Flood Monitoring and Early Warning System using Ultrasonic Sensor

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Abstract

The purpose of this study is to develop a real-time flood monitoring and early warning system for the northern portion of the province of Isabela, particularly the municipalities near Cagayan River. This study focuses only on the water level detection and early warning system (via website and/or SMS) that alerts concern agencies and individuals for a potential flood event. Furthermore, inquiry system is also included in this study to become more interactive wherein individuals in the community could inquire the actual water level and status of the desired area or location affected by flood thru SMS keyword. The study aims in helping citizens to be prepared and knowledgeable whenever there is a flood. Ultrasonic sensing techniques have become mature and are widely used in the various fields of engineering and basic science. One of advantage of ultrasonic sensing is its outstanding capability to probe inside objective non-destructively because ultrasound can propagate through any kinds of media including solids, liquids and gases. The novelty of this work falls under the utilization of the Arduino, ultrasonic sensors, GSM module, web-monitoring and SMS early warning system in helping stakeholders to mitigate casualties related to flood. The paper envisions helping flood-prone areas which are common in the Philippines particularly in the local communities of the province. Indeed, it is relevant and important as per needs for safety and welfare of the community.

Keywords: Flood Monitoring, Ultrasonic Sensor, Early Warning System, SMS, Real-time Monitoring

1. INTRODUCTION

In most countries in the world, flood had caused damages to properties and it involved a large amount of loss to individuals and governments. During flood, it is important to have efficient flood response operation system to manage all activities among different related agencies.

These last decades, lots of flooding risk technologies has been developed to minimize the danger of flood in inhabited areas. Currently, the Philippine government funded the Project NOAH of the Department of Science and Technology (DOST). They installed automated rain gauges (ARG) and water level monitoring stations (WLMS) along the country's major river basins (RBs) [1]. However, project NOAH is still under development in which some essential information are not yet available to view in their website.

Most of these technologies being developed commonly apply in weather forecasting, flood detection and monitoring system using sensing devices, modeling software, Internet and mobile technology [2]. However, these systems are usually for one-way communication only. In order to get an update or latest information, local communities need to access the website. And in accessing this website, it requires computer or smart phone that has an Internet feature, and most individual could hardly afford to purchase one. In addition to that, individuals are busy for their daily routine, and monitoring activity cannot be their priority [1]. These are the reasons why communities are blinded with the current status of the nearby river watershed. The unawareness led to the overflow of the watercourses of the river waterway and the subsequent inundation of various localities causing extensive damages to properties and human life.

The City of Ilagan is located in the central portion of the province of Isabela. It is the River Basin of its neighboring towns particularly in the southern portion of the province. Floods caused by these rivers flow down very slowly because of surface retention over the extensive flood plain, extremely gentle slope, retardation of flood by several gorges and river meander [3].

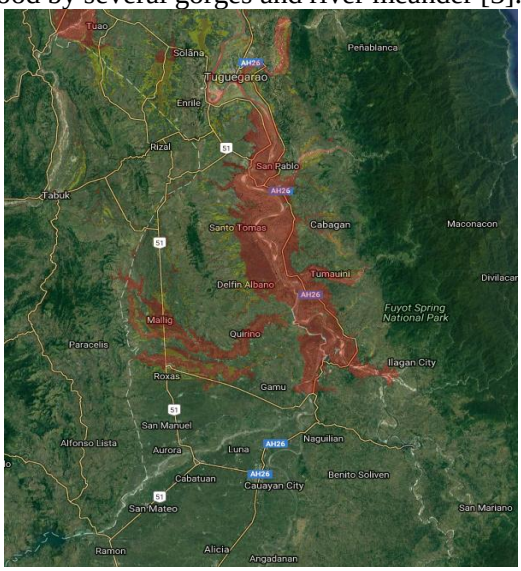


Figure 1. Geographical Map of Ilagan, Isabela

This paper present a project that is more localize to help the communities affected by flood in the province of Isabela particularly in the northern area by providing an interactive and real-time information on the current water level in the two major portion of the province. This project also widen the coverage of people that can receive the information to improve the emergency measures during floods.

1.2 Conceptual Framework

This project builds a prototype that detect the current water level across the watershed of Cagayan River and its surrounding areas through ultrasonic sensors. The geographical area was sub-divided into two, where monitoring devices were installed. Each device signifies a warning level. Once a sensor is triggered, an output signal will be relayed to a microcontroller which serves as a switch that triggers the connected GSM module to send an alert message to another GSM modem connected to the computer server. Then, the developed program installed in the computer server will automatically send a text message to the concern agencies' numbers stored in the database. Also, the developed program will then automatically relay the alert message by uploading a warning post on a website. Furthermore, concern agencies, local officials and the communities could inquire about the current status by sending a message thru keywords.

