Archive System to Browse the Roads with Extremely Delayed Recovery after the 2011 Tohoku Earthquake

Noriaki Endo, *Member, IAENG,* Jieling Wu, Bingzhen He, and Satoru Sugita

***Abstract*—In our previous study, we identified the municipalities and each road within these municipalities for which road recovery was extremely delayed after the 2011 Tohoku Earthquake. In this study, we built an archive system to monitor these roads following the 2011 Tohoku Earthquake to identify and confirm the vulnerabilities of roads and raise their resilience. This system allows us to browse video images of vulnerable roads that are narrow, steep-walled, and located in mountainous regions. To date, we could only identify the type of problematic roads, but we had not developed methods for increasing their resilience, which can be done using the proposed system. The next step is to confirm the vulnerability of road components in detail.**

***Index Terms*—2011 Tohoku Earthquake; disaster archive system; probe-car data; telematics data; vehicle-tracking map**

I. Introduction

A. Disaster archive system of the 2011 Tohoku Earthquake

Immediately after disasters such as the 2011 Tohoku Earthquake [1] [Figs.1 and 2], the people present in the disaster area are forced to focus on not only their survival but also the survival of their neighbors. After the situation settles down to some extent, people begin to consider sharing their experiences from the disaster with the next generation and utilizing these experiences for future disaster prevention. These disaster experiences could be of great interest to people for disaster prevention, not only in afflicted areas but also throughout Japan and the world. Therefore, we created an experimental archival system to preserve digital images from the disaster as archival material for the next generation [2].

B. Road usage recovery following the 2011 Tohoku Earthquake

In our previous work [3], [4], [5], we evaluated regional differences for road recovery in the Iwate Prefecture after the 2011 Tohoku Earthquake. For these studies, we used vehicle-tracking maps constructed from probe-car data that were made available on the Internet by Toyota Motor Corporation, Japan. In these studies [3], [4], [5], we also determined the municipalities and each road within these municipalities with extremely delayed road recovery after the earthquake.

C. Purpose of this Study

In this study, by combining the scopes of our studies [2], [3], [4], [5], we built an experimental archival system for browsing roads with an extremely delayed recovery after the 2011 Tohoku Earthquake. The purpose of this system is to help identify the vulnerable road components to raise overall road resilience.

N. Endo, J. Wu, and B. He are with Iwate University, Morioka City, Iwate, Japan e-mail: (see http://www.hss.iwate-u.ac.jp/endo/). Satoru Sugita is with Chubu University, Kasugai City, Aichi, Japan.

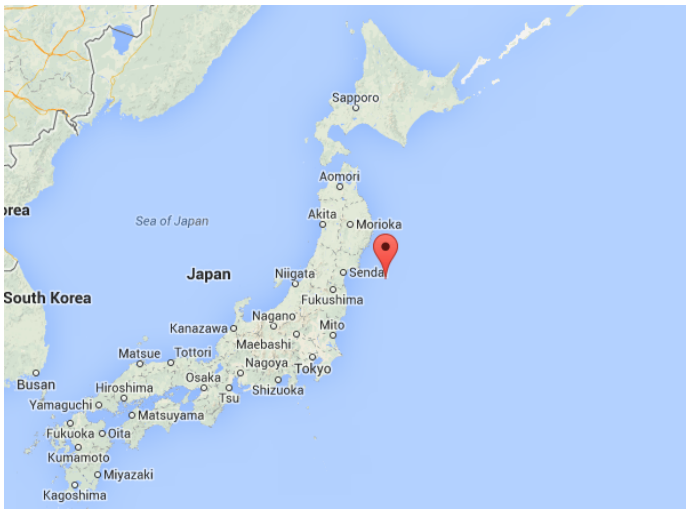

Fig. 1. The epicenter of the earthquake that occurred on March 11, 2011 in Tohoku (https://www.google.co.jp/maps/).

Fig. 2. The epicenter of the earthquake that occurred on March 11, 2011 in Tohoku (magnified, https://www.google.co.jp/maps/).

II. Methodology

A. Research area

All areas of the Iwate Prefecture afflicted by the 2011 Tohoku Earthquake [Fig.3].

