Flood monitoring and warning system utilizing internet of things technology

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Abstract

Flooding is one of the major disasters occurring in various parts of the world including Malaysia. To reduce the effect of the disaster, a flood warning and monitoring are needed to give an early warning to the victims at a particular place with high prone to flood. By implementing the Internet of Thing technology into the system, it could help the victim to get an accurate status of flood in real-time condition. This paper develops a real-time flood monitoring and early warning system using wireless sensor node at a high prone area of flood. This system is based on NodeMCU based technology integrated using Blynk application. The wireless sensor node can help the victims by detecting the water levels and rain intensity while giving an early warning when a flood or heavy rain occurs. The sensor node consists of ultrasonic sensors and rain sensor controlled by NodeMCU as the microcontroller of the system which placed at the identified flood area. Buzzer and LED started to trigger and alert the victim when the flood had reached a certain level of hazard. Data detected from the sensors are sent to the Blynk application via wireless connection. The victim will get to know the current status of flood and rain by viewing the interface and receiving a push notification that available in Blynk application via IOS or Android smartphones. The flood level's data sent to the email could help various organizations for further improvement of the system and flood forecasting purposes. As a test result had been conducted, it founds that this prototype can monitor, detect and give a warning with notification to the victim earlier before the occurrence of floods.

Introduction

Floods are among the most common and damaging disaster types in the world and affect the lives of millions of people worldwide annually. Floods and excessive rainfall are inevitable phenomena that can lead to massive loss of lives and infrastructure destruction. In Malaysia, flash flooding is a regular natural disaster that occurs during the monsoon season almost every year [1]. The Department of Irrigation and Drainage (DID), Malaysia has categorized floods into two categories that are flash floods and monsoon floods [2]. The difference between flash floods and monsoon floods were based on the time taken by the flow of the river to return to its normal position [3]. Flash floods suddenly occur without a warning that surprises people in their everyday lives [4]. Monsoon floods caused by the winds of the Northeast Monsoon occur between the months from November to March and the winds of the Southwest Monsoon from May to September [1].

The floods in December 2006 and January 2007 are also classified as the most damaging flood in Malaysia's history. The water level recorded during the floods reached 2,75 meters, the highest level since 1950. The mortality rate was 18, with more than 100,000 people evacuated during the disaster [3]. Many factors that might be taken from the above cases, such as problems with drainage systems, dam breaks, urbanization and environmental management, weather and pollution, but the one that will be highlighted in this paper is the problem of the early flood monitoring system.

The cost of flood damage is closely related to the warning time given before the occurrence of flood and this makes flood monitoring critical in reducing the cost of damages. Based on Sukeri Khalid et al, most of the people are agreed that the early warning system at Sultan Abu Bakar dam are not working in a good condition which caused a flash flood and about four people die and other property damages [5]. Hence, this shows that early flood monitoring is very important in Malaysia to avoid more victims and flood damages to occur. Based on Mary Anne M. Sahagun et al, [6] the importance of further studies in determining the water level in high-risk areas is consistent to warn the public about the potential rise in flood water level. In Malaysia, most flood cases rise more quickly and people have less time to evacuate and save their life and belongings. This is because some early flood alert systems are usually intended for the respective organizations and authorities [7].

When a flooding scenario occurs at a certain location, it will take time for them to reach as water rises rapidly. At the peak of the flood, there will be flooding in residential areas, public buildings and bridges that cause immediate damage. Lots of flood risk technologies have been developed over the last few decades to minimize the risk of flooding in inhabited areas. The Philippine government has now funded the Science and Technology Department's (DOST) NOAH project [8]. Automated Rain Gauges (ARG) and Water Level Monitoring Stations (WLMS) were installed along the main river basins (RBs) of the country. However, the NOAH project is still under development where some important information is not yet available on its website. This is a huge project that costly and needs a big spent of money for the maintenance and other work related to it.

One of the factors that contribute to the damages and loss of life when the flood occurs is poor flood monitoring system at a high prone area to flood. Poor flood monitoring can cause a disastrous effect to human and environment. Besides, victim cannot get accurate information on the current status and conditions before flood occurs in a short period of time. Accurate data need to be received by the victim quickly as the water level of flood rises rapidly. Lastly, a poor warning system of flood will lead to damages of livelihood and infrastructures.

