International Journal of Multidisciplinary Research and Publications
ISSN (Online): 2581-6187

Isabela City Flood Monitoring System Using Arduino and GSM Module

Claire O. Carpio[1], Muhsin U. Asnaul[2], Abeir H. Said[3], Binladen Y. Amerin[4]
[1, 2, 3, 4]CICTT, Basilan State College, Sumagdang, Isabela City, Basilan, Philippines, 7300
Email address: clairecarpio0114@gmail.com

***Abstract*—** *Flood is considered as a calamity which poses serious problems on most communities of the world. This surfaces the need for reinventing the disaster risk management schemes of governments, giving special points to telemetry instruments for providing early warning information to the public. Relevant studies in the past discussed the concepts of flood monitoring and warning systems with certain specifications. This study points to the concept of flood warning signs as key to saving more communities from the devastations that floods and other calamities. Agile development was used to describe the methodologies for incremental software development. Quantitative-survey design was administered to evaluate the device in terms of its functionality, reliability, usability, efficiency, maintainability and portability. Salient findings of the study as supported by the initial ground test conducted have shown how the Flood-Monitoring System provides effective and accurate warning signals given the condition*

***Keywords*—** *Flood Monitoring; Calamity; Warning Signs.*

I. INTRODUCTION

Amidst the continuously shifting climate conditions brought about by various ecological factors, the range of calamities for years have risen to certain extents which resulted to high casualties and property loss among citizens. More so often, these calamities were rooted from devastations caused by environmentally destructive human activities. Flood is but among the calamities which poses serious problems on most communities of the world. This surfaces the need for reinventing the disaster risk management schemes of governments, giving special points to telemetry instruments for providing early warning information to the public.

Most of the damages caused by natural disasters might have been prevented if communities were given early warnings on the approaching calamity. Readiness would have saved hundreds of lives and thousands of properties alike. This stirred governments and other institutions to develop instruments that would provide early warning information on the calamity strike.

There were many studies in the past which discussed the concepts of flood monitoring and warning systems within the specifications provided therein. Short Message Service (SMS) is commonly used to deliver warning information to concerned citizens. In a relevant study, online database was integrated to the commonly used SMS-based flood monitoring scheme. This study has used the water level monitoring reed relays and Zigbee module for data transmission. This allows convenience for people to check the flood water level of their area. On a separate study, the use of barometric pressure sensor to detect flood water level was highlighted. An SMS will be sent to users if the water overtakes the level as defined. In the context of the Philippines, the government has undertaken various initiatives to develop effective flood monitoring systems like the Project Noah by the Department of Science and Technology (DOST) which uses LiDAR technology that directs the data gathered to a server and to access this data, internet is necessary.

Notwithstanding these standing systems, still many aches and grieves from these destructive flood strikes – worsen by the spur-of-the-moment. In this response, the proponents of this study aims to develop a flood monitoring systems anchored on prevailing concepts of SMS-based notifications and microcontroller – crafted specifically for the target locale.

The Philippines for the longest time has suffered from the strikes of natural calamities which cost the lives of thousands of people and billions of properties. In response, the government in partnership with other institutions has continuously sought to develop technical instruments that could prevent communities from shattering. Relevant studies in the past discussed the importance of early warning information to prevent destructions at large. Flood was known as one of the common calamities experienced by most communities in the country and worldwide. Should there have been earlier information on the calamities to come, there might have lesser fatalities to count.

Despite the existing concepts on flood-monitoring, there have been few among all the others who made good use of these systems to lessen the adverse impacts of flood across societies. Specifically, for the purpose of this study, Isabela City as the target research locale has not used any flood-monitoring system in the past. Only when we see houses buried underneath, cars and other properties washed away; strong outcries from those who lost their families are heard that we know that there is calamity. All of these may be prevented if proper, accurate and reliable information were provided beforehand. Hence, the rationale of this study points to the concept of flood warning signs as key to saving more communities from the devastations that floods and other calamities might shower upon.

The researchers of this study aimed to develop a Flood Monitoring System with SMS notification using Arduino Uno and Sim 800l v2.0 for Isabela City. It specifically sought to,

- To develop a device that can monitor the flood water level;
- To develop a device that automatically sends warning information through SMS upon detecting water reaching the maximum level;

Claire O. Carpio, Muhsin U. Asnaul, Abeir H. Said, and Binladen Y. Amerin, "Isabela City Flood Monitoring System Using Arduino and GSM Module," *International Journal of Multidisciplinary Research and Publications (IJMRAP)*, Volume 5, Issue 6, pp. 13-17, 2022.

- To design a device that is cost effective; and

This project is motivated for the use of the City Disaster Risk Reduction Management Office (CDRRMO) personnel of Isabela City, Basilan. The initial version of the device is capable of sending unlimited number of SMS notifications per day. It is capable of detecting high water-levels and sending warning signals.

