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Design & Construction of A Flood Detection System with SMS Alert

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ABSTRACT

This project involves the design and construction of a flood detection system with SMS alert. The system is made up of a 9V DC battery for power supply, water level measuring sensors, a programmable microcontroller, a GSM module, an SD card module for data storage, and a liquid crystal display (LCD) to display the status of the system. The project utilized affordable embedded system components to provide timely flood alert text messages to residents and relevant authorities. The Global System for Mobile Communications (GSM) module is used for sending the mobile text message while the Arduino Nano microprocessor is used to read the input from the water level sensor unit and calculate the height of water. The water level sensor/measuring device in this work was designed using resistors and the principle of water conductivity. The design analysis and simulation was done with proteus and Arduino IDE software. The system was tested using salt water and the output at different water level was obtained.

INTRODUCTION

Floods are one of the most frequent and destructive natural disasters worldwide. They lead to loss of life, economic hardship, and large-scale displacement (Angelakis *et al.*, 2023). Flooding occurs when water overflows from rivers, lakes, or due to heavy rainfall (Todini, 2025). It can happen in both urban and rural areas, and at any time of the year. According to the Alcaras (2025), flood as a large volume of water covering a previously dry land area. The extent, duration, and flow pattern of water give rise to different types of floods. In Nigeria, floods occur in three common forms: coastal, river, and urban flooding (Cirella & Iyalomhe, 2018). Coastal flooding affects low-lying areas along mangrove and freshwater swamps. River flooding affects the floodplains of major rivers such as the Niger and Benue. Urban flooding occurs in cities, often caused by poor or blocked drainage systems (Cirella & Iyalomhe, 2018). A study observed that dam failures have contributed to major flood events. A clear example is the 2012 flood disaster, which affected 30 of Nigeria's 36 states and caused widespread damage and displacement. Natural events like heavy rainfall cannot be prevented (Magami *et al.*, 2014). However, their impact on human lives and property can be reduced through early warning systems. These systems detect rising water levels and alert people in danger. Flood detection systems have become a practical solution for disaster risk management, especially in vulnerable areas. When properly designed, they allow communities to prepare for evacuation and help relevant agencies act quickly (Henao *et al.*, 2025). Over the years, flood detection systems have used various sensors such as ultrasonic as well as pressure sensors.

Such systems continuously monitor water levels as well as store alarms when such water levels exceed set points. Some of them are connected to central control centers, while others notify individuals directly (Henao *et al.*, 2025). Most people residing in rural settlements, particularly at night, may fail to realize rising water levels (Canwat, 2023; Ibrahim, 2024). Early warning systems matter more than ever before. This project introduces the design, development, as well as assembly of an affordable flood detection system that uses a microcontroller and GSM module. The system includes a water level detection sensor that uses the property of the conductivity of water and resistors. It provides alarms through SMS to pre-programmed telephone numbers after detecting a hazardous water level. The choice of SMS as a communication means has taken into consideration the prevalence of mobile phones in Nigeria. GSM services cover rural as well as urban communities, meaning that such a system may be broadly deployed (Henao *et al.*, 2025). Flooding has always posed a serious threat in Nigeria. It damages infrastructure, disrupts socio-economic activities, and leads to the displacement of people (Ibrahim, 2024; Orimoogunje & Aniramu, 2025). Early detection and early warning systems reduce the effects of such disasters. Although various previous systems relied on expensive sensors as well as complex networks, the existing project considered affordable configurations as well as simplicity. The system that has been suggested uses affordable but easy-to-assemble configurations, which make it deployable to poor or rural communities.

The research objective is to create a flood warning system

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that monitors the level of water and gives SMS warnings when there is a threat. The specific research goals are as follows:

- To develop a flood detection system that includes LED lights, a liquid crystal display (LCD), and a water level sensor to monitor and display water levels,
- Program an Arduino Nano microcontroller in C++ using the Arduino IDE.
- Installation of a GSM module which gives SMS alarms when the water level crosses safe limits.
- Incorporating a buzzer alarm for localized alerts at the time of peak water levels.

The system has practical application to both rural and urban communities. With real-time monitoring of changes that occur in the water level, the system has the ability to reduce the danger of sudden displacement. It also provides relevant authorities, such as the National Emergency Management Agency (NEMA), time to react promptly. It has an inexpensive design as well as little power demands that make it affordable to deploy in communities that lack resources. It provides timely as well as precise warnings through SMS, which is one of the fastest means of reaching a large population like Nigeria. The design process involves creating a system block diagram, flowchart, and simulation using tools like Arduino IDE and Proteus. A prototype is built using simple hardware components. The system is tested under various conditions using salt water to simulate rising water levels. The microcontroller processes inputs from the sensor and activates the GSM module to send alerts. This paper is organized as follows: Section 2 presents a review of related work and past flood detection systems. Section 3 describes the system architecture, including both hardware and software components. Section 4 discusses implementation and testing results. Section 5 concludes the study and suggests directions for future improvement.

