35th Annual International Conference of the IEEE EMBS
Osaka, Japan, 3 - 7 July, 2013

Road Information Collection and Sharing System

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Abstract— **Walking is an important factor in good health, and people derive many benefits from travelling by foot. However, walking entails risks such as traffic accidents and falls. If people recognize specific risks before walking, then they may avoid such accidents. This paper proposes a road information collection and sharing tool for the public. The proposed system stores passive risks from the properties of the landscape and active risks identified by people. Moreover, it realizes an easy way to access such risk information. When people know and avoid these risks, they will be able to walk safely.**

I. Introduction

Walking is an important factor in good health. People can have good experiences when walking with their friends, shopping, sightseeing, and so on. However, some people may lose the ability to walk because of traffic accidents or falls. Some accidents are due to properties of the landscape such as steep hills and places with poor visibility. If people recognize specific risks before walking, then they may avoid such accidents.

Figure 1 shows the area covered by this research. This area, Nakayama, is a traditional town in Japan with a population of about 10,700. Elderly people (over 65 years old) account for 25% of the population, while those under 14 years of age account for 12% [1]. There is a railway station, a shopping center, a junior high school, an elementary school, and two kindergartens. However, there are risks in the landscape with its many steep slopes. Moreover, there is a lot of snow in winter and sometimes frozen, icy roads. These risks can be classified into passive and active risks. The passive risk is related to the gradient information of the route. Figure 2 shows a route between the station and the author's home. The difference in altitude of this route is 77 m, and the gradient is 10.3% (Figure 3). Some elderly people have lived here since childhood. Because they are in familiar surroundings, they confidently head down the road even though their muscles have declined with age. The active risks are mainly related to automobile traffic. There are many places with poor visibility caused by the properties of the landscape. Often, people remember and share bad experiences verbally so that everyone may avoid these risks.

The objective of this research is to develop a road information sharing system for residents that can reduce the risks mentioned above. When a resident knows about passive risks, they can choose a safer route. A first step of this research is the development of a data collection and visualization tool for the detail of the landscape properties. The second step is the development of a road information sharing system for residents. To make it easy to collect and access such information, residents can use this system to update or share road information with each other.

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II. Social Framework

The proposed system handles place-oriented information; therefore, the system requires a lot of support from the residents. Concretely, the system collects information from residents and allows them to share it with each other. A fundamental system architecture such as this is called a "Social Framework."

The social framework collects road information using an Android smartphone.

Recently, smartphones have become a popular mobile device. Smartphones includes many kind of devices such as GPS, accelerator, geomagnetic sensor, camera, Bluetooth, 3G networks, and a Wi-Fi connection. The two most popular smartphone platforms are iOS and Android. This research uses Android because its development environment is free and open source [2-3].

In this research, the proposed system consists of a "Crawler Device" and "Active Data Collector Application." Details of both are described as follows.

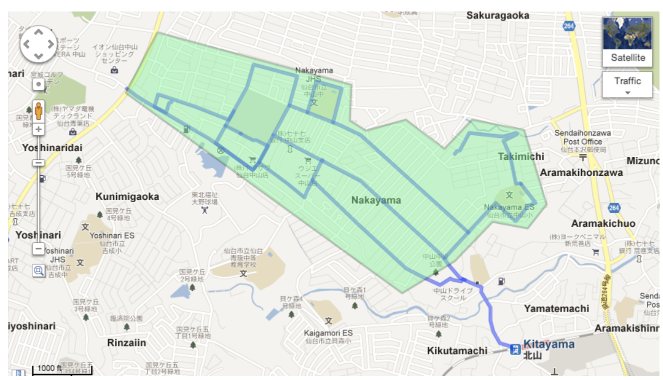

Figure 1. The coverage area: Nakayama (Aoba-ku, Sendai, Miyagi).

Figure 2. The route between the station and author's home.

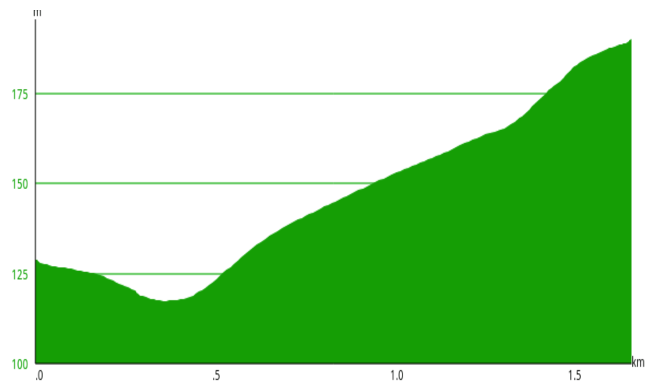

Figure 3. Altitude information of the route in Figure 2.

