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A UPS WATER LEVEL MONITORING DEVICE FOR RIVER ENVIRONMENTS

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ABSTRACT

This research seeks to establish a control network of the water level to be checked and verified for river ecosystems by rainfall causes. In its configuration for continuous service with power outages and data integrity and flexibility, the device must include an intermittent power supply (UPS) and memorycard. The goal is to insure the machine has at least 90 percent efficiency irrespective of heat, wave or power loss inaccuracies. The sensor consists of four samples which indicate whether the water level is classified as secure, small, high and critical. The data is then transmitted through the PIC microcontroller to the first-hand memory card and to the GSM module which transmit it as an SMS to selected cellular telephone numbers, which is used as a data backup.

Keywords: GSM module, memory card, probe sensor, PIC microcontroller, SMS, UPS.

1. INTRODUCTION

An annual problem tropical countries suffer from is the seasonal battery of typhoons. When these storms come many towns, especially in the rural areas which lack adequate emergency measures, suffer the brunt of these. These storms devastate crops, destroy both public and private property, hinder transportation and supply circulation, and claim lives [1, 2, 3]. A way to avoid some of these listed causes of death is for people to be warned immediately if water levels are being raised dangerously high [4, 5, 6]. One communication system that can be used is RFID, SMS transmission ndmanuial USB transfer [7, 8, 9].

At present portability has become an important part of modern life. It is due to this feature, that more environments that were once difficult to assess, can now be examined as compared to before. Smaller sensors, phones, cameras, and even computers are continually being developed to get ahead in the technological race [10, 11, 12, 13]. Because of the importance of portability and communication, many people bring cellular phones that can fulfill many functions.

This study aims to develop a water level monitoring device that can send the level of rivers via SMS, incorporate an SD card for data back up, and an Uninterruptible Power Supply for emergency power [14, 15, 16]. This may become an important asset as up to the minute information of sudden critical rises in water levels, can help manage transportation, weather forecast, or even save lives, in the rainy season and in time of typhoons and blackouts. The general block diagram is shown in Figure-1.

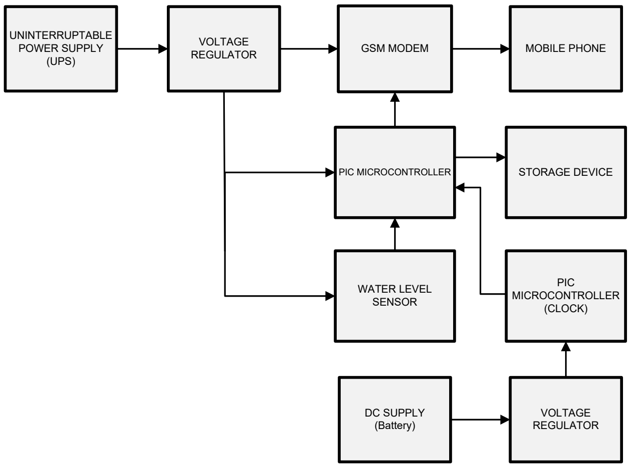

Figure-1. General block diagram of the system.

2. METHODOLOGY

2.1 System Layout

The copper probes, which are used as the water level sensors that designate the safe, low-tide, high-tide, and critical level, are connected to the ADC pins of the microcontroller. If the water level has reached one of the 4 designated water level probes, a signal will be transmitted to the microcontroller and it will execute a specific instruction set in its RAM. The data, whether it is in the SAFE, LOW-TIDE, HIGH-TIDE, and CRITICAL LEVEL, that was transmitted to the microcontroller will be sent to the designated cellular phone and will be copied to an SD card as shown in Figure-2. For Optimizing the System, the Neural Network and Rough Set Theory can be used like in the studies of [17, 18, 19, 20].

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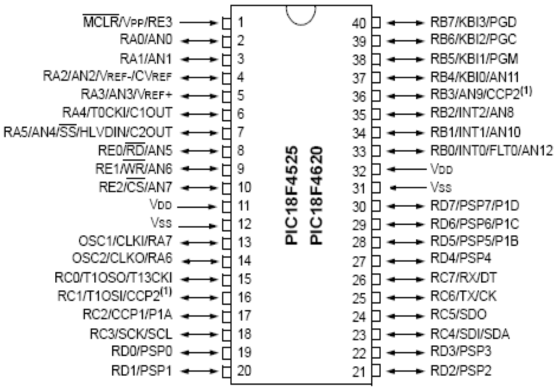

Figure-2. Microcontroller used in the System.