LITERATURE REVIEW

Flooding is one of the most common and damaging natural disasters globally. It accounts for over 40% of all disaster events and affects millions each year (Iqbal & Nazir, 2023; Umar & Gray, 2022). It regularly causes more than 20,000 deaths annually and impacts about 25 million people (Aliyu *et al.*, 2023). According to Denchak (2019), flood refers to the unusual accumulation of water on land, caused by high tides, heavy rainfall, or fast runoff from impermeable surfaces. Ahrendt *et al.* (2022) defined it as the situation where more water enters a drainage channel than it can carry, leading to overflow. ten Veldhuis *et al.* (2010) added that flood is any overland water flow over urban land sufficient to cause damage or health risks. In 2022, floods in Nigeria became the worst since 2012. They affected over 1.4 million people across 33 of 36 states, killed at least 612 individuals, and destroyed more than 200,000 homes and 110,000 hectares of farmland (Bankole, 2023). The World Bank's GRADE assessment, in collaboration with the Nigerian government, estimated

the direct economic losses at USD 6.68 billion, with a range of 3.79 to 9.12 billion USD (Akintola, 2023). Lagos State has experienced the highest frequency of flooding, though states like Niger, Adamawa, Oyo, and Kano also record frequent cases due to major rivers like the Niger and Benue (Mfon *et al.*, 2022). One of the worst disasters occurred in 2012 when 363 lives were lost and over 2.1 million people displaced. Despite early warnings by the Nigerian Meteorological Agency (NIMET), many residents ignored the alerts, leading to massive losses (BBC News, 2012).

Flooding in Nigeria is not just a result of rainfall. While climate change increases rainfall intensity, human activities are major contributors. Poor planning, rapid urbanization, deforestation, and blocked drainage systems are common problems (Cirella & Iyalomhe, 2018). Climate change affects flooding indirectly by increasing sea levels and making weather patterns unpredictable, especially in regions with poor forecasting tools. Most of low-income residents settle on flood-prone areas, which make them even more susceptible (Akanji, 2024). Poorly damaged infrastructures such as broken dams or choked rivers might also cause flooding (Akanji, 2024). Occasionally, rivers' natural currents are disrupted by building operations, leading to water overflow into settlements (Cirella *et al.*, 2019; Ogunseyin, 2025). Baguda dam rupture in Kano in 1998 and 2012 are some examples. Most of the Nigerian towns also have poor drainage systems, which worsen the situation when there has been incessant rain (Ologunorisa *et al.*, 2022).

In tackling flooding, Nigeria has undertaken various measures at institutional, community, and research levels. Institutions such as the Federal Ministry of Environment, the National Emergency Management Agency (NEMA), as well as NESREA, have had specific roles in assessing risks, educating the public, and emergency response coordination. NEMA, especially, has a leading role of keeping watch over preparedness, as well as providing relief material distributions, when there are floods (Guardian Nigeria, 2023; Ibrahim, 2024).

Research and the media also play a significant role. Various studies have concentrated on learning the causes and effects of floods in Nigeria. Local groups like NEST, BNRCC, and universities have raised awareness on the matter. The Nigerian media has also reported on flood occurrences, raising public knowledge as well as stimulating preparedness. Various researchers have put forward flood detection and warning systems. Atiah *et al.* (2023) designed a Goddard Scattering Algorithm (GSCAT) methodology application to evaluate the contribution of Mesoscale Convective Systems (MCSs) to the aforementioned flood cases. Another article offered a new flood monitoring as well as warning system (FMWS) that uses long-range wide area networks (LoRaWAN) to ensure effective measurement as well as monitoring of flood magnitude and rate of change. Kavitha *et al.* (2024) came up with a system utilizing wireless sensors incorporating GPS and cloud monitoring to monitor flood magnitude in real

time. Darwis *et al.* (2023) built a detection system using an Arduino Yun and ultrasonic sensors, powered by a solar power bank. The system had LEDs and camera integration for remote monitoring. Kaphungkui (2024) created a GSM-based flood detector using ultrasonic sensors to send text alerts. Their design focused on rural coverage and low cost. Another study developed a Flood Warning and Monitoring System (FWMS) using an Arduino Uno, an ultrasonic sensor (HC-SR04), and a GSM SIM900A module. The system monitors water level in real-time and sends SMS alerts at ‘warning’ and ‘danger’ levels to both residents and emergency authorities. The prototype also triggers a buzzer alarm as part of its alert mechanism (Zain *et al.*, 2020).

Hardware Components Description

Flood detection systems rely on several hardware components. Each component plays a specific role in sensing, processing, displaying, or transmitting flood-related information. This section outlines the essential hardware used in the development of the system.

Microcontroller

A microcontroller is a compact integrated circuit designed to control specific operations in embedded systems. It includes memory, input/output peripherals, and a processor in one chip. Microcontrollers are used in many electronic devices like washing machines, microwave ovens, and mobile phones. They are cost-effective and

consume low power. Most microcontrollers operate at low clock speeds and are suitable for simple, repetitive tasks. Popular types include AVR, PIC, and ARM. These newer versions support protocols such as I2C, SPI, and USB. This makes them ideal for tasks like reading sensors and controlling displays.

