Flood and Notification Monitoring System using Ultrasonic Sensor Integrated with IoT and Blynk Applications: Designed for Vehicle Parking

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Abstract. Terengganu received heavy rainfall during the Northeast monsoon which strikes between October and March thus can leads to severe floods almost every year all over the state. The floods around Dungun area of Terengganu state was due to the combination of physical factors such as elevation and its close proximity to the sea apart from heavy rainfall received during the monsoon period. A flood warning system is designed to warn and alert the owners of the vehicle about the flood immediately. The system will detect water level through an ultrasonic sensor and will automatically send a notification via IoT technology to the owner’s smartphone through the Blynk Application. A water level sensor will be set at two points which is at 0.05m and 0.09m from ground level. When the water reaches this point, it will light on LED and trigger buzzer that acts as an alarm to alert both owner and authorities. Alerting signs of water level are notified on the Blynk application that was connected through ESP8266 Wi-Fi module via IoT technology.

Keywords: water level monitoring, ultrasonic sensor, Arduino, flood warning, IoT

1. Research Background
Malaysia is one of the countries that are prone to natural disaster and the most common disaster which strikes Malaysia is the flash flood. While east Malaysia which is Sabah and Sarawak are exposed to the earthquake from the neighbouring country of Indonesia and at the same time this will lead to a tsunami. When an extreme rainfall affects the design rainfall of drainage system in an urban area, some part of flooded water intruded into spaces such as parking lot. There are many cases of floods which involved parking lot in Malaysia as reported in [1-4].

According to previous studies mentioned in [5-6], flash flood is defined as high velocity flows and short warning time. In flash flood, water is capable to rise in a short period of time at the highest level almost instantly. In Malaysia, the flash flood normally area of parking lots where most of citizens’ vehicles parked. Problem crop up during a flash flood is when owners of these vehicles do not have much time to move these vehicles to a safer place. This problem is a great concern especially when there are none available parking lefts making these people park far away from home thus taking longer time to reach to these places and eventually unable to move these vehicles before flash flood strikes.
At the same time, situation might get worsening and by the time the authority came to realize, it may be too late to move these vehicles to a safer place thus these people suffer a huge amount of property losses. Hence, a flood warning system using water level sensor integrated with IoT system has been invented to help sending out notifications to the users and warn the authority when the sensor senses a rapid increasing amount of water level during a flash flood.

This flood monitoring system is designed and developed to warn and alert both authority and the owners of the vehicles about the flood almost immediately. A water level sensor will be set at two points of water level which is at 0.05 m and 0.09 m. When the water reaches this point, it will light on the Light Emitting Diode (LED) and trigger the buzzer that acts as an alarm to alert both authority and owner. All the readings of water level are shown in an application called Blynk that will connect through the connection of a Wireless Fidelity (Wi-Fi) for reference. This project applied both, hardware and software programming. The hardware components of this system is divided into three (3) main parts which are: i) the water level sensor as the input system, ii) an Arduino Mega 2560 as the main microcontroller which control all inputs and output of the system and an ESP 8266 Wi-Fi module as an interface with the output and connection to application respectively and, iii) an LED and a buzzer as the output system. Meanwhile, for software programming, Arduino software IDE is used for hardware coding. Hence, a system and mechanism for real-time surveillance of the potential flooding at the car park should be established.

Other researchers also implement this type of project to overcome the flood crisis. The project as reported in [7-8] is quite similar with this project, but was more focused more on the detection of water level. Unfortunately, the system cannot send any notification directly to the users. Besides that, researchers in [8-9] also developed roughly the same system, where the system can warn and alert users through a technology called Global System Messaging (GSM) technology. System which is used in this research possesses advantages compared to these two systems where it can send notifications prompt, direct and fast, in fact the fastest to the users. Users can receive this notification through an application called the Blynk Application that has been installed in each user’s smartphone. This system has been implemented with the latest technology called the Internet of Things (IoT), that have this amazing capability of sending any information wirelessly.

The objective of this project is to design, develop and build a flood warning system especially for parking spaces that will alert and warn the vehicle owner apart from developing an application that can be monitored effortlessly via a newest technology of wireless connection.

