Autonomous Safety System for water bodies accidents

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***Abstract*—The Autonomous safety system is designed for real-time monitoring and emergency response in aquatic environments.The system integrates multiple modules including a NEO6M GPS module for location tracking, water sensors for detecting water levels, and a SIM900A GSM module for sending emergency signals.The core functionality of the system involves continuous monitoring of water levels and the automatic generation of emergency signals when abnormal conditions are detected.**

***Index Terms*—safety system, real-time monitoring, emergency response, water sensor, and NEO6M GPS module.**

I. Introduction

The project is an extensive endeavor focused on developing and deploying an autonomous safety system meticulously designed for addressing water-related emergencies.

This comprehensive system encompasses the seamless integration of GPS for location tracking, advanced water sensors for detecting changes in water levels and potential hazards, GSM communication for sending distress signals to designated emergency contacts. The primary objective of this system is to detect emergencies swiftly, accurately pinpoint their locations, and autonomously trigger appropriate responses, ultimately bolstering safety measures in aquatic environments.

Through meticulous planning and strategic implementation, the project aims emergency response capabilities in water environments. By leveraging the capabilities of GPS technology, the system ensures accurate and real-time tracking of emergency incidents, facilitating rapid intervention and rescue operations. The integration of sophisticated water sensors enhances the system's ability to detect subtle changes in water conditions, enabling proactive measures to mitigate risks such as flooding or sudden rises in water depth. Additionally, the utilization of GSM communication enables seamless communication with emergency contacts, ensuring timely assistance and coordination during critical situations.

Furthermore, the real-time implementation serves as a tangible demonstration of the system's autonomous navigation capabilities and operational effectiveness. This aspect not only showcases the system's functionalities but also provides a platform for rigorous testing and refinement, ensuring optimal performance and reliability in real-world scenarios. By amalgamating these components and functionalities, the project aspires to set new benchmarks in autonomous safety systems tailored for water environments, contributing significantly to enhancing overall safety and response capabilities in aquatic settings.

II. Literature Survey

This project along with real-time water level monitoring to include automatic emergency signal triggering and a predefined contact list for swift response. Utilizing a cellular network or specialized protocols and the system surpasses SMS alerts for detailed emergency messages inspired from [1]. Also achieves physical implementation by integrating a Bluetooth-controlled boat, our project showcases autonomous capabilities and facilitates safe user training.

This project prioritizes emergency response in aquatic environments, focusing on real-time monitoring of water levels to trigger automated emergency responses. In contrast, [2] concentrates on water quality monitoring using an AUV. This project targets surface water bodies with a Bluetooth-controlled boat, while [2] describes an AUV designed for underwater environments, likely operating at greater depths. The project gathers water level data for emergency responses, while [2] focuses on collecting various water quality data points for analysis and environmental monitoring.

This project focuses on aquatic environments, adapting sensor technology and communication protocols for underwater operations, utilizing water level sensors and GSM/satellite communication for emergency signals. While [3] focuses on worker safety hazards, our project addresses water-related emergencies like flooding, requiring distinct triggering mechanisms for the response system. Unlike worker safety systems, the aquatic system responds to people in the water by alerting emergency services, deploying flotation devices, or activating remote-controlled rescue boats.

This project prioritizes real-time detection of abnormal water levels (like flooding) and triggers automated emergency signals, contrasting [4] broader focus on autonomous water monitoring. While [4] proposes a multi-vehicle system, this project simplifies with a single Bluetooth-controlled boat, potentially reducing cost and complexity. [4] plan full deployment, but this project uses a Bluetooth-controlled boat for demonstrations, allowing safe observation of autonomous navigation functionalities.

This project prioritizes real-time monitoring and emergency response in aquatic environments, triggered by water level changes, contrasting [5] focus on seabed life detection using computer vision. This project uses water sensors for level variations, while [5] likely employs visual sensors like cameras. This reflects distinct sensor choices for specific objectives. This project operates near the water surface, monitoring levels, while [5] focuses on seabed life detection with computer vision, highlighting environmental depth differences.

The taken [6] paper centers on remote control of electrical appliances using GSM and Arduino, prioritizing user convenience and energy efficiency, without the inclusion of environmental monitoring or emergency response functionalities.