Arduino Nano

The Arduino Nano is a small, breadboard-friendly microcontroller board based on the ATmega328. It functions like the Arduino UNO but in a compact form. It connects to a computer via a Mini-B USB cable, which also supplies power. The Nano runs on 5V logic and has 14 digital I/O pins, 8 analog inputs, and a 16 MHz clock speed. It is suitable for embedded applications, including flood monitoring systems. It supports SPI and I2C communication, making it easy to connect to modules like GSM, SD card, and sensors.

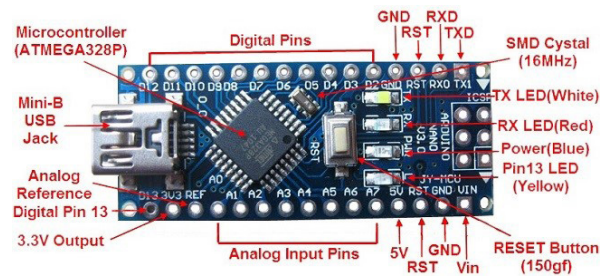


Figure 1: PCA Visualization of Benign and Malicious Traffic

Table 1: Arduino Nano Specifications (www.avrchip.com)

Microcontroller	Atmel ATmega168 or ATmega328
Operating Voltage (logic lev-cl)	5 V
Input Voltage (recommended)	7-12 V
Input Voltage (limits)	6-20 V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	8
DC Current per I/O Pin	40 mA
Flash Memory	16 KB (ATmega168) or 32 KB (ATmega328) of which 2 KB used by bootloader
SRAM	1 KB (ATmega168) or 2 KB (ATmega328)
EEPROM	512 bytes (ATmega168) or 1 KB (ATmega328)
Clock Speed	16 MHz
Dimensions	0.73" x 1.70"
Length	45 mm
Width	18 mm
Weight	5 g

DS3232 Real-Time Clock (RTC)

The DS3232 is a high-accuracy real-time clock with a temperature-compensated oscillator. It maintains time during power outages using a backup battery. The clock keeps track of seconds, minutes, hours, day, date, month, and year. It operates on a 3.3V supply and uses the I2C interface for communication. The module has built-in alarms and a square-wave output. It is compact and

designed to function in various temperature ranges. This makes it reliable for continuous time tracking in remote monitoring systems.

16x2 Liquid Crystal Display (LCD)

The 16x2 LCD is a common display used in embedded projects. It shows 16 characters per row on two rows. Each character is displayed using a 5x8 pixel matrix. The module

supports both 8-bit and 4-bit data communication modes. It includes an interface IC, usually the HD44780, which receives commands and data from the microcontroller.

The LCD operates at 5V and consumes low power. It is used to display water level information, time, and alert messages to the user.

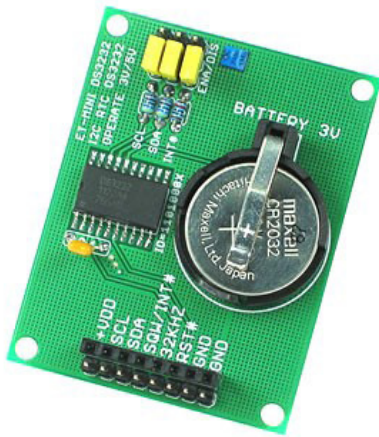


Figure 2: Sample of Ds 3232 RTC
(www.amazon.com/mini-Real-time-clock)

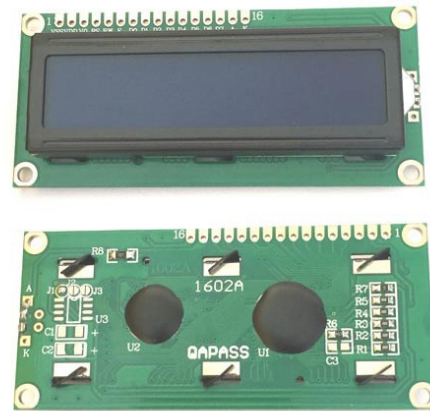


Figure 3: Sample of 16x2 LCD Module
(www.Components101.com/LCD)

Table 2: LCD Pin Configuration

Pin No	Pin Name	Description
1	Vss (Ground)	Ground pin connected to system ground
2	Vdd (+5 Volt)	Powers the LCD with +5V (4.7V – 5.3V)
3	VE (Contrast V)	Decides the contrast level of display. Grounded to get maximum contrast.
4	Register Select	Connected to Microcontroller to shift between command/data register
5	Read/Write	Used to read or write data. Normally grounded to write data to LCD
6	Enable	Connected to Microcontroller Pin and toggled between 1 and 0 for data acknowledgement
7	Data Pin 0	Data pins 0 to 7 forms a 8-bit data line. They can be connected to Microcontroller to send 8-bit data. These LCD's can also operate on 4-bit mode in such case Data pin 4,5,6 and 7 will be left free.
8	Data Pin 1	
9	Data Pin 2	
10	Data Pin 3	
11	Data Pin 4	
12	Data Pin 5	
13	Data Pin 6	
14	Data Pin 7	
15	LED Positive	Backlight LED pin positive terminal
16	LED Negative	Backlight LED pin negative terminal

SD Card Module

An SD card module provides external memory for storing data like water levels and timestamps. It connects to the microcontroller using the SPI interface. The card requires 3.3V for operation and uses pins such as MISO, MOSI,

CS, and CLK. SD cards are ideal for data logging because they offer large storage space in a small form factor. They are used in many portable devices and embedded systems. In flood monitoring, they help store sensor data for later analysis.