2. Research Methodology
In this project, an ultrasonic sensor which is HC-SR04 as shown in figure 1 is used to detect the water level during flood strikes. This sensor is often used for distance measurement applications such as level control and also capable of detecting most objects that are metal or non-metal, clear or opaque, liquid. The ultrasonic sensor emits a 40 000 Hz ultrasound through the air and it will bounce back to the module if there an object in front of it. To generate the ultrasound, the Trig must be set on a High State for 10 µs which will be sent the 8-cycle sonic burst which then will travel at the speed of sound and it will be received in the Echo pin. The Echo pin will output the time in microseconds, and the sound wave travelled is shown in figure 2.
2.1. Flowchart of water level monitoring system integrated with ultrasonic sensor

This simple circuit is starting with initializing port which declared in the Arduino software beforehand. Then, two (2) sensors are placed at a certain height which is 0.05m for the first sensor and 0.09m for the second sensor. When water level rise to 0.05m from the ground level, LED 1 will light on and Buzzer 1 will beep as well. The server will get the data if both outputs triggered and data are directly send to the application to monitor the current condition. Somehow, if the server failed to accept the data, system will repeat the steps from the beginning which is initializing port.
Figure 3 shows the flowchart of this water level monitoring system integrated with the ultrasonic sensor. Figure 4 presents a water level sensor which placed at certain heights, in this case 0.05m and 0.09m. When water rises to 0.05m, the authority will get notified through the IoT application, green LED will light on and buzzer will also beep. The water level value will be displayed on the LCD screen as shown in figure 5. As water reaches the second level which is denote as the ‘danger stage’ that is 0.09m, the authority will also get notified but with a slight different notification where the system will trigger both outputs simultaneously which are red LED and buzzer but with different sounds-compared to the first level. Authority will then alert all users to move each vehicle instantly to avoid more water rising causing flash flood which could affect and ruins any part of the vehicles especially, the engine system. In a nutshell, the system is not only limited to monitoring water level in a flash flood, but also is capable of notifying certain individual.
There are 3 stages in the Flood Warning System using Ultrasonic sensor for vehicles parking, which is input, process, and output. This system has only one input which is the ultrasonic sensor. All the data then will be process by Arduino to produce an output. There are two different points to place the water level sensor which is 0.05m and 0.09m each will trigger LED and buzzer based on the height of water. The data then will be sent to the user’s smartphone via the Blynk Application.
3. Results and Discussion
The simulation for this system is constructed and simulated by using Proteus Professional 8 software. To simulate the circuit, first, the library of the software must be added with the Arduino library. After that, the simulation can be done by picking all the components and the script for the circuit was loaded to the Arduino board in the Proteus. The figure below shows the simulation on the water level sensor without connecting to the Arduino board in order to get the voltage and current for each leg. It used five (5) voltage operating powers.

Figure 7 to 9, show the measurement results of this flood warning system. The result was shown in three methods; LCDs, the lighting of two LEDs and message notifications that has been sent to the user's phone. The LCD is used to display the water level reading of the flood. When the water level reached the ‘danger stage’, the red LED will be light on and the message will be sent directly and wirelessly using the Blynk application as shown in figure 8. The Blynk application can be installed by the user to their mobile phone via Android Operating System or IOS Operating System.

3.1. Measurement result

Figure 7. The readings on water level displayed on LCD.

Figure 8. Alert notification received on the smartphone via the Blynk Apps.
Figure 9. Results show on the LCD.  

Figure 10. Circuit constructed on the breadboard.

The type of sensor was defined as an ultrasonic sensor, the specification referred for the sensor to operate was using datasheets. The datasheet for another component was referred to acknowledge the behavior and characteristic of the component. The connection of the controller (AT MEGA2560) was drawn and the number of pins to connect is set. ATMEGA2560 supplies 5volt voltage to the ultrasonic sensor, with a voltage divider supplying 3.3volt to a Bluetooth module. When ultrasonic sensor detects the level of water it will trigger the buzzer and will light on two LEDs in green and red accordingly. The LEDs constructed in parallel and each of LED represents the stage of water level where green as the first stage and red as the third stage which is the ‘danger stage’. Coding to operate the component was created using the Arduino IDE. An equation to measure the level of water in the tank was created. The last part of this system is to send the data or notification to the user's smartphone through the Blynk Application that was installed. IoT technology is implemented in this part by using the ESP8266 WiFi module board [10].

4. Conclusion
In conclusion, the Flood Warning and monitoring system for vehicles parking using a water level sensor integrated with IoT and Blynk applications has been designed, constructed and developed. The motivation of this project is due to the regular natural disaster that strikes Malaysia which is the flash flood especially in the parking lot area which affect public vehicles mostly in terms of losses. Hence, this project can help by providing solutions to the community and eventually the country especially for people whom living in a flash flood area.

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