Situation Visualization System of Disaster Area Using Truck-mounted Camera

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ABSTRACT: When a disaster occurs, early evacuation of residents is one of the effective ways for reduction of human damage. Then, the rapid collection and delivery of accurate disaster-related information are essential. With this background, the authors' research group is focusing on how Twitter is utilized at the time of disasters. For example, we have researched the implementation of disaster-related information sharing systems that utilize Twitter. However, since these systems require users to send disaster situations manually, it is difficult to collect the situation in the disaster area comprehensively. By the way, recent commercial trucks are equipped with a communication function, which makes it possible to grasp movement history and failure status in real-time. Then, there are studies on obtaining the image of the car-mounted camera automatically in real-time for grasping the road condition. It is thought that the image taken by the car-mounted camera is useful not only for understanding the road condition but also for visualizing the conditions in the disaster-affected area. Moreover, it is considered that trucks travel in a wider area than passenger cars. Therefore, in this study, we propose an automatic situation visualization system of a disaster area and implement the prototype of it. The system collects and visualizes images taken by the car-mounted camera of a truck running in areas where a disaster occurs, or an occurrence of a disaster is predicted. The proposed system makes it possible to grasp the situation in the target area quickly and comprehensively. In this study, we implement a prototype of the proposed system by using a single-board computer, Raspberry Pi, a web camera, and a GPS module. The system gets longitude and latitude information at regular intervals by using the GPS module. If it is determined that the truck equipped with the system is in the area where a weather warning, such as the heavy rain warning, is issued, sending an image taken by the camera of the system starts. The images sent from trucks are stored in a database with longitude and latitude information and shooting time. We moreover implement a visualize system which shows the images stored in the database on the Web map.

1. Introduction

When a disaster occurs, early evacuation of residents is one of the effective ways for reduction of human damage. Then, the rapid collection and delivery of accurate disaster-related information are essential. Various methods such as aerial photography, fixed-point cameras, and SNS postings are conceivable for collecting information during disasters. With this background, the authors' research group is focusing on how Twitter is utilized at the time of disasters. For example, we implemented disaster-related information sharing systems that utilize Twitter in the previous studies (Uchida et al., 2016; Kosugi et al., 2019). In these systems, tweets are posted with the hashtag of the form "# [city name of the current location]_disaster" based on the location information, and those posts are viewed in a state mapped from DIMS be able to. However, since these systems require users to send disaster situations manually, only the damage recognized by the user can be confirmed. It is difficult to collect the situation in the disaster area comprehensively. Therefore, it is considered difficult to collect the situation comprehensively in the affected areas such as where the damage is occurring and where there is no abnormality. By the way, recent trucks are equipped with a communication function, which makes it possible to grasp movement history and failure status in real-time (MFTBC, 2019). Then, there are studies on obtaining the image of the car-mounted camera automatically in real-time for grasping the road condition. For example, the study conducted by Ishii et al. aims to stabilize logistics when a disaster occurs using in-vehicle cameras, satellite images, traffic performance information, and traffic volume prediction (Ishii et al., 2017). On highways in Hokkaido Area, Japan, cameras mounted on high-speed buses are used to determine visibility (Suzuki et al., 2012). It is thought that the image taken by the car-mounted camera is useful not only for understanding the road condition but also for visualizing the conditions in the disaster-affected area. Moreover, it is considered that trucks travel in a wider area than passenger cars. Therefore, in this study, we propose an automatic situation visualization system of a disaster area and implement the prototype of it. The system collects and visualizes images taken by the car-mounted camera of a truck running in areas where a disaster occurs, or an occurrence of a disaster is predicted. The proposed system makes it possible to grasp the situation in the target area quickly and comprehensively.