However, the limitations of the study are as follows:

- The system is developed solely for purposes of monitoring water level and sending warning signals.
- Since the device is powered by lithium battery, the device can only last up to 10 hours.

The conceptual framework as referred in Figure 1 outlines the necessary inputs needed, the main processes undertaken as well as the resulting system. This study has considered some key points in developing the system includes but is limited to the design and architecture, development and coding, software testing, maintenance and support. These are evidently significant to attain the optimal effectiveness of the system device.

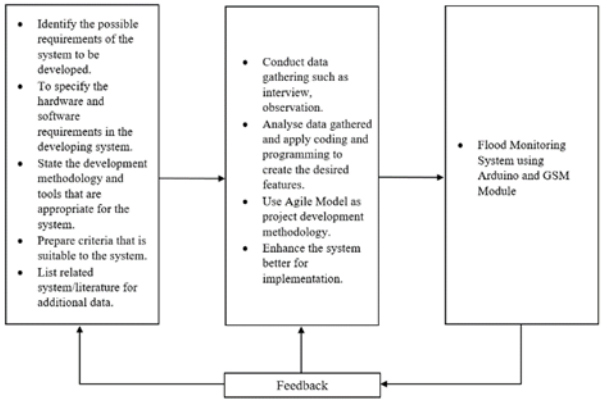

Fig. 1. Conceptual Framework

The researchers used the Agile Development Model following a series of development phases running from the requirement specifications down to the implementation and maintenance support. Agile development is a phrase used in software development to describe methodologies for incremental software development.

Fig. 2. Agile Development Model

Requirements

This stage the researchers will conduct on-site visit to the target community to determine the needed requirements for the project and to gather information to create the target outcome of the flood monitoring system given the geographical conditions.

Hardware and Software Requirements:

- Arduino Uno
- Sim 800l v2.0
- 9v battery
- Dupon wires
- LCD
- Breadboard
- Adapter
- Water sensor
- LED
- 330 ohm resistor
- Python Programming Language
- Arduino IDE

Plan

In this phase, the collected first and second hand data will be filtered according to their relevance to the study being conducted. Relevant data will further be subjected for analysis to determine their significance in the development of the device.

Research Respondents

The researchers will invite twenty (20) personnel from the City Disaster Risk Reduction Management Office (CDRRMO) for the initial device test to be conducted at Riverside Barangay, Isabela City, Basilan.

Research Locale

The researchers will conduct the system testing at Riverside Barangay, Isabela City, Basilan.

Research Tools

The researchers will employ survey questionnaires with integrated unstructured interviews for data gathering. The questionnaire will adopt the Five Point Likert Scale consists of four basic responses as shown in Table 1. To further supplement the findings of the study, second-hand data will likewise be utilized.

TABLE 1. Five Point Likert Scale

Score	Corresponding Mark
4.50 – 5.0	Highly Acceptable
3.5 – 3.59	Acceptable
2.5 – 2.59	Fair
1.5 – 2.49	Unacceptable
1.0 – 1.49	Poorly acceptable

Design

This research study will use a quantitative – survey design. Check-list questionnaire will be used by the researcher with Likert scale responses in gathering information about the evaluation of the device.

Claire O. Carpio, Muhsin U. Asnaul, Abeir H. Said, and Binladen Y. Amerin, "Isabela City Flood Monitoring System Using Arduino and GSM Module," *International Journal of Multidisciplinary Research and Publications (IJMRAP)*, Volume 5, Issue 6, pp. 13-17, 2022.

Development

The development of the system shall be done using the Python programming language and Arduino IDE. The system is integrated using Arduino Uno board. It is a microcontroller board based on the ATmega328. It has a 16 MHz ceramic resonator, 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a USB connection, a power jack, an ICSP header, and a reset button.

Fig. 3. Arduino Uno Board

Sim 800l v2.0 will be used as the GSM module. It is a QUAD BAND GSM/GPRS module which compatible with Arduino.

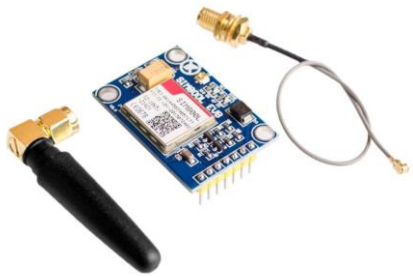

Fig. 3. SIM 800l V2.0

TABLE 2. Arduino Uno Specification

Microcontroller	**ATmega328**
Operating-Voltage(OV)	**5Volts**
Recommended input voltage	**7 to 12 Volts**
Limits of inputs voltage	**6 to 20 Volts**
Digital I/O Pins	**14 (of which 6 provides PWM output)**
Analog Input Pins	**6**
DC Current per I/O Pin	**40 mA**
DC Current for 3.3V Pin	**50 mA**
Flash Memory	**32 KB (ATmega328) of which 0.5 KB used by bootloader**
SRAM	**2 KB (ATmega328)**
EEPROM	**1 KB (ATmega328)**
Clock Speed	**16 MHz**
Length	**68.6 mm**
Width	**53.4 mm**
Weight	**25 g**

