３．２．４　自律移動支援に関する研究

Technical Specifications of the Free Mobility System

Kunihiko OKA[1], Shinsuke SETOSHITA[2]*
1. Director, Advanced Road Design and Safety Division
National Institute for Land and Infrastructure Management
Ministry of Land, Infrastructure and Transport, Japan
2. Senior Researcher, Advanced Road Design and Safety Division
National Institute for Land and Infrastructure Management
Ministry of Land, Infrastructure and Transport, Japan
1 Asahi, Tsukuba, Ibaraki, Tel: +81 29 864 4539, setoshita-s8910@nilim.go.jp

ABSTRACT

The free mobility project is being implemented using information and communication technologies to develop a system that removes obstructions to the movement of all people. By 2005, a corroborative experiment had been carried out to survey route guidance services with visually impaired people and wheel-chair users acting as the monitors, to survey multi-lingual store information provision services with foreigners acting as the monitors in order to develop a general purpose system and to survey the performance of communication equipment. These results have been summarized to prepare technical specifications as standards for future development throughout Japan.
The technical specifications include overall guidelines that specify the configuration of the overall system and system operation guideline and written technical specifications prepared separately for each element necessary to standardize the equipment that makes up the Free Mobility System.

KEYWORD
Assistance for the elderly and physically impaired, RFID tag, location based service, ubiquitous computing

FREE MOBILITY PROJECT

The Ministry of Land, Infrastructure and Transport of Japan began to carry out the Free Mobility Project in 2004 in response to the demand for action to deal with the rapid aging of the population, the rising number of foreigners visiting Japan, the growing participation of women and disabled people in social activities, and the falling birthrate. This project uses ubiquitous network technology to create an environment in which everyone can, at any time, anywhere, access information such as route, transportation method, destination etc. that are needed by disabled and elderly people to participate in society and employment and to develop the Free Mobility System through field experiments.

FREE MOBILITY SYSTEM

The following diagram shows the overall configuration of the Free Mobility System.