A. *Crawler Device*

Currently, there are some Android applications that collect road information for car/motorbike/bicycle/runner [4]. The information in Figure 3 has been collected by such an application, which gives a smooth altitude curve [5]. However, the actual road is more irregular, and this research handles local, discontinuous road information. Normally, such an application uses GPS information to create altitude curves. However, the accuracy of GPS is generally less than 5 m, so such applications can obtain only rough data [6]. In addition, the large rubber tires of cars/bicycles cancels out the irregularity of road information. For the above reasons, this research requires its own crawler device for data collection.

The crawler device collects road gradient information over a large area in an objective way by combining a dolly and smartphone. Figure 4 shows the prototype dolly. It is made of aluminum and polyurethane rubber wheels. The smartphone is attached to the dolly, and measures road gradients using its 3D-axis accelerator sensor. The dolly holds the phone parallel to the surface of the road. By using the dolly as a crawler, a person can obtain gradient information for a wide area.

The data-collecting application runs on the smartphone. Figure 5 shows the application window. This application polls GPS information, and when a difference is detected between latitude and longitude, the application obtains the gradient from the accelerator sensor. Generally, the accuracy of GPS is more than 5 m. However, for certain coordinates, the GPS accuracy can drop to 20 m, caused by poor satellite visibility.

This application was developed using App Inventor [4], an application that allows users to develop applications for Android phones using a web browser and connected smartphone. App Inventor has an Android Block Editor (Figure 6). Even inexperienced Android programmers can build application logic using "Blocks," and do not need special development environments. When people wish to expand this application, it is therefore easy to modify.

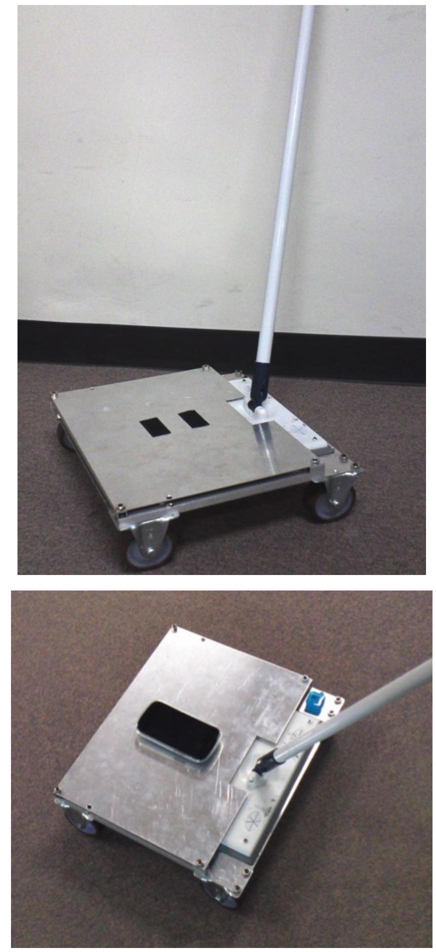

Figure 4. Prototype of Crawler (top) and Crawler with smartphone (bottom).

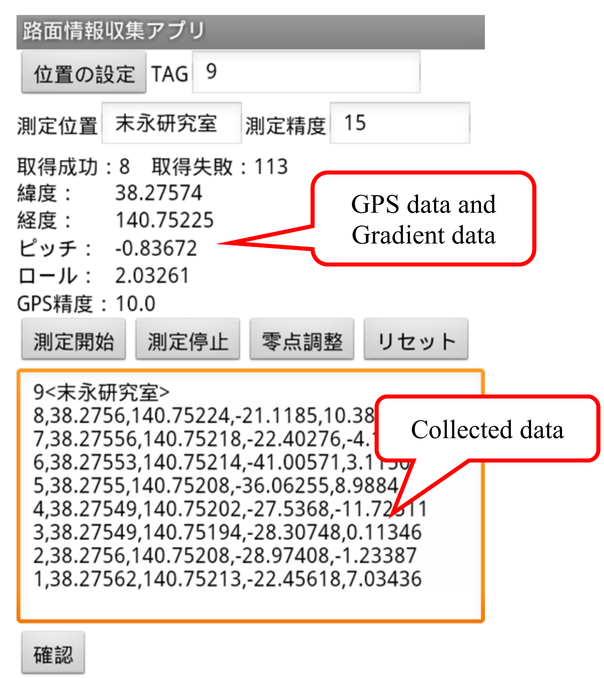

Figure 5. Altitude information of the route in Figure 1.

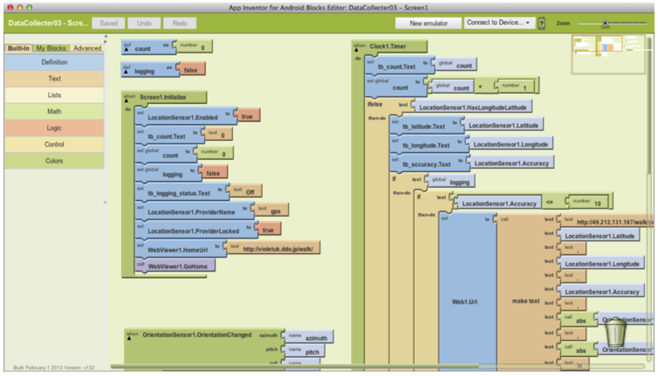

Figure 6. Android Block Editor.

