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Development of Centralized Real -Time Flood Detection and Warning System

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Abstract: The flooding problem in Malaysia currently is very concerning even though Malaysia's advancement in the field of technology is quite high. There are a few key problems that allow this problem to persist which are high cost of flood detection technology, lack expert manpower, and connectivity issue between different systems. The objectives to be achieved in this project are to design a suitable LabVIEW Graphical User Interface (GUI) for the centralized flood warning and prevention system, to implement the autonomous system with the developed GUI in real - time application using a model scaled prototype, and to analyse the performance of the system in terms of reliability and performance. The objectives listed in this project can be achieved by developing a system that uses an ESP32 microcontroller paired with water level sensors that will send the sensor readings into Firebase Database. The readings can also be used in the LabVIEW software with the proper indicators for the graphical user interface (GUI). At the end of the project, all the collected data will be inserted into a Microsoft excel spreadsheet which can be used to plot a line graph. All in all, based on the findings made the project can be considered a success but there are still some improvements that can be made such as changing the type of sensor used that has higher capability to measure the water level such as an underwater ultrasonic depth sensor.

Keywords: Flood detection, LabVIEW GUI

1. Introduction

The flooding problem in Malaysia currently is very concerning even though Malaysia's technological advancement is quite high. There are a few key problems that allow this problem to persist. One of those problems is that the Malaysian government utilizes high-end technology that cost a lot of money and this in turn would cause the Malaysian government to implement the system in certain high-profile area only disregarding any other areas. Furthermore, the current system complex nature needs the attention of experts for maintenance which Malaysia currently do not have which makes the system inefficient and most the time are not well maintained. Besides that, the current

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implemented flood warning systems are not connected with each other all the time so this will cause the system to detect the flood only at local level and not at its root.

1.1 Related projects

This section explains briefly for various projects around the world in the past or are currently being worked on which involves some sort of flood warning or detection system.

1.1.1 Design of ZigBee based wireless sensor network for early flood monitoring and warning system.

For the emergency procedure personnel which oversees planning of the flood relief operations, real-time and accurate information is crucial to make the most logical decision at that particular moment [7]. The current technology involves using depth or flow sensor in areas that highly to suffer from flooding and then feeding the data to a grid-base computational models to predict flood events. The system will only issue a warning to a large general area and this system relies on a network of sensors that are few in numbers and far from each other. Balaji et al. [7] system's implements the use of ZigBee which is connected directly to the dam to transfer the water level and water flow data immediately to the regional servers where another ZigBee is connected.

1.1.2 Flash flood warning system using SCADA system: Laboratory level.

This project was able to be brought into light due to the major flood tragedy that hits the central district of Thailand in 2011. Many people suffer loses either financially or physically due to the flood and all this happens because of the lack of warning system. This project is dedicated to developing a flash flood warning system that is capable of being installed at nearly any place with any condition. The system is designed to either be a standalone system or connected to a large network of sensors to collectively send sensor data to a centralized monitoring system.

Achawakorn et al. [3] focuses on 3 main topics which are the impact of flash floods and ways to minimize the damage, the functionality of water level sensor to measure the level flood water, and the ability of a sensor network to transmit data to a central monitoring system for data processing.

2. Materials and Methods

This chapter will discuss the method outline for this project. This chapter will also explain every component that will make up the different sub-systems be it for experimental purpose or for the final product prototype. The LabVIEW software GUI which will be used for data collection and analysis will also be briefly explained.

2.1 Materials

To achieve the set objectives, there are some key components either software or hardware that needs to be used. This project uses only 2 main hardware which listed below with its function:

- ESP32: a microcontroller board with inbuilt wifi module that can send sensor readings over the internet into the database.
- Rain sensor module: detect the current water level of the simulated test setup.

For the software part of this project, 3 key components are needed which are LabVIEW, Arduino IDE, and Firebase database. All the function of those software is listed below:

- LabVIEW: provide a graphical user interface to read the data send from the ESP32.

- Arduino IDE: Compile and upload the Arduino program into the ESP32.
- Firebase database: a free google database that can store the water level reading from the ESP32.