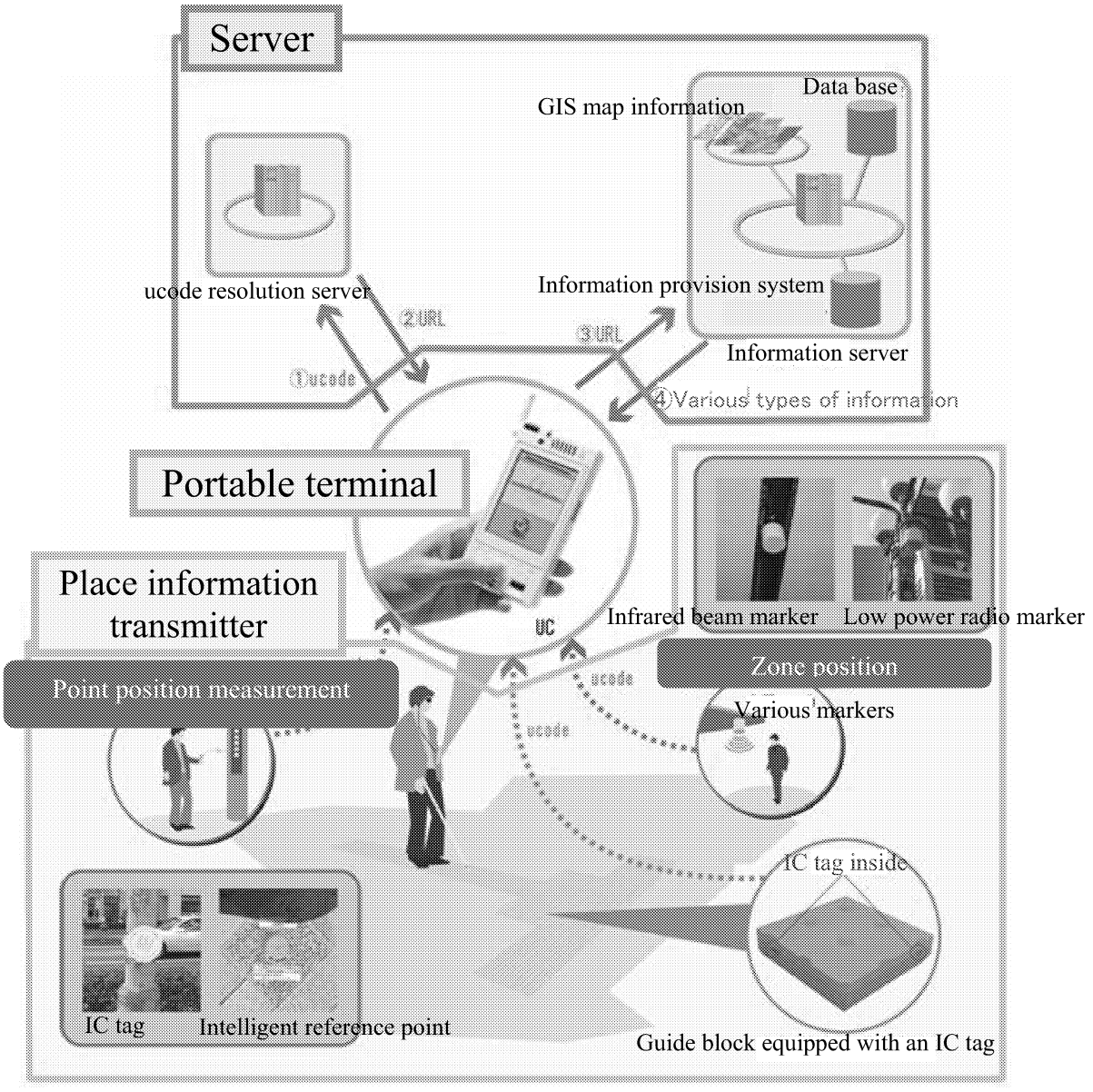

Figure 1. Overall Configuration of the Free Mobility System

In this system, the guide blocks used by visually impaired people installed on road surfaces and tags installed along streets do not contain detailed information that must be provided; they contain only unique ID codes (place ID codes) that distinguish individual locations. Detailed information is obtained by using a portable terminal to submit an inquiry through a communication network based on the place ID code.
The following is the flow of information through this system.

(1) Place codes transmitted by place information transmitters—the tags embedded in the guide blocks for visually impaired people and markers attached to facilities etc.—are read in (or received) by white canes or portable terminals.

(2) The portable terminals use the place code to ask the service provider's server to search for information.
(3) The service provider's server converts the place code to a URL and uses this URL to search for information and map data in the information provision system, then responds to the portable terminal.
(4) The portable terminal displays the information it has obtained.

Using this method, only a small quantity of information need be stored in the tags embedded in road surfaces and streets. This reduces the cost of the tags and permits the information to be changed in real time rather than separately at each location.
Users can obtain information that meets their individual needs by using their portable terminals to submit requests including user attributes (type and degree of disability, role as facility manager, etc.) and terminal attributes (screen size, multimedia function, and other terminal features).
The method of accessing the network is not specified so that it can be selected from among wireless LAN, cell-phone network etc. according to the location and type of terminal, but no matter which method is used, there is a time delay as it resolves the place code and obtains the desired information. Therefore, in anticipation of cases where a delay in providing information would be critical—when providing a visually disabled person of approaching danger for example—another method is added: caching data within a fixed range in the portable terminals in advance so that it is not necessary to access the network.

CORROBORATIVE EXPERIMENT IN THE KOBE REGION

Course of the experiment

The Free Mobility Project included a preliminary corroborative experiment in 2004 followed by the main corroborative experiment beginning in 2005. The model location chosen for the experiment is Kobe, a tourist city with a long-established trading port that has been recovering since the Hanshin Awaji Earthquake (January 17, 1995), and a center of land, marine, and air transportation services where a new airport opened in 2006.