The technology used to detect floods is now more accurate than the devices of the last decades. Unfortunately, an early warning system still showing some lacks of significant and difficult to alert all the people in the area [5]. Therefore, multiple of factors that need to be considered to develop a wireless sensor node system in order to avoid any failure occurred. The system should be low-cost, multifunctional, low-power and wireless sensor nodes of small size that work together to sense the environment, process the data and communicate wirelessly over a short distance [9]. Sensor is a device that measures and converts a physical quantity into a signal that an observer or an instrument can read [10]. Usually the sensors are used to monitor physical or environmental conditions, such as sound, pressure, pollutants, water level or motion at areas of interest. Accurate data from the sensors are important for many kinds of purposes including forecasting on flood event and for the future improvement of the system.

Study about Internet of Things (IoT) technology has gain popularity and becoming important for solving more problem in various disciplines, for example water monitoring system [11], flood monitoring [12] and weather station application [13]. Elias S. Manolakos et al had proposed a study on wireless sensor network application to detect hazard. The purpose of the study is to monitor and report the environmental status by physical parameters such as the temperature at a rate that can be adapted to current conditions so as not to waste energy and bandwidth [14]. Thinagaran Perumal et al [15] had proposed a study on the Internet of Things for water monitoring system. In their project, they detect on desired parameters by using water level sensor. They proved that when the water level reached at a certain point, the signal will be feed in real time to social network like Twitter. Besides, a cloud server is used to display the result in the dashboard. Priya J et al [16] had proposed a study on IoT based water level monitoring system to inform the user on water level of liquid prevent it from overflowing. The ultrasonic sensors is used to detect and compare the water level with the container depth. While Muthamil Selvan.S et al [17] had proposed a research on Automatic Water Level Indicator using Ultrasonic sensors and GSM Module. IoT describes a system consist of sensors that connect items in the physical world are via wireless or wired Internet connections. Here, things are interconnected without human intervention to automatically identify intended activities [18]. Today, the Internet has become an integral part of the lives of people, influencing almost every human being's for everyday activities. Due to the continuous effects of a wide community, the Internet of Things (IoT) is developing enormously every day.

Hence, in the field of flood disaster risk reduction in particular for early warning and monitoring system, an IoT application is needed to link the victim with the sensor node applied at a high prone area of flood via internet connection so that they will always keep updating on current situation more precisely. Due to the continuous effects of a wide community, the Internet of Things (IoT) is developing enormously every day. The IoT tends to have unlimited applications because in every sphere of life there seem to be unlimited needs. Therefore, with a low-cost and effective flood monitoring system, this paper present a prototype to help communities affected by flood in high prone areas by providing interactive and real-time information on the current water level and rain intensity with alert notifications by using Blynk Application. By applying an Internet of Thing could help victims to monitor the flood water level and rain intensity via the apps in smartphone together with the alerting system for incoming flood via the apps. A wireless sensor node connected with NodeMCU is used which consist of ultrasonic sensors and rain sensor to collect data and sent them via cloud to be viewed in Blynk application.

Research Method

In this study, flood monitoring system using wireless sensor node is developed to observe the status of flood which could alert people who were in the area frequently affected by floods in Selangor state, Malaysia. The system consists of a sensor node which detects the water level and rain intensity using an Ultrasonic Distance Sensor (HC-SR04) and rain sensor respectively. When the water level and rain intensity reaches a certain level of hazards, the device will generate an alarm system with three different colours of LEDs indicating three levels of detection for flood level in order to notify people on incoming flood in that area that could endanger their life.

Numerous types of ultrasonic sensors with significant differences in frequency and power consumption are available. The high-frequency ultrasonic sensors will have a sharper beam width and may detect obstacles in a longer range. Some of the new sensors also have the same detection range as previous models but less power consumption. The ultrasonic sensors must be able to detect obstacles or objects between 2cm and 50cm in this project. Since the entire system supply is taken out of the supply, less current consumption is crucial and must be capable of operating at low voltage. HC-SR04 meets this project's criteria for detecting the level of flood water after long research between the HC-SR04 and other ultrasonic sensors.

NodeMCU based technology that acts as the microcontroller of this system that attached with ultrasonic and rain sensors to form a wireless sensor node and placed at a high prone area of flood. When the sensors were triggered, all the data will be sent to Blynk application to be viewed on user’s smartphone via the wireless connection. The integrated IoT architecture with Blynk application as it illustrated in Figure 1 [18][19]. At the same time, the data is stored in a CSV database. This data can be converted into excel form through email which could alert the local authority for further action once the level reached warning and critical level.

