FLOOD DETECTOR SYSTEM USING ARDUINO

[1]EDWIN DE GUZMAN, [2]VALERIE SHANE CUADRA, [3]AILEEN GRACE DE LUNA, [4]CHRISTIAN VILLANUEVA

[1,2,3,4]Roy Allan Santos, Ryan Richard Guadaña, Our Lady of Fatima University
E-mail: [1]dwin_deguzman@yahoo.com

Abstract— Flood is an unavoidable natural disaster in Metro Manila, Philippines, causing heavy flow of traffic and can also cause severe damage to properties and lives. For this reason, researchers created a flood detection system to monitor rising water in residential areas. Using ultrasonic sensor, researchers created flood level sensing device which is attached to Arduino Yun to process the sensor's analog signal into a usable digital value of distance. The user can get real-time information on monitoring flooded roads over the livestream plus SMS based service. Flood height is determined by subtracting the sensor's height with respect to the floor minus the sensed distance between the sensor and the flood water. Updates on the height of the water level will be texted to the rescue team (Local Government Unit) and to the residents of Barangay Marulas, Valenzuela City, Philippines and can the locals can also view level of the flood in the interface of the system. The level of the flood will be divided into four. The flood sensor and microcontroller will be powered by a solar power bank with 80,000 Ampere-Hour (mAh) for the benefit of continuous operation of water flood height detection and network data transmission. The Arduino Flood Detector System is developed to be one of the fastest method to monitor flood that will help motorists or road user to avoid problem when flood occurred.

Index Terms— Arduino, Detector, Flood, Sensor.

I. INTRODUCTION

Flood occurs when water overflows from the river, lake or from heavy rainfall and it can happen at any time of the year. Flooding can be very dangerous, when floods happen in an area that people live, the water carries along objects like houses, cars, furniture and even people. It can wipe away property, trees and many more heavy items.

For years, flooded roads have been a problem in Metro Manila. It causes heavy flow of traffic. Both motorists and commuters ARE getting stuck in a flooded areas and getting lost in finding possible routes just to go to their destinations. When traffic happened, people's money, time and effort are wasted. Through the local government unit flood control has been extending their efforts to inform the commuters regarding the situation in flooded areas during rainy season, still the dissemination of information to the locals are not enough. For this reason, the "Arduino Flood Detector System" is been develop, to help the road user to avoid this problem happened. It was invented based on problem faced by motorists and commuters when flood occurred. This will avoid the traffic jam because the users have a time to find a possible routes before they are going to be stuck at the flood area.

The system will function when the admin activate the system and when water along the road detected by distance over ultrasonic sensor. When the flood occur, the ultrasonic sensor will sent signal to the microprocessor circuit and the sense water level will be display in the user interface and it will automatically send a Short Message Service (SMS) to those recognized residents and it will continue update until the water level detected returns to normal. The process repeats as the water level continuous to rise. The idea of an SMS based warning system was proposed because mobile phones have become a popular communication device among people all over the world. All mobile phone are able to communicate because it comprises of a GSM.

This system used to detect the current water level of flood around the road and will give real-time information to the motorists or commuters that has still not passing through the flooded areas to avoid problem.

II. OBJECTIVE OF THE STUDY

The main objective of this project is to develop and design a flood detection system that will detect flood automatically and send data to the Local Government Unit and to residents using an Arduino.

Specific Objectives

- To design a circuit and create a programming code using the microcontroller.
- To apply the Serial Communication in transmitting the data from one place to another place.
- To detect the current level of the flood where the system sensor will be divided into four levels.
- To warn residents of Barangay Marulas, Valenzuela City about the flood water level.

III. SIGNIFICANCE OF THE STUDY

This study may prove to be useful to the following groups of individuals.

Commuters. With the SMS advisory service, notifications on impassable flooded road will be available. Thus, commuters can avoid getting stuck along the way. It will help the commuters to save money, time, and effort.

Local Government. Upon achieving the actual output of this innovation, it would be easier for the officer in charge in flood to monitor and disseminate information to the locals. Officials could also provide other information or preventive measures to take during the rainy season.