2.2 Methods

Development of the proper method of testing and implementation is crucial for the success of the project. Figure 2.1 below shows the block diagram of the system m which simplify the working principles of the system in an easy-to-understand graphical representation. The system is separated into 2 parts that consists of 3 different sub-systems which is the remote viewer part and also the on-site monitoring part. Sub-system 1 and sub-system 2 will make up the remote viewer part and sub-system 3 will make up the on-site monitoring part that is connected to the internet using ESP32 wifi module.

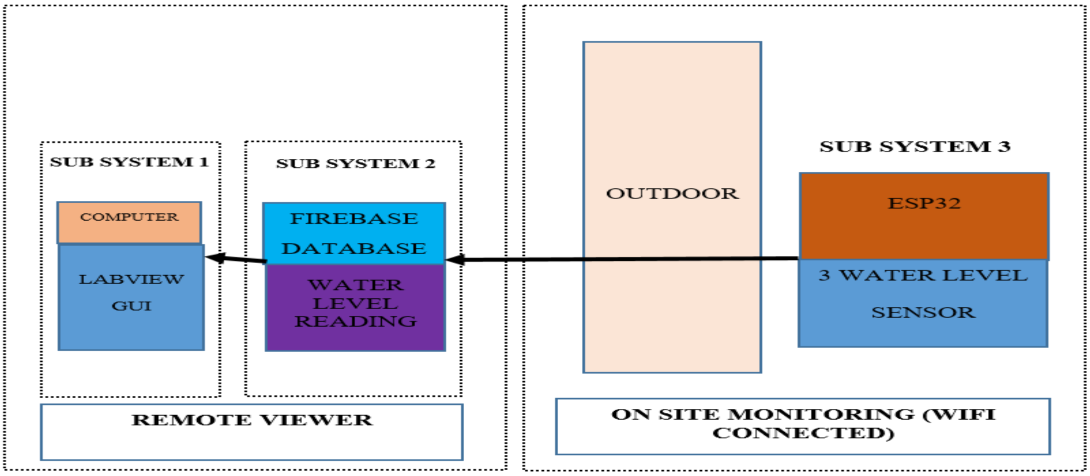

Figure 2.1: System block diagram

2.2 LabVIEW Graphical User Interface

This project uses the LabVIEW software to display all the sensor reading using the software built-in graphical user interface. The LabVIEW graphic interface is a simple drag and drop function that can display multiple type of data like graphs, gauge, and simple word messages. The LabVIEW software will receive data from sub-system two which stores the sensor reading data in a cloud database and LabVIEW will call all data and represent it in a graphical interface.

Figure 2.2 below depicts the final design of the LabVIEW Graphical interface and the interface different type of graphics for each and every one of the sensors reading. The interface also implements different type of output to displays the warning messages when a flood happens which is represented by three led display and a word message that display the current status.