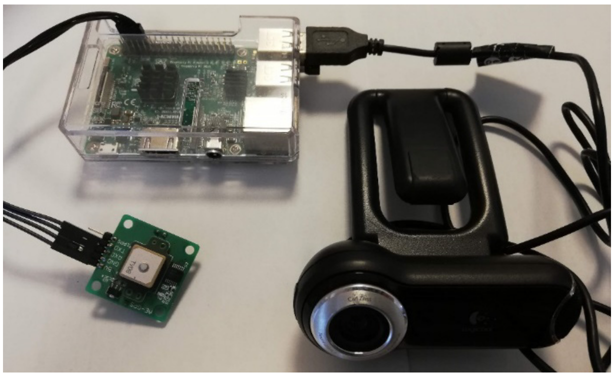

Fig. 1 Raspberry Pi, camera, and GPS module used for the prototype creation

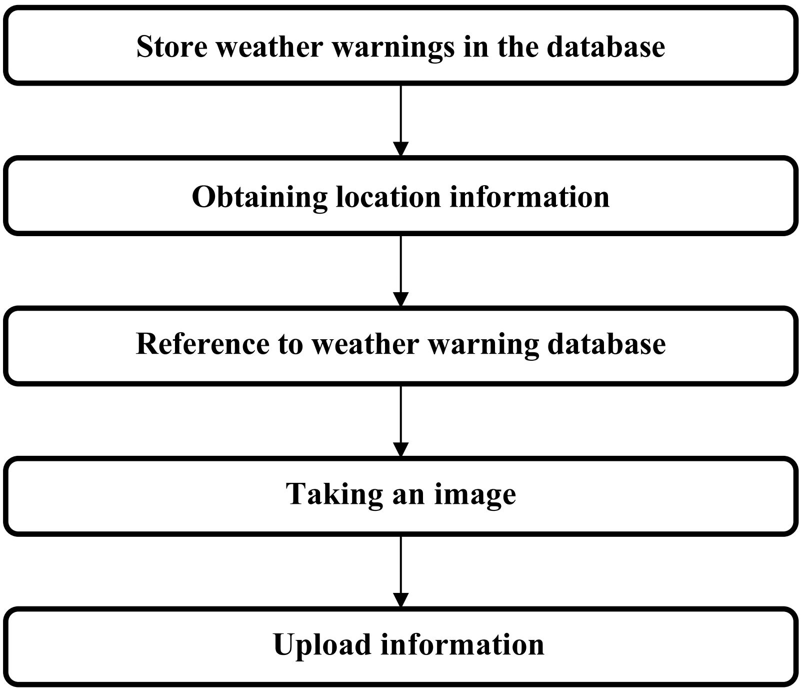

Fig. 2 Overview of the proposed system

2. Proposed system

2.1 Overview

The system proposed in this study uses a built-in communication module in the truck. It assumes that the system starts automatically when the engine is started and does not require any operation of drivers. In this study, we created a system with equivalent functions by using a Raspberry Pi, a camera, and a GPS module (Fig. 1) as a prototype. As triggers to start posting captured images, it is conceivable to use local information such as weather warnings, river water level information, Sediment-related Disaster Warning Information, and earthquakes with high seismic intensity, and information on the vehicle such as sudden braking and traffic jams. It is also possible to collect images during normal times and compare them with those collected at abnormal times. However, this prototype only uses weather warnings as the trigger to start posting images. The posted contents in this prototype are latitude and longitude, images, and image shooting times. However, we think that adding information such as speed and outside temperature to the information to be posted is also beneficial. Figure 2 shows an overview of the proposed system.

2.2 Store weather warnings/ advisory in the database

Since December 2012, the JMA homepage has released information on weather conditions, weather warnings/advisories, earthquake, and volcanoes, etc. in XML format. There are two types of JMA xml: PUSH type, which requires user registration and is automatically notified, and PULL type, which allows users to obtain information at any time. This system uses the PULL type. Information (JMA, 2019a) of posted warnings and advisories is always acquired at regular intervals and stored in the database. Records are searched for by the municipality code (MIA, 2019), and each warning/advisory is handled for that record. (8 for heavy rain warning, for example) (JMA, 2019b) is stored in text type. When multiple warnings and advisories are issued, both codes are stored separated by slashes.

2.3 Obtaining location information

In this prototype, Akizuki Denshi's "GPS receiver kit with 1PPS output, compatible "Michibiki" reception with 3 units" was used. The latitude and longitude are acquired from the data sent from the module using the library.

2.4 Reference to weather warning database

From the location information obtained in 2.3, the municipal code is obtained using the reverse geocoding service of finds.jp (NARO, 2019). The municipality code obtained from finds.jp is a 5-digit code that does not include the final check digit. In this prototype, when any warning (including special warnings) is issued, it shifts to 2.5.

2.5 Taking an image

This prototype uses Logitech Webcam Pro9000 as a camera. When the weather warning is found in the current location in 2.4, the system takes an image from the camera. The system uses the current date and time for the file name.

2.6 Upload information

The system sends the latitude and longitude acquired in 2.3, the camera image acquired in 2.5, and the current time to the server with a post request. The PHP file in the server stores images and stores the file name, latitude, longitude, and shooting time in the database.

2.7 Mapping system

The image uploaded from the track is displayed on the WEB map, as shown in Fig. 3. Yahoo! Open Local Platform (Yahoo!, 2019) was used for making the map. When browsing the Web map, the posted information stored in the database is mapped using latitude and longitude. When the marker is clicked, the image and shooting time are displayed in a balloon as shown in Fig. 4.

3. Verification experiment

An experiment was conducted to verify the practicality of the proposed system. In this experiment, the prototype was installed in a general passenger car and the system was operated during driving. 37 images were posted, and it was confirmed that the system was operating normally. The location information was traced almost accurately. However, there was an error of up to 20 meters between the location where the image was taken and the location on the map. This is thought to be due to the fact that there is a slight time lag between the acquisition of position information and the image capture in the prototype program. However, this error is not considered to cause a big problem in using the system in practice.

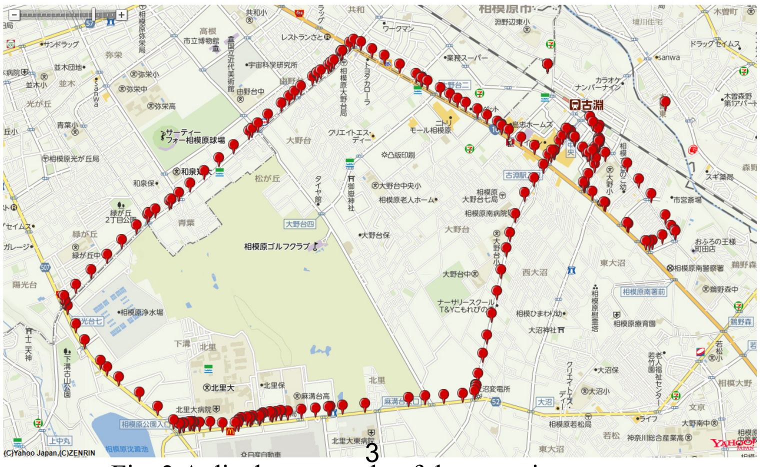

Fig. 3 A display example of the mapping system

Fig. 4 A display example when a marker is clicked

4. Summary

In this study, we proposed an automatic situation visualization system of a disaster area and implement the prototype of it. The system collects and visualizes images taken by the car-mounted camera of a truck running in areas where a disaster occurs, or an occurrence of a disaster is predicted. In the future, we plan to consider appropriate shooting intervals, improve the visibility when a large number of markers are placed on the map, and improve the mapping system such as adding a function that allows third parties to add comments.

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