IV. SCOPE OF THE STUDY

This study is conducted to solve the problems brought about by floods. The device shall contain with the following features: It has ultrasonic sensor to sense the distance of water level of flood on the road. The system provided a camera that will display the real-time image of the flood that can view via livestream. It includes Serial Communication to send warning text message with the content of date, time, water level and road accessibility. The system has three (3) modules which are Users, Logs, and Contact Numbers. It can be modify by the admin. The unit containing the sensor is suggested to be place infront of Our Lady of Fatima University, Marulas, Valenzuela City. The position of the sensor must be placed perpendicular to the flood water; otherwise, there will be an imperfect reflection of ultrasonic waves and cause measurement errors. The sensor is suggested to be placed on a pole with a height of about 3 to 3.5 meters. The flood sensors and microcontrollers will be powered by a Solar Power Bank with 80, 000 Ampere Ampere-Hour (mAh) for the benefit of continuous operation of water flood height detection and network data transmission.

V. RELATED SYSTEM

A. PagAsa Alert System – Philippines

Philippines' economy is losing too much because of Metro Manila traffic. The loss is estimated at 2.4 billion pesos everyday according to President Benigno Aquino III in his 2013 State of the Nation Address. And in the recent typhoon Maring that hits the country, the damage is pegged at 67 million pesos (ph.news.yahoo.com, 2013). Because of these tremendous loses, the government increased the allocated budget for weather forecasting.

With PAGASA's new equipment, (wind profiler, Doppler radar, and supercomputer), weather forecasting has been more accurate than before. It now has Rainfall Warning System and the codes are easier to disseminate and understand (Castillo, 2013). All of these are part of DOST's Project NOAH as a response to the call of President Benigno S. Aquino III for more accurate, integrated, and responsive disaster prevention and mitigation system. Real-time weather forecasting is now accessible through this project. Officials can now quickly announce school and work suspension because of these information from PAGASA.

Also, DOST had accomplished 26% completion rate on June 2012 of their deployment of 50 water level flood monitoring stations inside and out of Metro Manila that monitors flood height levels on Marikina-Pasig River for their EFCOS Restoration and Rehabilitation Initiative. The water level monitoring apparatus of the project are equipped of solar panel, ultrasonic sensor, GSM, EFCOS Rain Gauge, Data Logger, Server, and web visualizations (geographical via Google Maps, graphical, and tabular views). This project has the following features: water level sensor, real-time data collection (10-minute data collection via cellular network through SMS or text messaging and Central Server/Back-up System), flood forecasting model and online data visualization for decision support. This project was able to develop a system which make use of the ultrasonic sensor device to accurately measure and determine the rate of change of flood water level using the principle same to radar and sonar through calculating the time interval between sending the signal and receiving the echo of the signal.

B. MMDA Flood Control Information Center

While the government has yet to come up with a long-term plan to prevent flooding in the Philippines, the Metropolitan Manila Development Authority (MMDA) has launched the **Flood Control Information Center** (FCIC) to help the agency monitor flood-prone areas in the metropolis. The MMDA-FCIC, which was launched on August 3, will serve as a "nerve center" for flood-control and disaster-related operations in Metro Manila.

"It's a decision support system especially for emergencies," said MMDA-FCIC head Ramon Santiago. "It collects all information regarding floods and operating systems, especially our pumping stations. We'll be able to draw in information from PAG-ASA (Philippine Atmospheric, Geophysical and Astronomical Services Administration) and information in critical areas so we can plot incidents and what is the response that we have done, and what further measures we need to do."

Monitoring will be done via more than 70 closed-circuit television cameras placed on key Metro Manila intersections, flood-prone areas and pumping stations. Images will be displayed at the MMDA-FCIC, which is equipped with 16 LCD monitors. Aside from the PAG-ASA, the MMDA-FCIC will also be connected with other international satellite-based weather monitoring services. With an incident management and map navigation software, the MMDA will collate information on flood and other disaster-related incidents. The center also has a floor map of Metro Manila and outlying waterways that will help trace communities that would be affected when water systems overflow.