Release

After considering the user's feedback, the researchers will evaluate the system's overall operation to detect if there are still errors or bugs occurring while the system is being tested by the researchers. The researchers did a demonstration of the system in order for the respondents to know the functions of the system and how to operate it. The system was deployed in Riverside Barangay, Isabela City, Basilan.

Track and Monitor

The researchers on this stage are satisfied with the result of the performance of the system. Here the researchers gave some instruction on how to use and maintain the system.

II. Results and Discussions

Result for End User Evaluation

This study used quantitative-survey design to evaluate the device in terms of its functionality, reliability, usability, efficiency, maintainability and portability. Twenty (20) CDRRMO personnel were taken as respondents of the study who were subject to survey. The evaluation results provided valuable inputs in determining the weak points of the device.

Requirements

The software and hardware requirements of the device were determined and consequently matched for compatibility with the device.

Plan

The researchers have conducted subsequent textual analysis of available secondary references to form the supporting literatures of the study. These literatures contributed key points for the development of the device. In the same manner, survey questionnaires were likewise administered to target respondents to determine the areas for improvement. The salient findings of the survey conducted have similarly identified the prospects of the device in contributing solutions to prevalent societal concerns brought by natural calamities.

Design

The researcher decided on the design specifications of the device based from the determined software and hardware requirements. In this phase, the design of the device were finalized based from the perceived performance output. The portability and maintainability aspects were essentially considered in the determining the project specifications. The researchers designed the device with optimal effectiveness, efficiency and usability.

Development

The development of the system is done in two stages: integrated module construction stage and programming. Generally, the construction of integrated component or module is designed using the use - case diagram as shown in Figure 4. The system begins with a water sensor and the GPS module sends water level data and to Arduino Uno as data processor. Both data are sent in the form of SMS data received by the end - user.

The system generates a flooded information of the water level. The prototype system circuit has been construct successfully as shown in Figure 5. The prototype system consists of water sensors, Arduino Uno and GSM module.

Release

The initial ground test conducted on the device provided the researchers with the aspects to be reconsidered for

Claire O. Carpio, Muhsin U. Asnaul, Abeir H. Said, and Binladen Y. Amerin, "Isabela City Flood Monitoring System Using Arduino and GSM Module," *International Journal of Multidisciplinary Research and Publications (IJMRAP)*, Volume 5, Issue 6, pp. 13-17, 2022.

improvement. The respondents' feedbacks were similarly utilized to determine how effective the device was in terms of providing early flood-warning signals. The initial test was conducted at Riverside Barangay, Isabela City with the CDRRMO as respondents.

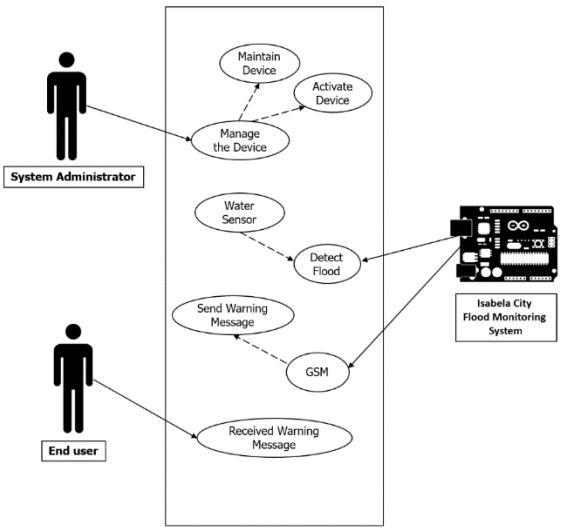

Fig. 4: Use Case Diagram of the Isabela City Flood Monitoring System

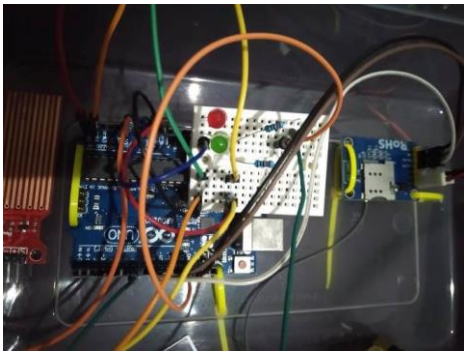

Fig. 5. Flood Monitoring System Circuit

Track and Monitor

The key findings of the initials test conducted were overall acceptable in terms of its functionality, reliability, usability, efficiency, maintainability and portability. In this phase, the researchers considered the maintenance of the device so as it can sustain optimal performance.

