Personal Computer (PC)-Based Flood Monitoring System using Cloud Computing

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ABSTRACT

Urban cities in the Philippines are prone to floods. Every year, lives and properties are taken away by flood without warning. The aim of this research is to design a system that can monitor the water level using sensors and sends an alert level text message to barangay officials of the affected area. The computer program keeps track of the measurement of the water level from time to time and creates a record into a database. Clickatell's global short message service (SMS) gateway has been effectively used for sending the mobile communication data through Peripheral Interface Controller (PIC), a form of small computer commonly used to process data coming from sensing devices and then display the result for processing. The warning system is a quick method of alerting people of the coming danger brought about by these natural phenomena fast enough compare to manual monitoring used in the past. The prototype can be easily integrated into a computer program that will help the system in monitoring timelines and water level using PIC integrated circuits (ICs). Furthermore, the system as communication environment, broadcast information in the form of recorded data in the database. In this manner, many individuals are informed and are given warnings on the dangers brought by floods.

Introduction

Different sectors are concerned with the abrupt changes in the overall climate. It is perceived that the danger brought about by climate change may endanger most of the inhabitants of earth through "global warming." Global warming is considered to be the most significant environmental problem facing the world today.

The Philippines is not exempted from these natural occurrences in the form of storms and typhoons. Every year, agricultural sectors, settlements, and human lives are destroyed by the resultant floods and landslides. The most affected are the poor people, often unaware and unprepared to handle disasters and do not know what to do in time of disasters and actual emergencies making it difficult to protect their lives and

properties. In a report from floodlist.com (2015), a week of severe weather caused by tropical cyclone "Melor" has left the country with over 40 people dead prompting the government to declare a state of national calamity.

The Philippine Atmospheric Geographical Astronomical Services Administration (PAG-ASA) is the government agency responsible for observing the Philippine weather. PAGASA assigns personnel for the flood monitoring system which use a specific device to detect the water level in an area so they can forecast an alert to the public. Through their observations, they can advise people on the affected area to evacuate to the nearest evacuation center.

However, the efforts of the agency are not enough to assure safety. Apparently, local researchers/scientists could assist the agency in monitoring flood levels by providing flood monitoring systems in the local scenario immediately alerting those who will be affected. Numerous studies on the topic helped minimize the casualties of such disasters.

In the studies of Chang (2006), Hughes (2006), De Roure (2005), flooding technologies were developed under various considerations and methodologies such as wireless sensors networks, global messaging systems, and other remote systems. These are very useful since wireless technologies are more effective and efficient because of modern communication devices. Moreover, internet-based real-time data acquisition about flood monitoring and warning systems proved to be very effective as well (Chang, 2002; Creutin, 2003; Zhang 2002). In addition to stand-alone sensing devices, space and satellite data technologies have been used to improve the accuracy of monitoring and forecasting (Manusthiparom, 2005; Veijonen, 2006). The presented method provides insights into the development of flood monitoring,

and forecasting using satellite data and image processing.

As an additional discovery, the researchers made innovative PC-Based Flood Monitoring System that can help the local government to supervise their area, so authorities can immediately take actions on the affected areas of their city. A small prototype of the system ensured persistence in using the technology making it highly beneficial.

Töyrä, et al. (2002) evaluated the use of radar and visible/infrared satellite imagery for mapping the extent of flooded wetland areas. The results from this study indicated that the information from radar and visible/infrared satellite imagery is complementary and that flood mapping in wetland areas can be achieved with higher accuracy if the two image types are used in combination.

The purpose of the project of Pagatpat, Arellano and Gerasta (2015) is to develop a local real-time river flood monitoring and warning system for the selected communities near Mandulog River. It focuses on the detection and early warning alert system (via website and/or cell phone text messages) that alerts local subscribers of potential flood events. Furthermore, the system is interactive wherein all non-registered subscribers could inquire the actual water level of the desired area location they want to monitor. The estimated time it takes for a particular river waterway to overflow is also included in the analyses. The hardware used in the design is split into several parts namely: the water level detector, Global System for Mobile communications (GSM) module, and microcontroller development board.