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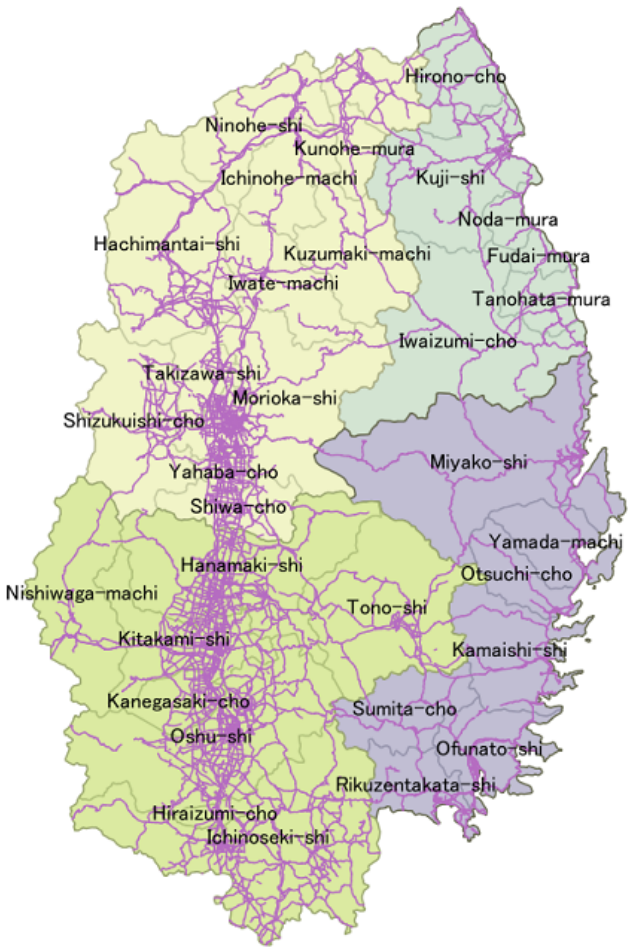

Fig. 3. The vehicle-tracking map of Iwate Prefecture is shown by the violet lines. The perimeter of a city is shown by a gray polygon. Iwate Prefecture has been divided into four areas: the Northern Costal, Southern Coastal, Northern Inland, and Southern Inland areas.

B. Research materials

In this study, we used video data for the roads in the Iwate Prefecture with extremely delayed recovery after the 2011 Tohoku Earthquake. The video images were captured in the afflicted area of the Iwate Prefecture, following post-disaster road recovery. We used video data available on the Internet through services such as YouTube with the consent of their creators.

C. System

1) The server for providing the content: Hardware: a PC server assembled by the author

Software: The operating system(OS) was Linux. Apache HTTP server was used as the HTTP server software.

2) The client for creating the content: Hardware: a PC client

Software: Notepad was used for writing and editing the code of the system. The system was deployed on a web browser such as Firefox or Internet Explorer.

3) The role of the local server: We used the server for serving HTML, ASX files, and video data to the clients. The ASX file functions will be mentioned in the following section.

4) The role of the web service: We used the Yahoo! JavaScriptMap API as the platform (the developing environment which was provided by Yahoo Japan) to draw background maps. Accordingly, the system was programmed in JavaScript. Using this web service, we could build a sophisticated system rather easily.

III. Construction of the Archive

The method used in this study was similar to the one used in our previous study [2].

By linking video data and high-resolution satellite images, captured in the target earthquake disaster area, with the digital map of the area, we built an archival system for browsing disaster images clearly and easily.

A. Specifying the exact route of the video

Images uploaded on the Internet do not often have exact geospatial attributes and exact route attributes. Therefore, initially, we specified the start point, midpoints, and end point of the video file. We watched the video and map of the location in the video simultaneously. The routes in the video were specified based on the signs of structures such as buildings and roads. We recorded the route information as a geospatial attribute.

B. Making links from each node to the video scene

We measured the time from the initial node to each node and made ASX files to play the video between two nodes (beginning node to end node) by clicking on the beginning node. We used the Yahoo! JavaScript Map API to link the map images and ASX files. This has been illustrated in Figs. 4 and 5.

C. The role of ASX files

An ASX file is a type of Windows meta file that makes it possible link web pages and Windows Media Audio (WMA) servers or web server content. Using an ASX file, we were able to control the playback of Windows Media Video (WMV) files. We could specify the beginning of the video by using the StartTime tag. Additionally, we could specify the playback duration time of the video using the Duration tag. This made it possible to set multiple playback patterns for one video file. Therefore, in this study, we were able to consider a video without any geospatial attributes as one with geospatial attributes.

