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Development of Solar PV Powered Smart Flood Monitoring System Apply for The Unmanned Substation

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Abstract: Flood has always been a disaster to the world. Sudden flood and flash flood is unpredictable and can cause much damage. The unmanned substation also gets the impact of a flood unpredictably occurs. Many components and equipment will be damaged and will cost loss for the community. The person in charge must be notified if a flood will occur, as any device can warn them when it occurs. The existing water level device is inconvenient because of the device design, just like a giant ruler with a number on it. There are no components to send the data to the person in charge about the condition of the water level. Because of this, the development of a Solar PV Powered Smart Flood Monitoring System Applied for the Unmanned Substation is made. This project is developed to measure water level and define the weather condition, whether rain or not. Then the project was developed to send the data through the IoT platform and notify the user about the weather and water levels. This project is developed using an ESP32 module as the microprocessor, a water level sensor as the weather condition definer, and an ultrasonic sensor as the water level measurer. The IoT platform used is the Blynk interface, which can show the sensor data reading and give notifications through the smartphone. The output will show the condition of the unmanned substation such as it rain, the interface will notify that is rain at the substation and other condition.

Keywords: Flood Monitoring, IoT, Flood Detection, Unmanned Substation, Blynk

1. Introduction

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Flood have been the main problem to our country. Unpredictable weather condition will lead to a flood. A sudden flood, or flash flood will cause unexpected damage to everything in the world. Flood cause significant harm to life, the spread of disease, property and also economy. Scientist and meteorologist can hardly monitor when a flood occurs. Figure 1 shows the flood occur at Selangor in 2020.

Figure 1: Flood occur at Selangor in 2020.

The unmanned substation is only monitored sometimes by the person in charge. If a flash flood occur, there will nothing to notify the person in charge about the condition of the substation. So, the substation will highly risk to get flood and damage the component in the substation. The damage will also give impact to the community as the current supply is cut off and taking time be repaired. Figure 2 show the unmanned substation got flooded at Selangor.

Figure 2: Unmanned substation got flooded at Meru, Selangor .

A Smart Flood Sensor with the Internet of Thing (IoT) system is developed to create this problem. The project is mainly function at lower ground's electrical substation. This project is will warn the person in charge to get notified early before the flood occurs to avoid any damage to the substation

The problem that found in the reason to develop this system is the existing device to monitor the water lever in canal and river is too primitive. The mechanism of the device is measuring the water level in the canal by using a giant ruler that show the water level. The inconvenience of this device is because there is nothing to send the data of the water level to any department that appropriate. So there will be no warning about the flood making the risk to the substation to be flooded is extremely high. Figure 3 show the current technology of water level indicator at canal and river.

Figure 3: Current technology of water level indicator.

There are several objectives in this project development to achieve. The first objective is to design a monitoring system of flood using sensor with IoT for lower ground unmanned substation and using solar photovoltaic based power supply to supply the system. Next objective to build a hardware prototype of the system that can monitor the water level and alert the person in charge if the sensor detecting something unusual. The last objective of this project is to verify the prototype working condition in term of functionality/ capability to sense, monitor and analyze the water level and sent the information wirelessly to person in charge.

There is scope and limitation need to be followed in developing this project. The first scope and the limitation is this project only monitor water level at the lower ground unmanned substation. Next is the water level status is sent through notification to the person in charge by using Wi-Fi. Next, the notification will be sent according to water level condition at the unmanned substation. Lastly is the supply for this system is only using solar photovoltaic base power supply and use battery to store current.

2. Summary of The Project

This system consists of two sensors: HC SR04 ultrasonic sensor and water level sensor, connected to the ESP32 module. The system starts by the ESP32 module connected to the Wi-Fi connection. Next the system read sensor data based on the required parameter. Then the data is send to ESP32 and Blynk cloud platform to monitor the data. The data received is displayed on LCD on the hardware and in the Blynk interface and also the notification in the Blynk.

