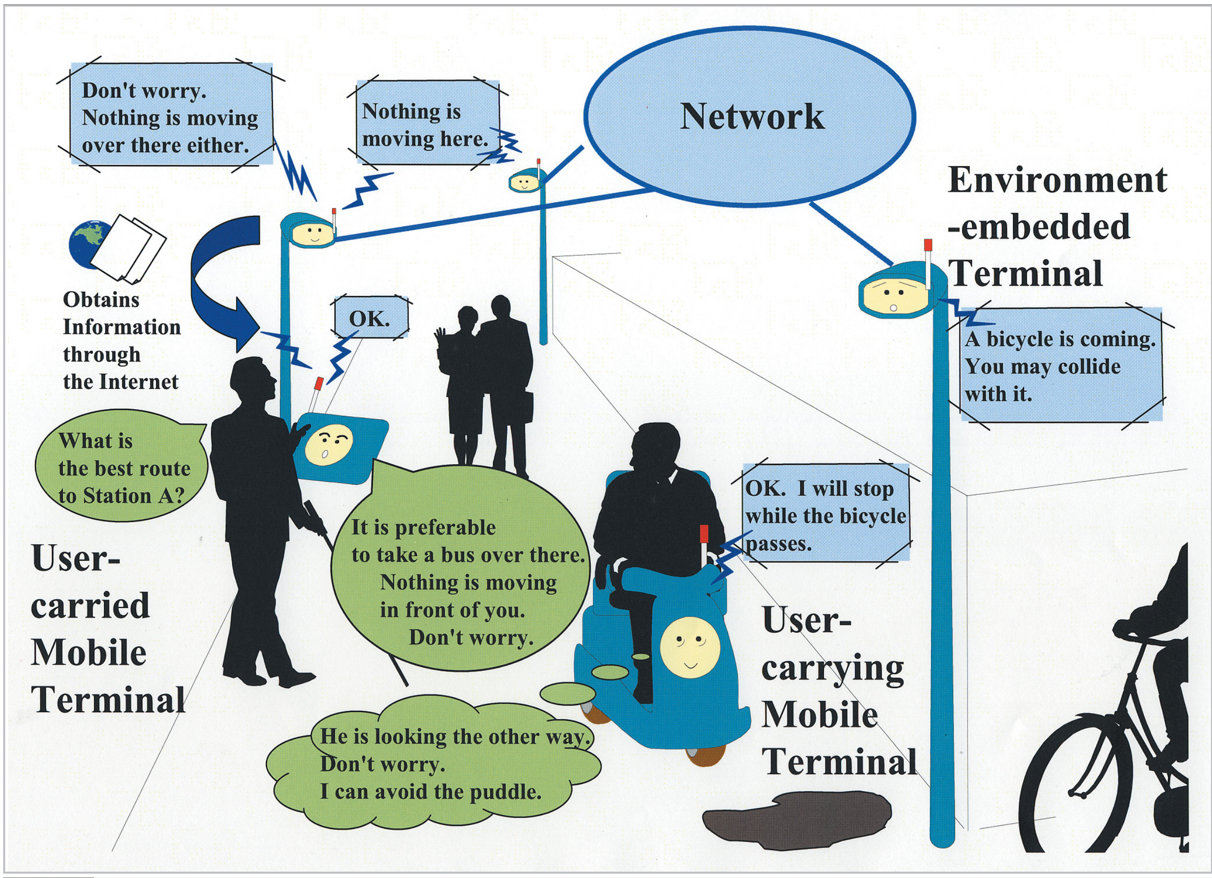

Fig.5 Robotic communication terminals improving the mobility of an elderly or disabled

actions and environment and detecting the user's intention, obstacles, and moving bodies; and (3) a map information database on barrier-free facilities that enables the retrieval of routes. To generalize the function of support system, we examine (4) what support tasks should be performed for each of the classified disabilities.

3.2 Environment-embedded system

Fig. 6 shows the environment-embedded system. This system obtains information from fixed cameras to monitor passing pedestrians, bicycles, parked and moving vehicles, and other obstacles 24 hours a day and, if necessary, to provide such information to users of the support system and the mobile system.

We started collecting data after preparing the hardware and installing the algorithm for recognizing moving bodies during the daytime [14]. We intend to improve the accuracy of both recognition and real-time performance to enable information on road conditions to be provided in order to increase mobility, to allow the study of the recognition of moving bodies, to help the user adapt to special environments such as those with wind and rain, and to cope with quickly moving and dangerous objects such as vehicles.

3.3 Mobile system

We developed an intelligent city walker (ICW) as a user-carrying mobile system, as shown in Fig. 7[15].