IV. Results: Archive System Operation

Figure4 depicts the example map containing the routes of the video data taken around Iwate Prefectural Route 7, 158, and 160. System users can play the video between two nodes (the beginning and end nodes) by clicking on the beginning node on the map [Fig.5]. When the cursor is pointed at each node, the number of the nodes appears at the bottom of the map.

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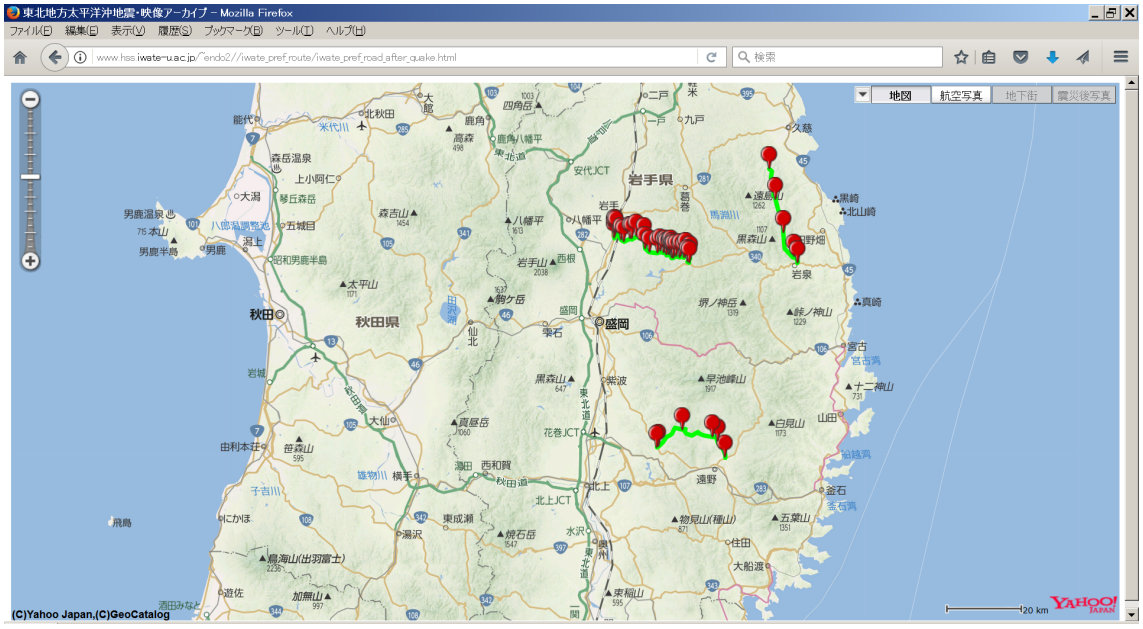

Fig. 4. An example map for browsing the roads with an extremely delayed recovery following the 2011 Tohoku Earthquake.

Fig. 5. A video image of the road with an extremely delayed recovery following the 2011 Tohoku Earthquake (Iwate Prefectural Road 158).

V. Discussion

A. Upgrading public Internet images to geospatial data

Although the images provided by the media, such as TV stations, were useful with regard to the 2011 Tohoku Earthquake, the images uploaded on the Internet proved to be more informative. However, images uploaded on the Internet usually have no exact geospatial attributes. In particular, the route information is completely absent. This means that they do not have much value as geospatial data.

Accordingly, in this study, we added routing data to images uploaded on the Internet to upgrade them for their use as geospatial data. Finally, we accumulated the data to build an earthquake disaster archive of the 2011 Tohoku Earthquake. We particularly looked for images from areas around main roads because we considered that most people would be interested in information about the roads. These images can be used for the disaster education of both children and adults and hopefully in preventing a future earthquake disaster.

B. Roads vulnerable to the next disaster

Using this system, we could browse the video images for vulnerable (problematic) roads. These roads were narrow, steep-walled, and located in mountainous regions. They were just what we had expected from the results of our previous study [5]. Until now, we were only able to identify the type of problematic roads but had not developed techniques to

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increase their resilience. The next step is to identify the vulnerable points on the roads in detail. To realize this, we have to collect the documents containing the recovery history of the roads and evaluate them in future studies.

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