GSM Module

The GSM module is used for wireless communication. It sends SMS alerts to predefined numbers when water levels

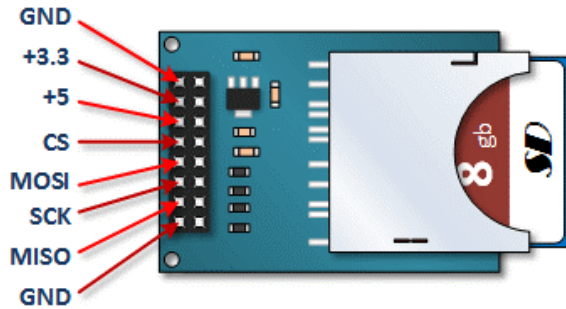


Figure 4: Sample of SD-Card-Pin-Outs
Source: www.benrysbench.com/pinout/arduino-SD-card/

rise above a threshold. It operates using AT commands and communicates with the microcontroller through serial communication. The module supports quad-band



Figure 5: GSM module
Source: www.engineersgarage.com/GSM-module/

GSM frequencies and can be powered by a 3.4V to 4.4V supply. It is compatible with most microcontrollers, including Arduino. For basic operation, pins such as VCC, GND, TXD, and RXD are used. It also supports voice calls and GPRS data.

functions during power outages. The typical capacity of the battery is 170mAh, making it suitable for low-power applications like sensors and microcontrollers.

Power Supply – 9V Rechargeable Battery

The system is powered using a 9V Duracell rechargeable battery (DC1604). It has a nominal voltage of 8.4V and supports a range of 7V to 9.5V. It is based on nickel metal hydride (Ni-MH) chemistry, which is safe and reusable. The battery can operate in temperatures from -10°C to 50°C and has built-in short-circuit protection. It supplies power to all components in the system, ensuring it



Figure 6: Duracell Rechargeable
Source: Battery (DC1604) (www.duracell.com)

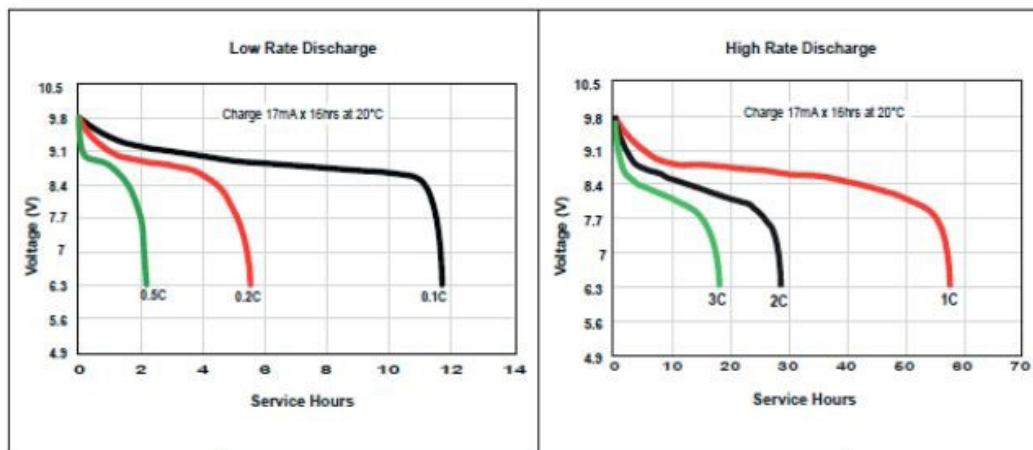


Figure 7: Battery Service Hour Rate
Source: www.powerstream.com/9v-alkaline-test

The design of the flood detection system followed a top-down approach. This section outlines both the hardware and software components used in the project. The system was divided into two primary sub-units: the hardware unit and the software unit. Together, these components work to detect rising water levels and alert relevant users via SMS.

MATERIALS AND DISCUSSIONS

System Architecture and Methodology

The hardware unit is made up of the power supply, control, and communication units. The control unit contains the water level sensor, LCD display, LEDs, and buzzer alarm. These elements work together to collect input and show