The SD card acts as the recovery device of the whole system if the transmission of data to the cellular phone did not succeed. Also, the whole system containing the microcontroller circuit, GSM module, and SD shield are connected to a power supply. In case a power outage occurs, the whole system will be supplied by the UPS which acts as its backup power supply [21, 22, 23].

3. EXPERIMENTATION

3.1 Actual System Layout

The water level sensor is a probe-type consisting of four (4) 30-inch copper-coated metal rods mounted on an aluminum frame in a ladder set up. The distance between the centers of each rod is 3.5 inches to ensure a relatively fair distance for the water level to rise. Besides, a water pump was used to simulate current in rivers. Figures 3, 4 and 5 shows the Whole System Setup, Container without simulated water current and the container with simulated current.

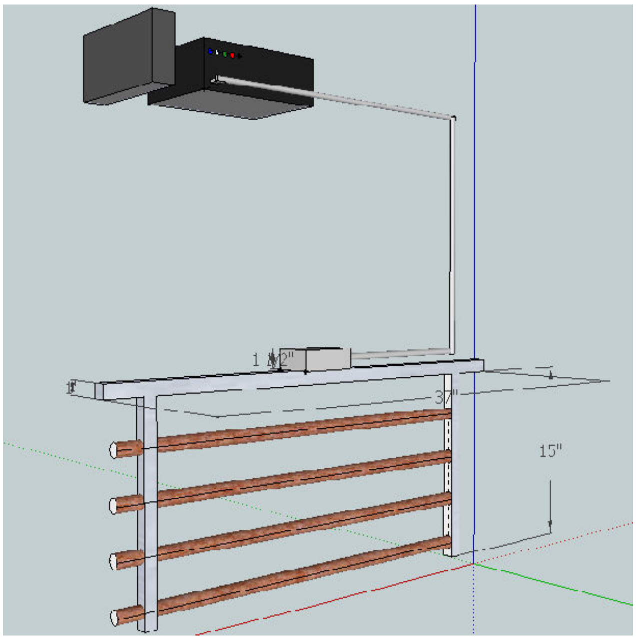

Figure-3. Whole System Setup.

Figure-4. Container w/o simulated water current.

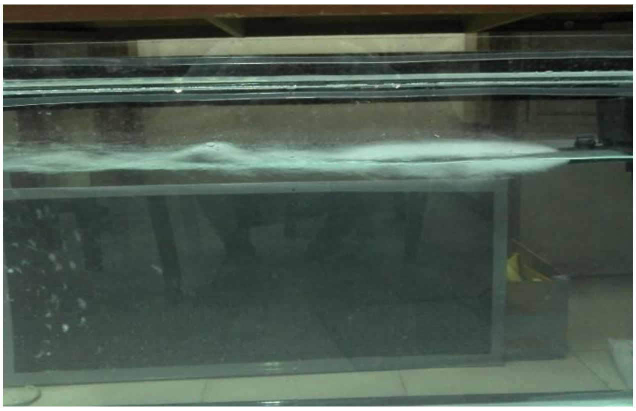

Figure-5. Container w/ simulated water current.

The level sensor is mounted on 35 by 10 by 20-inch aquarium. Each copper rod has a wire which joins in a DB9 serial cable. The cable leads to the circuit box which stores data and sends the measured water level via SMS. In dealing with uncertain values the Logic Scoring of Preference (LSP) can be used [24].

3.2 Data Gathering

The accuracy of the water level data gathered by the sensor will be conducted in three (3) kinds of situations: Varying Water Level without Simulated Rain, Varying Water Level with Simulated Drizzle, and Varying Water Level with Simulated Heavy Rain.

In testing without rain, the group tested the accuracy and reliability of the water level sensors. The level sensors will have a sampling time of one (1) minute. Only the water level was varied for fifty (50) times for a relatively large sample size. Water is raised and drained by the use of pumps [25, 26, 27]. Table-1 shows the actual and device readings without rain.

