On-Demand Barrier-Free Information Provision System for Providing Sensor Information from General-Purpose Wheelchair Users

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***Abstract*— In this study, we propose a system for collecting barrier information from the various sensors attached to general-purpose wheelchairs and constantly feeding back the latest information to wheelchair users, that is to say an "on-demand barrier-free information provision system." In this paper, we show the results of an evaluation experiment using a prototype of this system. By carrying out this evaluation experiment using this prototype system, we can demonstrate the effectiveness of this system.**

Keywords—Wheelchair; Barrier-Free; Sensor Information; Web Application; IoT

I. INTRODUCTION

In recent years in Japan, elderly people with a physical disability are increasing. For this reason, the use of wheelchairs to support the movement of such people is also forecast to increase moving forward. As wheelchair users experience danger and anxiety due to the existence of these kind of steps, the introduction of a barrier-free environment for wheelchair users is an urgent requirement. However, in order to realize a barrier-free environment, it is necessary to grasp where such steps exist, and there is the issue that gaining this understanding requires a large amount of time and labor cost. Further, as the state of such steps changes in a dependent way based on repair of such steps by the city office and acts of God such as earthquakes, it is necessary for this information to be continually updated. However, there is the issue that the existing system has a low update frequency [1,2].

In this study, we propose a system for collecting barrier information from the various sensors attached to general-purpose wheelchairs and constantly feeding back the latest information to wheelchair users, that is to say an "on-demand barrier-free information provision system." In this system, multiple wheelchair users become information providers. As this system involves attaching the Raspberry Pi 2 single board computer to general-purpose wheelchairs and collecting barrier information from multiple users, it is able to collect information in a short time and at low cost compared to existing systems, and continually feed the most up-to-date information back to the users. This system not only uses the confirmation of the step by the wheelchair users, but can also utilize the step repair work by the city hall (figure 1). In this paper, we show the results of an evaluation experiment using a prototype of this system. By carrying out this evaluation experiment using this prototype system, we can demonstrate the effectiveness of this system.

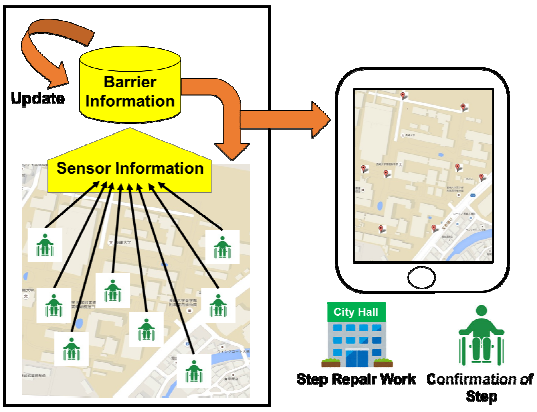

Fig. 1. Use Case of On-Demand Barrier-Free Information Provision System

II. ON-DEMAND BARRIER-FREE INFORMATION PROVISION SYSTEM

An overview of the on-demand barrier free information provision system is shown in figure 2. In this system, the three types of information, that is to say the acceleration information, longitude and latitude information and photographic information related to steps in the road are collected from the various sensors (acceleration sensors, GPS, camera) connected to the Raspberry Pi 2 while travelling in a wheelchair, and these are stored on the Raspberry Pi 2 using a barrier information collection program. The various sensor information (barrier information) stored on the Raspberry Pi 2 is uploaded to the Server using the data transfer program when connected by Wi-Fi, and the database information on this Server is updated using the data update program. There are regular updates every 1 minute on the Server. Users of this system can constantly confirm new information via the WEB application. It is considered that the communication between Raspberry Pi 2 and the Server can use lines other than Wi-Fi, such as 3G lines. As installing and maintain 3G lines is expensive, Wi-Fi was used for the prototype of this system.

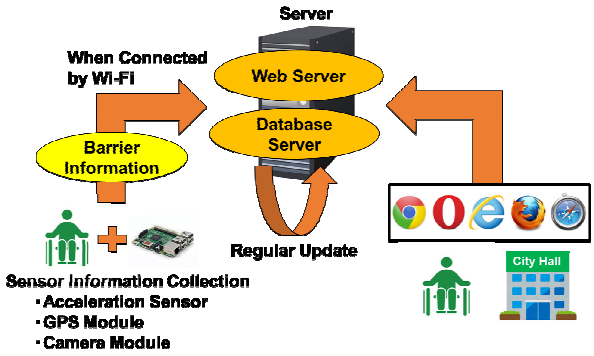

Fig. 2. Overview of On-Demand Barrier-Free Information Provision System

A. System Requirements

The requirements for realizing this system are as follows.

Requirement 1: Acquiring barrier information.

The barrier information can be obtained using the various sensors and the barrier information is saved on the Raspberry Pi 2.

Requirement 2: Sending and receiving barrier information.

When connecting with Wi-Fi, the barrier information on Raspberry Pi can be transferred to the Server.

Requirement 3: Updating barrier information.

The barrier information on the Server can always be updated with new information.

Requirement 4: Providing barrier information.

Can provide barrier information (step information) via a WEB application.

III. Evaluation Experiment

In order to experiment the effectiveness of this system, an evaluation experiment satisfying the four conditions of section II.A was performed using a prototype of this system. The result of the evaluation experiment was as follows.

A. Requirement 1: Acquiring barrier information

In regard to requirement 1, this prototype system was attached to a general-purpose electric wheelchair owned by the authors and when passing by a step riding this electric wheelchair, an experiment was performed on whether the system could detect the steps, photograph the step location and save this step location. The result was that it was confirmed that the steps were detected, the step location photographed and the step photos were saved on the Raspberry Pi 2.

B. Requirement 2: Sending and receiving barrier information

In regard to requirement 2, we performed an experiment on whether the barrier information was stored on Raspberry Pi and the data was transferred when connected by Wi-Fi. The result was that it was confirmed that, when connected by Wi-Fi, the barrier information on the Raspberry Pi was correctly transferred to the Server.

C. Requirement 3: Updating barrier information

In regard to requirement 3, we performed an experiment on whether the regular update program would operate correctly on the Server. The result was that it was confirmed that the regular update program operated every 1 minute, and when the new barrier information was transferred from the Raspberry Pi 2 that the barrier information could be correctly updated.

D. Requirement 4: Providing barrier information

In regard to requirement 4, we performed an experiment on whether the barrier information stored on the Server (step information) was correctly displayed on Google map, and whether the step photos were correctly displayed. The result was that it was confirmed that it was correctly displayed on Google Map (figure 3). Further, it was also confirmed that when the barrier information was updated by the regular update program it was correctly displayed.

Fig. 3. Barrier Information Provision Experiment

IV. Conclusion

In this paper, we proposed a system for storing information from various sensors attached to a general-purpose wheelchair, and constantly feeding back the most up-to-date information to wheelchair users, that is to say an on-demand barrier information provision system. Further, the effectiveness of this system was demonstrated with an evaluation experiment using this prototype system.

In future, we plan to perform an evaluation experiment in which it is evaluated when barrier information is collected from multiple wheelchairs whether the data is correctly updated.

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