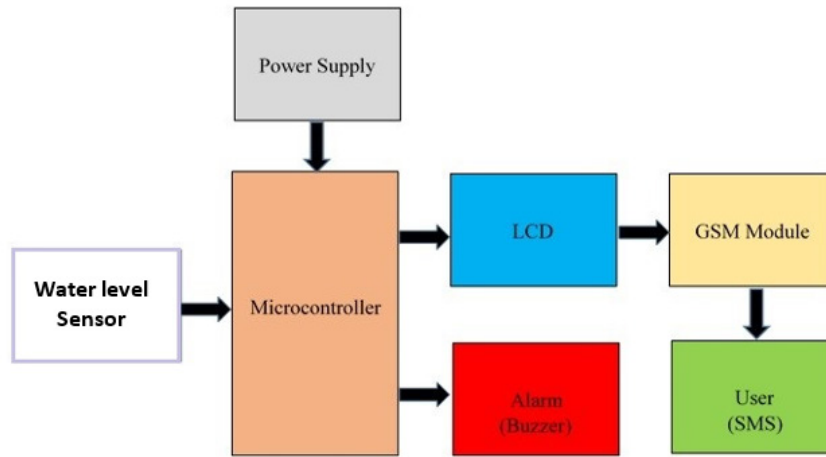


Figure 8: Block Diagram of Flood Detection System

system status. The communication unit includes the GSM and SD card modules, which handle data transmission and logging. The software unit consists of programming tools used to control the hardware. Embedded C programming was used to configure the Arduino Nano microcontroller, which is central to the system's operation.

Hardware Implementation

The hardware setup includes the following components:

- Arduino Nano (microcontroller)
- DS3232 RTC
- 16x2 LCD module
- Buzzer alarm

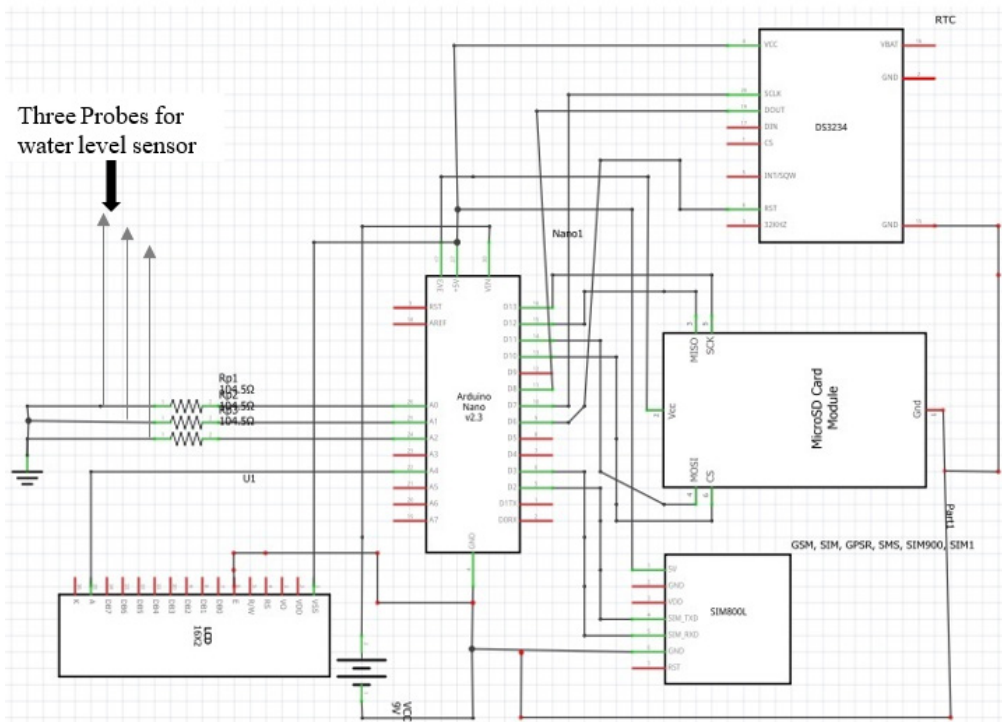


Figure 9: Circuit diagram of the implemented system

- SD card module
- GSM module (SIM800L)
- Water level sensor
- 9V rechargeable battery

These components were integrated to build a functional prototype that senses water level and sends alerts via SMS.

Software Implementation

The Arduino Nano was programmed using the Arduino IDE. This environment allows the user to write, compile, and upload code to the board. It supports C and C++ and provides real-time feedback on code performance. Notepad++ was also used for writing and editing the code due to its lightweight and efficient performance.

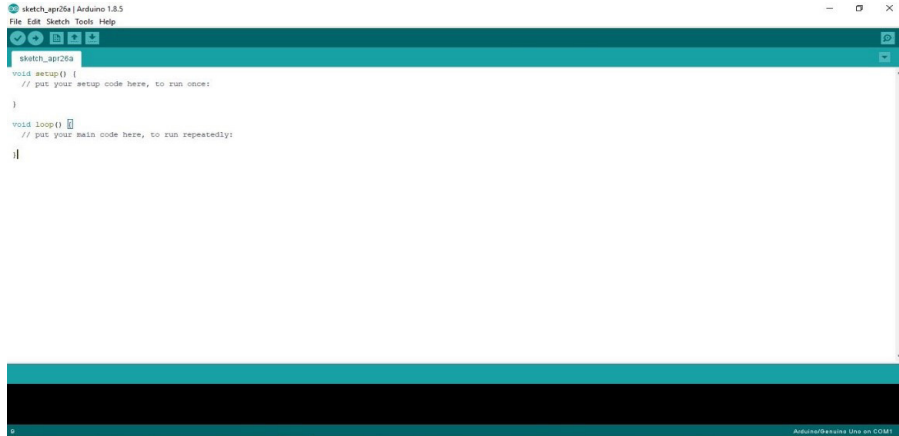


Figure 10: Arduino IDE. (Screenshot)