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Table-1. Actual and device readings without rain.

Trial	Result (actual)	Result (device)
1	Low Tide	Low Tide
2	High Tide	High Tide
3	Low Tide	Low Tide
4	High Tide	Critical
5	Critical	Critical
6	High Tide	High Tide
7	Low Tide	Low Tide
8	High Tide	High Tide
9	Critical	Critical
10	High Tide	High Tide

The overall accuracy of the test is shown below in the form of a line graph. Figure-6 shows the sensor accuracy without the rain.

NOTE: The errors were caused using false positive testing

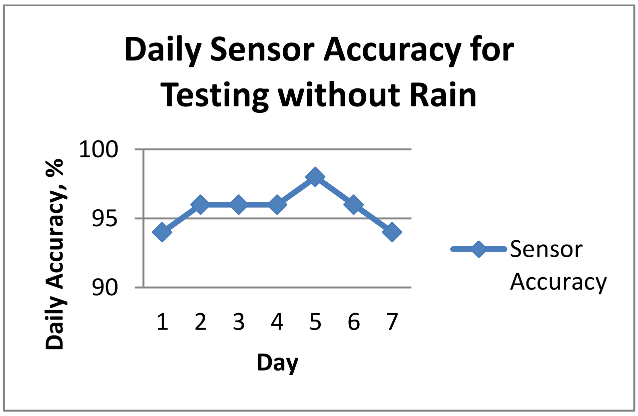

Figure-6. Sensor Accuracy without Rain.

The testing conducted for Varying Water Level with Simulated Drizzle is similar to that of the first part with the exception of a drizzle or mist effect applied directly on the sensors. This was done to test how accurate the sensor can read the water level without being affected by the inclusion of rain [28, 29, 30]. Table-2 shows the actual and device readings with drizzle.

Table-2. Actual and device readings with drizzle.

Trial	Result (actual)	Result (device)
1	Safe	Safe
2	Low Tide	Low Tide
3	Safe	Safe
4	Safe	Low Tide
5	Low Tide	Low Tide
6	Low Tide	Low Tide
7	High Tide	High Tide
8	Critical	Critical
9	High Tide	High Tide
10	Low Tide	Low Tide

Figure-7 shows the sensor accuracy with drizzle.

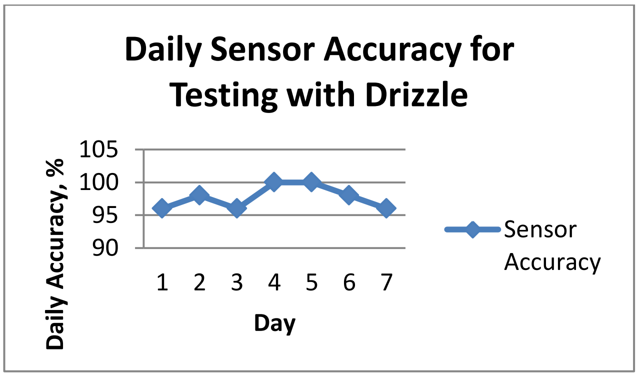

Figure-7. Sensor Accuracy with Drizzle.

The last testing scenario was the same as the Varying Water Level with Simulated Drizzle but the drizzle was replaced with a heavy shower effect. Table-3 shows the actual and device readings with heavy rain.

Table-3. Actual and device readings with heavy rain.

Trial	Result (actual)	Result (device)
1	Safe	Safe
2	Low Tide	Low Tide
3	Safe	Safe
4	Safe	Safe
5	Low Tide	Low Tide
6	Low Tide	Low Tide
7	High Tide	High Tide
8	Critical	Critical
9	High Tide	High Tide
10	Low Tide	Low Tide

Figure-8 shows the sensor accuracy with heavy rain.

