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Solar Powered Flood Detection Device: With Datalogging and Global Positioning System (GPS) For Traffic Diversion

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Abstract: This paper discusses the development of sensor node circuit design for the use of Real Time Flood Detection System for Traffic Diversion Assistance in Urban City. The step of designing the sensor circuit and the technical explanation can be found in further section of this paper. The experiment is conducted to evaluate the performance of each sensors and their durability and reliability. The step of designing the solar power system and the method used to develop the charge controller is explained in detail in this paper. The experiment is conducted to evaluate the designed system performance. The cost of the development of device is presented.

Keywords: Flood Detection, Traffic Diversion, Solar Powered

1. Introduction

The main goal of the work is to develop the Flood Warning and Detection System for monitoring flood situation and measuring the water level at the high risk area [1]. It will then warn related authority of imminent flooding [2]. This project aims to design and construct a working circuit for 4 sensors that are used in a flood detection system. The sensors involved are Rain Sensor Module (RSM), Temperature and Humidity, Ultrasonic, and Global Positioning System (GPS Module) to measure all 4 aspects of a flood detection. The design consists of six stages including initial sensors integration into Arduino, reliability testing of each sensor, sensor node operation and flowchart implementation, real time testing, and integration of solar charging circuit with sensor node. The experiments conducted are to test the reliability and durability of every sensors throughout project period and future applications.

This project is also aims to design and construct a working prototype of the solar power system with the custom made of the charge controller. The design of solar charge controller circuit consists of four stages which include theoretical calculation, designing the charge controller, the experimental process, and the PCB design. The experiment is conducted using the available solar panel and battery

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to evaluate the performance of the charge controller and suggest the suitable capacity of the battery and solar panel for future applications.

2. Materials and Methods

The steps of designing the sensor circuit in flood detection system are discussed in detail under this section.

2.1 Materials

The materials include through and alongside this project are listed as below. Noted that in the development of circuitries, few electronic components such as resistors, ICs, and more are included. Specifications and properties of materials, equipment, and other resources used in the current study should be described in this section. Should a bulleted list be required, it may be included and should look like this:

- Solar Panel
- Aluminium Frame
- Junction Box
- 12V Lead-Acid Battery
- Arduino Uno
- Raspberry Pi 3 [5]
- Sensors
- USB Broadband

2.2 Methods

The methods of this project are summarized in the following flowchart.

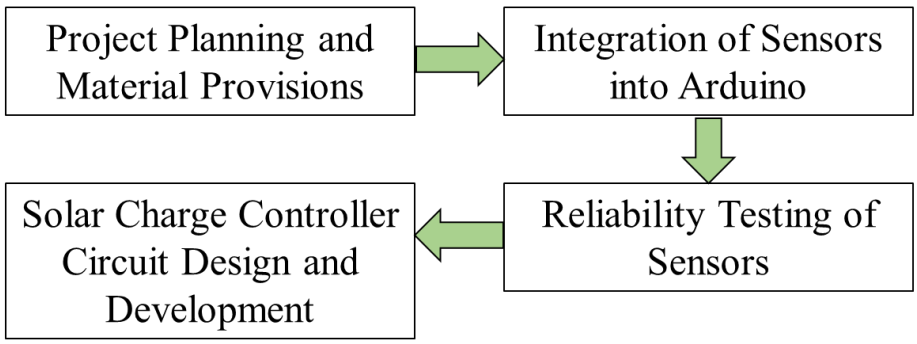

Figure 1: Project Method Flowchart

Figure 1 shows the flowchart of method taken to complete the project. The first step is Project Planning and Material Provisions. Firstly, project are proposed and consulted as for the suitability of implementation which then proceeded to material research and provision. Next, the second step is integration of sensors into Arduino. After the sensors were chose, they are then integrated altogether with Arduino to create a measure system. Then, after they are successfully integrated, each sensors are tested for reliability and endurance in third step. Lastly, after the sensors are tested and proved functional as expected, solar charge controller are designed and develop to provide power cycle for the system.

2.2.1 Project Planning and Material Provisions

In this phase, project are firstly proposed and supervised before proceeds to be constructed. This includes material research, comparison between sensors, and theory calculation of sensors.

2.2.2 Integration of Sensors into Arduino

There are 4 sensors chose after revising required specification in the device. They are listed in the Table 1 as follows.

Table 1: List of sensors and their figure

Raindrops Volume	Ultrasonic	GPS Module
		

For Ultrasonic module, the module chose are HC-SR04 which has better stability in terms of readings [3]. Waterproof Ultrasonic module are chose over the normal HC-004 [4] are important due to the nature of project and outdoor device location. In the early phase of experiment, sensors circuit are equipped with LCD Display to display the output thus ensure the values measured are expected [6].

