A simple low-cost video-based surveillance system for a flash flood warning system

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Abstract. Flash flood is the most common and frequent natural disasters worldwide and can cause a loss of life and damage to property and the environment. In 2014, Manado city has experienced the most devastating flood that caused 19 people died, 10,884 homes destroyed, 2,091 people became homeless and estimated an economic loss of US$ 124 million. The huge loss was caused by the people and government did not receive information about water level rising on the watershed of the Tondano River. In conventional, decision maker needs the precipitation data and critical threshold value to issue the evacuation. There is an urgent requirement for end-to-end solution where the flash flood early warning system (FEWS) which can processed data in real-time can be integrated with Video-Based Surveillance System to take a role in saving peoples life. The aim of this study was to create a stand-alone system (Sensor Node) that could be placed on the watershed to monitor the water level rising using a microcomputer, a camera and a distance sensor. The aim of the system proposed was to measure the water level rising and when the threshold value was reached, the system would capture and display a real-time video. Future research can be done to “go-live” and posted the captured real-time video on the YouTube or Facebook in which people used them widely as a social media.

1. Introduction

Flash flood is the most common and frequent natural disasters worldwide and can cause a loss of precious life and damage to property and the environment [1], [2], [3]. In 2014, Manado city has experienced the most devastating flood that caused 19 people died, 10,884 homes destroyed, 2,091 people became homeless and estimated an economic loss of US$ 124 million. The huge loss was caused by the people and government did not receive information about water level rising on the watershed of the Tondano River [4].

In conventional, decision maker needs the precipitation data and critical threshold value to issue the evacuation. There is an urgent requirement for end-to-end solution where the flash flood early warning system (FEWS) which can processed data in real-time can be integrated with Video-Based Surveillance System to take a role in saving peoples life [5].

2. Flood Early Warning System

The rapid development of information technology, natural disaster prevention are dealing with image based flood alarm system [6] and video surveillance system [7], [8]. Videos in the form of recorded videos, off-line videos and real-time video streaming are considered as the best sources of information.
for various applications [9]. Application such as an advance safety vehicle (ASV)[10], home security [11], flood area detection based on UAVs (Unmanned Aerial Vehicle) [2] have been used video as source of information.

3. Hardware Design
The realization of the proposed sensor node can be seen in Figure 1. We choose to use a Raspberry Pi (RPi) minicomputer and pi camera module (PiCam) as computer and camera for the streaming hardware. We also use a ultrasonic sensor module to measure distance. All this module are cheap, simple and relatively easy to be bought on online or offline electronics store. It is also can be customised and open to be modified to meet other requirements for other purpose. We use Python programming language to program the RPi.

3.1. Raspberry Pi
The Raspberry Pi [12] is a low-cost credit card-sized single-board computers, running an open-source Linux as operating system, which is designed and developed by non-profit charitable Raspberry Pi foundation, UK. Originally, it is intent to promote the teaching of basic computer science in school and developing countries [13].

The Raspberry Pi 3 Model B specifications used in this paper has a Quad Core 1.2GHz Broadcom BCM2837 64bit CPU, 1GB RAM, onboard BCM43438 wireless LAN and Bluetooth Low Energy, 100 Base Ethernet, 40-pin GPIO, 4 USB 2 ports, 4 pole stereo output and composite video port, fullsize HDMI, CSI camera port for Raspberry Pi camera, DSI display port for connecting a Raspberry Pi touchscreen display, Micro SD port for loading operating system and storing data. It is powerful enough to be used as a video streaming device and only cost about IDR 660,000.

3.2. Pi Camera Module
We are using the Raspberry pi camera module (PiCam) version 1.3 which can be connected directly to the Raspberry Pi board via CSI connector using a ribbon cable provided on the package. The camera module features a 5MP Omnivision 5647 CMOS sensor with 1.4 μm X 1.4 μm pixel size and focused lens able to deliver a 2592x1944 pixels resolution still image, or 1080p HD video recording at 30fps[14]. The PiCam module is cost about USD 30 (IDR 450,000)

3.3. Ultrasonic Sensor
The sensor is used for measuring the distance of the object [15]. It works by sending 40 kHz ultrasonic wave and detecting whether there is echo resulting from it. Even though its maximum distance is relatively small (5m), its accuracy is quite high (3mm) and stable. The distance itself is calculated according to the duration of the signal high level, where the distance is proportional to the duration. In addition, this sensor consists of ultrasonic transmitter, receiver and control circuit.

4. Software Design
Python programming language is used in the system to communicate with the General Purpose Input (GPIO) ports in RPi. We also use SimpleCV [16] technique to communicate with the camera to capture and stream the successive image.

The system design as follows. The ultrasonic sensor measured the distance (water level) and whenever the distance are less than the threshold value, it’s value triggers the camera to start capturing image and streaming it to the monitor. If the value are more than the threshold value, the camera will be in sleep mode and display black screen.

5. Experimental Result
We tested the sensor node at a bridge by first measuring the normal height (from the bridge) to riverflow below it. The normal height was 3,402 cm. We set this “normal height” as the threshold to trigger the camera to start capturing and streaming to a monitor.
We tested the system by lowering the sensor node by 30 cm. As the sensor node becomes lower to the river, the “normal height” is less than the threshold value and the sensor node starts to streaming video to the monitor. An example of video streaming captured by the sensor node can be seen in figure 2.

6. Conclusion and Future Work
In this paper, design of a low-cost video-based surveillance sensor node for a flash flood early warning system is implemented. It is advantageous as it low-cost, easy to use, small-size and portability. It can be place in any kind of bridges for surveillance. Future research can be done to “go-live” and posted
the captured real-time video on the YouTube or Facebook in which people used them widely as social media.

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