Experiments on the early detection method of wandering dementia patients by using GNSS

Kenchi Kishimoto (1), Masaaki Shikada (1), Riwa Nakamoto (2) and Naotake Nakayama (1)

[1] Kanazawa Institute of Technology, 7-1 Ogigaoka, Nonoichi City, Ishikawa, Japan.
[2] Tokiwa Hospital, 4-123 Nakabayashi, Nonoichi City, Ishikawa, Japan.
Email: b6801577@planet.kanazawa-it.ac.jp

KEY WORDS: QZSS, GIS, GNSS Logger, Smartphone Application

ABSTRACT: The number of Japanese elderly people (over 65 years old) has continued growing, and the proportion of elderly people in 2018 has grown to over 25% of the total population. The proportion of dementia patients also increases with the rise in the number of elderly people. Therefore, the proportion of missing people among dementia patients is increasing every year. When dementia patients go missing, they often get in trouble or have an accident. When an accident occurs, families who care for these patients may be required to claim damages from the company. In addition, the patient's family may have to quit work so that the patient does not go wandering. This wandering causes many social problems. One promising development is to use the position search services that a company or city office provides, so the patient's family can find the wandering patient. However, these measures have problems such as expensive equipment, unstable positional accuracy and information leakage to outsiders. Especially, system users need to pay expensive fees to keep track of the patient's position. Therefore, there are some problems to locate a patient's position. The major aim of this research is to verify the hypothesis that condition of patient movement by using GNSS logger is effective in finding wandering patients. In this study, we analyzed the behavior by using a SMARTPHONE as a GNSS logger, and tried to solve the problem of dementia patients. One of the reasons is that the number of elderly people with smartphones is increasing in recent years. We thought that they could carry a smartphone without resistance even if they begin to show signs of dementia, and it could record their location with low cost and high accuracy. Japan has been developing Michibiki that is QZSS (Quasi-Zenith Satellite System). Owing to the increase in the number of satellites, we thought GNSS logger could specify position accurately. Our results suggested that smartphone using QZSS could receive effective data for behavioral analysis. In addition, there were no differences in the position between smartphones using QZSS and GNSS logger.

1. Introduction

1.1 Aging situation in Japan

Elderly people are increasing in Japan and dementia patients are increasing with the rise in the number of elderly people (Cabinet office, 2019). According to a 2018 police investigation (National Police Agency, 2018), about 20% of missing people are known to have dementia. In Japan, because the number of elderly people has continued growing (Cabinet office, 2019), there is a shortage of staff in retirement homes. As a result, many elderly people receive nursing care from their families at home. However, many families have to quit their work in order to provide this nursing care. This is a difficult problem for the family because the wandering behavior of patients with dementia is a social problem, as well as a family problem.

1.2 Activity of wandering people

Local government and private companies are proposing different ways to solve the problem. One of them is to use GNSS equipment to search for the position in real time. However, interviews with the caregivers showed that there were some problems with these measures. First is the huge problem that dementia patients may refuse to carry a GNSS device and throw it away. Second is the high cost of purchasing and managing GNSS devices. Third is that the position accuracy is not very good. The patient walks in various paths so the device needs to have sufficient accuracy even in the mountainous area. Ueshima (Ueshima, 2018) proposed a method for the estimation of a missing person's position from moving lines of usual life. It used a cheap receiver because of no need to know the position with real time. [1] However, it is unknown whether this method is effective in searching for elderly people. We will get a behavioral route in advance just like him. This research conducted a demonstrational experiment by elderly people at the time of paper submission. Those data will be analyzed with a doctor in our local area. The purpose of the research uses this result and spatial information technology to detect missing people.

2. GNSS receiver

In the experiments, we used two category GNSS receivers. They are GNSS logger and smartphone with application. The reason for using a smartphone is that elderly people are increasingly using them. Elderly or wandering people can wear the device without resistance because smartphones are becoming increasingly popular in that demographic. The received data is saved as a GPX file, and GNSS logger used nine kinds as shown in Fig.1 and Table.1. Table.1 shows the types of receiving satellites for each devices and the indication of operation time. These devices can receive position information from one of QZSS, GPS, and GLONSS or some of them. The demonstrational experiment to elderly people used Type-2 and Type-4. Smartphone used Xperia XZ3 and iPhone 7 can supplement three satellites.