Two sensors are used as inputs to the NodeMCU and power supply of 5V is used to power up the system to function well. The ultrasonic distance sensor is used to detect the flood level at a high prone area of flood (maximum is 3m away from it). In this project, 40cm of distance from the ultrasonic sensors and the water level will trigger the buzzer and LED. The rain module sensor detects the rain intensity and develops a notification alert when raining heavily started. The scope of this project is focusing at a high prone area of flood in Selangor. The Blynk application provides an interactive and easy to access platform for user or victim to get accurate information on the incoming floods by displaying current condition of flood water level and rain intensity in real-time condition.

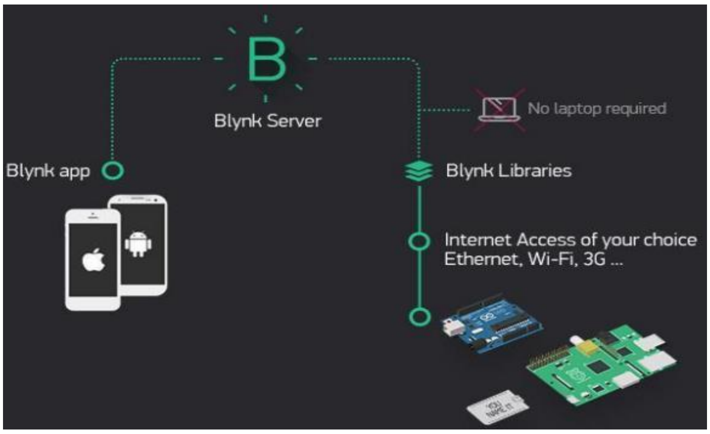


Figure 1. Blynk IoT-cloud Based Architecture [18] [19]

When there are changes in flood level, the graphs captured the data and change the measurements accordingly. So, when there is immediate change in the measurement, the buzzer and LEDs will turn on which act as alerting purposes. Blynk’s alert notification also sent to the victims when the flood water level or rain intensity reached a certain point of hazard. From Figure 2, the flow chart explained the overall system and how it works. First, NodeMCU connected with the internet via Wifi connection. After the Blynk connection is established, ultrasonic sensors and rain sensor act as two different input of the system. When the water level rises, the system will continue to the next steps. Three processes when water level rises which are greater than 20%, greater than 40% and greater than 60% which trigger green, yellow and red LEDs respectively. Buzzer triggered with different frequency for every different process before sending the data to Blynk application. Besides, when the rain intensity rises, two processes occur which are greater than 60% and between 30% to 60%. All of these data are sent to Blynk application on user’s smartphone. Finally, notifications via Blynk and email are sent to the user for alerting purposes.

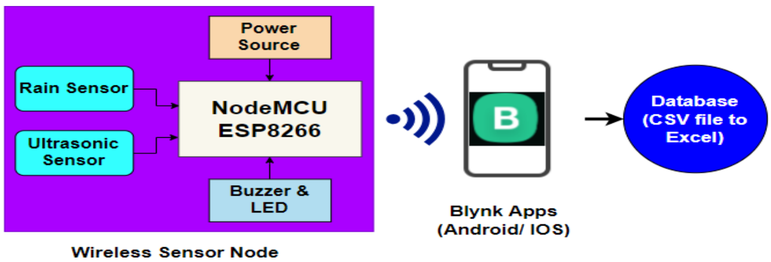


Figure 2. Schematic Diagram of the Proposed Flood Warning and Monitoring System

Blynk was designed to remotely controlled hardware where data can be displayed, data stored and data monitored. The Blynk platform consists of three main stages which are Blynk cloud, Blynk apps and Blynk database as shown in Figure 3.

Figure 3. The Flow Database Via Blynk Apps

In this work, Blynk was used to create a flood monitoring system application for monitoring data from NodeMCU which connected with ultrasonic and rain sensors over the internet by using a smartphone. There will be LCD to display the level indicator (safety, warning and critical level) inside the Blynk's interface. Next, the value display widget will display the flood's level sense by ultrasonic sensors. Besides that, different LEDs light up according to the current level to indicate the current status of flood. Lastly, the history graph widget could track the flood's level and save it into the database. Figure 4 shows the layout design of Blynk used in this work.