The present system is intended to function as follows:

1) To create and execute a danger-avoidance plan in accordance with the acquired user's surroundings and operational situation
2) To create and execute a danger-avoidance plan after obtaining environmental information from the environment-embedded system
3) To provide the user with all necessary information, inform him/her of dangers, and infer the user's intention

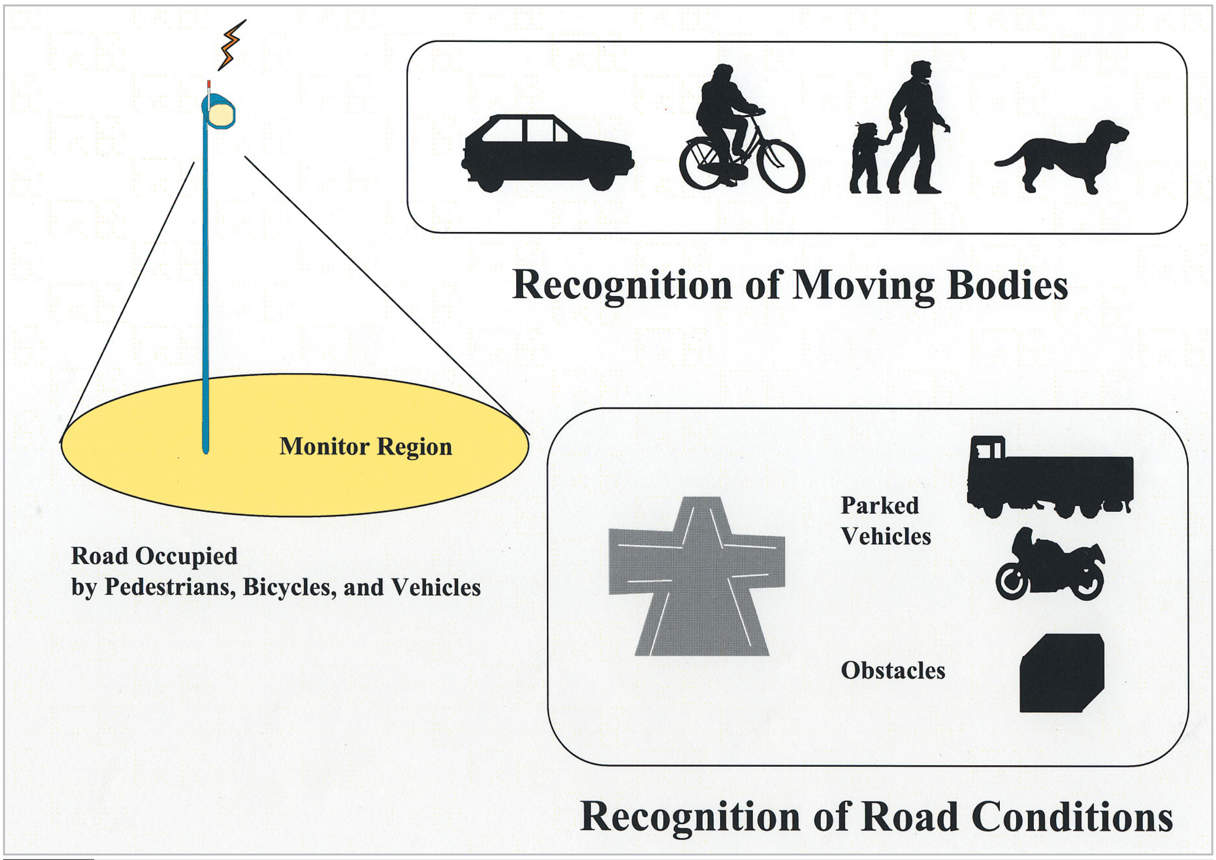

Fig.6 *Environment-embedded system*

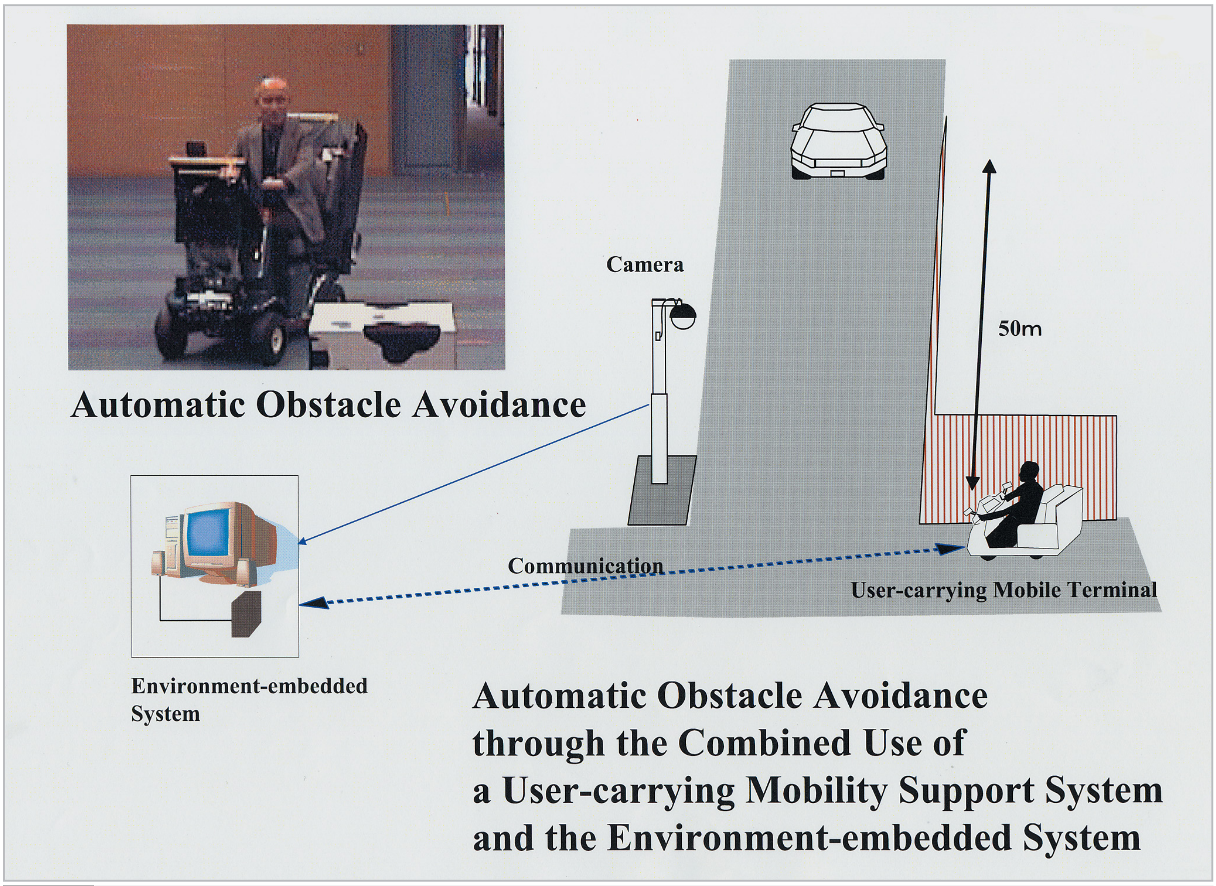

Fig.7 *ICW and automatic obstacle avoidance through the combined use of an ICW and an environment-embedded system*

We have not yet begun to develop a user-carried mobile system. The user-carrying system will, in addition to carrying the user, have all of the functions that such a user-carried system will have. Thus, generalities in the above functions 2) and 3) will be taken into consideration in its development.

3.4 Map information database of barrier-free facilities

It will be necessary to study how to accumulate information on barrier-free facilities in city areas, where mobile terminals and environment-embedded systems will be used in the future. It will also be necessary to study how to guide elderly and disabled users to their desired destinations. We are developing map information databases on barrier-free facilities in all areas of Koganei City and some areas of Kokubunji City, Tokyo, as follows[16]:

1) Survey of the elderly and disabled
2) Design of a network database for pedestrian walking routes
3) Preparation of the network database for pedestrian walking routes
4) Retrieval and provision of functions of the network database for pedestrian walking routes

In the future, we plan to develop functions for allowing the database to be accessed by the public on the Internet, navigating the disabled by different methods depending on the type of disability, and guiding the user by showing navigation text as well as vocalizing it. We also plan on providing barrier-free information to the mobile system, and matching the barrier-free data with data collected by the environment-embedded system.

3.5 Determination of mobility-support tasks in accordance with the type of disability