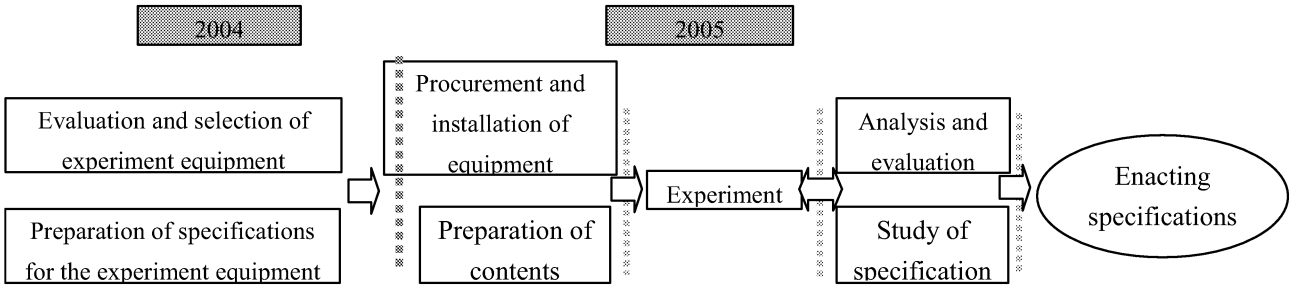

Figure 2. History of the Corroborative Experiments

Experiment period

June 2005 to March 2006

Experiment district

The experiment was performed at places with different features such as roads, railways, large event facilities, airport, port and harbor facilities etc. in various parts of Kobe, to study problems unique to each type of place.