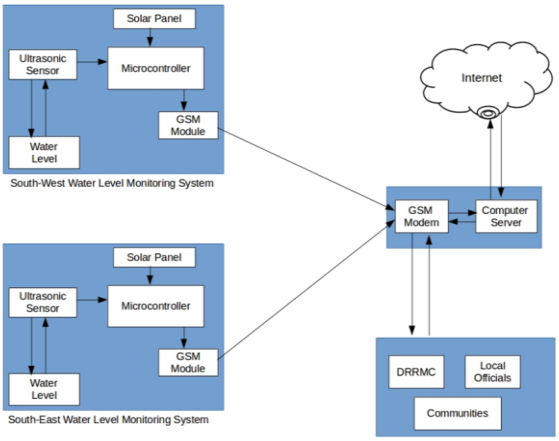


Figure 2. System Architecture

1.3 Objective of the Study

This project builds a prototype that detect the current water level across the watershed of Cagayan River and its surrounding areas through ultrasonic sensors. The geographical area was sub-divided into two, where monitoring devices were installed. Each device signifies a warning level. Once a sensor is triggered, an output signal will be relayed

• Created a flood monitoring system that monitors the water level of the rivers using ultrasonic sensor.

• Designed and developed an early warning system using SMS to warn the flooded barangays.

2. MATERIALS AND METHODS

2.1 Methodology

The study "Flood Monitoring and Early Warning System using Ultrasonic Sensor" is developed to build a water level detection using ultrasonic sensor to be used in monitoring the rivers in the south-east and south-west portion in the province of Isabela and develop a web and SMS application as an early warning system that provides essential information to the local communities. An SMS communication approach was implemented for the early warning system where in concern individuals and agencies can receive SMS notification. When the development of the prototype was finished, the model had undergone several tests and experimentations to check the effectiveness of the system.

2.2 Hardware Components

2.2.1 Ultrasonic Sensor

Ultrasonic sensors measure level and distance through air using ultrasonic sound waves, often replacing unreliable mechanical devices.

2.2.2 Arduino Microcontroller

Arduino Microcontroller is an open-source electronics platform based on easy-to-use hardware and software.

2.2.3 GSM Module

GSM module (Global System for Mobile communication) is used to establish communication between a computer and a GSM system. It consists of a GSM modem assembled together with power supply and communication interfaces for microcontroller or computer.

2.2.4 Solar Panel

Solar panels are active solar devices that convert sunlight into electricity. They come in a variety of rectangular shapes and are usually installed in combination to produce electricity.

2.2.5 Charge/Battery Regulator

A charge regulator or battery regulator limits the rate at which electric current is added to or drawn from electric batteries. It prevents overcharging and may protect

against over voltage, which can reduce battery performance or lifespan, and may pose a safety risk.

2.2.6 Rechargeable Battery

The battery is responsible for storing the conventional power or current accumulated by the solar panel.

3. RESULTS AND DISCUSSION

3.1 Flood monitoring system that monitors the water level of the rivers using ultrasonic sensor

The researchers played out a model test the ease of use and dependability of the developed prototype. It was tried first in a prototype environment that the researchers made and played out the trial. The test decided whether it meets the necessities of the client. Figure below shows the connection of the ultrasonic sensor and the Arduino Mega, GSM Module and the buzzer.

The first statement of objective of the developed project was achieved using a prototype using the Ultrasonic Proximity Sensor shown in the figure below. It is a hardware that uses ultrasonic sound waves to detect at a specified distance. With its range of up to 13 ft., it provided us the needed distance of 9ft., needed to identify the level of the flood and give more for the allocation of the developed project to avoid it being destroyed. It is also designed to handle the distance of liquid in an environment.

Figure 3. Connection of the Ultrasonic Sensor

Figure 3 shows the created prototype in a secured box. In the upper deck, the controller is set. In the middle deck lie the battery and the adapter. A charge regulator or battery regulator limits the rate at which electric current is added to or drawn from electric batteries. It prevents overcharging and may protect against overvoltage, which can reduce battery performance or lifespan, and may pose a safety risk. It regulates the voltage and current coming from the solar panels going to the battery. And in the lowest deck lies the Arduino Mega topped by the GSM Module and the Ultrasonic sensor.

Figure 4 shows the solar panel that serves as the power supply of the hardware components. Solar panels are active solar devices that convert sunlight into electricity. The primary component of a solar panel is the solar cells, or photovoltaic cell.

Figure 4. Solar Panel

3.2 Sensor Testing

The researchers tested the sensor through a prototype basin to test the level of water. The inputs have several sub-parameters to obtain accurate data. The input has three options to consider. In water level, there are the Emergency, Alert, and, Light states. The output, Flood Alert Level, has the categories as Evacuation, Warning, and Preparation.

3.3 Designed and developed an early warning system using SMS to warn the flooded barangays.

The second objective was accomplished utilizing Arduino Mega and the GSM Module. The Arduino Mega was in charge of commanding and analyzing the information gathered by the sensor as per the codes transferred in it. And after analyzing the data the Arduino then requests the GSM module to send a message on the enlisted telephone numbers in the database.