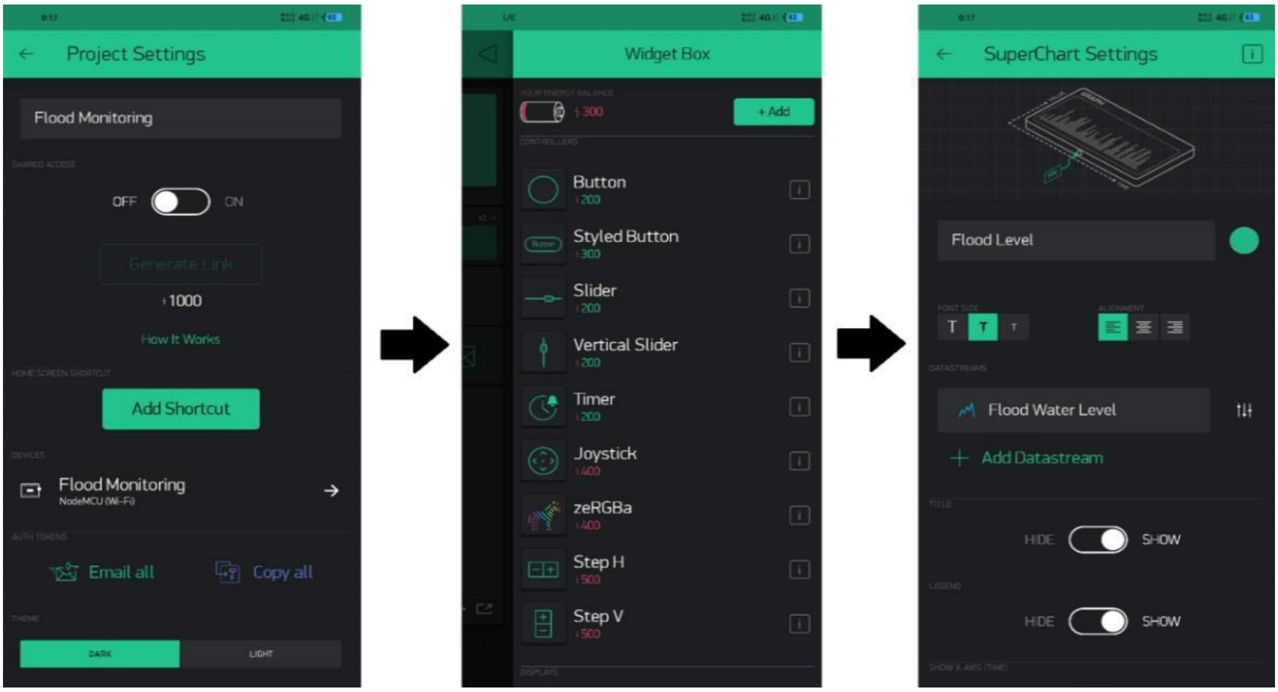


Figure 4. Schematic Diagram of Steps to Build Blynk Interface

In Figure 4, the step by step procedure for building the Blynk apps using a smartphone is illustrated. Users could install or download Blynk apps for android or iOS at Google plays store or app store. User needs to install Blynk library in the Arduino IDE library folder to interface with Arduino. The work for Arduino based application as it reported by the Authors [20]. Furthermore, open the apps on the smartphone after the installation is complete and create a new account to log in to a new project. The selected hardware is NodeMCU for this project and the type of communication is WiFi ESP8266. The authentication token must be obtained first to build a project. Once the authentication token is obtained by the user, the Blynk apps can be designed.

Figure 5. Completed System Blynk's Interface

Figure 5 shows the complete setup of Flood Monitoring System via Blynk application. An LCD display indicates flood detection on water level status which appear whether Safety level, Warning level or Critical level. Next, three LEDs that act as an indicator are displayed which triggered based on flood level status. Rain intensity level widget is added to display the rain intensity which acted as the first system's monitoring on rain before huge flood occurs. A flood level is displayed in cm unit and the system sends the alert notification and email to the victim continuously when the flood water level together with rain intensity reached certain level of hazard. For the user or victim that always used social media, this system was very useful as it can send the alert via Twitter so they will keep updating with the latest condition of flood at their place. At the lowest part of the interface shows a Super-chart widget which could display the graph of flood level in real time condition. All the widgets kept updating between each other that lead to the combination of very useful system to warn and monitor current flood condition at place with high prone of flood in Selangor State.

Advanced Sensor Technologies:

IoT-based flood monitoring systems are incorporating more advanced sensors. For example, Doppler radar sensors, LiDAR (Light Detection and Ranging), and ultrasonic sensors provide more precise data on rainfall, water levels, and flow rates.