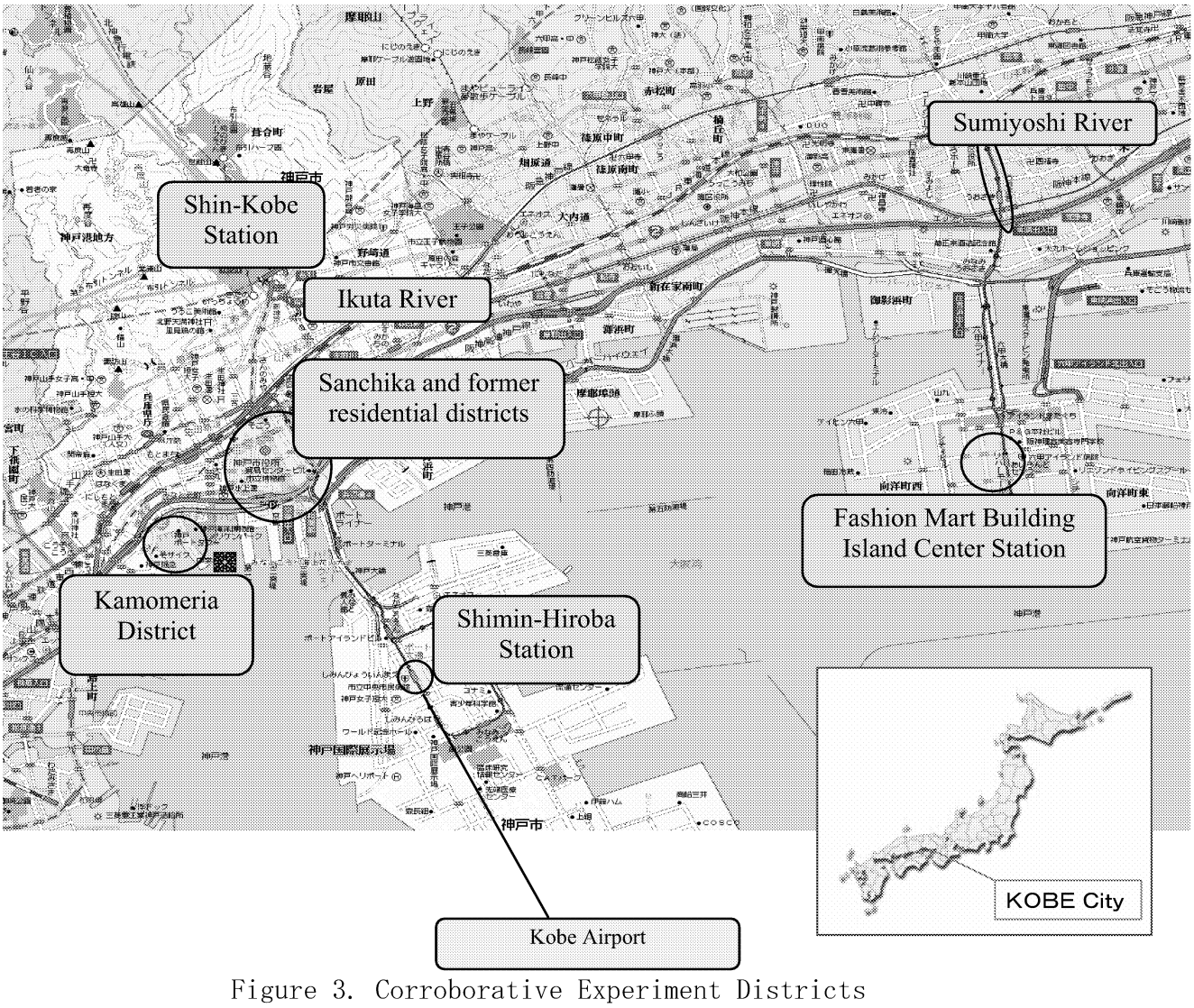

Figure 3. Corroborative Experiment Districts

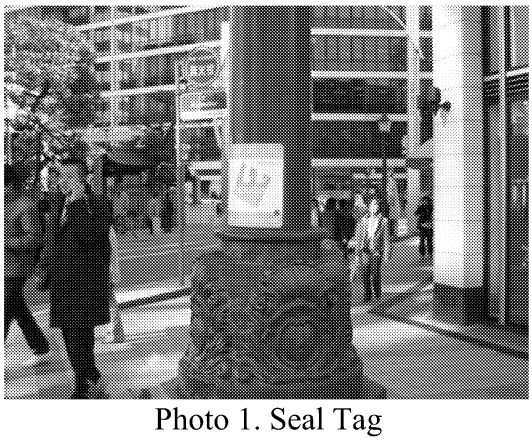

Photo 1. Seal Tag

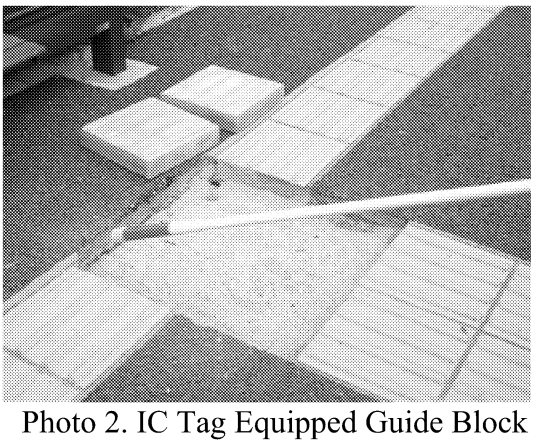

Photo 2. IC Tag Equipped Guide Block


Photo 3. Infrared Marker


Photo 4. Radio Marker

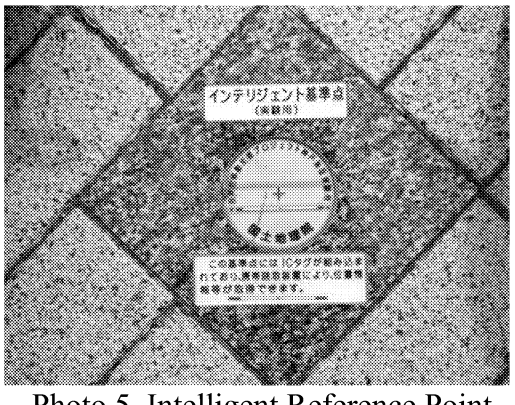

Photo 5. Intelligent Reference Point


Photo 6. i-Box

Description of the experiment

The Free Mobility System consists of the elements: tags, markers and other information transmitters and portable terminals. In order that private companies can freely enter this field to manufacture mutually compatible products, standards for the interfaces between the constituent equipment and constituent elements of the system must be established.