VI. CONCEPTUAL FRAMEWORK

The procedure, by which the system developed, consists of defined procedures such as requirements,

design and architecture, development and coding, quality assurance and software testing, implementation and maintenance and support. The output was referred to this research, Flood Detector System using Arduino.

This represented the steps in the progress of the developed system. The study characterized the developed system and sited the possible difficulties which they encountered in the development of the study. Working plan sensibly followed and lead to the development of the system. Multiple testing and further evaluations was accomplished and determined the specified objectives that are being satisfied by the system and doing necessary alterations if needed arises.

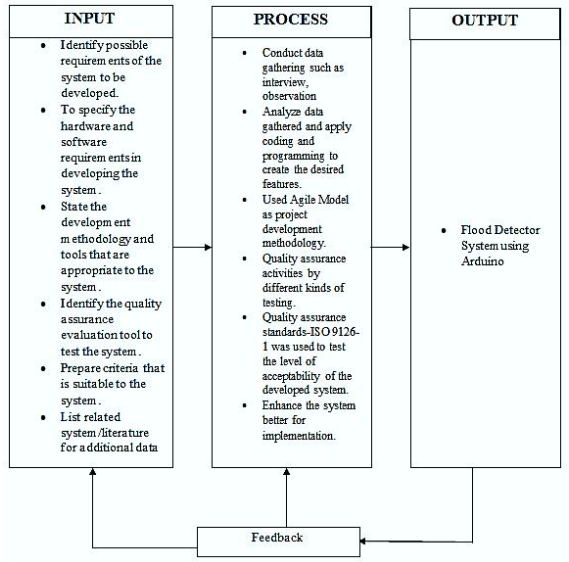

Figure 1: Conceptual Framework of the develop system

VII. METHODOLOGY

Agile Development Model generally promotes discipline in software development process where Agile Manifesto was introduced. Agile development is a phrase used in software development to describe methodologies for incremental software development.

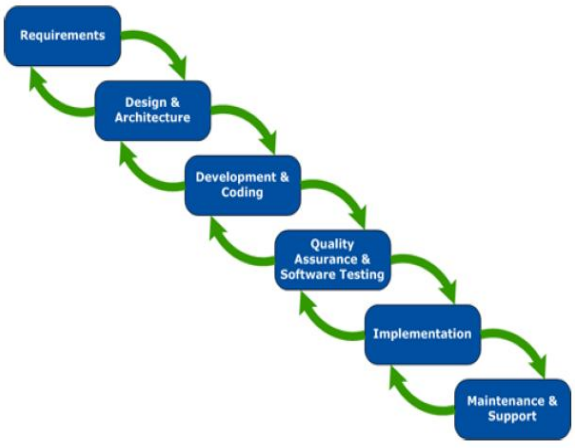

Figure 2. Agile Development Model

Agile development is an alternative to traditional project management where emphasis is placed on empowering people to collaborate and make team decisions in addition to continuous planning, continuous testing and continuous integration.

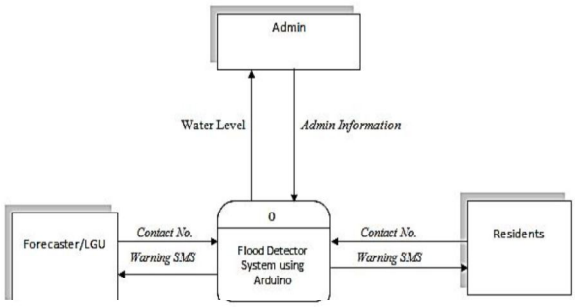

Figure 3: Context Diagram Level 0 of the developed system

This figure 3 illustrates that the Forecaster or LGU, residents will provide a contact number; so that the system will send a warning message about the water level of the flood. The admin will give personal information so that the admin can access the system and see the water level of the flood.