Wireless Sensor Networks:

IoT-based flood monitoring systems are moving towards wireless sensor networks, reducing the need for physical connections and enabling more flexible deployment in remote or challenging terrains.

Satellite and Remote Sensing Integration:

Integration with satellite technology and remote sensing allows for a broader, bird's-eye view of flood-prone areas. Satellite data can be used to monitor large regions and provide early warnings.

Real-time Data Processing:

Improved data processing and analysis capabilities using edge computing and cloud-based solutions enable quicker and more accurate flood predictions. Machine learning algorithms can be applied to real-time data to refine predictions.

Blockchain for Data Security:

The use of blockchain technology can enhance data security and integrity in flood monitoring systems. It ensures that the collected data remains tamper-proof and reliable.

Integration with Weather Forecasting:

IoT-based flood monitoring systems are increasingly integrated with weather forecasting models. This allows for more accurate predictions and early warnings by factoring in meteorological conditions.

Smart Infrastructure:

IoT-enabled flood monitoring can also be integrated with smart infrastructure, such as smart dams and flood barriers. These systems can automatically respond to flood warnings to mitigate damage.

Predictive Analytics:

Advanced analytics, including predictive analytics, can anticipate potential flood events based on historical data, current conditions, and weather forecasts, providing even earlier warnings\
.

Public Engagement through Mobile Apps:

Innovative mobile applications can provide real-time alerts to the general public, allowing residents to stay informed and take appropriate action in response to flood warnings.

Cross-Platform Integration:

Flood monitoring systems can integrate with other platforms like social media, emergency services, and transportation systems to improve preparedness and response coordination.

Drone Technology:

Drones equipped with sensors and cameras can be deployed for aerial surveillance and data collection during floods, providing valuable information for decision-makers.

Community-Based Monitoring:

Some systems engage local communities and volunteers to collect data and participate in flood monitoring, enhancing the coverage and accuracy of information.

Low-Power IoT Devices:

Energy-efficient IoT devices ensure longer battery life, making it possible to deploy sensors in remote areas for extended periods.
These innovations in IoT-based flood monitoring and early warning systems not only help in early detection but also aid in better response coordination, reducing the impact of floods on communities and infrastructure.

The Development Process Of An Iot-Based Flood Monitoring System Involves Several Key Stages:

1. **Requirements Gathering and Planning**:

- ✓ Define the objectives and scope of the flood monitoring system.
- ✓ Identify the geographic areas to be covered.
- ✓ Determine the parameters to be monitored, such as water levels, rainfall, and weather conditions.
- ✓ Specify the desired communication methods and data transmission frequency.

2. **Sensor Selection and Deployment:**

- ✓ Choose appropriate IoT sensors capable of measuring the required parameters.
- ✓ Deploy these sensors strategically in flood-prone areas.
- ✓ Ensure sensors are weatherproof and have a reliable power source, often using solar panels or batteries.

3. **Data Collection and Transmission:**

- ✓ Configure sensors to collect data at regular intervals.

Establish communication protocols, such as Wi-Fi, cellular, or LPWAN (Low Power Wide Area Network), for transmitting data to a central hub

4. **Data Processing and Storage:**

- ✓ Set up a central data processing system to receive and store sensor data.
- ✓ Implement data validation and quality checks to ensure accuracy.
- ✓ Store historical data for trend analysis and modeling.

5. **Integration with IoT Platform:**

- ✓ Integrate the sensor data into an IoT platform that can manage and process the information.
- ✓ Implement security measures to protect data during transmission and storage.

6. **Data Analysis and Early Warning Systems:**

- ✓ Utilize machine learning algorithms and data analysis techniques to detect patterns and anomalies in the data.
- ✓ Implement early warning systems that trigger alerts based on predefined thresholds.

7. **Visualization and User Interface:**

- ✓ Develop a user-friendly interface to visualize real-time and historical flood data.
- ✓ Provide access to relevant stakeholders, such as emergency responders and the public, through web or mobile apps**.**

8. **Community Engagement:**

- ✓ Encourage community involvement by allowing the public to report local flooding incidents and contribute data.
- ✓ Establish channels for feedback and communication with local residents.

9. **Testing and Validation:**

- ✓ Conduct thorough testing of the entire system to ensure its reliability and accuracy.
- ✓ Validate the effectiveness of early warning systems and response mechanisms**.**

10. Scalability and Maintenance:

- ✓ Ensure the system can be scaled to cover larger areas or accommodate additional sensors.
- ✓ Establish a maintenance plan to regularly check and service sensors and data infrastructure.