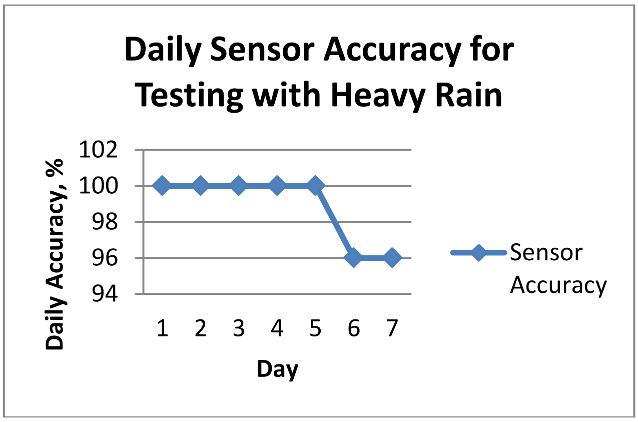

Figure-8. Sensor accuracy with heavy rain.

3.3 Back-Up Power

To provide power in case of power outages, surges, and voltage spikes, a PUP-500 UPS was used. The PUP-500 was designed to provide approximately 18 minutes of reserve power to a 500 VA load, however since the system's load was 24 watts (21 VA), the PUP-500 UPS was able to last well over six (6) hours.

3.4 Removable Data Log

The group considered the possible problems regarding cellular SMS, such as late messages or messages that are never received due to problems with the cellular service itself. As such, a SD card was included in the design to provide first hand data gathered by the sensors. The back-up data is saved in the SD card in a text file format. In Table-4, the sample data is displayed in the following order: Time and Water Level Recorded. Table-4 shows the water level trial.

Table-4. Water level trial.

Trial	Time	Water level
1	13:05	Safe
2	13:06	Critical
3	13:07	Safe
4	13:08	Critical
5	13:09	Low tide
6	13:10	High tide
7	13:11	Critical
8	13:12	Safe
9	13:13	Low tide
10	13:14	High tide

Figure-9 shows the System Flow Chart.

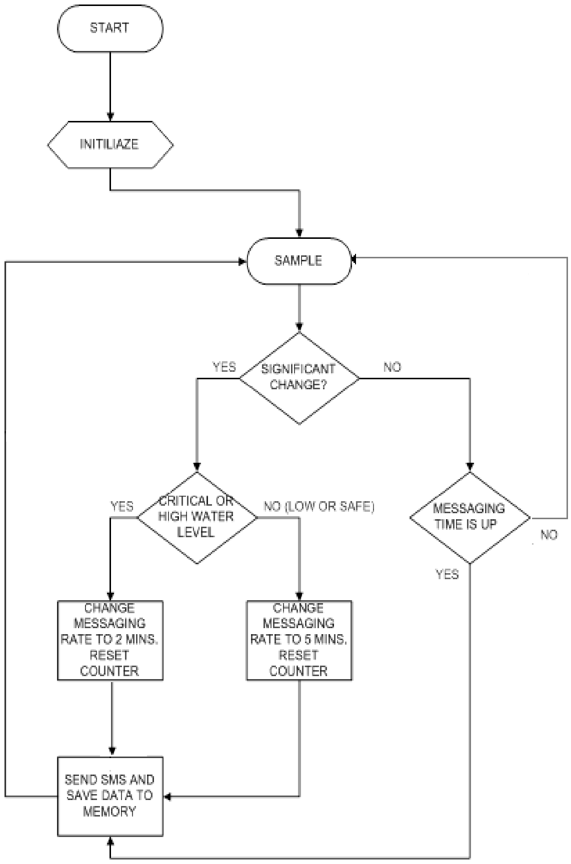

Figure-9. System flow chart.

4. CONCLUSIONS

Based on the different tests that consisted of 50 trials which simulate real-life situations like rising of water level without rain (i.e. due to water dams), rising of water due to light rain showers and rising of water level due to heavy rain showers, the group has proven that the whole system provides measurements with high percentage of reliability and acceptable error through the utilization of copper rods with high conductivity while submerge. The high percentage of reliability was acquired from the correct indication of the actual water level, successful transmission of SMS, and accurate acquisition of data from the MCU to the SD Card. The error was caused by the cohesion of the water droplets coming from the copper rods to the water surface because the water level was extremely close to the next copper rod. The integration of a UPS with the water level monitoring apparatus provided a sufficient amount of energy to operate the whole system.

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