2.1 Components

Table 1: List of Components

Component	Quantity
ESP32	1
HC SR04 Ultrasonic Sensor	1
Water Level Sensor	1
I2C OLED Display	1
LED	3
Buzzer	1
Polycrsytalline Solar Panel	1
Solar Charger Controller	1
LM2596 Step Down Buck Converter	1
Lithium Ion Battery	4

2.2 Block Diagram

Four Lithium-Ion 3.7V batteries are linked in series and parallel to provide the needed output. The solar cell's voltage will be connected to the charger controller before recharging the battery to prolong its lifespan. Step-down buck converters will maintain the circuit's supply before it reaches the circuit. Next, the ESP32 supplied by the battery acts as a microprocessor. The system's brain, the ESP32, can store coding with command and data signals. In this project, the water sensor will serve as a water detector. The water sensor will demonstrate whether or not it is raining. The ultrasonic sensor will signal the microprocessor about the water level. The Blynk cloud will receive all sensor data from the microprocessor. Blynk will present cloud data through smartphone apps and web consoles. The I2C LCD will display sensor data to indicate condition and value. Figure 4 show the block diagram of this project.

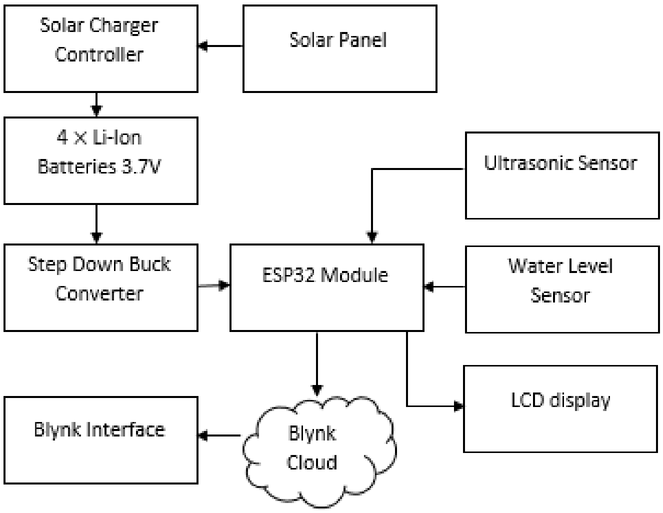


Figure 4: Block Diagram of the System

2.3 Flowcharts

In this project, there are two flowcharts for this system that is supply flowchart and system flowchart. Supply flowchart is for supply that start from solar panel to step down buck converter. Figure 5 show the supply flowcharts.