11. Collaboration with Authorities:

- ✓ Collaborate with local authorities, disaster management agencies, and meteorological departments to improve response coordination.

12. Continuous Improvement:

- ✓ Continuously monitor the system's performance and gather feedback for ongoing improvements.

The development of an IoT-based flood monitoring system is an iterative process that requires careful planning, ongoing maintenance, and adaptability to changing environmental conditions. It plays a crucial role in enhancing flood management and disaster response efforts.

PART - 2

The Development Process Of An Iot-Based Flood Monitoring

Creating a flood monitoring and early warning system using the Blynk app requires integrating Blynk's mobile app with IoT hardware, sensors, and a backend system. This example will guide you through creating a simple prototype of a flood monitoring system that provides real-time water level data and flood warnings on the Blynk app. Please note that this is a simplified version, and a real-world system would require more complex components and data sources.

COMPONENTS NEEDED:

1. Blynk Mobile App (Android/iOS)
2. IoT Hardware
3. Water level sensor (e.g., ultrasonic sensor)
4. Internet connection for your hardware
5. Blynk server (hosted or local)

Steps:

1. **Set Up Blynk Project:**

   Create a new project in the Blynk app and obtain the authentication token.

2. **Hardware and Sensor Setup:**

   Connect your IoT hardware (e.g., ESP8266) and the water level sensor. You may need to install relevant libraries for sensor support.

   Write the code for your hardware to read data from the sensor and communicate with the Blynk server. Use the Blynk library for your chosen platform.

Here's a simplified example in Arduino:

```
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>

char auth[] = "YourAuthToken";
char ssid[] = "YourNetworkSSID";
char pass[] = "YourNetworkPassword";

void setup() {
   Blynk.begin(auth, ssid, pass);
}

void loop() {
   // Read water level data from the sensor
   float waterLevel = readWaterLevel();

   // Send the water level data to the Blynk app
   Blynk.virtualWrite(V1, waterLevel);

   // Add logic for flood warnings and send alerts
   if (waterLevel > 1.5) {
      Blynk.notify("Flood warning! Water level is high.");
   }

   Blynk.run();
}
```

3. Blynk App Configuration:

In your Blynk app project, add a Gauge widget (for water level) and a Notification widget (for flood warnings).

Configure the Gauge widget to display the water level data (V1 in the example code).

Set up the Notification widget to receive flood warnings.

4. View Data and Warnings:

Open the Blynk app, connect to your project using the authentication token, and you will be able to monitor real-time water level data and receive flood warnings on your mobile device.

5. Advanced Features (Optional):

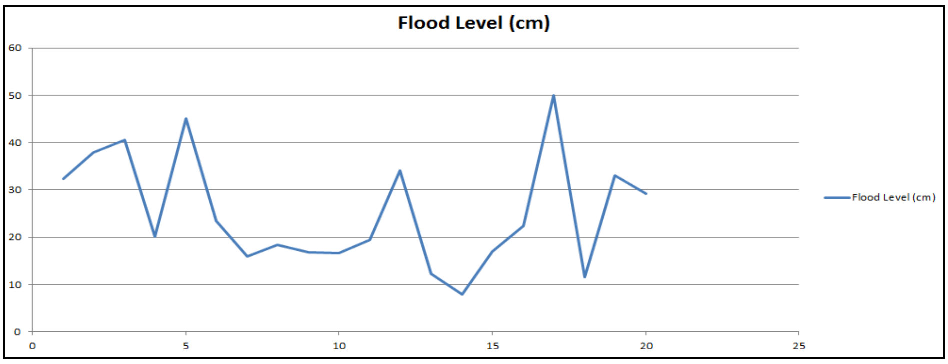
You can enhance your system by adding more sensors, geographical information, and data analysis. For example, you might use multiple sensors at different locations and display them on a map widget in your Blynk app.

Please note that this is a basic prototype, and a real-world flood monitoring and early warning system would require more sophisticated hardware, redundancy, and data analysis. Additionally, data security and reliability are critical when dealing with life-saving information, so take those aspects into account as you expand the system.

