Web Camera Sensor Coupled with Lidar Data Flood Map for Flood Warning System

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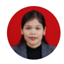
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WEB CAMERA SENSOR COUPLED WITH LIDAR DATA FLOOD MAP FOR FLOOD WARNING SYSTEM

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ABSTRACT

In this research, a Flood Warning System is designed based on Water Level Data image obtained by a simple web camera. The system processes the output data from the water level image into tables and then connect to the flood map database to select the corresponding map to be displayed as a flood prediction image with a GIS program. The system processes the data in real time to provide public users with an accurate flood area prediction. By using this system, user can expect the area which will be affected when the water level rises to allow peoples that live near the affected area to evacuate or at least to prepare for the upcoming flood. This kind of early warning system is expected not only will save the lives of people who live near the affected area but also save their valuables from the flood disaster. The flood area is segmented from LiDAR data at 1 m intervals and the water level is recorded at 10 cm intervals. The resulting area obtained from elevation data is considered as the boundary of the maximum extent of the flood. Each corresponding map layer is linked to specific water level recorded by the camera.

***Index Terms*—**web camera, flood sensor, remote sensing, flood warning, database

1. INTRODUCTION

Flood is a natural phenomenon that occurs because of the water volume in the channel, hence: canals, rivers, streams, surpass the capacity of the channel itself. Flood disasters cause significant material loss as well as psychological effect for the affected community. It also spawns further post-disaster problems like health problems, diseases, and also logistical problems. Many efforts have been undertaken by the government and by the community itself to address this problem, but all of these efforts will not function effectively without prior knowledge about the coming of the flood and the potentially affected areas. To provide early warning for the incoming flood, many systems have been developed utilizing microcontroller or microprocessor based electronic systems combined with a variety of level sensors to detect the water level of the nearby river that potentially floods an area [1, 2]. Most flood early warning systems only provide information that flood is imminent, but not the area that would be flooded, therefore, the information about the affected area has not sufficiently reached the community and the general public. With the advances in Information and Communication Technology (ICT), all concerned parties can utilize the technology to develop a system to predict areas with flood potentials. Website is one of the effective forms for information dissemination, which can come in messages, graphs, maps, and images, utilizing river water level data obtained from sensors located at sluice gates as the input, the resulting information is expected to be always up to date [3]. The purpose of this research is to develop a flood area potential prediction system based on water level image of the nearby river.

2. METHOD

Many flood warning systems have been developed, with sensors as the main detection method is mostly of contact type. One example is by using water as a conductor of t sensor system, the principle is the same method as in the automatic water pump [1]. When the water reaches a certain level, then the sensor will be connected to the water and the water pump will stop or triggers the alarm in case of flood detection. Other systems were developed by using ultrasonic sensors for measuring the depth of water by calculating the time when sensors transmit ultrasonic waves until the signal is received back by the sensor, while not directly contact the water, the sensor still uses float as detection surface [4]. In either case, especially for trash-ridden rivers in Jakarta, these systems are prone to damage by floating debris; therefore, a non-contact method by using an optical sensor is proposed [5]. Revilla-Romero et. al. [6] proposed flood detection by evaluating images from the satellite. The aim of his research is to test the Flood Detection System for converting the flood detection signal into river discharge values.

Our proposed method is to overcome the problem by using a simple image from a web camera and segment the Region of Interest, hence, the measuring scale. The resulting image is used to calculate the river water height and correlate the height to a corresponding map.

2.1. Region of Interest Detection

Region of Interest (ROI) is used to create a portion of an image that is being processed further, to filter or perform some other operation. ROI is similar to cropping of an image at particular interest area and eliminates the rest. By using ROI, the noise or unwanted image which outside the ROI can be eliminated, so the process will be faster and easier. In this research, the ROI is a measuring scale on a riverbank in downtown Jakarta, directly across a river watch post, which is replicated as the template, as can be seen in Fig. 1. The normal river depth is about 4 m while the maximum height of the riverbank is 7 m.

