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ON THE AVAILABILITY of REAL-TIME GIS, GPS and IC TAG for UBIQUITOUS SOCIETY

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KEY WORDS: Real-Time GIS, GPS, GIS, IC tag, Advanced Spatial Information Society

ABSTRACT: Japan is now experiencing an aging society and every person should be safe and feel relieved. The Japanese Government executed a new law NSDI for a spatial information society on May 30, 2007. (NSDI: National Spatial Data Infrastructure). In this law, everybody can know positional information in real time anytime and anywhere. In addition, it is necessary to use satellite positioning for realization of seamless positioning, and to promote ubiquitous network technology. However, the technology has not been established yet. Our laboratory is conducting a study of referring to positioning by Real-Time GIS, GPS, and IC tag for realizing an advanced spatial information society.
The research is to confirm whether absolute positions can be obtained accurately by Real-Time Kinematic-GPS (RTK-GPS), Virtual Reference System-GPS (VRS-GPS), and Differential-GPS

(D-GPS). However, GPS receiver could not receive signals from GPS satellites at an area surrounded by canopies and buildings. Therefore, Integrated Circuit Tag (IC tag) was used where GPS signals could not be received to obtain information on the absolute position. The IC tag is used in distribution systems, but the method for using geoinfomatics has not been established yet. The experiment was conducted to verify the reading rate of IC tag on different types and conditions. Kind of IC tag has passive type and active type. The method is different by a purpose of use. The IC tag has many advantages of transmitting and receiving of the information, and obtaining the absolute position without any contact. A passive and active IC tags made of different materials were experimented to verify the reading rate at the outside and inside of a laboratory. In this study, it became clear how to use appropriately passive type IC tags. However, the active type is in a stage of growth because method is no clear for using by various conditions. Therefore it is necessary to do additional experiment of indoor positioning.
Our research suggested that establishment of a method for seamless positioning information has to need in the advanced spatial information society.

1. INTRODUCTION

Japan is now experiencing an aging society and every a person should be safe and feel relieved. The Japanese Government executed a new law for a spatial information society on May 30, 2007. In this law, everybody can know positional information in real time anytime and anywhere, both of the mappings of a national common base map, and environment for utilizing satellite systems. In addition, it is necessary to keep satellite positioning for realization of seamless positioning, and to promote ubiquitous network technology. However, the technologies have not been established yet. Our libratory is conducting a study of referring to positioning by Real-Time GIS, GPS, and IC tag for realizing an advanced spatial information society. In this study, an experiment was performed to confirm whether accurate position information can be obtained by D-GPS and VRS-GPS. Moreover, a verification experiment was performed to complement position information by the IC tag where GPS signals could not be received to obtain information of absolute positions in future research.

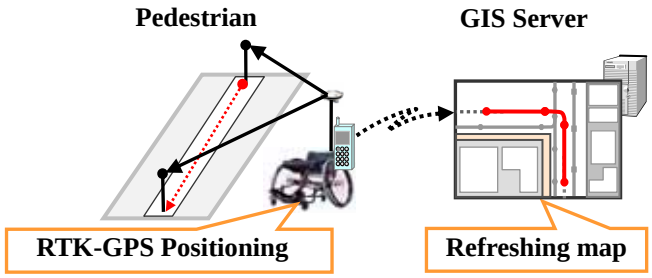

Figure 1 Concept of “REAL TIME GIS”

2. EXPERIMENT BY GPS POSITIONING

An experiment was performed inside the KIT campus at Kanazawa district in central Japan by a D-GPS and a VRS-GPS. The purpose of the experiment is to acquire positional data accurately and to understand the features of places where accuracy is poor. Accuracy of positioning D-GPS and VRS-GPS was verified.

3. VERIFICATION OF OVERLAPPING

Positioning data of D-GPS and VRS-GPS were displayed on the DM (Base Map of the Nonoichi town on a scale of 1/2500) by using GIS software (Figure 2). Background of Figure 2 is an aerial photograph.

