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Prototype of Google Maps-Based Flood Monitoring System Using Arduino and GSM Module

Dedi Satria[1], Syaifuddin Yana[2], Rizal Munadi[3], Saumi Syahreza[4]

[1] Department of Informatic Engineering, Universitas Serambi Mekkah, Provinsi Aceh, Indonesia
[2] Department of Industrial Engineering, Universitas Serambi Mekkah, Provinsi Aceh, Indonesia
[3]Department of Elecrical Engineerin , Universitas Syiah Kuala, Provinsi Aceh, Indonesia
[4]Department of Physics , Universitas Syiah Kuala, Provinsi Aceh, Indonesia

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Abstract - *The headway of flood early warning technology has grown rapidly. The technology has led to improvements in terms of communication and information. Internet of Things Technology (IoTs) has greatly influenced the development of early warning information systems. In this article a prototype of flood monitoring system based on Google Maps has been designed by integrating ultrasonic sensors as a height detector, Arduino Uno as a processor, U-Blox Neo 6m GPS module and GSM module as the sender of water level and the coordinates to the flooded information system station. The design of the prototype produces flood altitude information along with its location based on Google Maps interface.*

Key Words: Flood, Arduino, Internet of Things, GSM, Google Maps

1.INTRODUCTION

Nowadays the extreme weather changes have affected the disaster significantly. Flood is one of the disasters that often occur due to extreme weather. The main cause of flooding is not only influenced by the weather but also the human activities that damage the forest. To avoid more victims, it is needed to anticipate the upcoming flood. The use of flood early warning system is one way to anticipate the upcoming flood. The Government has encouraged institutions and the private sector to develop telemetry instruments for providing disaster early warning information [1].

Several studies have been conducted in the research and development of early warning systems based on mobile communication and information-based technologies. It is known that communication technologies involving mobile devices and machines are growing rapidly in the industrial and global world [2]. Previous research has been built using mobile communication-based technologies such as flood monitoring systems and SMS-based early warning [3] [4] [5].

The result of the studies are data of flood height which is sent by using SMS collaborate with Arduino Uno and GSM module which ended with alarm on flood information system station. In addition to flood warning systems, Landslide warning systems have been built based on Arduino microcontrollers and GSM modules [6]. Generally the research produced an efficient way to inform an early warning message so that it does not require human presence to inform that a landslide is imminent.

Presently, the development of early warning information systems has led to Internet of Things (IoTs) technology for disaster risk management and environmental effects [7]. the application of the internet of things (IoT) has been widely built for disaster monitoring such as fire disaster monitoring [8]. The use of internet-based technology has done some previous research such as the use of Google Maps as internet-based location information and research design of vehicle tracking system in real-time based Google Maps and Arduino Uno [9]. In this study the system sends the coordinate data of the vehicle through the GSM module to the user in the form of location based on Google Maps displayed through Browser.

Based on previous research, it is needed to design an Internet-Based flood early warning system (IoTs) that displays flood height information along with the location of flooding in real-time. The study was built using ultrasonic sensors as a water level detector and U-Blox GPS module as a detector of flood coordinate location. Both water level data and location coordinates are processed by Arduino and sent via GSM SIM900 module in SMS to the flood information station. The information is displayed as a map with the data of flood height through the browser.

2. MATERIAL AND METHODS

In this research, the design of the system uses Arduino Uno as data processor. Arduino Uno as shown in Figure 1 is a processing board using an 8-bit Atmega328 Microcontroller as the main chip. Arduino Uno operates with a voltage of 5 Volts. Arduino provides 14 digital pins, 6 analog pins, 32 kB flash memory, 2 kB SRAM, 1 kB EEPROM, 16 MHz clock speed and a USB connection [10].

Fig-1: Arduino Uno

GSM sim900 module is a module that provides the intermediary microcontroller in the process of sending SMS. The SIM900 GSM module as shown in Figure 2. is a GSM / GPRS Quad-band GSM/GPRS which uses single chip processor LPC2148. The features within GSM SIM900 are capable of sending SMS and voice data.

Fig- 2: GSM SIM900 Module

The GPS U-Blox 6m module as shown in Figure 3 is a kind of stand-alone GPS receivers that feature high performance as a positioning machine [10]. With optimized architecture, power, and memory this module is perfect for devices that use the battery as a resource with limited cost and space making it very suitable to use on CanSat. By having 50 channels of positioning engines, it can accelerate Time-To-First-Fix (TTFF) for less than 1 second.