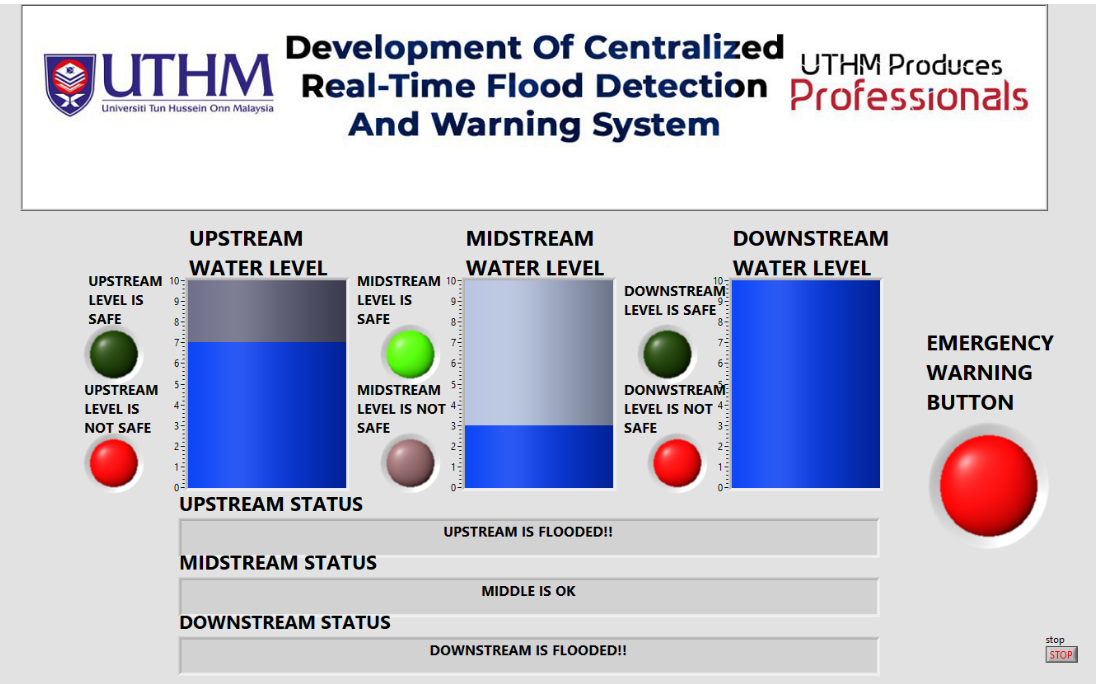

Figure2.2 : Complete LabVIEW GUI

2.3 Circuit Diagram

A proper circuit design is also needed to make sure that there will be a reference during the assembly of the final prototype so that no components will be broken. Figure 2.3 will show how the circuit connection is made.

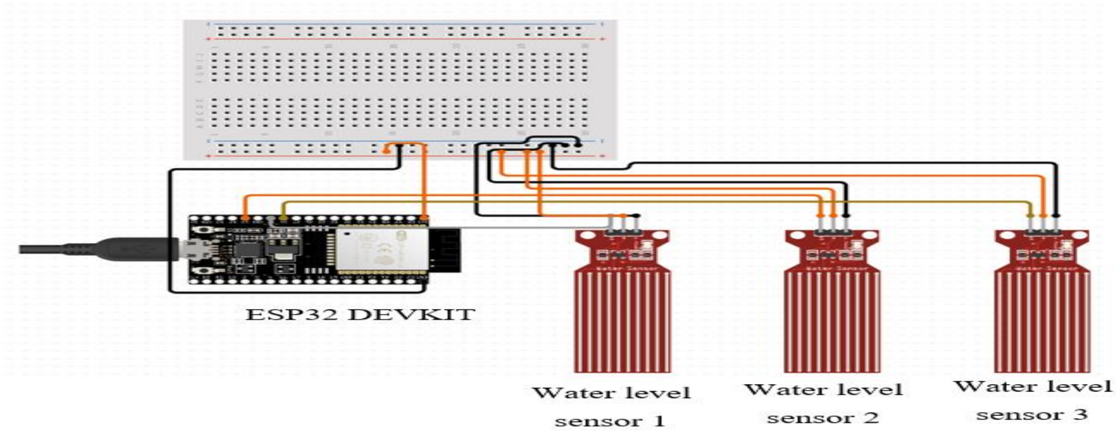

Figure2.3 : Full Circuit Diagram

3. Results and Discussion

This chapter will be discussing the initial testing and final results for this proposed project. For the initial testing results, each components of the system is tested individually to make sure that the components are working as expected. The final results will include actual setup for real-time implementation as well as a data analysis of the sensors reading that has been collected in the database.

3.1 Full Simulation Setup

Since testing at a real river can raise many safety concerns so it is decided that for a proof of concept, the data collection will be conducted in a smaller scale that can be controlled. A simple setup consisting of 3 different water level sensor at different heights is put in a bucket of water as illustrated by figure 3.1. To simulate the changing water level of the river, water is poured into the bucket or removed from it either in small volume at a fixed interval or large volume of water all at once.

Figure 3.1 : Picture of Full setup

3.2 Data Analysis

Figure 3.2 illustrates the line graph that has been automatically generated by the Microsoft excel software. The graph has 2 axes which is the Y-axis that shows the amplitude of the sensors reading while the X-axis shows the time at which the data is recorded. Based on the line graph, we can see the value of sensor 1 ranges from 2500 to around 250. The water level sensor used for this project works by giving a lower value the deeper it is submerged, so from that we can imply that the 1st sensor submerged almost completely most of the time. For the 2nd sensor, its readings ranges from 2500 all the way to 4100 and thus we know that the sensor is only partially submerged or not submerged at all. This result can be observed because the second sensor is positioned higher than first sensor and since the water level in the bucket is never full, the second will never give a very low reading. Also an important point in the graph is between 8.00 am to around 6.00 pm where the all the reading of the sensors stays at 4000. This is because at that time the water bucket is empty and the sensors do not detect any presence of water.