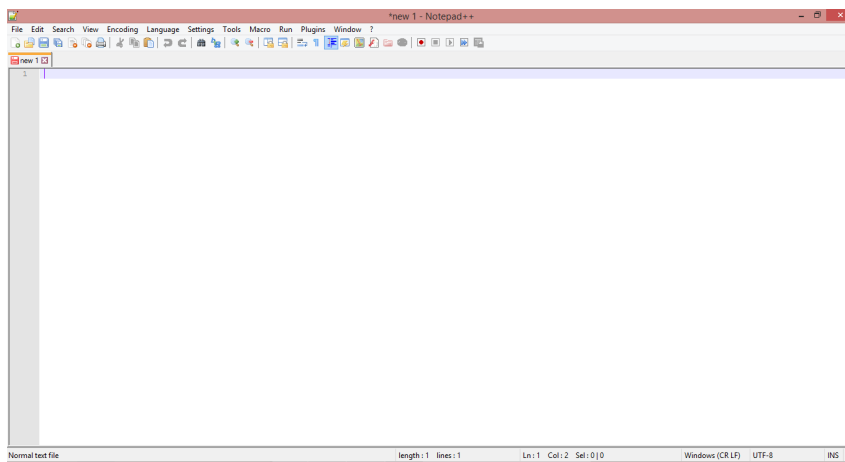


Figure 11: Notepad++ IDE (screenshot)

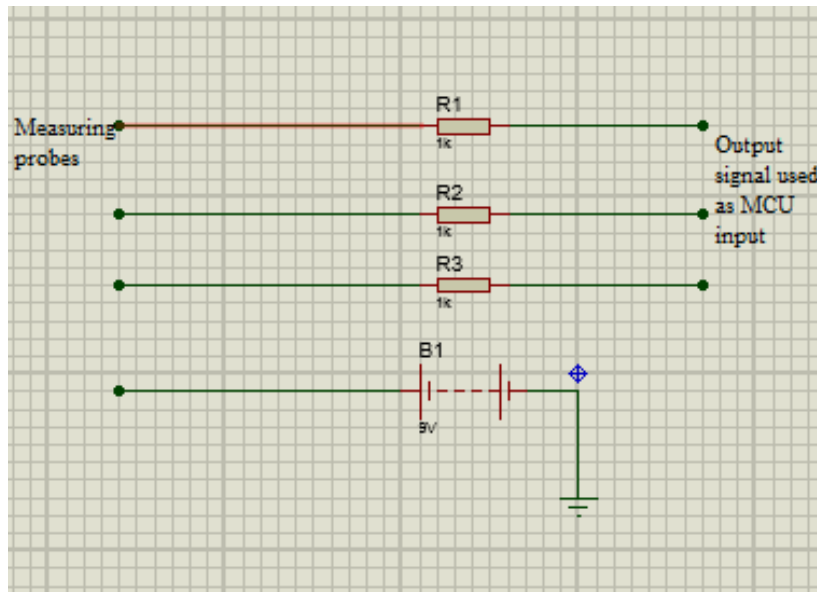


Figure 12: Water level indicator circuit (Proteus Screenshot)

Water Level Sensor Unit

The water level detection is achieved using a simple resistive probe setup. Three resistors serve as probes to detect different water levels—safe, warning, and critical.

When water touches any probe, it completes an electrical path due to water’s conductivity.

Resistivity (ρ) and conductivity (σ) of the water are calculated using the following formulas:

$$\sigma = 1/(R_w * A) \text{ S/m}$$

$$\rho = (R_w * A)/l = 1/\sigma \text{ } \Omega\text{m}$$

Where,

l = length of the container

A = cross-sectional area

R_w = measured resistance

σ is the Conductivity.

ρ is the resistivity.

The resistivity of some waters includes;

Table 3: Resistivity of typical water samples

Water	ρ(Ωm)
Pure water	20,000,000
Distilled water	500,000
Rain water	20,000
Tap water	1,000-5,000
River water (brackish)	200
Sea-water (coastal)	30
Sea-water (open sea)	20-25

The values for the three resistors which will be used as probes for sensing water level is gotten mathematically using ohms' law;

For R_{p1} taken as the first probe;

$$V = IR \tag{3}$$

From the circuit when the probe comes in contact with water, the resistance of the probe will be in series with the resistance generated by the water i.e. Rp1 + Rw which represents the total resistance.

$$V = I*(R_{p1} + R_w) \tag{4}$$

$$R_{p1} = V/I - R_w \text{ (}\Omega\text{)} \tag{5}$$

Where,

- I is the DC current for input/output pin of Microcontroller which is 40mA from datasheet.

- V is the voltage of DC battery or voltage input from the microcontroller.

- R_w is the resistance of water gotten experimentally.

- R_{p1} is the =resistance of the first probe.

Resistance values for probe 2 and probe 3 (RP2 & RP3) is also calculated using equation 3.5.

