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Developing an IoT-enabled Water Level Detection with Short Message Service (SMS) notification System for Flood-prone School Campuses

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Abstract – *The increasing frequency and severity of floods have become a major concern in many regions, particularly in areas with a high concentration of vulnerable populations such as school campuses. Timely detection and monitoring of water levels can play a crucial role in mitigating the risks posed by flooding to the safety and wellbeing of students, teachers, and staff. The creation of an Internet of Things (IoT)-enabled water level detection system with SMS notifications is presented in this research study. Its purpose is to give flood-prone school campuses early warning and real-time monitoring capabilities. It measures the water level in each building using close traversing approach. It automatically updates the staff, teachers, and students on each building's water level and status. The notification provides the individual with the choice of the safest exit route from the premises.*

Key Words: **IoT, Water Level Detection, SMS, School, Traverse**

1.INTRODUCTION

One of the main issues in the Philippines is flooding, which is caused by heavy rain brought on by tropical storms. Extreme weather hazards and occurrences can affect many kinds of infrastructure and transportation operations directly or indirectly [1].

According to Panay news, all 180 of Iloilo City's barangays are under risk of flooding, according to the Mines and Geosciences Bureau (MGB) in Region VI. They have several levels of susceptibility: extremely high, high, moderate, and low, according to the most recent comprehensive (1:10,000 scale) geohazard model of the city produced by MGB-6[2].

Floods have a disastrous impact on education as well, even though their negative impacts are frequently concealed. An Asian Disaster Preparedness Center study done in Cambodia in 2002 lends credence to this conclusion. The results of the poll indicated that one of the things preventing students from finishing their studies and, consequently, bringing down the quality of education today is flooding, especially in provinces where schools were constructed without sufficient flood resilience [3].

Keeping students, faculty, and staff safe and healthy is a daily struggle for schools. Because there is no drainage system in place, rain constantly pours down on the school grounds during bad weather, causing floods at Iloilo National High School in Iloilo City. As the water level rose, it became more challenging for the students to find a way out of the school that would be both safe and navigable. Furthermore, flooding and water leaks can jeopardize business, seriously harm property, and even endanger human health. Manual checks are a common component of traditional water level detection technologies, but they can be laborious and inefficient especially in big buildings.

The aim of this research was to develop a water level detection system for schools that is localized and equipped with Internet of Things (IoT) capabilities, along with Short Message Service (SMS) notifications. When flooding occurs on school property, the system notifies staff, instructors, and students by measuring the elevation ground point in each area to determine the safest area and the water level. It made use of the closed traverse approach.

2. LITERATURE REVIEW

Fajar Rahayu, et.al [4], proposed a study Prototype Flood Detection Water Level Monitoring IoT Web Based with Ultrasonic Sensor HC-SR04. This project intends to develop a real-time Internet of Things (IoT)-based flood control system. The purpose of this research is to design and build a prototype for a water level monitoring system and to explore the idea of preventing floods in local communities. Using the concept of a smart home, the device object aims to create applications that can be used as displays that can be viewed on a computer or smartphone. The HC-SR04 Ultrasonic module serves as the primary data source, providing a changing water level. The data gathering procedure begins in a glass tube container with no items, followed by the addition of solid objects as a sensor barrier against the water's surface.

Then, by observation, data is collected in stages by raising the water level and comparing the height with a ruler in real-time apps, or the value can be seen in ESP8266 serial monitors.

The proposed study [5] by Jadaalli Sreedhar, et.al, Water Level Monitoring System using GSM Network provides a solution for a water monitoring system that uses a Global System for Mobile Communication (GSM) network to minimize human control issues. This prototype sends a water level notification to a mobile phone connected to a GSM network, allowing for monitoring of the tank's water level. When the water level reaches its highest point, the pumping system automatically shuts off.

According to Samuel C. Olisaa, et. al [6], many residences use a two-tank water system to store and distribute water. Water is delivered via a pipeline network from the storage tank (lower tank) to the distribution tank (overhead tank) by electric pumping equipment. An Android mobile app and control system were designed to monitor water quality, check overhead tank levels, and activate intelligent pumping control. Water level checks were performed using an ultrasonic pulse-echo technique, whereas water turbidity and pH signals were employed to assess water quality. Three levels of control (LC_1, LC_2, LC_3) and two water quality check conditions. (QC_1 and QC_2) were developed and included into the system's intelligent control algorithm.