All the cited studies tried to make flood monitoring very efficient by finding effective means to determine flood level and warning people of the detriments flooding can incur. From sophisticated cabling to remote and wireless systems, related literatures

presented methods that contribute to this study creating an effective system with lower cost.

Purposes of the Research

The study aims to design, develop and test a PC-based Flood Monitoring System using Cloud Computing that will connect the water level sensor together with the hardware interface to PC, record the data, and send data using cloud computing designed for the function.

The specific objectives of the study are as follows:

1. To design a PC-based Flood Monitoring System using Cloud Computing.

2. To develop the system using low cost but quality materials.

3. To test its functionality, effectiveness, usefulness, and acceptability.

4. To improve deficiencies found.

Methods and Materials

Primarily, in the development of the prototype, the material cost amounted to 1,031.50 Philippine pesos. This system includes spare parts needed to construct the said prototype

Description of the System

The system consists of a controller (computer program), and hardware interface. The system is integrated with water sensors that will allow the flow of data to be received by the interface. The hardware interface reads the incoming data using serial port. Monitoring of the data received in the interface allows to immediately respond to send text messages

based on the data received. The said system is used Microsoft Visual Studio-C# language in making the user interface. Figure 1 shows the System Architecture.
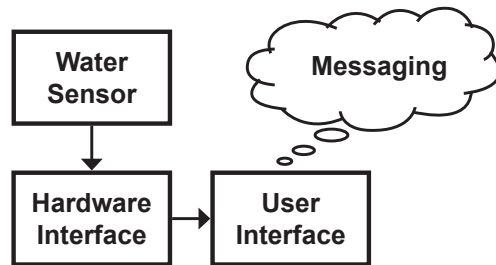

Figure 1. The System Architecture showing the flow of data from the Water Sensor to Hardware Interface to User Interface finally to Cloud for Messaging.

In the development of the system, the following sequence of operation were considered.

First, the water level sensor sends data in the hardware interface using the wired connection. Then, the interface processes the data and transforms them into electrical pulses. Lastly, the hardware interface accesses the main system through a computer program using C# programming language. The program serves as the user interface in monitoring the flood and sends text messages to different stakeholders by clicking the send message button. The project is capable of monitoring different levels of flood conditions such as no flood, normal level, green warning, voluntarily evacuation, and force evacuation.

Preliminary testing of the system was done using an aquarium to simulate the flood water level as the input in the system.

The methodology used in this research is developmental and prototyping. Each stage was separately designed, developed, and tested to ensure its functionality. Integrating these parts is a challenge because there were many constraints like

signal, internet connection, and etc. in using cloud computing.

Results and Discussion

The User Interface

A computer program was developed to act as the user interface in the prototype, by accessing the data communication terminal of the PC (parallel port), a data signal was utilized as a trigger to control the interface module of the system comprising primarily of a PIC IC. The signal coming from the water level sensors composed of metal rings strapped around a plastic pipe connected to the input terminals of the PIC IC module actuates and provides input signals to the interface devices.

Testing was made by emerging the pipe with water level sensors in an aquarium. Water was poured gradually in the aquarium to simulate the rising of the water level. The sensor sends data signal based on the water level. The data signals sent are 0, 1, 2, 3, 4, 5 - the number signals that were based on the water level.
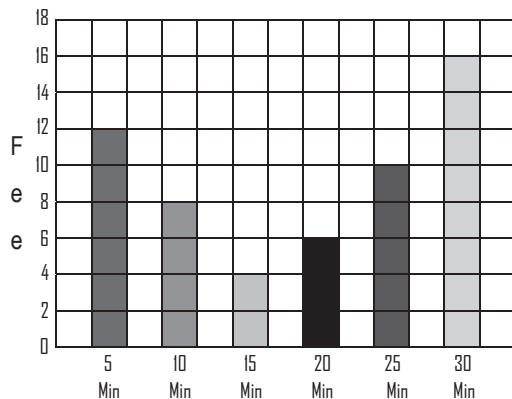
Flood Monitoring System

Figure 2. Main Interface showing the rising of water through a bar graph foot/minutes.