Calculation from the Salt Water Resistance Test

Volume of water used = 50cl

Quantity of salt = 1 teaspoon

Voltage input from the microcontroller = 5V (from datasheet)

Current output pin of the microcontroller = 40mA = 0.04A (from datasheet)

Resistance of water gotten experimentally Rw = 16 - 25 Ω = 20.5 Ω (Average value)

Resistance of each probe is gotten using equation 3.5

$$R_{p1} = 5/0.04 - 20.5 \text{ (}\Omega\text{)}$$

$$R_{p1} = 104.5 \text{ (}\Omega\text{)}$$

A resistor with a rating of 104.5(Ω) or higher will be used for probes R_{p1}, R_{p2} and R_{p3} in the water sensor unit.

Flowchart and System Logic

The program logic reads the water level from the sensor, converts it from analog to digital, and compares it to a defined threshold. If the value exceeds the limit, an alert SMS is triggered.

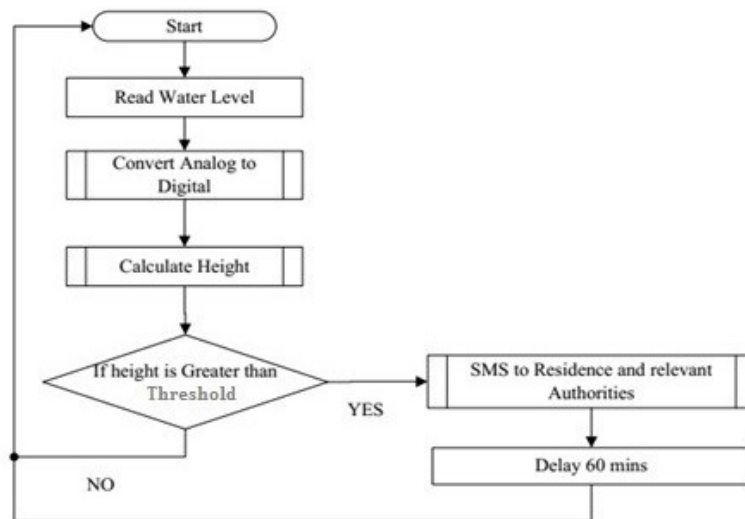


Figure 13: System flowchart showing control logic

Pseudo-code Summary

Start:

```

Read ("Water Level");
Convert (Convert Analog to Digital);
Print (height);
If (height >= Threshold) {YES
  Print (SEND SMS);
  Delay (60 mins.)}
  
```

Else (Repeat);

End Stop

This system enables early response to flood threats by notifying key contacts and authorities like NEMA.

RESULTS AND DISCUSSION

This section describes the testing of the electronic components, power supply (9v battery) and the software

simulation of the complete system circuit using ARDUINO IDE and Proteus. This section will also focus on the actual construction and testing of the complete flood detector system.

Testing

The construction of the complete system will start with the testing of the individual hardware components before soldering and packaging. The testing of the individual hardware components is carried out so as to detect faults and errors and to adjust the circuit accordingly. The power supply which is the 9v battery was checked for proper voltage level from its output pins with a multimeter. The control unit which consists of the water level circuit, LCD and the buzzer, and the communication unit which consists of the GSM module and SD card module were tested. The system software program was simulated and debugged before burning it to the Arduino Nano microcontroller chip.

Hardware Components Testing

Each hardware component of the system was tested before soldering them to the Vero board. The testing process is explained in this section.

Resistor

The digital multimeter was used to measure the resistance of the resistor used for the design according to the design specification.

Power Supply (9v Battery)

The digital multimeter was also used to measure the output voltage of the battery.

Microcontroller and Electronic Modules

The required microcontroller (Arduino Nano), and electronic modules such as the GSM module, SD card module, LCD, RTC module and the buzzer were purchased and tested following the procedure below;

i. The datasheet for each of the modules were downloaded from the internet. The datasheet contains circuit diagrams, required library, test programs, voltage and current specification. This datasheet acts as a guide when purchasing these modules.

ii. The required library is installed in the Arduino Integrated Development Environment (IDE). This process enables easy simulation of the modules with other electronic components on the IDE software and Proteus software.

Circuit Testing and Simulation

The water level circuit in Fig. 12, which acts as the input for the system, was interfaced with the microcontroller, which processes the current signals sent from the water level unit. The GSM module which acts as the output for the system was also interfaced with the microcontroller. The interfacing of the water level circuit with the microcontroller and the GSM module was carried out on a bread board.

The microcontroller is connected to the IDE software through a USB connection. Having completed the setup, the three input probes of the water level sensor which represents the three different levels for flood alert, were each connected one after the other to the general purpose input/output pin of the microcontroller, which was configured as an input pin in the software program for simulation purpose to generate a current signal. The current signal for each input probe is processed by the