Figure 7. Example of GPS accuracy errors (red circles).

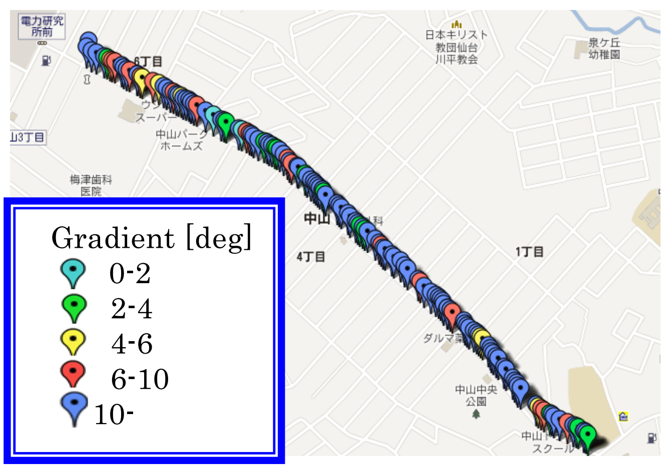

Figure 8. Experimental result using data collection using the dolly.

Figure 7 shows an example of the errors of GPS accuracy. In this case, two data points mistakenly placed far from the route. To keep positional accuracy, the application also obtains gradient information at an accuracy of less than 5 m.

Figure 8 shows the first experimental results of data collection using the dolly. This result shows that collected data is placed on the road, and its positional accuracy is sufficient. However, most of the gradient angles are too large and undulating. Because of this, the application is too sensitive to obtain useful road gradients. To solve this problem, the crawler device needs to be vibration-insensitive.

B. *Active Data Collector Application*

The crawler device can collect a large amount of information about road gradient. In practical terms, however, gradient data does not tell us the risk of traffic accidents or similar risks. Sometimes, there are traffic accident between car and pedestrians at places of poor visibility. In such cases, people need to know additional information.

Figure 9 shows another application that collects data by word of mouth. The data consists of latitude, longitude, geomagnetic data, gradient data, age of registered person, and comment. People can see the registered comments on Google Maps (Figure 10).

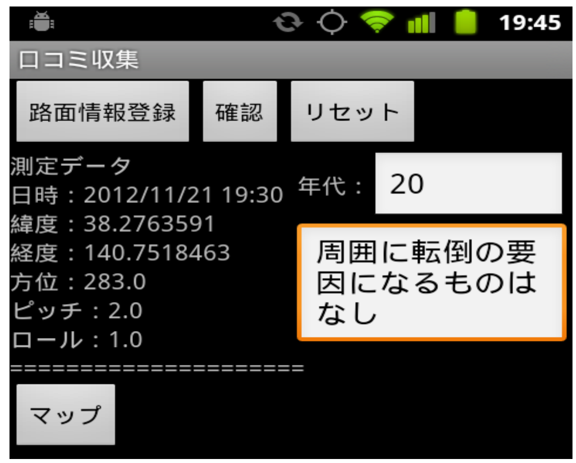

Figure 9. Active Data Collecter Application.

Figure 10. Example of a comment data view.

C. *Data Visualization*

After collecting active and passive data, the data is stored on an SQL database server and KML data [5] is generated for Google Maps [6]. Each data point is displayed using a colored marker and comment window (Figure 10), from the Google Maps API [7]. Google Maps is a typical map service for many types of devices, which enables people to see this information using a smartphone, PC, and so on.

Figure 11. The result of field experiments.

III. FIELD EXPERIMENTS

The proposed system was evaluated by conducting field experiments. Figure 11 shows the result of this experiment. Different colored markers indicate the gradient of the road used in the test. These markers color show mild shifts that correspond to the landscape gradient. This result shows the success of the vibration-dampening functions.

IV. FUTURE WORK

This paper proposed a road information collecting and sharing system. A field experiment demonstrated the function of passive data collection and display. When the proposed system collects more information about the Nakayama area, residents can understand the properties of the landscape, and minimize the passive risks.

The next step of this research is to compare the above result with actual traffic accident data around Nakayama. When we understand the relationship between road properties and traffic accidents, this system can provide much more information to reduce residents' risk.

ACKNOWLEDGMENT

This work was supported by JSPS KAKENHI, Grant-in-Aid for Challenging Exploratory Research Number 23650359.

The author is also grateful to Mr. Yuki Ishii and Mr. Ryo Yabe of Sendai National College of Technology.

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