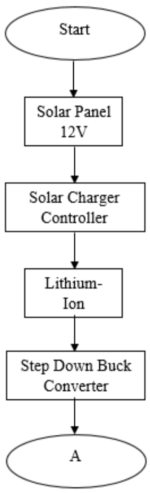


Figure 5: Supply Flowcharts

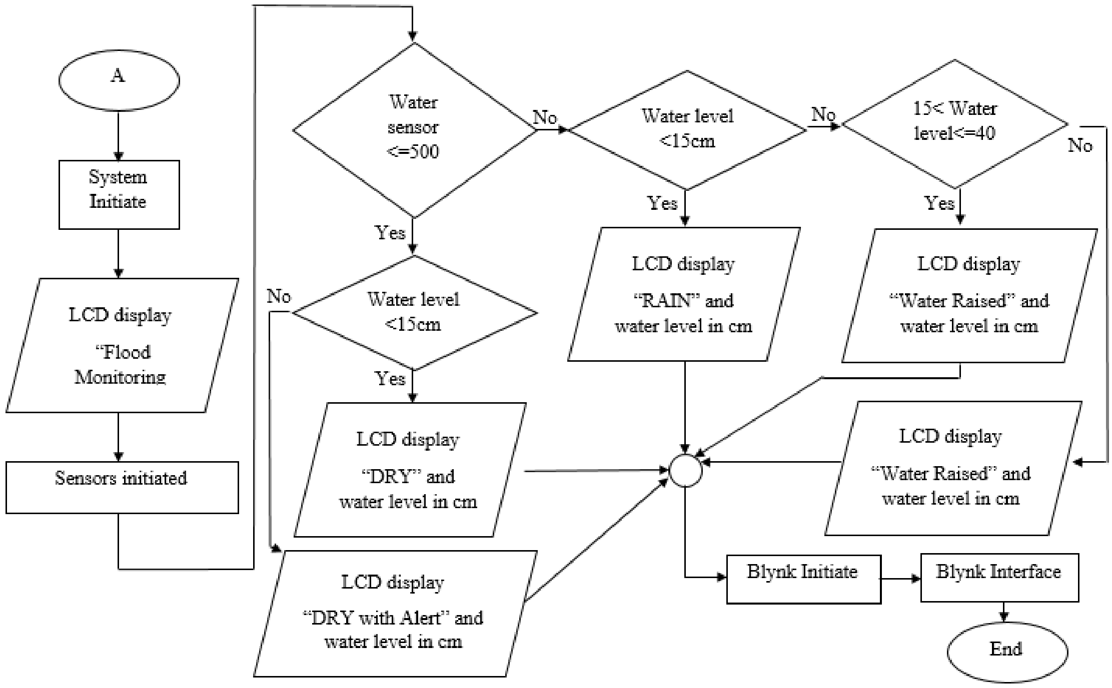


Figure 6: System Flowcharts

The project system flowchart is shown in figure 6. Supply from the supply flowchart supplies the system. The LCD will display "Flood Monitoring by Nizaruddin" when the system starts. All sensors will start and collect data. The water level sensor is ultrasonic. Water level sensor data is used in the flow chart. Ultrasonic sensors measure water levels. Five conditions use the parameter. The LCDs are "DRY," the water level is in centimeters when the water sensor value is less than 500, and the water level is less than five. The LCDs "DRY with Alert," and the water level is in centimeters when the water sensor value is under 500, and the water level is over 15. When the water sensor value exceeds 500, this occurs. The LCDs "RAIN" and the water level if it is below 15. The LCDs "Water Raised" and the water level value if the water level is 15–40. The LCD will display "Flood Occur" and the water level if it surpasses 40. All water level values are centimeters. IoT will follow. The Blynk cloud receives all sensor values after activation. Blynk's smartphone and online interfaces display all values.

3. Results and Discussion

After the project testing's methodological phase was over, the findings were collected and documented. Several tests were conducted to ensure the project was functionally complete and to assist with problems that developed throughout the hardware and software phases. The debugging procedure was one of the options since the software problem only presented itself in a specific situation. When the system is completely operational and the data has been collected, the results are carefully examined to ensure they support the project's objectives. Two circuits in this project are the supply circuit and the system circuit. Figure 7 show the supply circuit, and figure 8 shows the system circuit.