The program presents two types of graph. The first graph is a bar graph which projects the time to which water level rises. The second graph is a line graph that keeps track of the condition of the water level every fifteen minutes. The x-axis represents the water level while the y-axis represents the time the water level rises.

Figure 2 & 3 show the user interface.

Flood Monitoring System
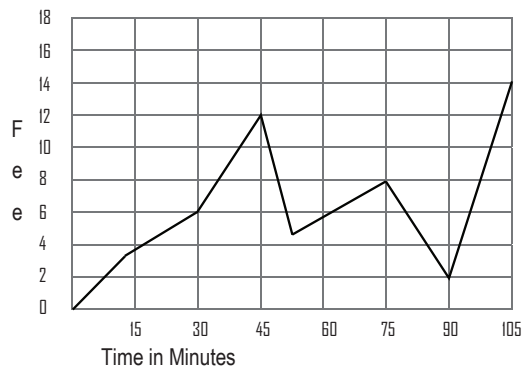
Figure 3. Main Interface showing the water level and corresponding time every 15 minutes through a line graph.

Hardware Interface

The hardware interface consisted of two circuits: a) load interface, and b) Universal Serial Bus (USB) to Universal Asynchronous Receiver/Transmitter (UART) converter. The load interface served as the reader of the data coming from the water sensors. This circuit classified the data for a particular level. Second is the USB to UART converter which served as the connection between the sensor and the interface. It also acts as the bridge between the PC and hardware interface.

Figure 4. Load Interface

Figure 5. Load Interface for USB

Figure 6. Sensor

Figure 7. Schematic Diagram of US to UART

Final Testing of the prototype

After assembling the different parts of the prototype, final testing was conducted. The following observations were recorded: 1) delay of the text message, sometimes no text message received, and 2) unexpected error in the user interface program such as connecting to the database. No problems were encountered on the cloud computing.

Defects and Remedies Imposed

The delay of the text message was attributed to the presence of network providers' cell site in the area. The remedy was to add multi-network (Tri-Net) sim card in the system.

The first user interface designed consisted of a radio button that posed a problem because it cannot implement the automatic detection of the received data in the program. In that case, the radio button was removed and replaced by a textbox.

After the try-out was conducted, a survey questionnaire was administered to selected faculty and experts as to its functionality, effectiveness, usefulness, and acceptability.

Table 1 presents the results of the assessment of the selected respondents.

Table 1

Assessment of the respondents on the PC-based flood monitoring system using cloud computer

Criteria	Faculty		Experts		Composite	
	WM	VI	WM	VI	WM	VI
Functionality	4.13	VG	3.73	VG	3.93	VG
Effectiveness	4.31	E	4.05	VG	4.18	VG
Usefulness	4.13	VG	3.78	VG	3.96	VG
Acceptability	3.96	VG	3.85	VG	3.91	VG
Overall values	4.13	VG	3.85	VG	3.96	VG

Legend: 4.20–5.00 Excellent (E), 3.40–4.19, Very Good (VG), 2.60–3.39 Good (G), 1.80–2.59 Fair (F), 1.00–1.79 Poor (P)

As shown in Table 1, the composite assessment of the respondents yielded mean values of 3.93 for functionality, 4.18 for effectiveness, 3.96 for usefulness, and 3.91 for acceptability all verbally interpreted as "very good."

These results shows that the developed PC-Based Flood Monitoring System using Cloud Computing is very functional, effective, useful, and acceptable as assessed by the selected respondents.

Conclusion

The prototype can provide a flood monitoring system that transforms actual water level to digital data and can transmit information in two modes, via short message system (SMS) through sim cards, and through cloud computing platform using a multi-casting technique to reach more people in the shortest possible time during flood water emergencies. The prototype is low-cost utilizing cheap but quality materials. It was found to be very functional, effective, useful, and acceptable.

Recommendations

Further improvements towards the attainment of a prototype that can be patented may be considered. To further improve the operation of the system the following can be integrated: E-mail module which can send information in e-mails; adding websites to view information for future reference.

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