In [7], H. Hassan, et. al proposed study IOT System: Water Level Monitoring for Flood Management. To limit losses and offer early communication to the impacted population, an informative flood notification system must be developed. The notification system uses the GSM network and is generally available throughout Malaysia. Notification messages will be issued to users in that region, including the village head, the police station, and the nearest safety authorities. The system architecture created with Arduino UNO serves as the system's microcontroller, doing various tasks such as monitoring water level, temperature, and humidity, as well as sending SMS via the GSM shield. To validate the accuracy of the proposed system, experiments were conducted utilizing a small-scale prototype.

In [8], Neeraj Gupta, Allan Sasi, and Ayush Deep conducted a study of the IoT based Water Level Management System. This study offers an IoT-enabled device that aids in administering and monitoring water consumption in numerous buildings at the same time. This module can be easily repaired. Transfer to the proper water containers and continue for the lengthy run. The ultrasonic sensor is mounted on the top of the tank, which constantly keeps track of the water level in real time, which will alert users about the level of liquid and automatically turn on/off the water.

In [9], the study proposed by Shahirah Binti Zahir, et. al, Smart IoT Flood Monitoring System, here all the shortcomings of the current system were resolved by having a smart IoT flood monitoring system. The suggested system works well in both urban and rural settings. In addition, anyone with internet connection can keep an eye on events and forecast when the web server may overflow in the future. The suggested system is simple to maintain and has a cheap cost of design. To enable prompt essential action, this project updates the water level at the web server and sends out a warning signal to the public for evacuation.

3. SYSTEM REQUIREMENTS

The following are the system requirements used in developing the system.

Hardware Requirements

- Arduino Board
- Water level sensor ESP32 module
- GSM Module: SIM800L
- SIM Card: Activated with SMS capabilities
- Arduino Power Supply: USB cable for connecting to a computer or a 9V battery/adapter.
- GSM Module Power Supply: 5V or 12V respectively
- Breadboard: For making connections.
- Jumper Wires
- Resistors: As needed based on the sensor and GSM module specifications.
- LED: For local alarms.
- Relay Module: For controlling external devices like pumps or valves based on water level.

Software requirements

- Arduino IDE
- PHP: Hypertext Preprocessor
- MySQL

4. SYSTEM DESIGN

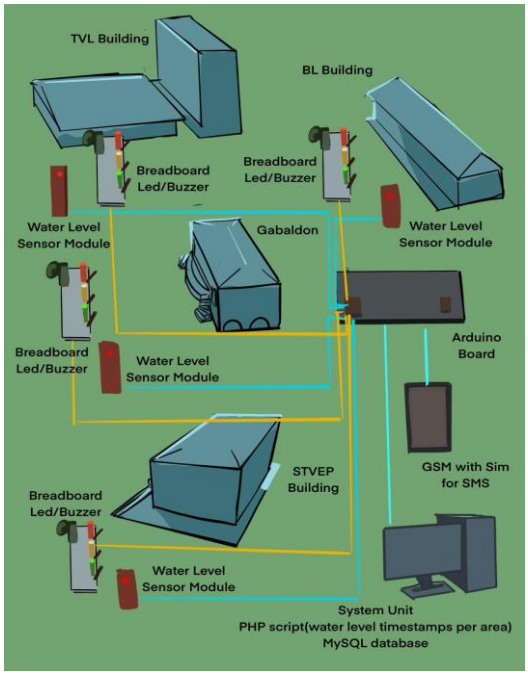

Fig. 1: System Architecture

4.1. System Architecture

Figure 1 above showed the system architecture of the proposed system. This system utilizes an Arduino board as the central processing unit, working in conjunction with several other components to continuously detect and monitor water levels and send SMS notifications in case of pre-defined thresholds being crossed. Here's a detailed breakdown of the system architecture:

4.1.1 Data Acquisition

Every building on the school grounds, including the TVL, Gabaldon, BL, and STVEP buildings, includes a water level sensor ESP32 module that is connected to provides a signal corresponding to the water level.

4.1.2. Processing Unit

The Arduino board receives the analog or digital signal from the water level sensor, converts it to a readable water level value using pre-defined calibration factors.

4.1.3. Data Transmission

The Arduino transmits the measured water level data (along with timestamps) serially to a computer running the PHP script. This serial communication can be established using a USB cable.

4.1.4. Software

A computer running a web server will host the PHP script and MySQL database. The PHP Script receives the serial data from the Arduino, parses it to extract water level and timestamp information. The script connects to the MySQL database and stores the received water level data along with timestamps in a designated table. This creates a historical record of water level measurements. The PHP script implemented the close traverse approach to analyze after level data ensuring accurate water level readings.