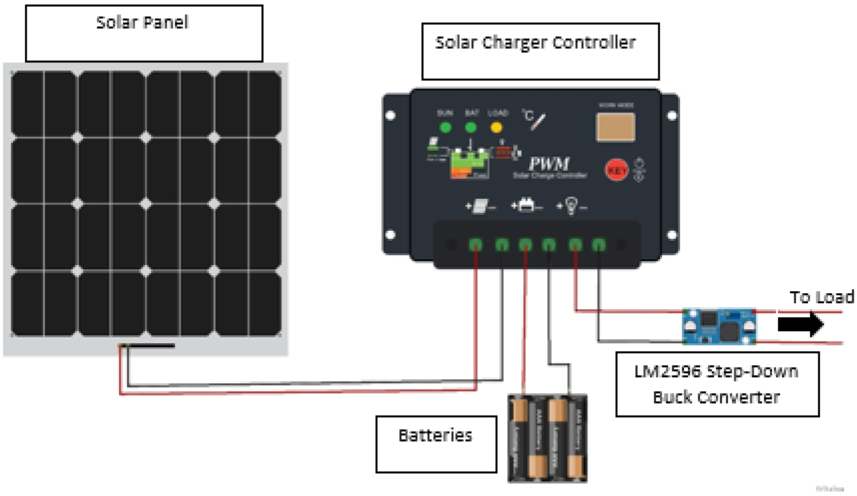


Figure 7: Supply circuit connection

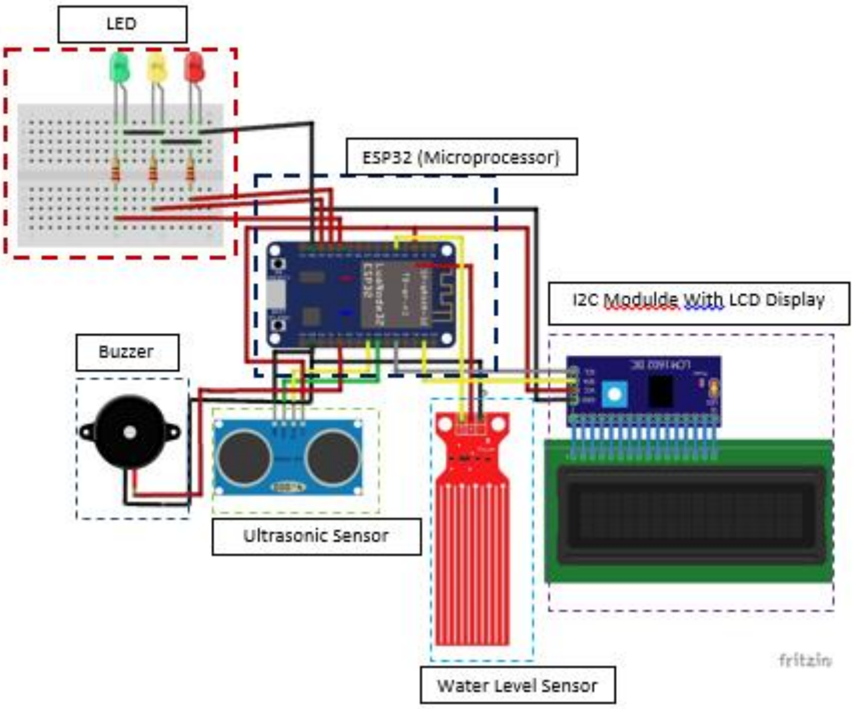


Figure 8: System circuit connection

3.1 Solar Charging Capabilities

Using solar as the main power supply, it is a must to ensure the solar panel should be able to charge the battery throughout the day the solar only function when the solar got sunlight. The data is taken within the day start at 9.00 am to 6.00 pm. The reading is collected and put in table show in table 2

Table 2: Data Collected for the solar

Time	Solar Panel Output
9.00 am	12.4V
10.00 am	12.5V
11.00 am	12.5V
12.00 pm	12.7V
1.00 pm	13.1V
2.00 pm	12.9V
3.00 pm	12.6V
4.00 pm	12.6V
5.00 pm	12.5V
6.00 pm	12.3V

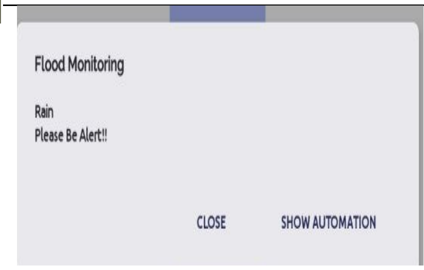
3.3 Result for the system

The result in this subchapter is for the system output. The result is based on the condition that have been set in this project. The condition is based on water level sensor value that is name as resval and the ultrasonic sensor value that is name as water level. The result is based on the output at the LCD and the Blynk interface. Table 3 show the result and the output of the system.