This paper focuses on real-time monitoring of aquatic environments for emergency response using a GSM module, GPS, and water sensors. [7] paper offers a general overview of GSM module applications without specifying a particular use case or environmental context.

The selected [8] paper concentrates on using a GSM module to wirelessly monitor radiation levels and transmit the data via SMS, without addressing realtime emergency response or aquatic environments.

The paper [9] concentrates on home safety and security, employing GSM technology for remote monitoring and control of home appliances, with a primary focus on intrusion detection and security alerts.

This paper focuses on real-time aquatic environment monitoring and emergency response using sensors and communication modules, while [10] present a digital electronic board using a GSM module and database for a completely different application.

The paper [11] concentrates on electricity management, employing a GSM controller to reduce wastage through a missed call-based approach.

The paper of next interest [12] focuses on indoor environment monitoring, specifically temperature and humidity, with an alert system triggered by abnormal readings. It does not involve aquatic environments, GPS, or autonomous navigation components. It focuses on post-incident action through violation detection and reporting. The paper concentrates on tracking and managing fleets of vehicles using IoT devices and geofencing, primarily focused on land-based transportation and logistics.

The paper [15] evaluates the performance of a GPS-based IoT system using LoRa, concentrating on system evaluation and not real-time environmental monitoring or emergency response.

Focus on vehicle tracking and monitoring using IoT technology, emphasizing GPS and sensor data for vehicle location and status updatesis observed in the [16] paper.

The paper [17] concentrates on monitoring carbon monoxide levels using a quadcopter equipped with an IoT system, emphasizing air quality monitoring rather than aquatic safety. It targets indoor navigation for the blind using IoT technology.

The project in the [19] targets enhancing safety for visually impaired people through a microprocessor-based smart glass system, incorporating features like GPS tracking and obstacle detection.

The work in [20] primarily concentrates on a basic water level sensor and controller system for water conservation, lacking advanced features like GPS, GSM, and emergency response mechanisms. It focuses on water pollution monitoring using an RC boat equipped with sensors to measure water quality parameters and transmit data via IoT.

The paper [22] presents a flood early warning system using Android for multi-location monitoring, relying on Arduino and GSM for data collection and transmission, primarily focusing on information dissemination to users rather than autonomous response.

The work done in [24] concentrates on water level control using IoT devices, emphasizing system design and implementation rather than emergency response. It focuses on water quality monitoring by measuring turbidity and temperature using a GSM module, lacking the emergency response, GPS, and physical demonstration components of your project.

The paper [26] consists of work focusing on emergency response rather than mere water level detection. While they utilize IoT for monitoring, your research integrates GPS, GSM, and a controlled boat demonstration for real-time alerts and autonomous navigation, addressing broader safety concerns in aquatic environments.

The paper [27] concentrates on water conservation in urban areas by controlling water supply using ultrasonic and flow sensors, with a focus on smart water management rather than emergency response. It focuses on water quality monitoring and control, employing solar power, turbidity, and pH sensors to regulate a water pump.

The paper [29] concentrates on developing a smart sanitation module for improving hygiene and waste management using various sensors, microcontrollers, and communication technologies.

III. Proposed Method

This diagram outlines the detailed step-by-step process for developing, testing, and validating a system or device.

The process begins with research on the components and conditions. This involves identifying the essential components and understanding the environmental or operational conditions under which the system will operate. It is important to ensure that the right foundation is set for the project by analyzing all necessary requirements.

Next, research on previous and similar models is conducted. This step involves studying existing solutions or systems to gather insights, learn from previous designs, and avoid potential mistakes. It helps in understanding the feasibility of the project and refining ideas for improvement.

Once the research is complete, the focus shifts to selecting suitable components for disposal. The right components are chosen based on the research findings to ensure compatibility, efficiency, and reliability. This step is crucial for ensuring that all parts of the system can work seamlessly together.

In the developing model and writing the required code phase, the actual work begins. The model or system is designed, and the necessary code is written to implement the desired functionality. After the code is ready, it moves to the next step, where it is dumped and debugged onto the device. This ensures that the code is transferred to the hardware and any initial errors are resolved through debugging.

Following this, testing and reviewing of the device is performed. The system is tested to evaluate whether it functions as expected. During this phase, issues or malfunctions are identified, which leads to the error rectification step. Here, the identified errors are fixed, and improvements are made to enhance the system's performance.