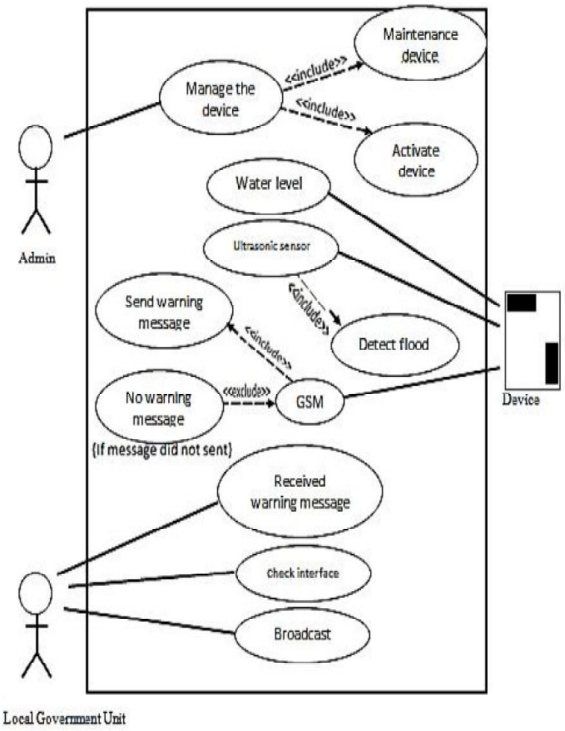

Figure 4: Use Case Diagram of the developed system

When the device is now activated, it can now detect the water level; and when the flood is being detected, Serial Communication can send warning messages to the Local Government Unit and will check the interface and disseminate it to the community. When the developed system did not detect the water level, the Local Government can still check the interface and disseminate it to the community if there are any signs of flood.

VIII. PRESENTATION OF DATA

Design Criteria	Mean	Description Rating
Functionality		
1. Suitability	4.71	Highly Acceptable
2. Accuracy	4.71	Highly Acceptable
3. Interoperability	4.43	Acceptable
4. Compliance	4.71	Highly Acceptable
5. Security	4.43	Acceptable
Reliability		
1. Fault tolerance	4.14	Acceptable
2. Recoverability	4.29	Acceptable
Usability		
1. Understandability	4.71	Highly Acceptable
2. Learnability	4.71	Highly Acceptable
3. Operability	4.86	Highly Acceptable
Efficiency		
1. Time behavior	4.43	Acceptable
2. Resource behavior	4.43	Acceptable
Maintainability		
1. Analyzability	4.43	Acceptable
2. Changeability	4.71	Highly Acceptable
3. Stability	4.71	Highly Acceptable
4. Testability	4.57	Highly Acceptable
Portability		
1. Adaptability	4.43	Acceptable
2. Installability	4.71	Highly Acceptable
3. Conformance	4.71	Highly Acceptable
Over All Mean	4.55	Highly Acceptable

Table 1.0 shows the Overall mean Functionality, Reliability, Usability, Efficiency, Maintainability, Portability is 4.55 which means the system is Highly Acceptable.

IX. STATISTICAL TREATMENT OF DATA

Statistical treatment of data is essential in order to make use of the data in the right form. Raw data collection is only one aspect of any experiment; the organization of data is equally important so that appropriate conclusions can be drawn. This is what statistical treatment of data is all about.

1. **Percentage**. The statistical treatment of data used to determine the percentage of acquiring the most common criteria was the percentage formula, as shown below.

$$P = \frac{F}{N} x\ 100$$

Where P = Percentage, F = Frequency and N = number of respondents.

2. Mean. The mean (or average) of a set data values is the sum of all of the data values divided by the number of data values. That is:

$$\square = \frac{\square}{N} x$$

Where $\square$ = Mean, x – raw score and n = total number of respondents.

3. **Weighted Mean**. The statistical treatment of data used to determine the percentage of acquiring the most chosen criteria was weighted mean formula, as shown below.

$$WM = \frac{\square}{N} fx$$

Where WM = Weighted Mean, f = frequency of score, x = raw score and n = total number of respondents.

4. **Five-Point Likert Scale.** It is the most widely used approach to scaling respondents in survey research, such that the term is often used interchangeably with rating scale, or more accurately the Likert-type scale, even though the two are not synonymous.

