Design of flood detection system based on velocity and water level sensor in Arduino with SWOD application on Kalimati-Kretsek Gantung DAM Banyuwangi

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Abstract. As a tropical country Indonesia has the potential to experience rain in several periods due to global warming of the weather becomes erratic resulting in extreme weather. With high rainfall intensity, as well as lack of absorption land can result in water volume in a dam can exceed capacity and overflow. During this observation process of increasing the volume of water using conventional method is considered less effective when viewed in terms of operational by the operator must come directly to the field at a certain period. If the condition of the water volume increases suddenly and the officer is not located then it will cause flood disaster therefore required a proper technology so as to overcome the problem. SWOD (Safety Water Overflow Detection) is an application that integrates with web server and sensor device as data taker able to provide real time volume and water speed information from dams through mobile device and comes with warning when reaching emergency condition.

Keywords: flood disaster; real-time; sensory device; SWOD

1. Introduction
Flood disasters always causing harm to humans, both from material and even casualties, and the impact of ecosystem changes, temporary or permanent. Floods that occur due to extreme weather resulting in high rainfall intensity, causing an abundance of water in the land that is marked by rising river water level. Water Monitoring applications utilize fast and accurate information delivery using server computers as containers of information so that handling becomes quick to open the floodgates.

In the conventional monitoring method usually Forman Officer of Dam has to standby 24 hours to monitor and detect water condition every day. If there is any dangerous situation and Forman Officer is not in the location, it can be a big problem for disaster information handling.

The results of this water monitoring will be send as information for water management so that the water level is suitable for river capacity. Forman Officer of Dam will open the floodgates when the water level reaches the safe zone. This is one of the efforts to anticipate flooding due to increased water volume. To facilitate the processing of water level monitoring information the authors want to build a
water quality information monitoring system that can provide information related to the status of water level in real time and connected with the application of Water Safety Overflow Detection (SWOD) so that anticipation and early warning of flooding can be done more fast and efficient.

2. Related Works

2.1. Disaster Alert and Notification System Via Android Mobile Phone by Using Google Map

The system consists of a third-party server named Disaster Management Server (DMS), android device on which our application installed and user. Updates of the disaster (tsunami, cyclone or flood) are put on DMS by the local weather office. To get automatic notification of upcoming disaster device user registers on Disaster Management Server (DMS) else user can gets manual notification. The user keeps in touch with DMS to get most renew data obtained by GSM. The proposed application notifies the user located in possible disaster zone with visual and audio disaster warning and evacuation guideline combine with nearest location of shelter or safe zone on the map of the application. DMS also tracked Evacuation progress and national identification of user [1].

2.2. View of Flood Disaster Management in Indonesia and the Key Solutions

Over the years, Indonesia has seen many flood disasters that have brought about great losses. The aim of this study is to address key issues that lead to flooding problems in Indonesia in response to the challenge of recurrent flood events. An overview of the past flood disaster profiles and ongoing flood management are presented. The problems with the current situation are identified and the critical solutions are recommended to manage flooding and mitigate the negative impact in a more sustainable way. This study shows that man-made factors, natural causes, and managerial issues are the factors that have contributed to the problem. The coordination and the public awareness are the challenges in improving the flood management. Efforts have been made to alleviate the problems through legal framework establishment, community participation programs, and flood-control projects. In the post-disaster stage, the authorities and public have been quite responsive. However, prevention and preparedness are still lacking. The overall current flood disaster management may lead to more recurrent events and cause severe impacts. Sustainable actions are needed to solve these problems that include environment-based flood integrated counter measures, improvement of water retarding function, eradication of deforestation, meteorological and hydrological prediction, and political will and law enforcement[2].

3. The System Overviews

With the progress of increasingly sophisticated technology can be utilized as a means of delivering information more quickly and efficiently. Internet of Things is one of the potential that can be developed which is a new breakthrough that combines the device with a system through the Internet network, no longer just on computers with internet but android devices (Mobile Phone) connected to the internet can be interconnected, the system we made is consist of 3 different part first the sensor device that build by ultra sonic and water flow sensor and sending data using wemos d1-mini, the second is web server and the third is SWOD android application that inform the notification report from the sensor device and web server to the officer so they can warn if there is flooding disaster happen earlier.

- The System Design

In this system there are two factors that play the role of managers as decision makers and PPA Officers (water door officer at DAM) From each of these factors have elements that must be fulfilled, among others, from the Officers PPA has 3 elements that determine the success of this warning that is, Knowledge, Attitudes, and Behavior. The managing party as a decision maker provides a decision based on the condition of monitoring data from the field through a Web Server, which then continues into several categories of early warning that can be directly connected to the body of preparedness such as BPBD (Regional Disaster Management Agency) and also the SAR Team & also local community.
Figure 1. The system Design

As we can see in the Figure 1, the water level detection process uses an additional component of an application via a mobile device. Previously the user must login with an account that has been created by the server. So it can login to the application and receive information provided by the server periodically and quickly. If the water level reaches the safe threshold point, a warning will appear immediately to the point of location. There are details that are accompanied by tips in certain conditions related to the condition when reaching a certain status. In this mobile application added with notification, so without opening the application the user can know the condition of the height and speed of water through the notification received.

