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DISASTER IMAGINATION GAME ENHANCED BY MOBILE MAPPING SYSTEM AND ITS APPLICATION

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DIG (Disaster Imagination Game) is known as one of the risk communication methods in Japan. The participants who live in the same area surround a map of the area and discuss the disaster information such as the evacuation routes and the dangers that may lie around. They try to find not only the hazards but also the useful information like the location of the shelter. The detected information is illustrated in the map with pens and seals to visualize the risk and help. Thus the information in the area is shared with the participants. In this study, the new developments are proposed in which the serial video captured by MMS (Mobile Mapping System) is used as well as the map. The combination of the map and the serial video helps to detect the hazards. Moreover, the hazards detected in the workshop are illustrated not only on the map but also in the serial video. The effectiveness of the proposed system is discussed through the application to the practice of DIG.

Keywords: Education, Risk communication, DIG, Serial video, Questionnaire.

1 INTRODUCTION

Disaster Imagination Game (DIG) (Komura 1997) is carried out as an emergency drill in Japan. In the DIG, assuming a situation where a large disaster occurs in the region, the predicted hazards are indicated in the transparent sheet which is put on top of the area map using pens and seals by the participants in a workshop. Thus creating the original hazard map in the area, the risk information can be shared in advance and the required preparation and cooperation can be recognized among the participants. Moreover, it is helpful to determine the appropriate location for the shelter and evacuation routes. The participants of DIG who live in the same area are usually divided into some groups and the leaders report the content of the discussion in each group in the end of the play. DIG is very effective as pre-training for the disaster.

However, the hazards are often overlooked since planar maps are generally used in DIG and the participants are required to predict the hazard by their prior knowledge about the region and the information acquired from the map. Recently, MMS (Mobile Mapping System) has been developed and used for surveying and road maintenance. Tsujihara *et al.* (2014, 2016) applied MMS to the visualization of the evacuation simulation and the learning materials for evacuation. In this study, the new developments are proposed in which the serial video captured by MMS is used in DIG as well as the map. The combination of the map and the serial video helps the

detection of the hazards. Moreover, the hazards detected in the workshop are illustrated not only on the map but also in the serial video by superimposing the displays and captions.

2 MOBILE MAPPING SYSTEM (MMS)

2.1 Hardware

MMS is the modular measurement system as shown in Figure 1. It consists of the parts such as an all-around view camera, accelerometer and GPS antenna. The multi-camera system Ladybug3 as shown in Figure 2 produced by Point Grey Research Inc. is used. It has six 2-megapixel cameras which allow JPEG-compressed 12 megapixel resolution images to be streamed to disk at 16 frames per second. In this study, IMS (Iwane Mobile Mapping System) (IMS 2016) is used.

2.2 Software

2.2.1 *Recording*

The images shot by six cameras are recorded with the information of the location by GPS and the data of accelerometer. Though only a part of the image in Figure 3 is visualized, the 360-degree surrounding image can be visualized by rotating the mouse cursor on the movie window.

2.2.2 *Camera vector operation*

The position and the posture of the camera can be derived only from the information contained in the moving image sequences. By calculating the trajectory of the camera in 3D space, the position of features within the source image sequence is described. Thus calculated or derived position of camera and features has relative value and the scale is relative. The absolute scale can be given by calibrating with the actual coordinates (GPS).

2.2.3 *Creation of moving image*

The pictures captured by the camera system are converted to the moving image. The global position of the frames in the image is given and the location can be shown in the map in parallel. Figure 3 shows a cut of the moving image and its location in the route map of movie shooting. The locator, which is shown as the arrowhead, moves in the map along with the moving image and the map scrolls automatically.

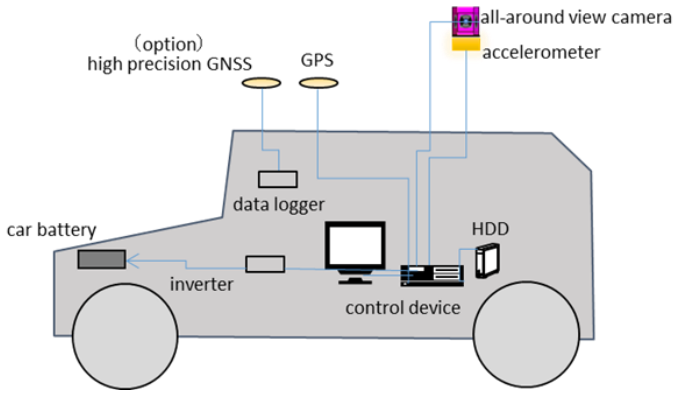


Figure 1. Mobile Mapping System.