Therefore, a corroborative experiment was done in the environment of the experimental use ubiquitous place information system constructed in Kobe City to prepare technical specifications to be introduced nationwide. The service experiment was a monitor survey performed to corroborate the route guidance method and the multi-lingual information provision method based on the Free Mobility System. The technological experiment made the fullest possible use of the tags and markers installed at the experiment sites and the network infrastructure to corroborate equipment installation and maintenance plus communication by the ubiquitous network. Part of this experiment is introduced below.

Experimental downloading of surroundings data

In the Ubiquitous Place Information System, the contents are basically in information servers, but when guidance is provided to visually disabled people and in other cases where it is necessary to reduce the time lag from the point that ucode is obtained until information is obtained, data should be recorded in terminals in advance. This experiment verified the practicality of a method of allowing pedestrians to place information about their surroundings in their portable terminals at street information stations installed so that terminal users can read in new data about the area surrounding each place they reach.

As a result, the time that passes between the request for download until the contents are displayed ranges from 3 to 5 seconds, that is considered to be adequate for practical use.

Experimental transmission of contents through the ucode resolution server
The major goal of this experiment is to evaluate the practicality of the Ubiquitous Place Information System on the hypothesis that information linked to the ucode in IC tags installed at shops and tourist attractions is obtained.
After ucode had been obtained from a tag, the ucode (obtained by requesting information about the location of the contents server with the information linked to the ucode that was obtained) was resolved, and the time required to obtain shop information from a contents server and display it on the UC screen was an average of about 5 seconds. It is possible to evaluate the results as adequately practical if it is shop information, tourism information or other information that need not be provided instantly.

TECHNICAL SPECIFICATION

In order that private companies can freely enter this field to manufacture mutually compatible products as the constituent elements of the Free Mobility System, standards must be established. So based on the results of the corroborative experiments, factors that must be specified were organized to clarify the interfaces between each constituent element in order to summarize technical specifications for the Free Mobility System. Figure 4 and Tables 1 and 2 show the items in the written specifications and the contents of the major descriptions entered.
The draft technical specifications that were prepared as a proposal for common specifications used by all companies and managers stipulated the equipment configuration of the Free Mobility System, and the functional conditions, environmental conditions, and reliability of the equipment, and methods of inspecting it as required items and common items of all systems.
To distinguish places, a ubiquitous ID architecture with general applicability to other services including private sector services and expandability is the foundation. And as place distinguishing codes, ucode with code length of 128bits was used. The specifications will continue to be based on the concept of keeping the system up-to-date while holding down its future total cost by keeping the specifications open, and will comply with JIS and ISO.
The draft technical specifications that were prepared through this research are based on the trial operation of the Free Mobility System held in model regions in various parts of Japan since 2006. In the future, knowledge obtained from the trial operation will be collected, and the technical specifications will be improved to finally introduce a working system.