The developed project has a two way communication in disseminating information to the citizens of the possible flooded barangay. One would be the real-time monitoring through a web-based system wherein in it monitors of the activities of the deployed hardware in the sites. Another one is the SMS notification where in an automatic communication between the system and the citizens with the barangay officials and the disaster council of Ilagan, Isabela.

The web-based module of the developed system has the capability to monitor, detect, and administer the users of the system. The administrator has the capability to monitor the activities of the hardware in-site and to have the decision making through fuzzy logic to administer the early warning for the citizens, disaster councils and the barangay officials.

In the figure below, when the LED lit the map in the website shows the level of the flood, the exact time of the rise of the water, and which hardware detected it. Also after the map indicates the status of the flood, the GSM module then sends an SMS alert saying the status of the water level to the registered mobile phone numbers.

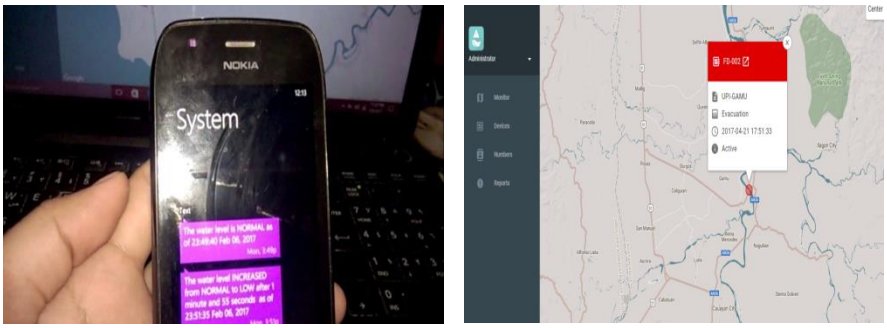


Figure 8. SMS Alert and Web-based Interface

If in case the water level will decreased from a certain stage, in order for the citizens not to panic, also an SMS was disseminated to the citizens declaring that the water level decreased.

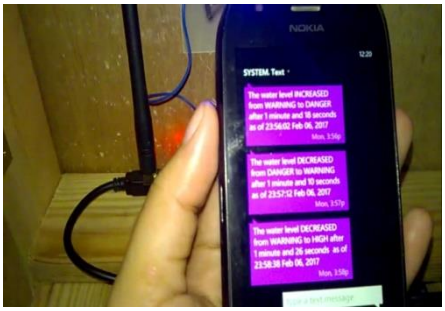
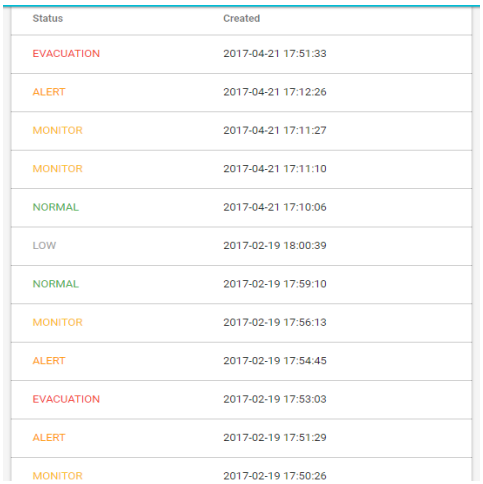


Figure 9. SMS if the water decreased

Sample table shows the response of the hardware to the real-time monitoring system. That if the ultrasonic sensor detect that the water level increases above the normal level an SMS notification will be send same as through on the real time monitoring. Real-time date and time is also reported on the web-based monitoring.



Status	Created
EVACUATION	2017-04-21 17:51:33
ALERT	2017-04-21 17:12:26
MONITOR	2017-04-21 17:11:27
MONITOR	2017-04-21 17:11:10
NORMAL	2017-04-21 17:10:06
LOW	2017-02-19 18:00:39
NORMAL	2017-02-19 17:59:10
MONITOR	2017-02-19 17:56:13
ALERT	2017-02-19 17:54:45
EVACUATION	2017-02-19 17:53:03
ALERT	2017-02-19 17:51:29
MONITOR	2017-02-19 17:50:26

Figure 10. Sample Table

4. CONCLUSION

The project contributes towards economy and the citizens. It envisions a safe, prepared and less casualty community before, during and after typhoon devastation. The model also promotes the use of real time monitoring system and SMS notification as an easy medium in programming field and enhances the awareness of people about the system. The use of categories under given parameters gives a more accurate and precise output about the situation.

The developed system automatically sends data from the hardware on the site into the real time monitoring system and the SMS notification. Therefore the developed system as an accurate data in sending data from the devices.

5. ACKNOWLEDGMENTS

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6. REFERENCES

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