

APPLICATION OF MOBILE MAPPING TECHNOLOGY AND REAL TIME GIS FOR UBIQUITOUS SOCIETY

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ABSTRACT:

Government and local government have to hurry up to build accessible facilities for elderly people and people who has disabilities. Because our country is experiencing an aging society, for example, pedestrian space should be safe and give a relief. However, it is difficult for everyone to easily know the route from the present place to a destination safety and relief at ease. One of the methods to solve those problems is to obtain absolute position with high accuracy. Therefore, we suggested here to make Universal Map (UM) with a large scale by using REAL TIME GIS with mobile mapping. And, it is the map including recent information for enabling people to understand the condition of absolute positions. The purpose of the research was to confirm whether absolute positions can be obtained accurately in mobile mapping. For the purpose of the study, the experiment was performed on our campus at Kanazawa district in Japan by using a D-GPS and a VRS-GPS. The experiment was performed by moving in the campus by a wheelchair to which a GPS antenna has been attached. As a result, it became clear that any experiment fields could not receive accurate data. To solve these problems, we adopted IC tags which are new ubiquitous technology to help people with disabilities. With the powerful advantage of IC tags one can receive data without any contact anytime, anywhere. For a solution, it is recommended that the UM be made by the REAL TIME GIS and IC tags.

1. INTRODUCTION

The birth rate is decreasing, the number of elderly people is increasing, and people with disabilities are unable to join a general society, which are big problems in Japan. It is suggested that the general society needs safety, relief and comfort in the near future. Recent internationalization of Japan increased tourists from foreign countries. However, many tourists including domestic persons feel some inconveniences in understanding where they stay now and how to select the best route to their destination from the present place.

One of the methods to solve those problems is to obtain the absolute position accurately by using geoinformatics. In this study, the concept of "REAL TIME GIS" named 3S technology of Geographic Information System (GIS), Global Positioning System (GPS), and Remote Sensing (RS) were used. If Real-Time Kinematic - GPS (RTK-GPS) is used, a digital map (DM) will change to realistic UM. It means that anyone can feel a comfortable life anytime, anywhere, for example, safe pedestrian space and a relieved life ubiquitously.

REAL TIME GIS is the system for real-time mapping at the field site using RTK-GPS, Virtual Reference Station - GPS (VRS-GPS), and GIS. It is possible to update DM data in real-time by using a cellular phone and RTK-GPS which has simultaneity. Moreover, UM including the proposed concept will be used by all users including the physically challenged and aged people. Concept of "REAL TIME GIS" has been studied for about a decade by us (Figure 1).

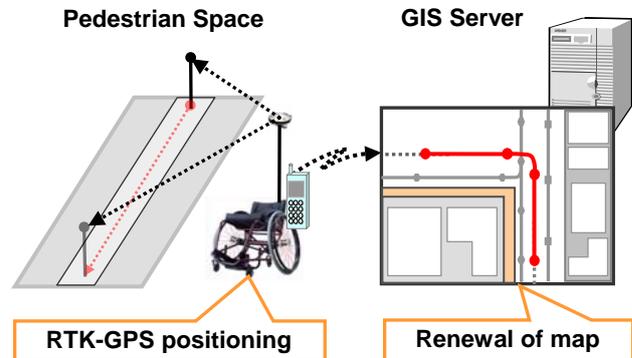


Figure 1. Concept of "REAL TIME GIS"

The basis of UM is a surveying and it consists of geoinformatics which is the latest survey technology. Anyone can use UM regardless of the physically challenged, healthy person, age, man and woman. Figure 2 shows essential and minimum requirements of UM and the concept of one.

UM means the newest map which can display the latest road condition and other information on a mobile PC. This map includes the recent information by which all users can understand the condition of absolute position anytime, anywhere. Additionally, measures to utilize spatial information become extremely important and the society might need UM with a lot of advantages in the future.