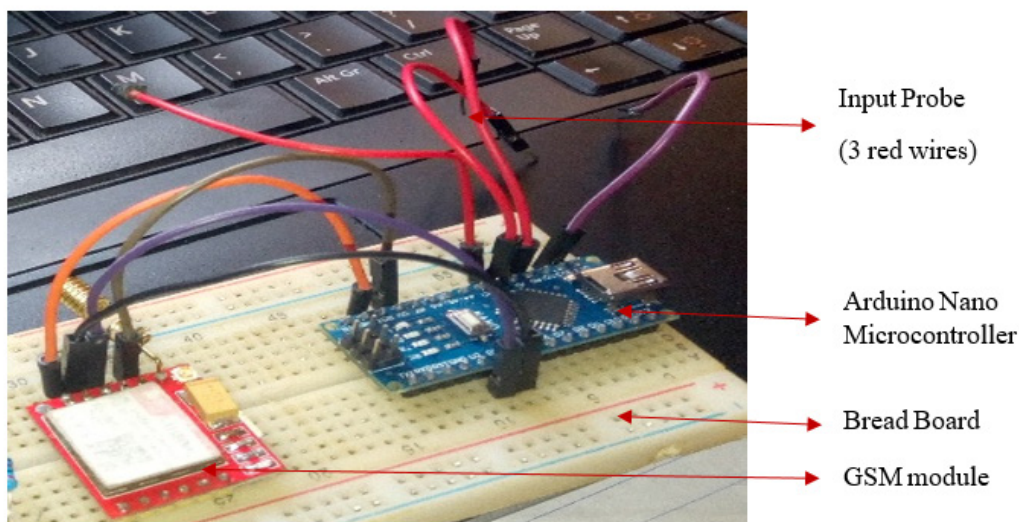


Figure 14: Bread board arrangement for Simulation test with Arduino IDE

microcontroller and transferred to the GSM module as a flood alert message.

Circuit Implementation

After conducting the tests and simulation to confirm that

all components to be used for the flood detector system are in good working condition, they were transferred to the Vero board for soldering following the circuit diagram in figure 9. Care was taken when soldering to prevent overheating of the components to be soldered.

Results of Tests

This section presents the results of the various tests carried out on the different hardware components, and also the results obtain when the complete flood detector system was tested at different conditions.

Table 4: Hardware components test result

Component	Simulation Value	Constructed Value
Resistor	104.5 (Ω)	200 (Ω)
Battery	9 (V)	8.67 (V)
Liquid crystal display	5 (V)	4.5 (V)
SD Card module	3.3 (V)	3.5 (V)
GSM module	4.4 (V)	3.49 (V)
Real time clock	3.3 (V)	3.0 (V)

Table 5: Results gotten after construction of the circuit

Process	Simulated result	Actual result / state of system
Switch in off state	Off state	Entire system is off
<ul style="list-style-type: none"> • Switch in ON state • Water vessel empty 	<ul style="list-style-type: none"> • System comes ON • LCD displays water level NORMAL • No SMS sent 	<ul style="list-style-type: none"> • System is powered ON • LCD showed water level as NORMAL • No SMS was sent
<ul style="list-style-type: none"> • Water vessel is filled with water (salt water). 	<ul style="list-style-type: none"> • LCD displays water level as; <ul style="list-style-type: none"> i. HIGH ii. CRITICAL 	<ul style="list-style-type: none"> • LCD displayed water level as; <ul style="list-style-type: none"> i. HIGH when the water level rose to the second probe ii. CRITICAL when the water level rose to the third probe In both conditions of the water level sensor an SMS alert was sent by the GSM module.

Discussion of Results

- When the flood detector system was tested using salt water, the system responded to the water level changes through the processing of the current signals sent to the microcontroller from the water level sensor unit.
- SMS alert was sent by the GSM module any time the water level increased to HIGH level or CRITICAL level.

- The system also adjusted accordingly anytime the water level dropped to NORMAL or increased to HIGH and CRITICAL level. A delay of 60 minutes was observed before sending another SMS.
- The water level data including the time and date of measurement was stored using the SD card module.



Figure 15: Complete Flood Detector System

CONCLUSION

This project involved the design and implementation of an early warning flood detection system using SMS. Upon simulating and building, the assembled hardware was tested, and the microcontroller successfully responded to the various input stimuli from the water level sensors. The GSM module transmitted SMS alerts when the water level crossed the threshold, while the SD card module stored real-time data such as date, time, and water level. The system was developed to monitor water levels in flood-prone areas and send timely alerts, enabling early evacuation. The alert messages can also be sent to emergency agencies to coordinate response efforts. The system was designed for easy maintenance and repair. It leverages embedded systems and cost-effective components to address real-life flood challenges, enhancing information flow to affected communities and emergency responders.

Key contributions of this project include:

- i. Development of a simple water level sensor using only resistors, which are cost-effective and durable. The system also has low power requirements (approx. 9V).
- ii. Compact design allows for easy deployment across various flood-prone areas. This addresses the high cost and complexity of conventional flood detection systems.
- iii. The use of GSM technology to send SMS alerts increases the system's reach, given the widespread use of mobile phones.

Recommendations

To improve on this design, the following recommendations are suggested:

- Future work should consider upgrading to newer, more efficient microcontrollers as technology evolves.
- A solar-powered energy source can be integrated with the rechargeable battery to ensure continuous operation.
- The system can be expanded to detect other environmental hazards by interfacing with sensors for rainfall, temperature, or humidity.
- Integration of a GPS module would enhance the alert system by providing location-specific data in the SMS alerts.

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