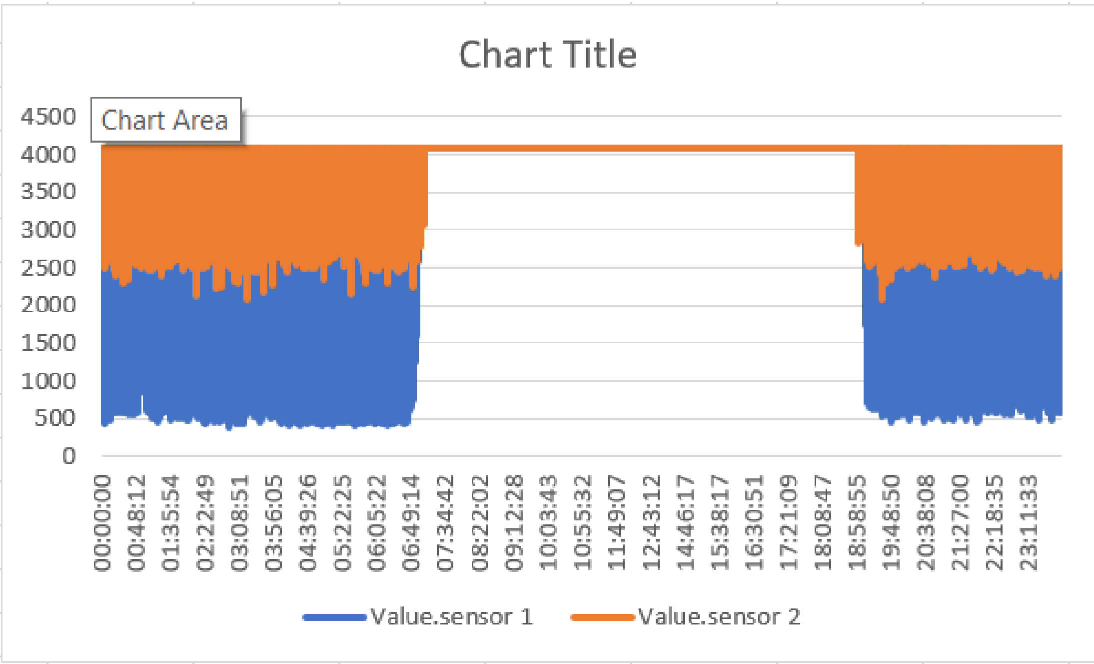

Figure 3.2 Line Graph of the Collected Data Output

After a few days of running the entire system at a fixed interval of one minute per sensor reading, the data collected at the database will be humongous and figure 3.3 shows a part of the long list of data and how they are stored in the firebase database.