Figure 2. All-around view camera.

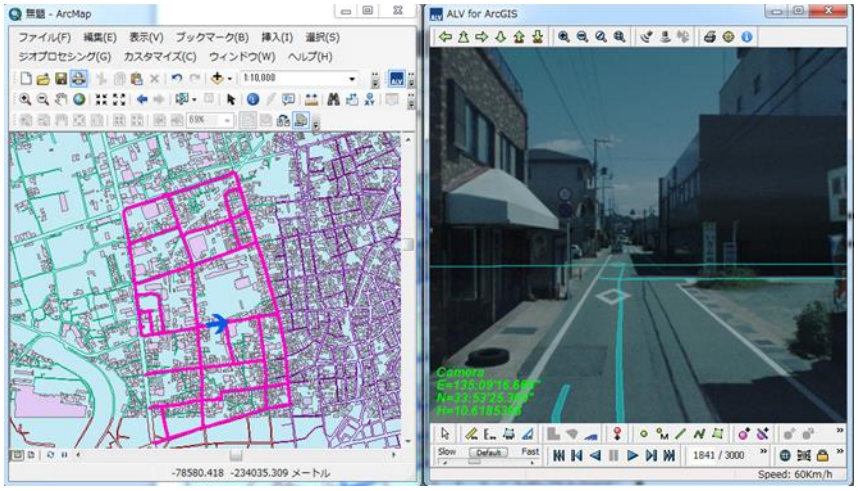


Figure 3. Route map of movie shooting and image at locator position.

3 APPLICATION TO DIG

3.1 Support in Detection of Hazards

In the conventional style of DIG, the participants surround a map and illustrate the predicted hazards on top of the transparent sheet which is put on top of the area map using pens and seals, assuming a situation where a large disaster occurs in the region as shown in Figure 4. In predicting the hazards, they refer only to the map and their memory about the region, so that it is very hard to cover the hazards without omissions.

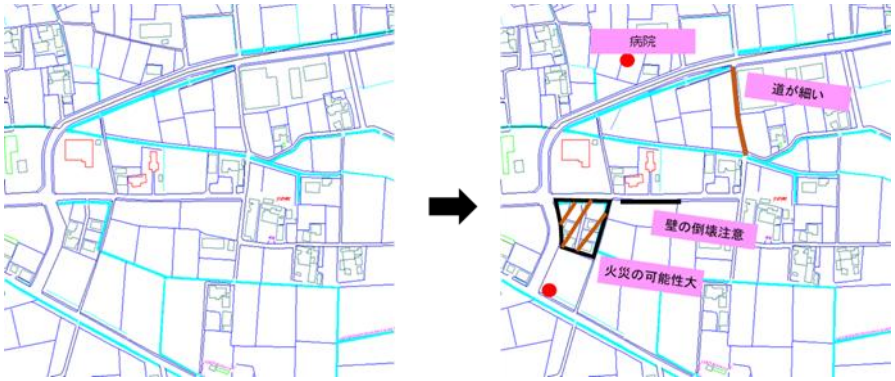
Figure 4. Conventional style of DIG.

The image recorded by MMS is helpful to identify the hazards. Moreover, MMS enables the measurement such as the width of street and the height of wall. The measurement can be done directly from the captured video. The participants can refer to not only the map and their memory but also the live-action video. They may gain new understanding about the region.

3.2 Data Mining in Video

In the conventional style of DIG, the detected information about the disaster is illustrated on the map as shown in Figure 5. Such visualization helps to keep that information in the minds of participants. In the system proposed in this study, the message boards are prepared, and they can be stuck in the video easily. Some message boards are shown in Figure 6. Figure 7