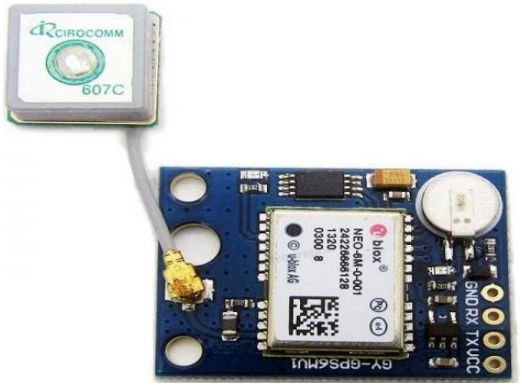

Fig- 3: GPS U-Blox Neo 6M Module

The HC-SR04 sensor is used in designing this prototype which is useful as a water level gauge. The HC-SR04 sensor as shown in Figure 4 detects the object's distance by emitting ultrasonic waves (40 KHz) during t = min 10 µs and then detect the reflection. The HC-SR04 sensor emits ultrasonic waves according to the control of the microcontroller (trigger pulse with t_{out} min 10 µs). The limit of sensor measurement is 2cm - 400cm, trigger-positive input TTL pulse, 10µS, Echo hold off 50 uS from fall of trigger pulse and Delay before next measurement 60 mS [11].

Fig- 4: Ultrasonic Sensor HC-SR04

The design of the prototype system is done in two stages: integrated module construction stage and programming. Generally, the construction of integrated component or module is designed using the block diagram method as shown in Figure 5 and it can be explained that the design of the system begins with an ultrasonic sensor and the GPS module sends water level data and coordinates of flood location to Arduino Uno as data processor. Both data are sent in the form of SMS data to the information system station received by the modem. Data is received by computer and processor to be a water level information system based on Google Maps.

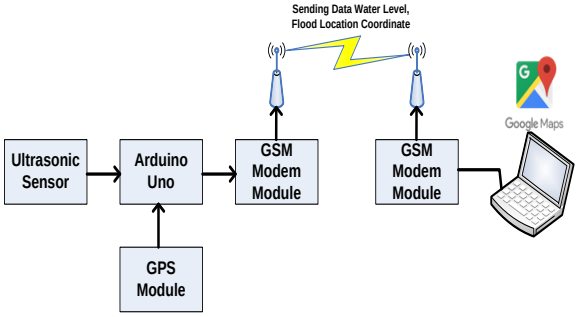

Fig- 5: Block Diagram of Prototype System

Whereas the prototype construction of water level detection as seen in Figure 6 is a construction which is constructed by using a paralon pipe with a float plate as an object of water level. Ultrasonic sensor is placed on the top of the pipe that emits signals from the trigger components and it will be reflected to the ultrasonic sensor which is captured by the echo component. Signals are processed by the system to be water level data.

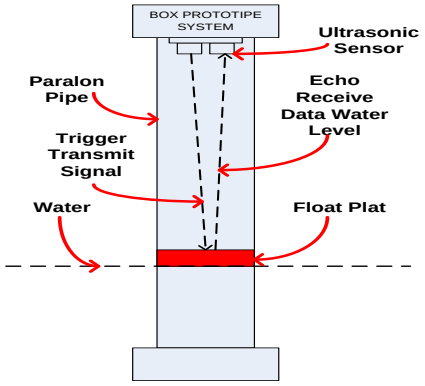

Fig- 6: Prototype Construction of Water Height Detection

3. RESULT AND DISCUSSION

The design of a prototype system generates a flooded information system based on Google Maps with information of water level data and flood location coordinates. The prototype system circuit has been construct successfully as shown in Figure 7. The prototype system consists of ultrasonic sensors, U-Blox Neo 6m GPS module, Arduino Uno and GSM module.

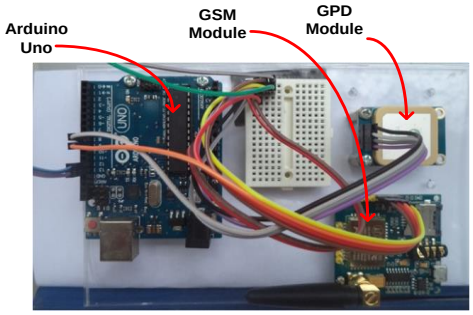

Fig- 7: Prototype System Circuit

The water level data is obtained from the water level detection devices that have been constructed using paralon pipes as shown in Figure 8.