3.1 Result

As a result of experiments, GPS could receive high-accuracy data at almost all places. However, the data were not accurate at the places where the measured place had not wide open sky. It seemed that other reasons affect a receiver. Data were intercepted at three spots, and a lot of measurement errors occurred there. In the next stage, our laboratory confirmed how long a signal is received around a canopy by a D-GPS and a VRS-GPS.

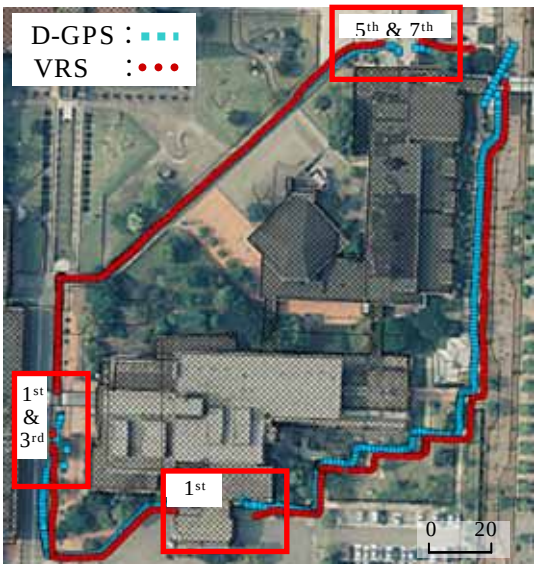

Figure 2 Overlapping of experiment data

Table 1 shows the length of interruption of raw data displayed on GIS. Table 2 shows the length of interruption of analytical data that include positional accuracy and errors. For example, we consider it is caused by dilution of precision (DOP), number of satellites, and standard deviation.

Table 1
Length of interruption in raw data

Building No.	Length of interrupted tracks	
	D-GPS(m)	VRS-GPS(m)
1st	4.624	7.908
1st and 3rd	5.119	7.396
5th and 7th	2.374	5.419

Table 2
Length of interruption in analytical data

Building No.	Length of interrupted tracks	
	D-GPS(m)	VRS-GPS(m)
1st	15.313	12.574
1st and 3rd	null	12.130
5th and 7th	12.952	5.419

3.2 Consideration

Important condition of GPS positioning is to receive four satellites or more in open sky. As a result, we acquired the absolute position accurately in open sky. However GPS receiver could not receive signals from GPS satellites at an area surrounded by canopies and buildings. Additionally, one could not obtain continuous GPS signals at districts overgrown with trees. In such a place, correction data received by a mobile phone might not give acceptable data. An area surrounded by canopies and buildings cause cycle slip and multipath to badly influence the DOP and GPS signals. If GPS positioning is conducted near buildings, it is necessary to consider the satellites situation and multi-path. Because those areas had poor signal conditions, remarkable differences were seen between D-GPS and VRS-GPS.

Interrupted signals of the D-GPS were shorter than those of the VRS-GPS as shown in Table 1, but VRS-GPS showed higher accuracy than that of D-GPS as shown in Table 2. As for the reasons for difference, VRS-GPS has the problem of initialization and D-GPS of a simple system doesn't have any problems. Therefore, it appears D-GPS had high continuousness and

VRS-GPS had reliability of positioning accuracy.
In the next chapter, we will show how to obtain an absolute position and other information at a place where the GPS signal does not reach.

4. COMPLEMENT OF POSITIONING INFORMATION

Chapter 3 shows that GPS receiver could not receive signals from GPS satellites at an area surrounded by canopies and buildings. To realize an advance spatial information society one should need to obtain positioning information anywhere. Therefore for the place that could not obtain information GPS positioning should be assisted by an Integrated Circuit (IC tag). The IC tag has an advantage transmitting and receiving information without any contact, and complementing positioning information. However, the use of the IC tag has not been established yet in the field of geoinfomatics. Therefore we thought a new method by the IC tag. Figure 3 shows the concept of continuously obtaining positioning information by the GPS positioning technology and IC tag. For example, GPS positioning is used in open sky, and IC tags are used in closed sky, which are good ideas because it is possible that a pedestrian space route can be acquired. In this system, the positioning information will be imagined ubiquitously.