For the sake of practicality, it is necessary to prepare a general-purpose system rather than a system specific to each type of disability. We must therefore investigate in detail what types of mobility-support tasks are suitable for each disability and for combinations of disabilities. We distributed a questionnaire to conduct this investigation and collected over 3000 replies from elderly and disabled persons. The results of the questionnaire will be made available to the public so that it can be used by similar developers and researchers as reference data.

4 Results and future problems

The rapidly developing information communication technology is considered the most important form of support for our aging society. This is due to the fact that mutual communication between the elderly and disabled is realized through the use of such technology, allowing a greater interaction between people, greater participation in society, a better chance of finding jobs, and improvement in direct connections to other rich social resources. It is estimated that 28 million people 65 years of age or older will benefit from the developed technology in 2010, and that this figure will continue to increase until the middle of the 21st century. It is also estimated that there are 2.8 million elderly people who require care, and that this figure will reach 5.2 million in 2025. There are not as many disabled persons, but they should have the same fundamental human rights. It should be stressed in particular that a system developed for the elderly and disabled is useful for normal, healthy people as well. In consideration of the popularity among the hearing-impaired of portable telephones displaying text, a system created for normal healthy persons may be developed into a device useful to the elderly and disabled.

It is estimated that, as of the year 2000, the percentage of people over 65 years of age is greater in Japan than in the U.S., Germany, Britain, France, and even Sweden. The Ministry of Health and Welfare states that one person in three will be elderly in 2050, and that no other countries will reach this rate by that year. It is to be hoped that the technological developments described above will result in the construction of a model system for other advanced nations that will become an aging society later than Japan.

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