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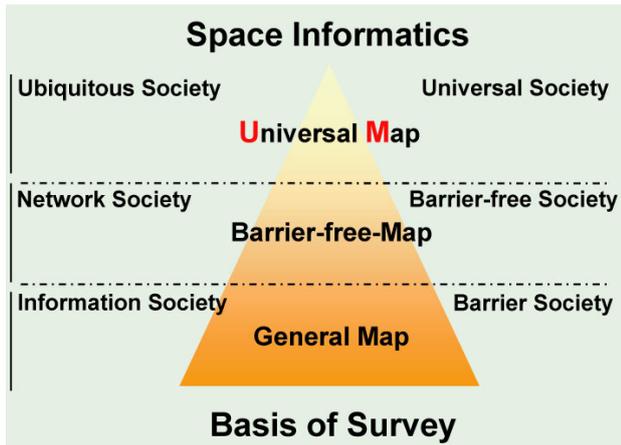


Figure 2. Concept of "Universal Map"

2. PURPOSE OF STUDY

Japan adopted a new standard for map geometry since April 1, 2002. Ellipsoid of a new geodetic system in Japan is almost equal to WGS-84 of GPS but most of the DM of local government is still Tokyo Datum of an old geodetic system. In order to correspond with two kinds of data which have different geodetic systems, it is necessary to transform coordinates.

On the other hand, much local government has been utilizing a large scale (1/500 or 1/1000) DM with GIS. Government has carried the law to construct the advanced spatial information society over to the next session. GIS will be able to efficiently help many workers who are managers and city planners in government and researchers. As an example, it is possible to improve the service to a citizen including elderly people and the physically challenged by sharing those data in local government. However, the maintenance and renewal of UM database need much labour and time and updating a map is not established yet and, there are only a few successful examples. This is a specific problem of a large scale map to achieve the spatial information society recently.

In the master's thesis of Ms. Naoko Matsuda who graduated from KIT, these problems were solved by using REAL TIME GIS and the achieved result is listed below.

- (1) Position data of latitude and longitude had high accuracy within 3 cm.
- (2) It is difficult to acquire high-accuracy data because geoids may influence the accuracy of height.
- (3) Because canopies interrupt wavelength from satellites, tracks were not displayed well though she tried to display tracks which moved by using a RTK-GPS in GIS.

As a result, at this stage, it is very difficult to solve problems by using a GPS only. Interruption of signals in course includes very important problems. If anyone is able to receive the positioning data ubiquitously, people obtain safe, relieved, and comfortable service.

The purpose of this study is to establish a method for updating a large scale map for local government, and to propose UM by using Remote Sensing, GPS, and GIS. These are new concepts of collaboration of geoinformatics technologies. Additionally, the important purpose of study is how to acquire the accurate positioning information without interrupting satellites information.

3. EXPERIMENT BY GPS POSITIONING

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

Figure 3 shows the experiment field and the route. Background of Figure 3 is Base Map of the Nonoichi town on a scale of 1/2500. ArcGIS 9.1 which is one of the general software of GIS was used to display the map and analyze the data.

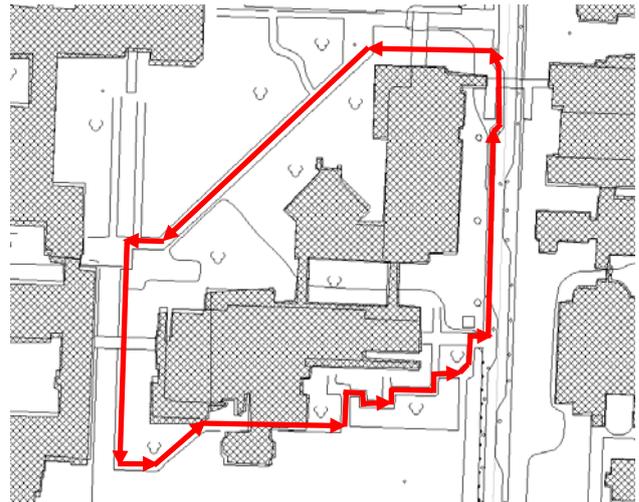


Figure 3. Experiment field and route

3.1 RTK-GPS Positioning

In this paper, RTK-GPS means that a reference station and a rover station were required for real-time GPS positioning. The reference station was made just on a control point. This control point is a levelling point which has the absolute position because the accurate positioning data by using static positioning were needed. Communication from the reference station to the rover station for the RTK-GPS depended on radio broadcasts.