Finally, the process ends with result verification. This step involves validating the system's performance to ensure it meets the required specifications and operates correctly under the given conditions. Once verified, the system is considered complete and ready for deployment.

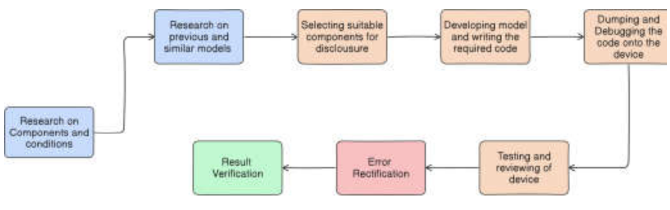

Fig. 1: Workflow of Autonomous safety system Project

different sensors and modules interact with the central Arduino Uno Board to achieve specific tasks.

On the input side, three key components are connected to the Arduino Uno Board:

Water Sensor: This sensor monitors water levels to detect conditions such as flooding or sinking. It ensures timely alerts when abnormal water levels are detected.

SIM 900A GSM Module: This module facilitates communication by sending emergency signals or alerts via GSM networks. It allows remote communication and real-time updates.

NEO 6M GPS Module: The GPS module provides real-time location tracking of the system or vehicle, which is essential for monitoring and navigation in aquatic environments.

At the center of the system is the Arduino Uno Board, which acts as the controller. It processes input data from the connected modules and generates appropriate outputs based on the programmed logic. It serves as the brain of the system, coordinating the tasks performed by the components.

On the output side, the Arduino Uno Board performs the following functions:

Sinking Detection: By monitoring water levels through the water sensor, the system can detect sinking or abnormal conditions and take appropriate action.

Energy Communication: The SIM 900A GSM module facilitates communication, ensuring energy-efficient transmission of emergency alerts and status updates.

Location Tracking: The NEO 6M GPS module provides the location coordinates of the boat, enabling tracking and monitoring of its position in real-time.

In summary, this flowchart highlights how the Arduino Uno Board integrates inputs from multiple modules (water sensor, GSM, and GPS) and produces outputs that include sinking detection, communication, and location tracking. This setup is highly useful for automated or semi-autonomous systems in aquatic environments, ensuring safety, monitoring, and control in real-time.

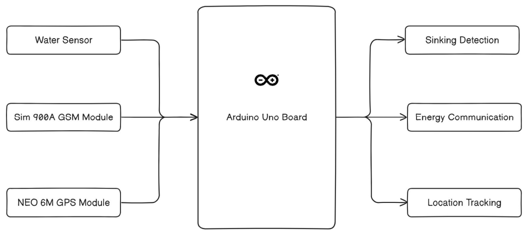

Fig. 2: Architecture of Autonomous safety system

IV. IMPLEMENTATION

A. Hardware Setup

This flowchart illustrates the working of an Arduino Uno-based system that integrates various components to perform critical functions, particularly in an autonomous or aquatic monitoring system. It provides a clear representation of how

B. Location Fetching

The NEO-6M GPS module provides location tracking, allowing the system to precisely determine the coordinates of the emergency situation. Water sensors are placed to detect changes in water levels, such as flooding or sudden rises in water depth, triggering the emergency response mechanism.

C. Information Sending

Upon detection of an emergency, the system utilizes the SIM900A GSM module to send distress signals to predefined emergency contacts, providing them with precise location coordinates for swift response. Additionally, the system incorporates a Bluetooth-controlled boat for practical demonstration purposes, showcasing the autonomous navigation capabilities in a controlled environment.

D. Practical Simulation

To enhance safety measures in aquatic environments by providing real-time monitoring and rapid response capabilities, ultimately minimizing the risk of casualties and property damage during emergencies. Integrating GPS, water sensors, and GSM communication offers a comprehensive solution for addressing safety concerns in water-related scenarios.

A simulated environment was set up to mimic real-world aquatic conditions. The system was tested with varying water levels to assess its ability to detect abnormalities and trigger emergency responses. Although conducted in a controlled environment, the results closely mirror expected real-world outcomes.