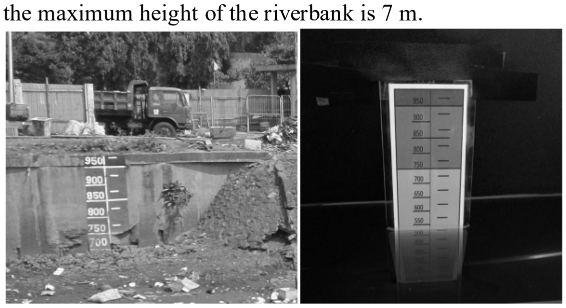

Fig. 1. Riverbank measuring board and the template

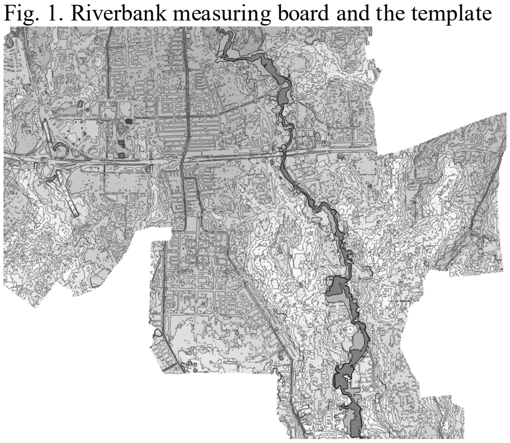

Fig. 2. LiDAR contour data with marked river area

2.2. Object Measurement

Edge detection algorithm finds edge points of a relatively horizontal river surface and point of measurement board height [2]. Since the rise of water level corresponding with reduced measurement board readability by the camera, this knowledge can be used to measure the surface of the river. The result is then correlated to the relevant map of maximum flood extent that possibly occurs. The map in Fig. 2 is derived from LiDAR contour data segmentation of Pesanggrahan River in South and West Jakarta [7].

3. RESULT AND DISCUSSION

The proposed system undergoes the test at the laboratory using equipment that simulating the actual condition. Fig. 3. Shows the web camera measurement reading from the image and the calculated water level height. On the other hand, the LiDAR contour data also consist of several images segmented from an elevation of 1 m below the riverbank elevation to 2 m above normal water level. The resulting height calculation from the web camera is linked with corresponding elevation image as shown in Fig. 4. The resulting calculation of the height and the corresponding area segmented from LiDAR contour data is shown in Table 1.

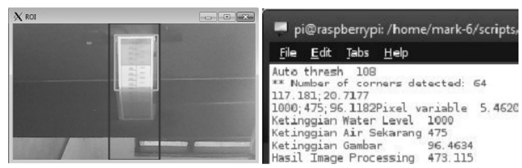

Fig. 3. River surface height calculation

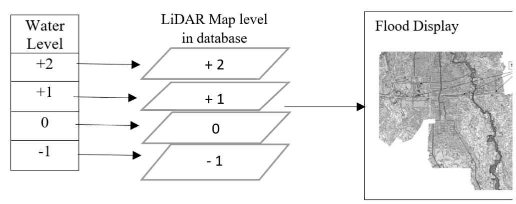

Fig. 4. Water level reading linked with corresponding LiDAR Map

Table 1. Calculations of water level from camera and area from LiDAR data

Water Level (cm)	LiDAR Elev. (m)	Total Ar (ha)
300	-1	26.77
400	0 (reference)	74.61
500	1	148.1
600	2	242.9
700	3	382.0

From the result in Table 1, it can be seen that in normal height the river watershed covers 74.61 hectares of which, 26.77 hectares around the riverbank lies 1 meter below the normal height and could be classified as not habitable due to the inherent danger of flooding. If the river water level rises to 500 cm, then the possible affected area grows to 148.1 hectares. The maximum record height of 700 cm is reached during Jakarta great flood in 2007 and the maximum extent of the potentially flooded area is 382 hectares.

4. CONCLUSION

From the experiment, the system could detect and discriminate the above water measurement band and therefore the resulting water level height by calculating the difference between the measurement band's full length and the detected length. When connected with LiDAR contour data, the result can be used to display potentially flooded areas when the river rises. The possible affected area is nearly doubled for each meter of river level rise, this figure is for the hilly southern part in Jakarta, where areas adjacent to the river is steep, the area figure could be higher for the flatter central and northern part of Jakarta.

5. REFERENCES

[1] A. Ariawan et al., "Image Processing Based Flood Detection," Proceedings of the 10th National Technical Seminar on Underwater System Technology, Springer, September 2018.

[2] Y. M. Akbar, I. Riyanto, and A. Musafa, "Image Processing-based Flood Detection for Online Flood Early Warning System," The 6th Indonesia-Japan Joint Scientific Symposium, October 2014.

[3] Wihartini, W. Pramusinto, I. Riyanto, "Mobile System to Support Flood Area Information Distribution. Case Study: Central Jakarta Area," The 5th Indonesia-Japan Joint Scientific Symposium, pp.301-306, October 2012.

[4] H. Isworo, *Sensor Level Air dan Pengontrol Pompa Air Otomatis Berbasis Mikrokontroller Atmega8*.

[5] B. D. Ulinnuha, B. L. Widjiantoro, *Rancang Bangun Sistem Pengendalian Level pada Mini Mikrohidro Skala Laboratorium di Workshop Instrumentasi*. Institut Teknologi Sepuluh Nopember, Surabaya 2012.

[6] B. Revilla-Romero, J. Thielen, P. Salamon, T. De Groeve, a G. R. Brakenridge, "Evaluation of the satellite-based Global Flood Detection System for measuring river discharge: influence of local factors," Hydrology and Earth System Science, Vol.18, No.11, pp: 4467-4484, 2014.

[7] L. Margatama et al., "Increasing Disaster Awareness of the Community by Flood Potential Mapping of Densely-Populated Urban River Watershed in South and West Jakarta with LIDAR Data Segmentation," Int. Conf. on Applied System Innovation, pp. 370-373, April 2018