4.1.5. Alert and notifications

Cellular communication is handled by the SIM800L, or GSM Module. A pre-activated SIM card with SMS capabilities is used to connect it to a mobile network. A command is sent from the Arduino to the SIM800L module to start an SMS notification when the measured water level goes below one of the pre-established thresholds (level 1, level 2, level 3). The pre-programmed information was shown in the SMS text, including the observed water level based on traverse measurements. The water level's height, the related text alert, and the LED light indication are described as follows:

- Green for Level 1 as “low” (12 inches)
- Orange is Level 2 as “medium” at 24 inches.
- Level 3 as “high” = Red for 36 inches

An Arduino-connected LED changes color in response to water level sensors, giving a quick on-site status check, and is used for local visual notifications.

Additionally, the name of each structure where the water level measurement is located is included in the text alert.

4.2. Block Diagram

The Basic structure of water level detection system with SMS notification is illustrated in Figure 2. The block diagram shows the system consists of a water level sensor (ESP32 module), breadboard, Arduino Board, SIM800L GSM Module. Arduino IDE, system unit for PHP, and MySQL. The system can measure the water level and give measurement report and notifies the students, teachers and staff thru SMS.

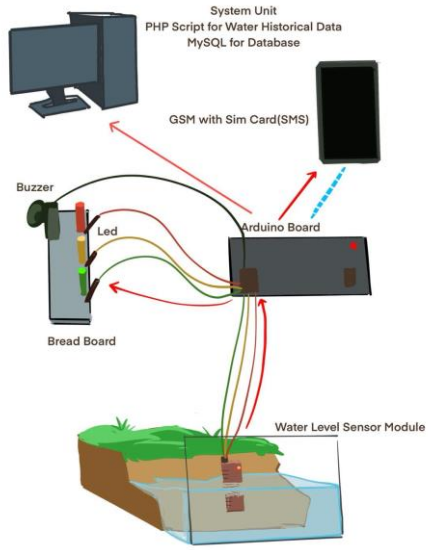

Fig. 2. System block diagram

4.3. System Flowchart

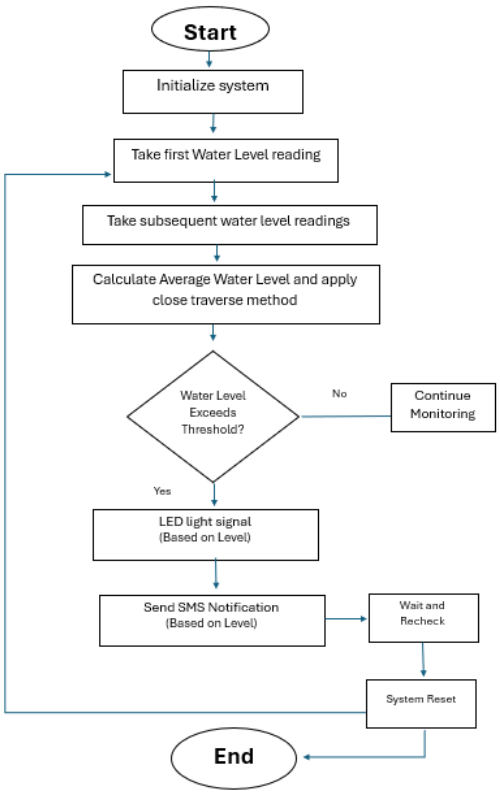

Fig. 3. System Flowchart

Fig. 3 displays the system flowchart, which began with system initialization, including setting up thresholds for high and low water levels, configuring sensor connectivity, and initializing variables to store multiple readings. The next action is to obtain the water level sensor's initial reading of data. After that, use the close traverse measurements based on sensor positions, compute the average water level, and take further readings. Comparing with thresholds is the next step. The system will continue to monitor if the average water level is below the low-level threshold, otherwise the LED light signal will change color and send an SMS notification based on pre-programmed information provided in the system. Then, before doing it again, wait a predetermined amount of time. The system will end itself in the event of failures or unanticipated circumstances and reset for a fresh restart.

5. CONCLUSIONS

In this article, we discuss "Developing an IoT-enabled Water Level Detection with Short Message Service (SMS) notification System for Flood-prone School Campuses". It uses hardware components such as Arduino, ESP32 water level sensor module, SIM800L GSM module to detect and monitor the water level during the flood and send notifications to students, teachers, and staff. The Arduino IDE, PHP and My SQL were utilized as the software to develop the system. Close traverses were used to measure the water level per building. Here, we can identify and keep an eye on the water levels in every building on the school grounds. Additionally, we can see the elevations of the water levels in each building, which helps staff, teachers, and students locate a better way out of the school grounds. We can expand the suggested system in the future to include data analytics and forecasts regarding the water level during bad weather on a monthly, quarterly, and annual basis as the foundation for disaster management.

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