Results and Discussion

To test whether the prototype works accordingly, an experiment was conducted to test the measurement of water detected by wireless sensor node. Buzzer and LED started to trigger when the water level reached 10cm until it reach critical level (30cm) away from the ground, a notification sent to victim through Blynk and email. Rain sensor detects the rain intensity and sends an alert when rain heavily started. Based on flood level detected, it can be viewed in the database that was sent to the email. Figure 6 shows the flood level for every minute. The x-axis is corresponding to the time, while y-axis is corresponding to the flood level monitoring. Whereas Figure 7 shows the Flood level on Blynk application that can be viewed on the user's smartphone. In this information, x-axis represents for time, and y-axis represents for flood level. Figure 7 provides an easy access for the user to get an accurate reading on flood level in real time condition. The graph shows the flood level reading for every second.

Figure 6. Schematic Diagram of Steps to Build Blynk Interface



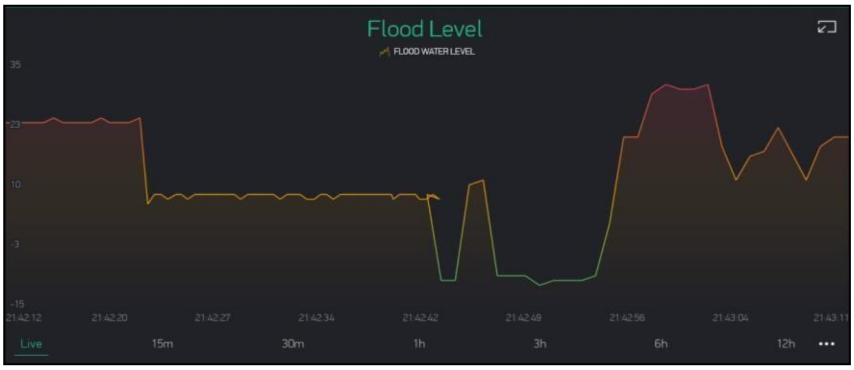


Figure 7. Flood Level Monitoring for Every Seconds in Blynk Apps

Figure 8 shows the reading of data sense from the ultrasonic sensors from the system in Blynk application. There are three mode displays on the screen of the smartphone. It displayed level of water either in safety, warning or critical level to alert victims in a high prone area of flood. The distance of the water is also displayed on the widgets which used LED as the indicator (green for safety, yellow for warning and red for critical). This history graph can be used to track the flood level in real time condition. There will be three states which are level 1, level 2 and level 3 to give alarm to the people. The data sensed by the sensor was displayed on the Blynk's interface reflecting the level indicator as well as the distance.

Once the data being received, green LED and buzzer started to trigger when level 1 of flood level detected. Then, level 2 yellow LED will blink and buzzer triggered and lastly, at level 3 red LED turn on, as well as the buzzer. Once the water level reached 31cm, the system will send the alert notification to the user via email and Blynk push notification. Table 1 tabulates the range of level indicator that indicates the distance of sensor for safety purposes.

Figure 8. Flood Level Detection Monitoring in Blynk Apps

Table 1. Flood Level Categories based on Flood Detection

FloodLevel(cm)	LevelIndicator	Warning Signage
11 -20	1	Safety
21 -30	2	Warning
31andabove	3	Critical

1.1 Rain Sensor Data on Blynk's Interface

Figure 9 shows the condition when the rain started to fall at the particular place. The level of rain intensity which is in green colour shows that the rain just started to fall. This indicates that the people who live nearby should alert a they know their place will get a very disastrous disaster if the rain started heavily. "Rain Warning!!" notification is sent to the user foe alerting purposes.

As stated in Figure 10, the rain intensity have reach a certain point that need to be consider by the victim who tend to face flood at their area. This is because, when the rain started to fall heavily, a higher tendency that a flood will occur at any time at that place. The system sends the notification "Raining Heavilly, Please be Aware!!" as an alert purpose so that the victim will get notified at any times and anywhere when the rain started to fall heavily.