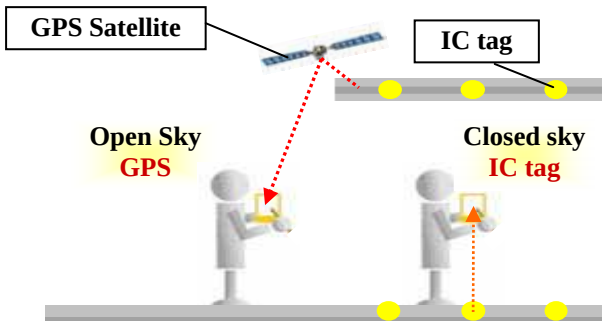

Figure 3 Utilization of IC tag

4.1 The kind of IC tag

The IC tag is available passive and active types. The passive type performs communicate by receiving radio waves in from an antenna device and sending back information. It can be miniaturized and thinned easily, and it can be produced at a low price. The active type can perform communication by automatically transmitting be IC tag's reader, and it is embedded with a battery. It has an advantage of achieving a longer radio waved than the passive type although the battery needs to be changed.

5. VERIFICATION EXPERIMENT OF IC TAG

5.1 Read Experiment by Shielding Material

(1) Experimental Overview

It is necessary to clarify that the height of IC tag's reader and conditions of use. An experiment was performed where the IC tag was buried under the shielding material and was read when reader move through the material. The experiment was conducted by a hand truck to which the IC tags reader was attached. The UID of the IC tag was recognized and the reading rate was investigated. The reading rate was expressed for 1,000 IC tags.

Figure 4 Read experiment by shielding material(wood)

(2) Equipment in Use
Made by Welcat Inc.

- IC tag's reader: EFG-400-01
- An antenna of exclusive IC tag's reader writer: ANU-100-01
- IC tag: card type(ISO15693, 13.56MHz)

(3) Setting conditions

(a) Used shielding material and its thickness

- Wood: 3, 6, 9cm
- Concrete: 6, 12cm
- Soil: 5, 10, 15cm

Shielding materials made of wood, concrete, and soil were used. These materials are used for general buildings and roads. The thickness of the shielding material has not been unified acquisition conditions

(b)The height of reader

The height of IC tag's reader was set to 15, 20, 25, and 30cm. The reason was shown by Mr. Shimano who graduated from Kanazawa Institute of Technology (K.I.T.) where the reading rate was high when the height of the reader ranged form 15cm to 30cm in his research. In this experiment, the height was set to a maximum of 30cm and a minimum of 15cm according to the result.

(c) Setting intervals

A setting interval of the IC tag is 10cm because it was the best interval by his research.

(d)The kinds of IC tags used

In the experiment, passive type was used.

5.2 Result and Considerations

As the thickness of shielding materials is increased, the reading rates tend to decrease. However, each material shows a high reading rate. Therefore, this height is the best suited.
The following shows appropriate conditions obtained by the experiment.

①Interval of passive type: Over 10cm
②Size of passive type used: Large size
③Moving speed to read: Normal walking speed
④Height of reader: below 15cm
⑤Thickness of shielding materials: below 10cm

5.3 Indoor Positioning Experiment

An experiment was used the IC tag of active type. An advance of this type is to transmit radio waves at regular intervals automatically, detect and specify IDs existing in a wide maximum range of 20m. And it can control information as a person, an object, a position, time, and condition at real time. An experiment was investigated to discuss a method for setting active

tag in a room and how to set in environment. By changing material and the height, a change in the member of need times and RSSI was verified. RSSI means a sensitivity to receive tag.

(1) Equipment in use

Made by Kyusyu Ten Co.

- Wireless reader: TGS-R300W
- Wireless tag: YGS-T300
- Wireless router: WIN-G54/R4-M(Made by I・O DATA Co.)

(2) Setting conditions

(a)The height of reader: 240cm

The height of reader is shown from the floor to the ceiling in experimentation area. It easy to receive the electric wave from a tag by reader is attached to the ceiling.

(b) The distance from a tag to a reader: 10m

(c)The time to read tag: 60 seconds

(d) Interval time of electric wave automatic transmission: 3 seconds

(e)Attached the material: person, wood and iron

According to statistics, an average height of Japanese is 170cm for the past 5 years. So the height of the tag is set 170cm at the maximum.