Testing

The researchers had successfully gathered the data from the respondents during the evaluation.

Research Respondents

The researchers invited twenty (20) personnel of the City Disaster Risk Reduction Management Office (CDRRMO) to participate in the system demonstration and evaluation at the same time.

Research Locale

The researchers conducted this evaluation at Riverside Barangay, Isabela City, Basilan.

Research Tools

The researchers used evaluation sheets for data gathering. The researchers also used the Likert Scale for data treatment and the formula below:

Formula:((Total*5)+(Total*4)+(Total*3)+(Total*2)+(Total*1))/ Total number of Respondents = Weighted Mean

Criteria: 4.50 – 5.0 (Highly Acceptable) , 3.5 – 4.49 (Acceptable), 2.5 – 3.49 (Fair), 1.5 – 2.49 (Unacceptable), 1.0 – 1.49 (Poorly acceptable)

FUNCTIONALITY QUESTION
1.) The system can detect water level
2.) The system can sending warning signal through SMS

DESIGN QUESTION
3.) The design of the system is good
4.) The system is clear and simple
5.) The system is user friendly

SECURITY QUESTION
1.) The security of the system is good
2.) The system is secured
3.) The system is free from security malfunction

EFFICIENCY QUESTION
1.) The system can sends real – time warning signal
2.) The system does not lag
3.) The system provides accurate and good results

RELIABILITY QUESTION
1.) The reliability of the system is good
2.) The system has no error
3.) The system is provides fast notification

Evaluation for the System

		Mean	**Descriptive Rating**
Functionality Questions	Q1	**3.62**	**Acceptable**
	Q2	**4.64**	**Highly Acceptable**
Design Question	Q1	**4.25**	**Acceptable**
	Q2	**3.22**	**Fair**
	Q3	**3.48**	**Fair**
Security Question	Q1	**3.71**	**Acceptable**
	Q2	**4.55**	**Highly Acceptable**
	Q3	**2.66**	**Fair**
Efficiency Question	Q1	**3.50**	**Acceptable**
	Q2	**2.54**	**Fair**
	Q3	**3.75**	**Acceptable**
Reliability Question	Q1	**4.15**	**Acceptable**
	Q2	**3.87**	**Acceptable**
	Q3	**3.91**	**Acceptable**
Overall Mean		**3.70**	**Acceptable**

Table shows the Overall mean in Functionality, Design, Security, Efficiency and Reliability is 3.70 which means the system is Acceptable.

III. CONCLUSION AND RECOMMENDATION

Conclusion

The salient findings of the study as supported by the initial ground test conducted have shown how the Flood-Monitoring System provides effective and accurate warning signals given the condition. This implies that the device can be used to save more communities from the destructions that sudden floods

Claire O. Carpio, Muhsin U. Asnaul, Abeir H. Said, and Binladen Y. Amerin, "Isabela City Flood Monitoring System Using Arduino and GSM Module," *International Journal of Multidisciplinary Research and Publications (IJMRAP)*, Volume 5, Issue 6, pp. 13-17, 2022.

might bring. Similarly, with its portable and cost-effective design, users would have ease of time in maintaining its components. However, to achieve optimal performance, the need to further improve its efficiency and design aspects have surfaced from the results obtained.

On the other hand, the device was designed specifically for the use of the City Disaster Risk Reduction Management Office (CDRRMO) personnel as the frontline responders to calamities and emergencies in the city. In the survey conducted, most of the respondents considered the device functional, secured, efficient and reliable. Hence, this study pointedly concludes that the Flood-Monitoring System could stem positive implications to the society it will serve in the future.

Recommendation

This study has outlined the strength and weak points of the device, so as to have a holistic view on how to further improve its performance in terms of detecting flood and subsequently sending warning –signals to the users via SMS. The initial version of the device is not final as it may have more refinements in terms of the system and hardware requirements. For further studies, future researchers may consider studying the possible shift from the use of lithium/dry cell to solar power. In this case, users no longer need to replace the battery every now and then which may save the cost for maintenance. Similarly, future relevant researches may also consider developing monitoring devices that would be able to detect not only floods but other calamities alike.

REFERENCES

[1] Azid, S., Sharma, B., Raghuwaiya, K., Chand, A., Prasad, S., & Jacquier, A. (2015). SMS based flood monitoring and early warning system. ARPN J. Eng. Appl. Sci, 10(15), 6387-6391.

[2] Sunkpho, J., & Ootamakorn, C. (2011). Real-time flood monitoring and warning system. Songklanakarin Journal of Science & Technology, 33(2).