Table 2.0 shows the Five-Point Likert Scale used for evaluation

Score	Corresponding Remark
4.50 – 5.00	Highly Acceptable
3.50 – 4.49	Acceptable
2.50 – 3.49	Fair
1.50 – 2.49	Unacceptable
1.00 – 1.49	Poorly acceptable

X. COMPONENTS OF THE DEVELOPED SYSTEM

This project is composed of two following parts: hardware and software. Hardware part is composed of Arduino Yun, LED for status indicator, ultrasonic sensor, solar power bank, and camera. On the other hand, the software part is consisting of user interface for data interpretation and presentation.

1. ***Arduino Yun.*** Is a microcontroller board based on the ATmega32u4 and the Atheros AR9331. The Atheros processor supports a Linux distribution based on OpenWrt named OpenWrt-Yun. The board has built-in Ethernet and WiFi support, a USB-A port, micro-SD card slot, 20 digital input/output pins (of which 7 can be used as PWM outputs and 12 as analog inputs), a 16 MHz crystal oscillator, a micro USB connection, an ICSP header, and a 3 reset buttons.
2. ***LED.*** Is a two-lead semiconductor light source. It is a p–n junction diode, which emits light when activated.
3. **Ultrasonic Sensor**. It provides an easy method of distance measurement. A single I/O pin is used to trigger an ultrasonic burst and then

"listen" for the echo return pulse. The sensor measures the time required for the echo return, and returns this value to the microcontroller as a variable-width pulse via the same I/O pin.

4. ***Solar Power Bank.*** Itemploys solar energy to provide electricity to devices or charge batteries. It can charge lead acid or Ni-Cd battery banks up to 48 V and hundreds of ampere-hours (up to 4000 Ah) capacity.
5. ***Camera.*** It feeds or streams the image in real time to or through a computer to computer network

XI. PROJECT EVALUATION

The system was tested and evaluated based on the criteria functionality, reliability, usability, efficiency, maintainability, and portability to decide the IT Experts acceptance. The researchers did a demonstration of the system in order for the respondents to know the functions of the system and how to manipulate it. The system was tested and evaluated in Nestle Business Services located at Meycauayan, Bulacan, in Action Center located at Dalandanan, Valenzuela City. Questionnaires were distributed to four (4) respondents from NBS, one (1) respondent from Officer in Charge - Flood Control, two (2) respondents from Accenture, and one (1) respondent from ClariTrade. The acceptability of the software was determined after computing the evaluation of the result of IT expert's evaluation.

SUMMARY, CONCLUSION AND RECOMMENDATION

SUMMARY

The objectives have been formulated as the working basis on completion of the study. The general objective of the researchers was attained which the developed system is entitled "Flood Detector System using Arduino" which will gradually help commuters to avoid getting stuck along the way. It will help the commuters to save money, time, and effort. The Flood Detector System using Arduino was developed to be one of the fastest methods to check and monitor the flood.

CONCLUSION

The study is all about detecting the level of the flood. Based from the existing way of reporting flooded roads in Brgy. Marulas,researchers have concluded that the Flood Detector System using Arduino can measure the height of the flood; and measurement data can be distributed to officer in charge and to the residents.The system also indicate passable and impassable road that will help commuters to avoid getting stuck in an impassable road. The system also provides camera to easily monitor the flood.

RECOMMENDATION

Based on the results of the findings and conclusion gathered, the researchers would like to recommend that the Local Government Unit Flood Control consider the study "Flood Detector System using Arduino" a necessary medium of information about the flood. The researchers would like to recommend to use Wireless Fidelity(WIFI) repeater 5km long coverage outdoor waterproof antenna CPE COMFAST CF-E214N wireless poecpeacess point for the video feed from OLFU to LGU. The researchers would also like to have a web based that is available to the residents which contain about the level of the flood. It is also recommend that the developed system will cater the whole Valenzuela. And also, for the future researchers, the researchers recommend to continue or gradually improveand enhance the project.

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