2.2.3 Reliability Testing of Sensors

The sensors chose are tested for endurance and reliability. This means each sensors are rigorously tested in real time simulation to ensure expected output. The results are included in this paper.

2.2.4 Solar Charge Controller Circuit Design and Development

In designing the solar power system, it is critical to evaluate the load that will be connected to the system to ensure the designed solar power system is capable of supplies the power demand from the load without any problem. The failure in this designing steps will result in the under sizing of the solar power system which is lead to the failure to supply the necessary power to the load. The over sizing of the solar power system is will increase the total cost of the project which is bad for the economic aspect.

2.3 Solar Cycle System Installation

In calculating Solar Charge Controller Circuit and battery suitability, a few calculations are included. The equations are listed as belows.

i) Load Assessment
ii) Battery Sizing
iii) Solar Panel Sizing

2.3.1 Load Assessment

In designing the solar power system, it is critical to evaluate the load that will be connected to the system to ensure the designed solar power system is capable of supplies the power demand from the load without any problem. The failure in this designing steps will result in the under sizing of the solar power system which is lead to the failure to supply the necessary power to the load. The over sizing of the solar power system is will increase the total cost of the project which is bad for the economic aspect.

The load assessment is made to estimate the overall energy consumption daily. The daily load profiles were determined by calculating the power demand (Wh/day) for all load types of equipment that will be connected to the system. The estimated daily energy demand is given in Table 2 below. Since all the load is in DC, the power factor is negligible.

Table 2: Load List (estimated daily energy demand)

No	Equipment name	Quantity	Voltage (V)	Current (A)	Power (W)	Time usage (h)	Daily consumption (Wh)
1	Arduino Uno	1	3.3	0.030	0.099	24	2.376
2	Xbee Pro 60mW	1	3.3	0.095	0.314	12	3.762
3	NEO-06MV2 GPS module	1	3.3	0.1	0.33	0.01	0.004
4	SD card module	1	5	0.030	0.15	12	2.7
5	Rain Sensor module	1	5	0.010	0.05	12	0.6
6	JSN-SR04T-2.0 Ultrasonic Sensor module	1	5	0.030	0.15	12	0.18
9	others	3	5	0.040	0.6	12	7.2
						Total	**16.822**

3. Results and Discussion

In this chapter, all the sensors were tested in real time to run in a period as expected. Device were tested in various situation to test the limit and capability of each sensors. In the testing phase, we have used several apparatuses to assist in our experiments. Each sensor will used with different apparatuses.

3.1 Rain Sensor Module.

Results can be presented in the form of tables, figures, charts, diagrams or other suitable formats. If required, raw data that is too lengthy to be put in this section can be moved to the appendix.

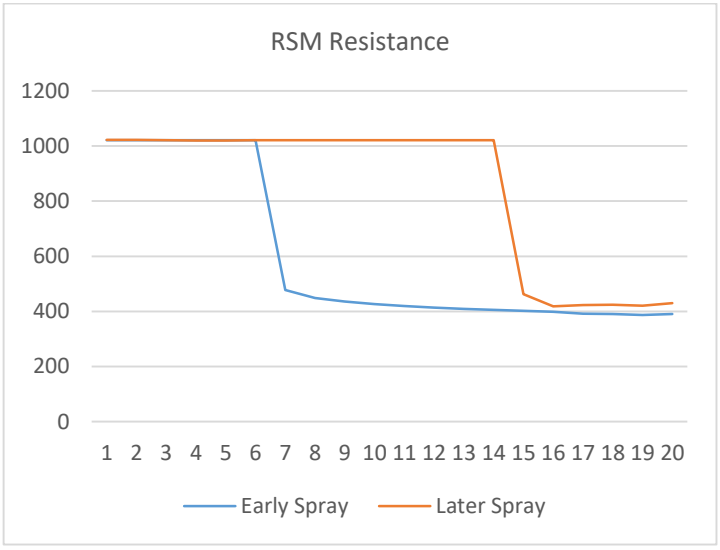

Figure 3: Rain Sensor Module result in ohm (Ω)

Figure 3 shows the reading graph From the graph shown, studies have found out that sensors react quickly as the water transfer the current from a positive side of copper to the negative side of copper on the sensor surface. It is however, if put on real-time testing, takes time to dry. Therefore, specific time are not recorded as sensors can quickly react without the need of current time measurement.