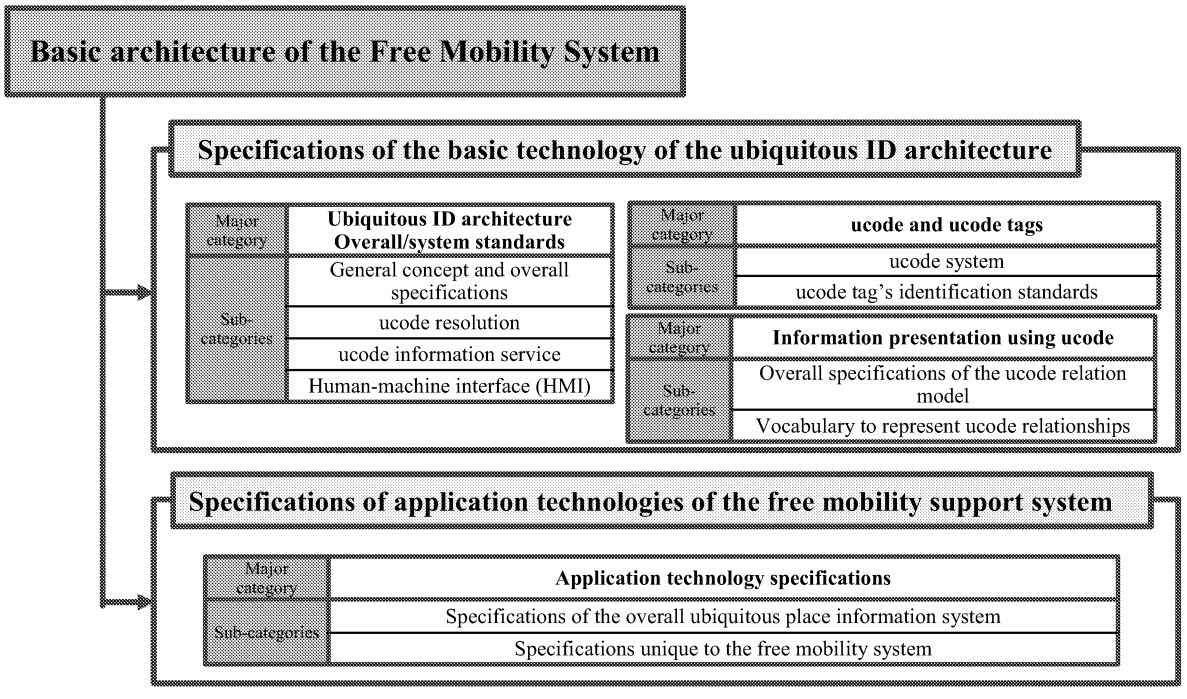

Figure 4. Configuration of the Technical Specifications of the Free Mobility System

Table 1. Contents of the Descriptions of Technical Specifications (Basic Technologies) of the Free Mobility System

Type		Technical specifications	Principal contents described
Overall/system standards	Basic concepts/overall specifications	Ubiquitous ID architecture	- Outline of the ubiquitous ID architecture, ucode, information presentation using ucode, ucode resolution and ucode information service
		Description method for ubiquitous ID architecture specifications	- Description method for formally describing protocol and description format
	ucode resolution	ucode resolution protocol specifications	- ucode resolution architecture, ucode resolution mechanism, ucode resolution protocol
	ucode information service	ucode contents transfer protocol specifications	- Role and positioning of contents provision service, protocol for obtaining contents
	HMI	Human machine interface specifications	- Interface that a ubiquitous communicator should provide
ucode and ucode tags	ucode system	Ubiquitous code: ucode specifications	- Uses of ucode and definition of metacode, specification of code structure of ucode
	ucode tag's identification standards	Tag recognition standards	- Standards for case of recognition as ucode standard tag (concerning category and class)
		Category 0 recognition standards	- Standard for a case where a printed tag is recognized as a ucode standard tag
		Category 1 recognition standards	- Standard for a case where a passive RF tag is recognized as a ucode standard tag
		Category 2 recognition standards	- Standard for a case where an active RF tag is recognized as a ucode standard tag
		Category 3 recognition standards	- Standard for a case where an active infrared tag is recognized as a ucode standard tag
Information presentation using ucode	Overall specifications of the ucode relation model	ucode Relation format	- Specification to represent the ucode Relation model (model that represents information related to ucode based on relation between ucodes)
		XML-based UCR (ucode Relation) description specifications	- Specification to serialize the graph that represents relation with ucode ※ Serialize means converting data handled by the software so that it can be stored in a file or can be transmitted and received in a network.
		Specifications for embedding UCR (ucode Relation) in SVG	- Specification to expand to ubiquitous computing of existing SVG ※ SVG (Scale Vector Graphic) is specification to describe two-dimensional vector drawings in XML format.
	Vocabulary to represent ucode relations	Standard vocabulary definition specifications	- Specification of the assignment of the meanings of basic theoretical ucode that must be commonly understood by a variety of applications
		Natural features attribute specifications	- Method of codifying place information or physical properties specifications, and simple longitude/longitude and elevation ucode
		Spatial network specifications	- Method of embedding specifications for spatial network data used by route guidance software etc. and spatial network data in SVG map contents
		Spatial accessibility specifications	- Vocabulary that represents types of physical conditions and hand baggage etc. related to the ability of people and goods to move. Vocabulary to describe accessibility when moving in actual space.