- The Rule of Flood Detection

When the officer wants to determining the Status of Flood Disaster Precautions, the Dam Management Party has two criteria such as Water Front and Water Speed. The management of this time is the Public Works Office of Water Resources of Banyuwangi Regency has a scale of height and water velocity with the potential of flood disaster is as in Table 1.

| No | Status Category | Water Level | Flow Velocity |
|----|-----------------|-------------|---------------|
| 1. | Aman            | <70 cm      | < 61000 L/Sec |
| 2. | Siaga           | 70 cm s/d 139 cm | 61000 L/Sec |
| 3. | Waspada         | 140 cm s/d 239 cm | 122000 L/Sec |
| 4. | Darurat         | 240 cm s/d > 240 cm | 273000 L/Sec |

- Ultrasonic sensor

To measure water level in the DAM Kalimati-Kretek Gantung used ultrasonic sensor.

As we can see in the Figure 2, the ultrasonic sensor has a transmitter and receiver. This sensor transmits ultrasonic wave for 200 μs and then detect the reflection wave. Ultrasonic wave spread in the air with the velocity about 344 m/s (sound wave velocity), touch the object and reflected back to the sensor [6]. That mechanism is used ultrasonic to measure the distance as equation (1).

$$S = \frac{(t_{IN} \times V)}{2} \quad (1)$$

Where $S$ denotes the distance between ultrasonic with object detected, $V$ indicates sound-wave velocity, and $t_{IN}$ denotes the wave deviation transmitting and receiving time [7].
The water speed detection is very significant in the water flooding detection. Accurate flow measurement is an essential step both in the terms of qualitative and economic point of view. Flow meters have proven excellent device for measuring water flow. Water flow sensor and circuit diagram show in Figure 3 and Figure 4. [5]

The position of this sensor is in the line with the water line and inside of sensor contains a pinwheel sensor. The pinwheel sensor has a function to measure how much water has moved through it. In this sensor also has an integrated magnetic Hall-effect sensor with an electrical pulse output every revolution. The rate of water flow will be directly proportional to the number of pulses counted. The pulse signal is converted into liters per minute using the following formula [8].

\[
\text{Pulse frequency (Hz) } / 7.5 = \text{ flow rate L/min}
\]

As we can see in the Figure 5, The Sensor devices and web server monitoring are interconnected with wireless connection using Wifi shield module. In the process of data transmission or communication between sensors with the web using HTTP protocol and this communication occurs in the form of request and response. To send commands to turn on flood warning alarms that exist in residential areas, the sensor will send a Get-Request command to the web server, while the web when receiving the Get-Request command will respond by sending http-response command. When the water condition is in a normal state between the sensor and the web is still connected.

As we can see in the Figure 6, The Wemos D1 Mini is a mini Wi-Fi device based on ESP8266EX chip. This device is a very compact solution for prototyping small smart objects linked to the World Wide Web, and it have an impressive ESP8266 Wi-Fi functionalities. The sensory device consists of an ultrasonic sensor used to measure the water level, and the waterflow sensor that is used to measure the speed of water flow, while the mini-d-1 wemos are used for water-level data transmission connection via wifi network which also uses wemos d1-mini device.

This research also make an application to inform water flow and water level condition. This information send to BPPD and local community which use this application. If there is critical condition SWOD application will make alert to the people. SWOD application flow shown in Figure 7.
3.1. The Experiment
The results of the data monitoring and SWOD application will be displayed in the web information systems and specially for android application will be explain in the text below:

- Data Monitoring of DAM Kalimati and Kretek Gantung.

From this system we get the result of data measurement during the time we observed and the level status of DAM kalimati & DAM Kreteg gantung in each our of observation can be seen in Figure 8 and Figure 9.

![Figure 8. Kalimati DAM](image1)

![Figure 9. Kretek Gantung DAM](image2)

- SWOD Application.

The SWOD application is an early warning system (EWS) that is used to monitor the water level in a dam from a distance without the need to come directly to the location of the weir or irrigation building. This app contains altitude information sent from the dam based on the sensor, as well as the change graph that has been completed with the safe boundary status of the dam conditions. In this application is also equipped with tips on handling information ranging from Safe to in case of emergency. This app can provide a notification if things start to standby until emergency even if not continuously in open.

Figure App Login View, in this view the user who can login is only those who have registered as a user in the head office that has been adjusted with the weir or buildings in the monitor. If unregistered then the user cannot see and receive notifications.
As we can see in Figure 10, the home view in the immediate live view contains real-time water status information including the time of change. In this view there is also a safe limit so that when passing through the red line officers can more easily understand the graph, the status can be viewed on a weekly and a monthly basis in Figure 10 (c). Emergency calls can be done quickly using the emergency call button connected to the BPBD (Badan Penanggulangan Bencana Daerah) for Kabupaten Banyuwangi.

4. Conclusion
Refer to above data show that application can be used as a solution for real-time water level monitoring process along with flood alert status. The system also easy to use and the information of system is very useful for people to prepare any condition from disaster effect. This application is made for users on each dam to facilitate the monitoring process associated with the maximum water heights that potentially flood disaster in each Technical Services Unit (UPT).

5. Acknowledgment
This research supported by LAB Nirkabel - State Polytechnic of Banyuwangi, LAB Elektronika - Brawijaya University and Ristekdikti in PEKERTI 2017 (Penelitian Kerjasama Antar Perguruan Tinggi).

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