Fig- 8: The Construction of Water Level Detection Device

The water level data and location coordinates from the U-Blox Neo 6m GPS module are delivered to the information system station and then received by the Wavecom USB Fast Track modem as shown in Figure 9.

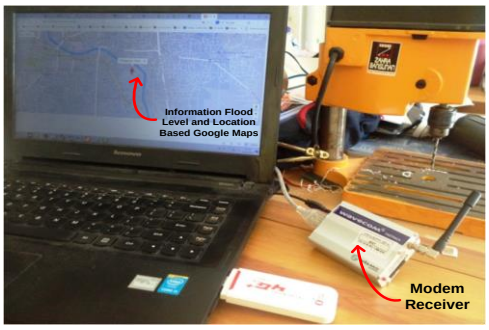

Fig- 9: Information System Station based GSM Modem

The data that has been processed by the flood location information system generates flood altitude information and location based on Google Maps as seen in Figure 10. The flood information system is programmed using PHP and DBMS MySQL with integrated Google Maps API on the program structure.

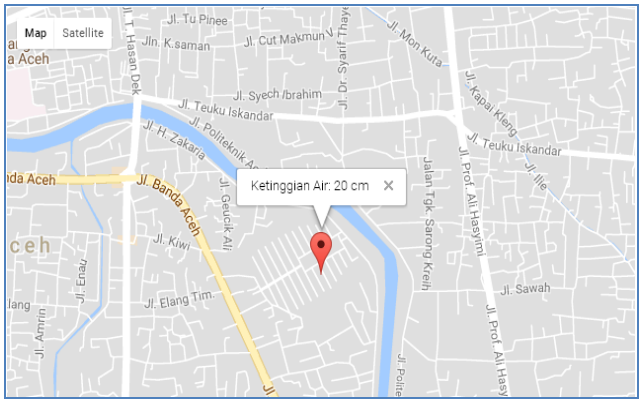

Fig- 10: Information of Water Level and Flood Location based on Google Maps

4. CONCLUSIONS

Based on the results, the flooded information system based on Google Maps has been done as expected. Using ultrasonic sensors, Arduino Uno, the U-blox neo 6m GPS module and SIM900 GSM module have been able to transmit water level data and the coordinates of flood location to the information system station. The flood information system station receives data through the receiver's GSM modem of data processor and displays the water level information and flood locations in the form of a marker label on Google Maps. This prototype is expected to give the information about water level and flood location.

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BIOGRAPHIES

Dedi Satria is a lecture in Department of Informatic Engineering form Universitas Serambi Mekkah, Banda Aceh. He received his B.Sc in Instrumentation Physics form Universitas Syiah Kuala dan M.Sc in Electric Electronic and System From Nasional University of Malaysia. He has experience in the teaching field and also in research. His research interests include embedded systems, internet of things, multimedia and information system.

Syaifuddin Yana is a lecture in Department of Industrial Engineering form Universitas Serambi Mekkah, Banda Aceh. He received his B.Eng in Industrial Engineering form ITENAS dan M.Sc in Manajemen From Universitas Syiah Kuala. He has experience in the teaching field and also in research. His research interests include supply chain management, management information system and knowledge management.

Rizal Munadi is Lecture in Department of Electrical Engineering form Universitas Syiah Kuala, Banda Aceh. He received his B.Eng in Electrical Engineering form Institut Teknologi Sepuluh Nopember Surabaya, M.Eng From Universitas Indonesia and PhD in Electric Electronic and System From Nasional University of Malaysia . He has experience in the teaching field and also in research. His research interests include Wireless and Mobile Communication, Antenna and Propagation, Wireless Security and Web Technology.

Saumi Syahreza is a lecture in Department of Physics form Universitas Syiah Kuala, Banda Aceh. He received his B.Sc in Physics form Universitas Syiah Kuala, M.Sc in Instrumentation Physics From Institut Teknologi Bandung and and PhD in Remote Sensing From Universiti Sains Malaysia. He has experience in the teaching field and also in research. His research interests include Electronic, Radar Remote Sensing and Environmental Monitoring.