Table 2. Contents of the Descriptions of Technical Specifications (Application Technologies) of the Free Mobility System

Type		Technical specifications	Principal contents described
Application technologies of the Free Mobility System	Specifications concerning the overall ubiquitous place information system	Intelligent reference point specifications	- Air interface of tags Tag hardware performance: description capacity/information contents other than ucode External specifications: shape, material, labels Durability: Environmental conditions and required service lifetime at the hypothesized equipment installation location Maintenance: hardware management and information management Utilization and operating method: functions as a terminal, limited/unlimited users, usage fees
		Basic specifications of street information stations	- Case design: basic shape of the case, range of dimensions, basic coloring, case structure Functions: essential functions and supplementary functions Durability: Environmental conditions and required service lifetime at the hypothesized installation location Evaluation standards: Evaluation standards to satisfy the service lifetime
	Specifications unique to the Free Mobility System	Guide blocks specifications	- System configuration: Description of the system configuration when using guide blocks. Shape of guide blocks, types and structures of guide blocks: Basic structural communication functions for each type of guide block (concrete, synthetic rubber). Air interface, communication protocol, communication distance, communication range, communication properties and other basic performances Durability: Environmental conditions and years of service at the hypothetical guide block installation location. Evaluation standards: Description of evaluation standards to satisfy the service lifetime under the installation environment conditions
		Installation and maintenance standard specifications	- Installation plan: Installation location and installation standards for each type of equipment Execution: Execution method by type of equipment installed and installation environment Maintenance: Standard for maintenance according to the equipment installed and installation conditions
		ucode storage container specifications (optical code)	- Air interface, communication protocol Basically complies with ucode tag interface recognition standard (Category 0)
		ucode storage container specifications (IC tags)	- Air interface, communication protocol Basically complies with ucode tag interface recognition standard (Category 1)
		ucode storage container specifications (radio markers)	- Air interface, communication protocol Basically complies with ucode tag interface recognition standard (Category 2) The basic communication range of the equipment and type of equipment used (wide area communication type and narrow area communication type)
		ucode storage container specifications (infrared markers)	- Air interface, communication protocol Basically complies with ucode tag interface recognition standard (Category 3) The basic communication range of the equipment and type of equipment used (wide area communication type and narrow area communication type)

ACKNOWLEDGEMENT

This research was done as part of the free mobility project. The authors wish to express their appreciation to all members involved in the project.

REFERENCES

[1] Toshiyuki Yokota, Susumu Takamiya, Yuji Ikeda (2000), Research on ITS for pedestrians, 7*th World Congress on ITS*, Torino.
[2] Nozomu Mori, Yuji Ikeda (2001), For Barrier-Free Society by using IT in the future, *Civil Engineering Journal*, vol.43, No.1, pp.38-43.
[3] Nozomu Mori, Yuji Ikeda (2001), Research on needs and system configuration of pedestrian ITS, 8*th World Congress on ITS*, Sydney.
[4] Nozomu Mori, Yuji Ikeda (2002), Current situation of research and development of ITS for Pedestrians, *Civil Engineering Journal*, vol.44, No.9, pp.54-59.
[5] Nozomu Mori, Yuji Ikeda (2002), Positioning technologies for pedestrian navigation, 9*th World Congress on ITS*, Chicago.
[6] Ken SAKAMURA, Yuichi TOYA, Kunihiko OKA (2005), Conduct of free mobility assistance project, *12th World Congress on ITS*, San Francisco.
[7] Jun YAMADA, Toshiyuki ADACHI, Shinsuke SETOSHITA (2005), A technical feature of free mobility assistance system, *12th World Congress on ITS*, San Francisco.