Figure 9. Low Rain Intensity Display

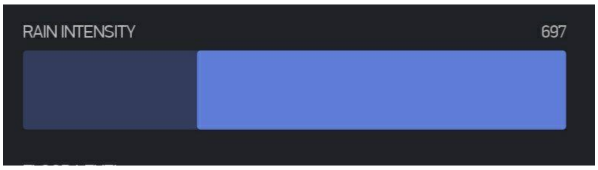
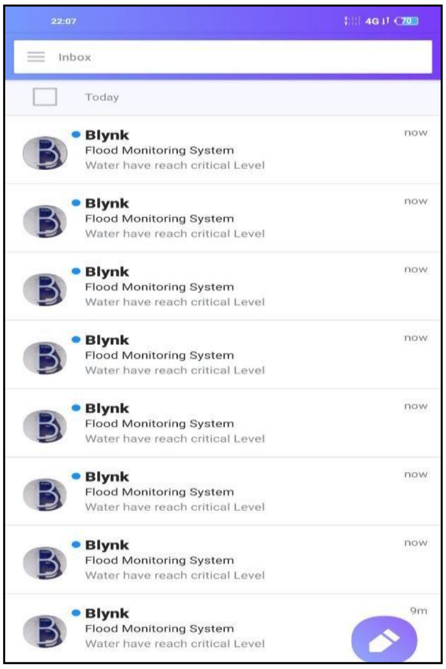


Figure 10. High Rain Intensity Display

Figure 11 shows the notifications sent to the victim's email regarding the water level which has reached a critical level. Therefore, victims will get to know the status of flood level precisely. Figure 12 (a) shows the side view of the prototype. From the above figure, a black box is used to place the microcontroller of the system which is NodeMCU integrated with sensors. An external 5V of power supply is used to power on the system. Figure 12 (b) shows an ultrasonic sensors is placed 50cm from the ground to detect the flood level in centimetre. Figure 12 (c) shows the top view of the prototype. From the above figure, rain sensor module is placed at the top of the system. This is because the rain sensor will detect the rain intensity that fall on it. Besides, three different LEDs are used to indicate the different of flood levels warning signage. A buzzer which is placed near the LEDs will trigger with different frequencies based on multiple warning signage and colours of LEDs.

Figure 13 shows the PC and smartphone for monitoring purposes. Users could get the data of the flood water level from ultrasonic sensors for every minute via email. Then, users could monitor the Blynk interface which is designed for monitoring purposes. A graph plotted the flood level in centimeter in Excel format. The data plotted are important for future work of the system especially in flood forecasting and other improvement of the system.

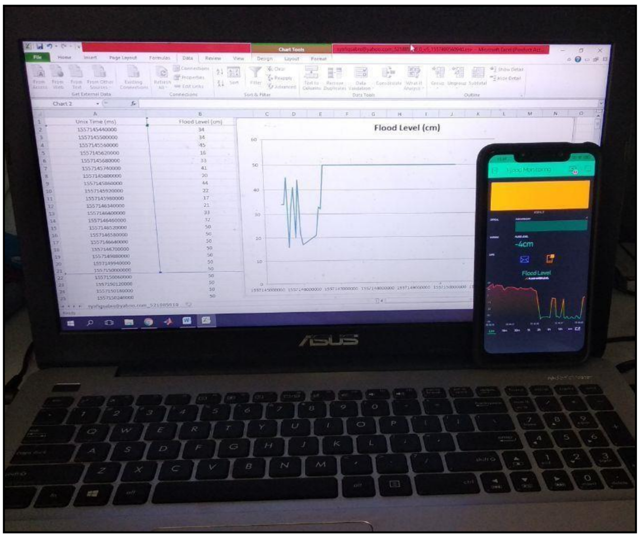
Figure 11. Notification Alert and Warning Sent by Blynk App



(a) (b) (c)

Figure 12. Low-Cost Prototype of Flood Warning and Monitoring System. (a) Side View, (b) Bottom View, (c) Top View

Figure 13. Monitoring Desk of Flood Warning System



Conclusion

This study based on the development of a smart flood monitoring system using ultrasonic sensors with NodeMCU and Blynk application. The results offer flexibility, efficiency and low cost. Wireless sensor node based on Blynk platform is an ideal platform to monitor flash floods and also as early warnings. The working of a low-cost ultrasonic sensors and rain sensor integrated with NodeMCU are able to detect and provide efficient and accurate sensing data for monitoring and alerting purposes. Through the experiment conducted, it shows that this system can be used for detecting, monitoring and alerting the community in Selangor in case of flash flood.

In this study, the prototype is only uses a small scale of sensor detection within 50cm. In actual world, the system needs to detect the flood for about 1 to 2 meter if the system is placed at the riverside to detect flood. Besides, this prototype needs to be improved on the water resistant features so that when the rain started to fall, it cannot damage the sensor node. A proper installation need to be done so that the system can be put at any kind of surfaces to avoid it being fall down when water level rise up. Therefore, the system could help a huge number of victim's life whenever the future work could be done on it.