(3) Experimental Overview

An experiment was performed where a wireless tag is attached to wood, iron, and people. By changing material and the height, a change in the member of need times and RSSI was verified. The active tag can automatically received control position information from attached object. Therefore, it was assumed that a tag was attached to a human body in a basis pattern. Wood and iron were used in comparison with a person from the result of experiment.

5.4 Results and Considerations

Table 3 shows RSSI and read times. The times and RSSI show higher values when the tag is attached to the iron as compared with a person. It seemed that tag served as an antenna when it was attached to the iron, and electric wave to reader were amplified. In addition, each values of attaching to wood and person were similar to basis. Therefore, the tag does not affect reception sensitivity if it is attached to the wood or person.

Table 3 RSSI and times to read tag

	0cm		70cm		100cm		170cm	
	RSSI	times	RSSI	times	RSSI	times	RSSI	times
Basis	4	17	6	21	4	21	6	21
Wood	4	18	6	19	5	19	4	21
Iron	8	21	8	22	8	22	8	22
Person	4	17	5	21	4	19	5	19

6. SIMULATION EXPERIMENTS

(1) Overview of Experiment

An experiment was performed to verify positioning information which will obtain seamlessly by GPS and IC tags. Figure 5 shows simulation experiment. GPS was used at open sky. IC tag of passive type was used at an area surrounded by canopies and buildings and was set up at the few cm of underground. IC tag of active type was used in a room.

(2) Results and Considerations

An area where GPS receiver did not receive could complement positioning information by IC tag. The reader could receive information continuously with both of IC tags. Therefore, it is

possible to get the position seamlessly from outdoor to indoor. In the future, simulation experiments will be conducted to verify whether positioning information obtained by GPS and IC tags and it can be shown on the GIS.

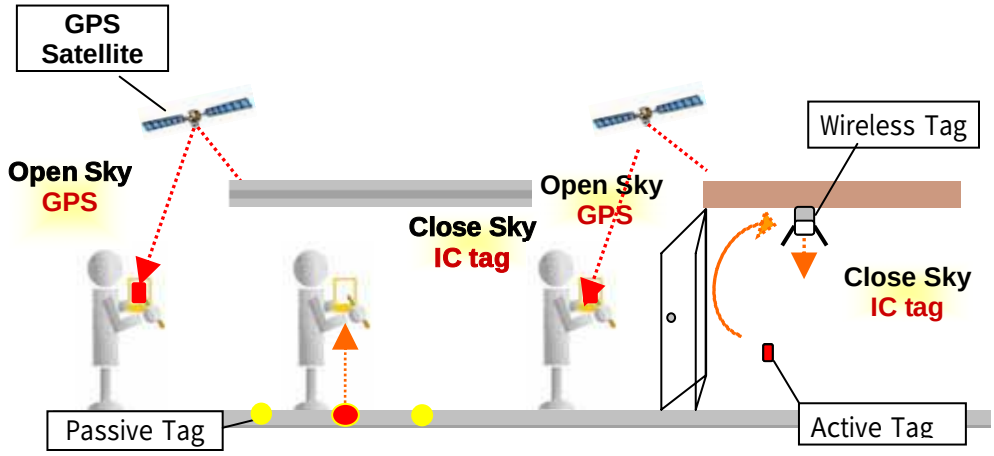

Figure5 Simulation experiment for pedestrian

7. CONCLUSION

Previous research confirmed whether high-accuracy positioning information continuously by a D-GPS and VRS-GPS. However, GPS can be obtained positioning was not performed in closed sky. It was proposed to obtain positioning information by a high-accuracy GPS positioning technology like an IC tag utilized at intelligent control points. Kind of IC tag has passive type and active type. The method is different by a purpose of use. In this study, it became clear how to use appropriately passive type IC tags. Active type IC tags are in a stage of growth on territory of geoinfomatics technology. In the future, simulation experiments will be conducted to verify whether positioning information obtained by GPS and IC tags can be shown on the GIS.

We hope that our research will help to revise basic map defined by NSDI in high accuracy and for arriving at an early advanced spatial information society.

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