The experiment was conducted by moving around by a wheelchair which is equipped with RTK-GPS at uniform speed inside KIT campus. Additionally, we have carried out the experiment by holding the RTK-GPS equipment with hands. In that condition, we could not obtain positioning data because a GPS antenna was swung on moving. This is the reason why a GPS was attached to the wheelchair or a hand truck for reducing an error. However, many errors happened in most of fields by using a RTK-GPS. One of the reason caused errors was buildings between the positioning points. Because communication area of radio broadcasts was narrow in such a situation.

3.2 VRS-GPS Positioning

A second experiment was performed by using VRS-GPS that is a kind of RTK-GPS positioning. In VRS-GPS, the reference station needs not be set. A virtual reference station was made virtually around the positioning point. Distance of a virtual point to an actual point is about 3m to 5m. A rover station received revision information from a mobile phone by a using wireless system. This system consists from GPS-based control

station. Geographical Survey Institute (GSI) made it at about 1200 points in Japan. In the wireless system, only one person is capable of positioning with a light baggage. The method of measurement is similar to that of RTK-GPS. Therefore, VRS-GPS has more advantage.

3.3 D-GPS Positioning

D-GPS positioning is a method that sends the revision value of a pseudo distance from each satellites, and calculates again in the rover station. Additionally, a rover station received revision information from a mobile phone by using GPS-based control station. Position accuracy is from 0.5m to 2.0m. This system is similar to the technique of VRS-GPS and it only needs a rover station. Moreover, the positioning cost is cheaper than that of VRS-GPS because of simple system. The experiment performed by using wheelchair which attached simultaneously D-GPS and VRS-GPS. The reason is to make the experimental environment almost the same and to acquire position data. Figure 4 shows the positioning of D-GPS and VRS-GPS by using a wheelchair.



Figure 4. Positioning of D-GPS and VRS-GPS

4. 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 5). Background of Figure 5 is an aero photograph.

4.1 Result

As a result of experiments, almost all places GPS was able to receive high-accuracy data. However, the data were not accurate at any places though the measured place had wide open sky. It seemed that other reasons affect a receiver. Data-intercepted spots were three, and a lot of measurement errors occurred at there.

In the next stage, we confirmed that how long a signal is received around a canopy by using a D-GPS and a VRS-GPS. Figure 6 shows one of enlarged canopy areas in Figure 5.