3.2 Ultrasonic

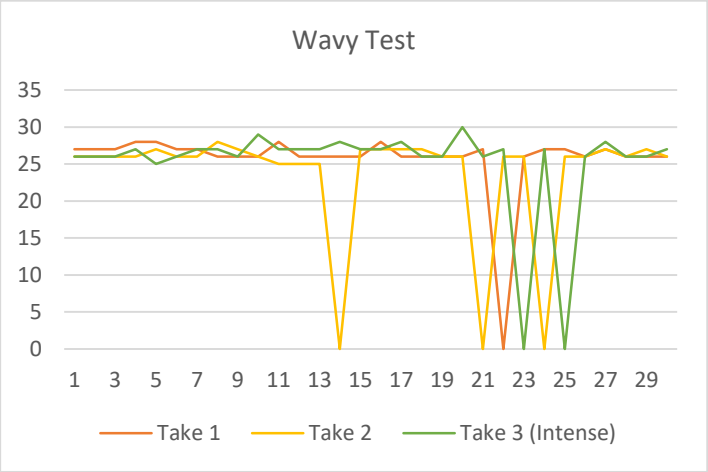

Figure 4: Ultrasonic Test Result from a drain with moving water in centimeter (cm)

Figure 4 shows the Ultrasonic initial test on a drain with running water. The readings were taken in centimeter (cm). There are slight zeroing on few interval while running the measure on a period. This is due to the splash and humidity of the drain.

3.3 GPS

The result for Global Positioning System are extracted in different method. Since initially produce raw data from the GPS IC, extraction program have been implemented and saved into microcontroller to decode the data. The result of every step are shown below.

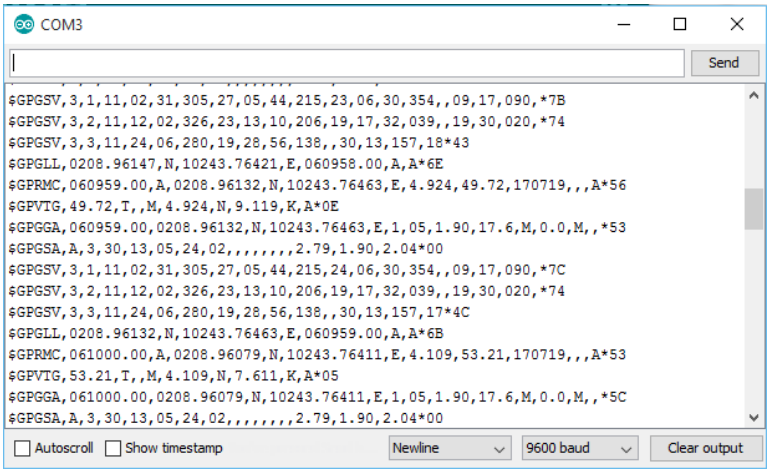

Figure 5: Raw data from the GPS module

Figure 5 shows the raw data generated by the GPS module when started. The module are connected to blank Arduino with no program. It generate data in a form of burst and uncontrollable. The details in the data generated included module's coordinate in the form of latitude and longitude, number of satellite connected, the condition of satellite, and more.

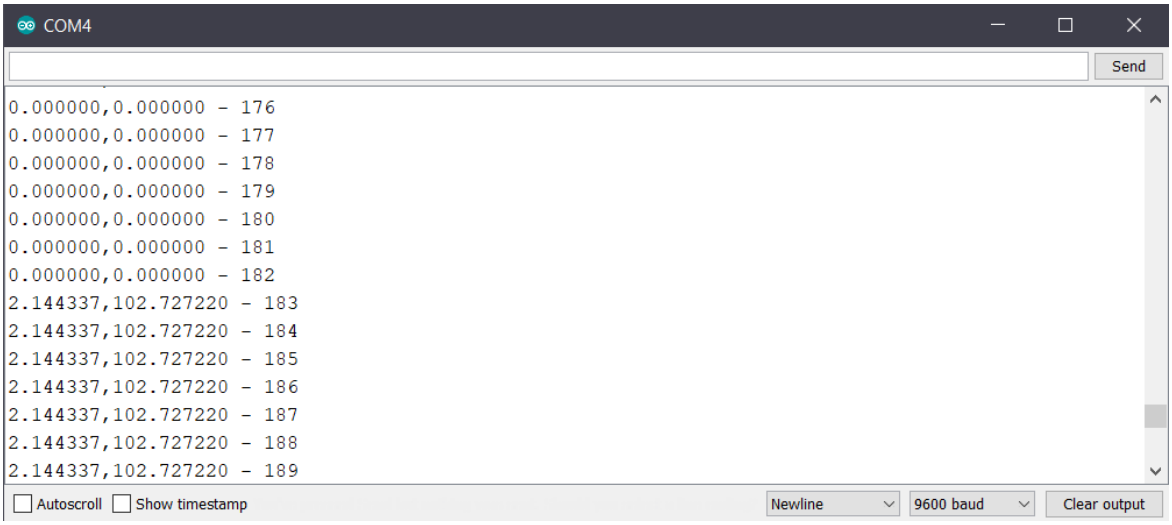

Figure 6: Data after decode program have been implemented

Figure 6 shows the data after extraction program have been uploaded into the Arduino microcontroller. This exclude all other information of the raw data and only record the latitude and longitudeof the module location.