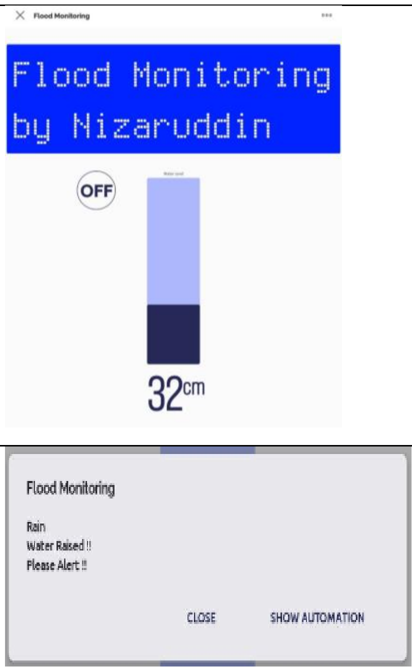
Table 3: Result and the Blynk interface for the system.

LCD Display	Blynk Interface	Explanation
	 No notification for this parameter	In this condition, the water existence reading from the water level sensor is below 500, and the water level is below than 15cm, the LCD will display "DRY" and the water level in cm. The green LED will be lit up to indicates there is no danger.

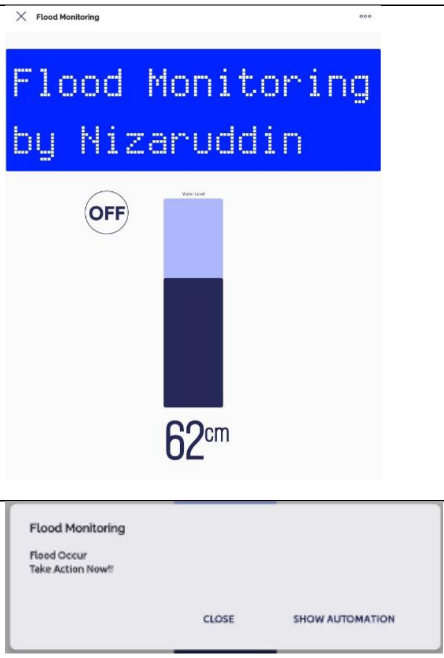
In this condition, the water level sensor reading is below than 500, and the water level is more than 15cm, the LCD will display “Dry With Alert” and the water level in cm. the Blynk interface in smartphone will also showing the water level in cm. Also there will be notification for this condition that send massages “No Rain, Water Still High”. The green and yellow LED will lit up to show the danger is intermediate.



For this condition, the resval is more than 500 and water level is below than 15cm. The LCD will display “RAIN” and the water level in cm. The Blynk interface will display the water level in the Blynk apss interface. A notification will be sent that display “Rain, Please be Alert!!”. The LED green will lit up to indicates there are no danger coming.



In this condition, the water level sensor reading is more than 500, and the water level is more than 15cm but not more than 40cm, the LCD will display “Water Raised” and the water level in cm. the Blynk interface will also showing the water level in cm. Also there will be notification for this condition that send massages “No Rain, Water Still High”. The green and yellow LED will lit up to show the danger is intermediate.



In this condition, the water level sensor reading is more than 500, and the water level is more than 40cm, the LCD will display “Flood Occur” and the water level in cm. the Blynk interface will also showing the water level in cm. Also there will be notification for this condition that send massages “Flood Occur, Take Action Now!!”. The green, yellow and red LED will lit up to show the danger is high

4. Conclusion

In summary, this project is developed to sense flood at an unmanned substation using a water sensor, ultrasonic sensor, and an IoT interface (Blynk) to give the output. Some conditions are set that are dry, but water is raised, rain, rain and water raised, and a flood occurs. This condition indicates the condition at the substation. For all these conditions except rain, there will be a push notification to the smartphone to notify the condition at the substation. But even with these positive results, much improvement can be made before commercializing this project prototype. The sensor accuracy needs to be improved to understand the water level and the water's existence. Furthermore, the supply for this project is needed to be improved as the battery may not be capable of supplying the system through the night. Lastly, this project is successful but must be improved in many ways before commercializing it.

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