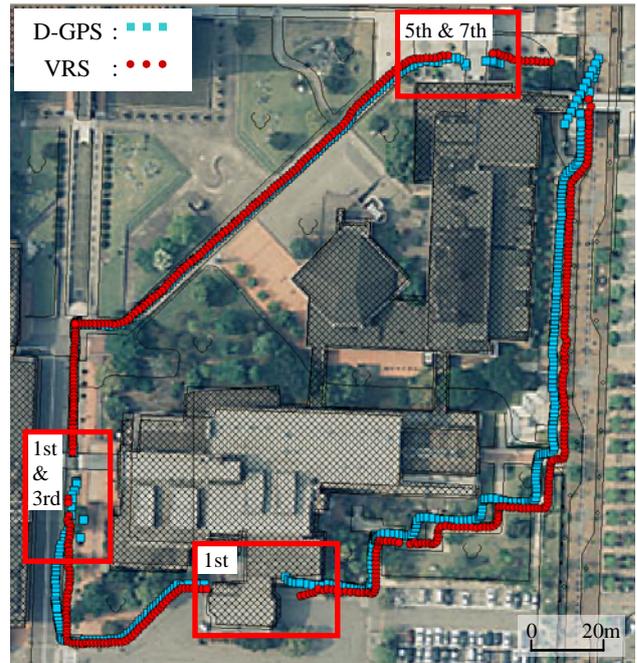


Figure 5. Overlapping of experiment data

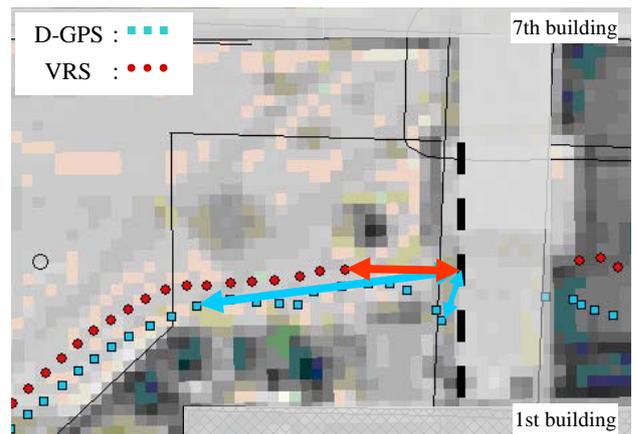


Figure 6. Verification around each canopy

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 1. Length of interruption in raw data

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

Table 2. Length of interruption in analytical data

Table 1 shows the length of interruption of raw data that was displayed on GIS. Table 2 shows the length of interruption of

analytical data that includes positional accuracy and error. For example, we considered dilution of precision (DOP), number of satellites and standard deviation.

4.2 Consideration

Important condition of GPS positioning is open sky. At an area surrounded by canopies and buildings GPS receiver was not able to receive signals from GPS satellites. Additionally, district overgrown with trees could not obtain continuous GPS signals. In such a place, revision data received by a mobile phone might not give acceptable data. An area surrounded by canopies and buildings causes is cycle slipping and multi-path to badly influence the received condition of GPS.

If GPS positioning is conducted near buildings, it is necessary to consider 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 was higher accuracy than that of D-GPS. 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.

5. SOLUTION OF PROBLEMS BY USING IC TAG AND GEOINFORMATICS

Pedestrian space is not safe and secure because people are not able to receive absolute positions and other information only by a current technology of spatial information. To solve these problems, we will adopt an Integrated Circuit tag (IC tag) to assist people including the physically challenged.



Figure 7. The latest technology in ubiquitous world

Figure 7 shows the IC tag equipments. Major advantages of IC tag are listed below.

The IC tag can

- Receive the data without contact.
- Memorize a lot of data and be very small size.
- Easily add information and update data.
- Has high durability that is better than its paper type.

If IC tag's powerful advantage is used fully, everyone will be able to receive the positioning data anytime and anywhere. For example, GPS positioning is used at open sky, and IC tags are used at closed sky, which are good ideas because one can continuously receive the signal from satellites and IC tags. This

system will imagine the positioning information ubiquitously (Figure 8).

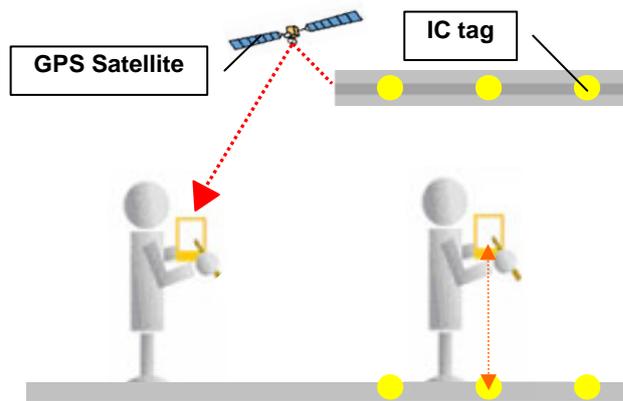


Figure 8. Utilization of IC tag

6. CONCLUSION

The experiment was performed by using a D-GPS and a VRS-GPS attached to wheelchair. As a result, we obtained high-accuracy positioning data under opened sky. However, there were measurement errors including cycle slipping and multi-path at some places under closed sky. Our researches confirmed that it is very difficult to solve these problems by using a GPS only. Additionally, we are not able to make a UM which is safe and give a relief in current technology only. Therefore, our study proposed the method by using geoinformatics and IC tags. Next step is to conduct the spatial simulation. Finally, proposed method expects to establish useful UM in the near future.

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