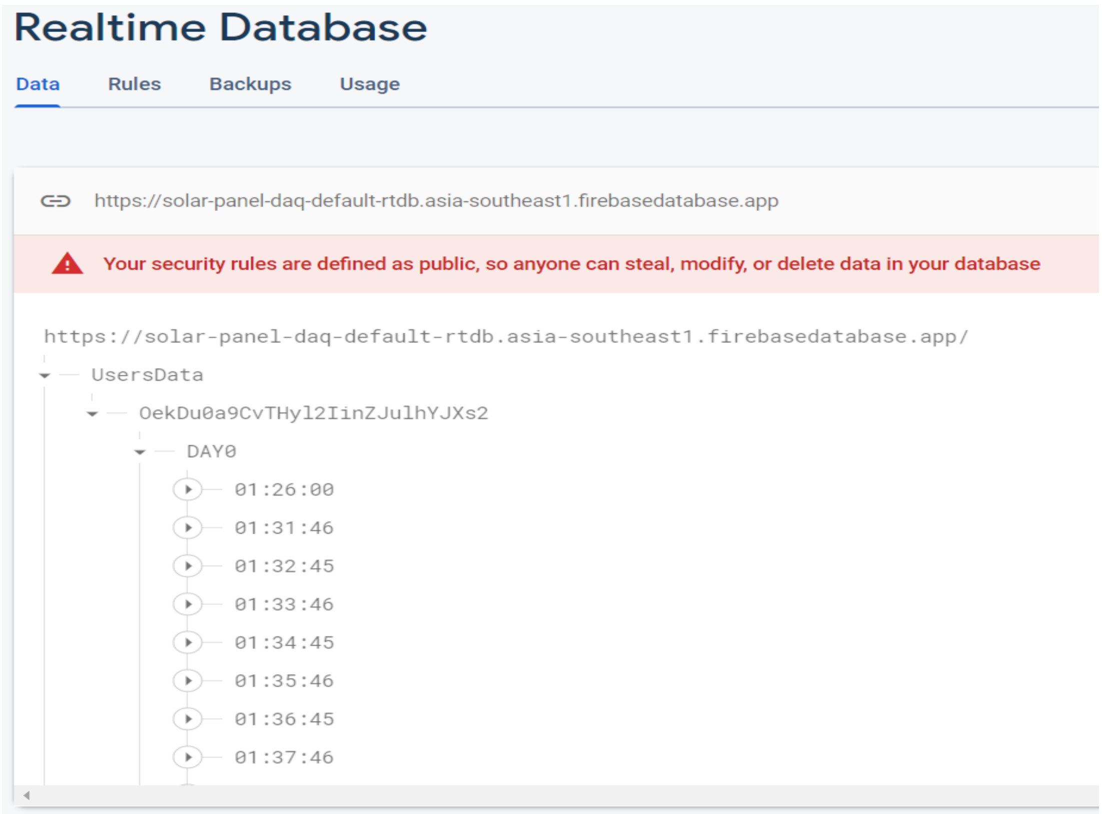

Figure 3.3 Snippet of Data in Firebase Database

All the data in firebase database can be imported into an excel spreadsheet just like how it is shown in figure 3.4. The data in excel spreadsheet can then be transformed or used to make a graph that is easier to be observed.

	A	B	C
1	Name	Value.sen:	Value.sen:
2	00:00:00	4095	4095
3	00:00:02	4095	4095
4	00:00:03	3952	4095
5	00:00:04	4095	4095
6	00:00:05	4095	4095
7	00:00:07	3911	4095
8	00:00:08	4095	4095
9	00:00:09	4095	4095
10	00:00:10	4095	2867
11	00:00:11	4095	4095
12	00:00:13	3613	3383
13	00:00:14	4095	4095
14	00:00:15	4095	4095
15	00:00:16	3927	4095
16	00:00:18	3964	3868
17	00:00:19	4095	4095
18	00:00:20	4095	3883
19	00:00:21	4095	3978
20	00:00:22	4095	4095
21	00:00:23	4095	4095
22	00:00:24	4095	4095
23	00:00:25	3959	3967
24	00:00:26	4095	3351
25	00:00:28	4095	4078
26	00:00:29	4095	4095
27	00:00:30	605	4095
28	00:00:31	4095	4095

Figure 3.4 : Collected Sensor Reading in Excel Spreadsheet

4. Conclusion

All in all, it is proved that the centralized real-time flood detection system is a reliable and effective system for monitoring based on the findings made during the project. The capability of the flood detection system to provide real-time sensor readings up to one data per second can also provide ample amount of data to plot a graph which can be used to predict the trends of an upcoming flood and countermeasures can be made early. As an added bonus, the ease of access of the system which is due to use of LabVIEW drag and drop coding allows the system to be easily deployable and repurposed. With the help of bright and large graphical indicators, the person monitoring the system can easily read the data and identify any warnings easily.

The initial objective set for this project has been successfully achieved which is to design a suitable LabVIEW graphical user interface (GUI) has been achieved which can be proved by the complete LabVIEW GUI shown in chapter that includes water level indicator, warning signs etc. The system is also able to transmit data from the sensors to database every minute for a few days and the LabVIEW software is also able to display those value in real-time. The system performs very efficiently both the on-site monitoring system and also the LabVIEW GUI which can works for long period of time with high precision and also low rate of error.

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