Fig.1 GNSS logger

Table.1 performance of logger

Equipment Name	Equipment Number	Observation Time (reference value) [hour]	Type of Satellite		
			QZSS	GPS	GLONASS
GT-900	Type-1	40	○	○	—
GT-730FL-S	Type-2	18	—	○	—
GT-120	Type-3	10	○	○	—
GT-600	Type-4	30	○	○	—
GL-770	Type-5	35	○*1	○	○
K-18U 900mAh	Type-6	24	—	○	—
GP-102+	Type-7	18	—	○	—
GT-740FL	Type-8	16	—	○	—
DG-500G	Type-9	15	—	○	○

*1... except for a stationary satellite

3. Preliminary Experiment

3.1 Compare with surveying data with VRS method

We compared the surveying data of Leica GS08 +, loggers and smartphones. The result of mobile observation in the campus is shown in Fig.2. Fig.3 shows the condition of experiment. The experiment used dolly and passed a place in Fig.4. The accuracy is bad in the place in Fig.4. This is an effect of multipath and canopy. The most important point in our research is whether the devices can capture for rough location. As shown in Fig. 2, we can see sufficient accuracy in almost all places.

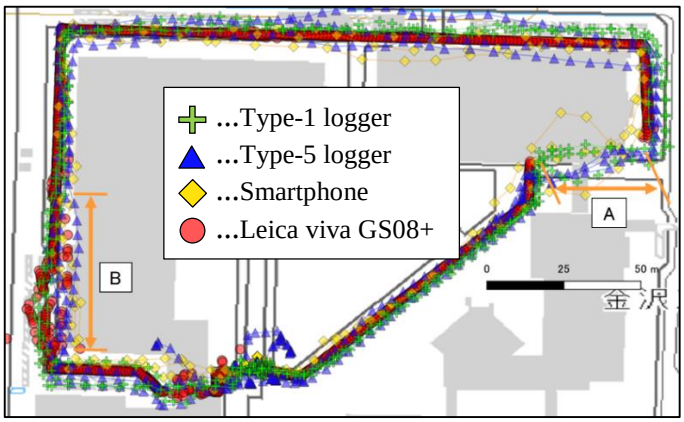

Fig.2 Gap of accuracy of different devices

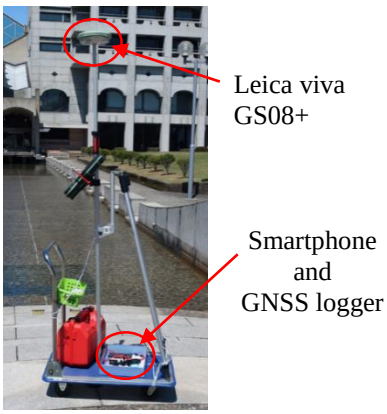

Fig.3 State of experiments

Fig.4 Location of experiment (left: part of A, right: part of B)

3.2 Performance difference in logger

The purpose of the preliminary experiment is comparison of accuracy with devises. We placed the receiver as Fig.5 where there was already an observed position information by using VRS surveying. Data from the logger was received by fixed observation. A part of the result is shown in Fig.6. Dark color in this figure indicates that the receiving points are duplicate. The result has a large error compared to VRS; however, we don't need the correct position information in this case because the purpose of the study is to estimate the patient's rough location, so the obtained data is sufficiently accurate.