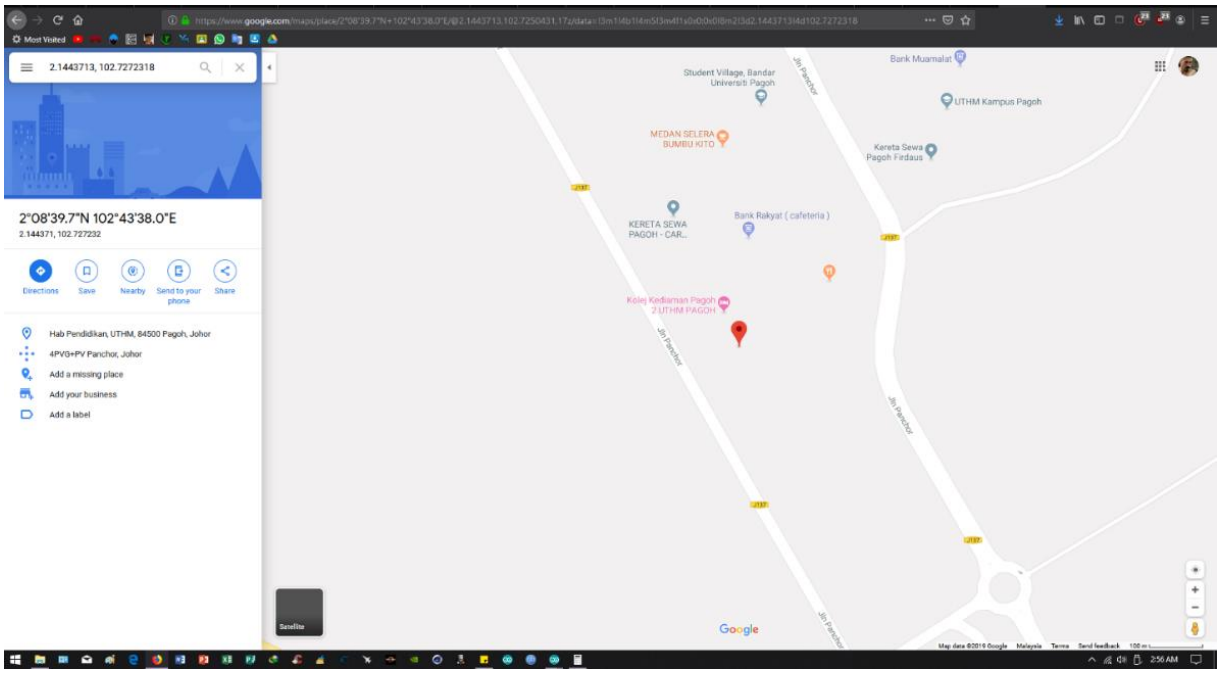

Figure 7: Location of GPS module after converting decoded data to Google Maps coordinate

After the latitude and longitude have been decoded and converted into calculation. The values have successfully pasted into Google Maps to show the current location of the GPS module as shown in Figure 7.

4. Conclusion

The first sensor, rain sensor module have been tested and all the expected outcome has been recorded. The second sensor, temperature and humidity required a calculation in coding as it produce values outside of a normal temperature range, which is then converted to optimal temperature and varies as expected. The third sensor, Ultrasonic Module, initially has unstable and high wavy pattern even though the water are not really wavy. It it then replace with another model which have better outcome

and more stable for a running water. Lastly, the GPS module are encoded from raw data and finally it shows the exact location of the module which is at Kolej Kediaman UTHM Pagoh.

As conclusion, this project is one of the effective methods to overcome traffic congestion in the areas surrounding a flooded territory. With the requirement of stable internet connection, the device can continuously feed real-time information regarding the weather and temperature of placed location to management center. Besides the sensor system, solar charge controller circuit are also a part of this project that has successfully functional as intended. With current management over solar energy, this circuitry has managed to provide current cycle efficiently without needing a microcontroller or advance Integrated Circuit (IC) despite it needed further assessment and improvisation to meets industrial expectation. Overall, project has borne expected outcome and can be improvise further to suit industrial needs and requirements.

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