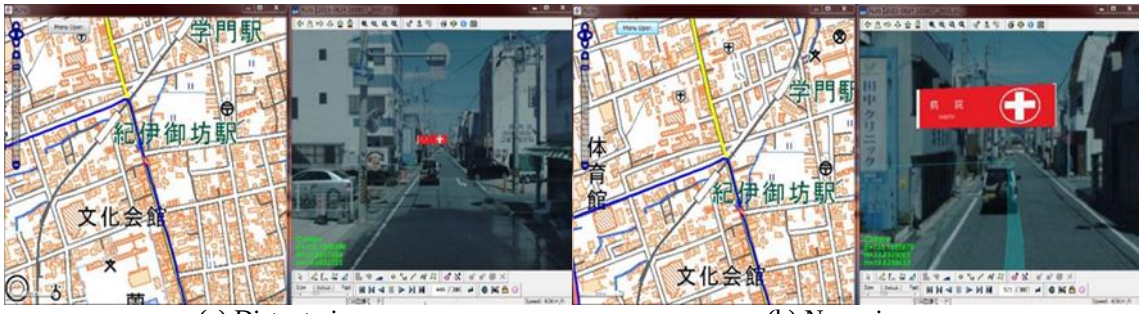
shows the message board of a hospital as an example, in which the screen shot of distant and near view is illustrated in the video as well as the camera location in the map. If the area is expected to be hit by tsunamis, AR (Augmented Reality) is effective as shown in Figure 8. The CG (Computer Graphics) representing the water surface is composited to the video image. It is expected that the participants keep the information in minds more strongly by the presentation in 3D. Moreover, if this composited video image is on the web, the residents who cannot attend the workshop may learn from the web site.



(a) Before illustration. (b) After illustration.

Figure 5. Illustration of information on hazards in the map.

Figure 6. Samples of message board.



(a) Distant view. (b) Near view.

Figure 7. 3D visualization of information in video.

4 APPLICATION TO PRACTICE OF DIG

The practice of DIG was held for 11 junior high school students on November 5th, 2016 in Gobo city, Wakayama prefecture, Japan. The participants were divided in to three groups. Though their home towns were not necessarily the same, at least one person living in the target city in DIG was included in each group. Figure 9 shows how DIG was practicing.

A Questionnaire survey was carried out after the practice. The questions and the answers are shown in Table 1 to 4. The participants are to select the number of one to five to each question. One is the most negative and five most positive answers. In the tables, the average values of the selected numbers are shown. Tables 1 and 2 indicate that the video image helped to read the map and to detect the hazards. Table 3 indicates that the participants of junior high school students have the ability to understand the hazards which are illustrated in the map. But even so, the video image in which the hazards are illustrated by message board is considered to be helpful for the understanding of the hazards. It is important to keep the contents of the practice of DIG in mind for long time. Table 4 indicates the effectiveness of using the video image to memorize long. To the question whether the participants can keep in mind for a month, the answers were not so positive. Even if the video image was used, their answer was 3.09 which meant that they were not sure whether they could keep in mind. There was no significant difference from without video image. The results of questionnaire suggest that the only message boards were not sufficient. Actually in the practice of DIG, message boards were mainly used and the CG such as the tsunami inundation which was expected to be effective was not used. In the next stage, the video made fully illustrated using CG should be used and the world of AR is to be prepared in which the evacuation drill can be done.

(a) Before inundation.

(b) After inundation.

Figure 8. Inundation simulation.

Figure 9. Practice of DIG.

Table 1. About map reading.

Questions	Average value
Could you read the map without movie?	3.36
Did the movie help to read the map?	4.64

Table 2. About detection of hazards.

Questions	Average value
Could you detect the hazards only from the map?	3.00
Did the video image help to detect the hazards?	4.82
If the map of your home town is used, do you think the hazards could be detected properly only form the map?	3.36
Even if the map of your home town is used, do you think the video image is helpful to identify the hazards?	4.64

Table 3. About recognition of hazards.

Questions	Average value
Could you understand the hazards only from the illustrated map?	4.00
Did the video image with the message boards help to understand the hazards?	4.18
Do you think the movie with the message boards is more helpful for younger children?	3.20

Table 4. About memorization.

Questions	Average value
Do you think you can keep the detected hazards in mind for a month?	3.09
Do you think you can keep the detected hazards in mind for a month, if the DIG had been carried out using only the map?	2.55

5 CONCLUSIONS

A new style of DIG is proposed, in which the serial video is used. The effectiveness of the proposed system is discussed through the application to the practice of DIG. The major results are summarized as follows.

1) Video image are useful for reading maps and detecting hazards.
2) Video image with message boards is helpful for the understanding the danger.
3) It is difficult to keep participants' memory long for just the message board synthesized in the video image.

Acknowledgments

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