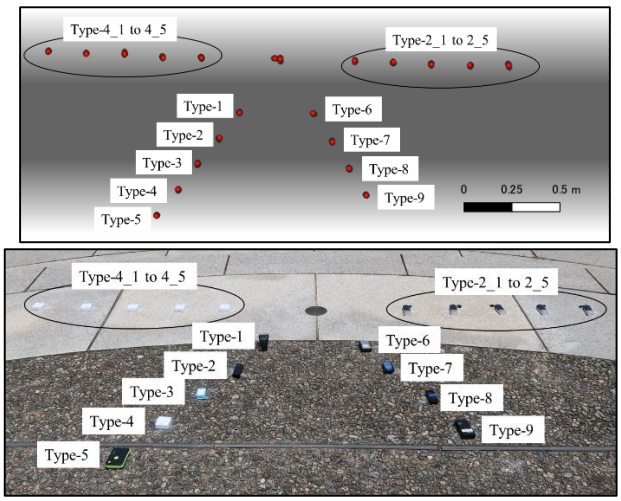

Fig.5 top: Placement of logger,
bottom: State of experiment

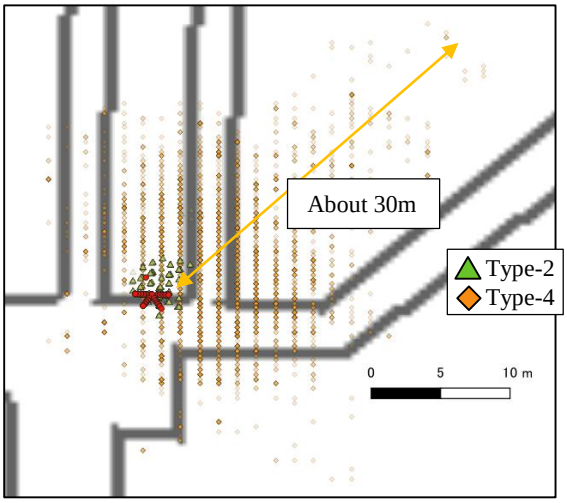

Fig.6 Difference in reception accuracy

4. Demonstrational experiment

The experiment was conducted with the cooperation of three elderly people living around the campus. The information of the examinees is shown in Table.2. The examinees put on a Type-2 or Type-4 logger to them for 3 to 5 days. We did not give any restrictions other than having examinees carry the logger or Smartphone. This is to

ensure that the experiment does not interfere with the examinee's normal activities. Fig. 7 is an example of data gathered. In cooperation with the hospital and the city office, we are currently collecting actual measurement data of elderly people.

Table.2 Information on examinees

Pseudonym	Sex	Age	Roommate
A	woman	82	alone
B	woman	76	family
C	man	83	alone

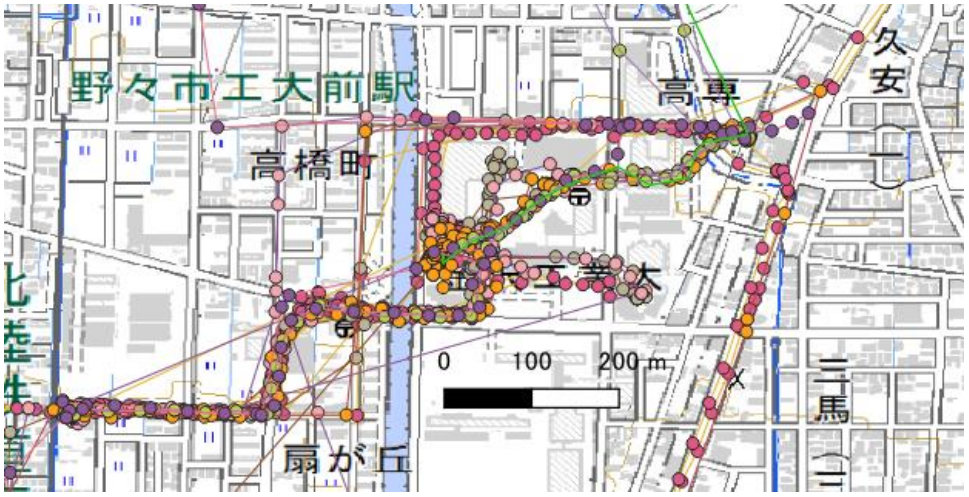

Fig.7 an example of author's behavior by smartphone data (The base map is GSI tiles.)

5. Conclusion

The research purpose is to estimate location information for elderly and wandering people by behavior analysis using a logger, smartphone and spatial information technology. There are few studies using smartphones instead of loggers in the conventional way of watching the elderly or wandering people. It is very important to conduct detailed examination through research. There are few verification experiments by cooperation of actual elderly people in previous research. As pointed above, it is important knowledge not only in the geo-space information field but also in the medical field. In the near future, we are going to verify from demonstrational experiments whether these methods are effective for behavioral analysis of finding wandering people.

6. ACKNOWLEDGEMENTS

The authors would like to thank to Dr. Riwa Nakamoto of Tokiwa Hospital who provided knowledge of the medical field to us. In addition, we got cooperation from the Nonoichi City office and Nonoichi citizens. We would like to express our deep thanks. Finally, we especially thank Mr. Ueshima, who led the research.

7. References

References from Journals:

Ueshima, Kentaro, Shikada masaaki, Nakamoto Riwa, Nakayama Naotake. 2018. Basic research on prevention of wandering accident by using GNSS. Asian Conference of Remote Sensing, Vol.3, pp. 1469-1472.

References from websites:

Cabinet Office, Government of Japan, 2019. Annual Report on the Ageing Society: 2019, Retrieved July 29, 2019, from https://www8.cao.go.jp/kourei/whitepaper/w-2019/zenbun/01pdf_index.html.
National Police Agency, Government of Japan, 2018. Situation of the Missing Person in 2018, Retrieved July 29, 2019, from https://www.npa.go.jp/safetylife/seianki/fumei/H30yukuehumeisha.pdf.
Geospatial Information Authority of Japan, 2019. Light colored map, Retrieved July 29, 2019, from https://maps.gsi.go.jp/development/ichiran.html, Shoreline data is derived from: United States. National Imagery and Mapping Agency. "Vector Map Level 0 (VMAP0)." Bethesda, MD: Denver, CO: The Agency; USGS Information Services, 1997.