For the design and Construction of the device, specific hardware components are required as mentioned below:

1) Arduino UNO

The Arduino Uno is a high-speed, user-friendly, and versatile open-source microcontroller suitable for a brand range of electronics projects. integrated into the Arduino platform, it features an IDE for programming and utilizes the ATmega328P microcontroller from Atmel. The combination of Arduino Uno modules and sensors is commonly employed in projects focused on detection, monitoring, and control.

Fig. 3: Arduino Uno

2) NEO-6M Module

The NEO-6M Module enables precise GPS location tracking, crucial for navigation systems. Its compact design and high accuracy make it ideal for various applications. Integrated with Google APIs, it enhances location-based services for seamless functionality.

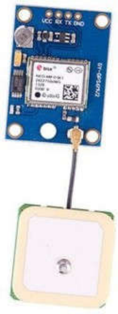

Fig. 4: Neo-6m module

3) SIM900A Module

The SIM900A Module enables seamless communication for emergency transmissions, ensuring swift distress signal delivery. Its integration enhances system reliability and responsiveness in critical situations. This module plays a pivotal role in the project's emergency response mechanism.

Fig. 5: SIM900A module

4) Water Level Sensor

Water level sensors detect and monitor changes in water levels, crucial for flood prevention and environmental monitoring. They provide real-time data for effective decision-making in water management systems.

Fig. 6: water level sensor

V. RESULT

A. System operation

The device's operation primarily relies on the Arduino board and interfacing with Modules.input data is provided in the code, debugged into Arduino board using the Arduino IDE or any compatible IDE. The device remains active continuously, with sensors constantly monitoring and assessing the surroundings.

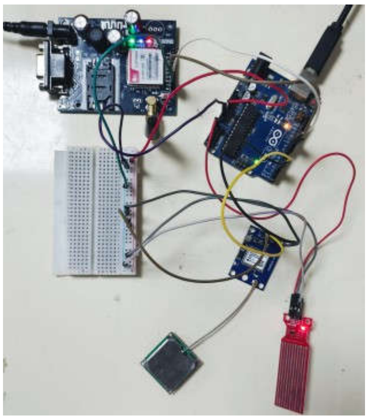

Fig. 7: Circuit Diagram

B. Location Fetching

To find our location using the NEO-6M GPS module with GPS, the module must be connected to the device and set up. With the NEO-6M module, the data sent is read through serial communication and read the data it sends, which includes details like latitude and longitude. For the GSM module, the GPS feature is activated using special commands and then reads the GPS data it provides. Both modules output data in a format called NMEA sentences, which contain information about our location. One need to parse these sentences to extract the latitude and longitude values. Once the information is collected Operations such as displaying it on a Screen or sending it to another device are performed. It's important to remember that the accuracy of the location data may vary depending on factors like signal strength and environmental conditions.

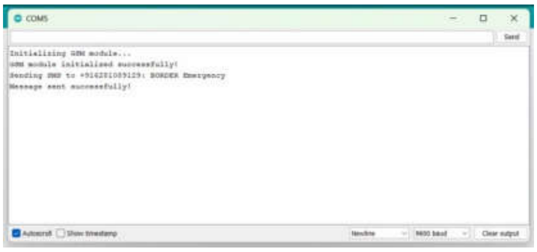

Fig. 8: Location Alert Mechanism

C. Water Level Sensing

To detect water using a sensor, connect the sensor to our microcontroller or development board and set it up properly. The sensor typically outputs a signal when it comes into contact with water, indicating the presence of moisture. The Signal is read using digital or analog pins of the device. Once the signal indicates the presence of water, such as triggering an alarm, activating a pump, or sending a notification. It's important to calibrate the sensor correctly to ensure accurate detection and to consider factors like sensor placement and sensitivity adjustments. Additionally, it is needed to implement power-saving measures to optimize the sensor's operation, especially in battery-powered applications.

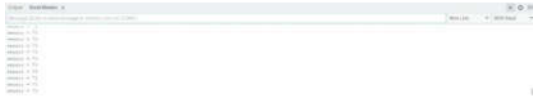

Fig. 9: Water Level Measuring

D. Communication

To enable communication with a GSM module, the Connection should be established with microcontroller or development board, ensuring proper wiring for power, ground, and communication pins. Once connected, it will establish serial communication between our device and the GSM module, typically using software serial or hardware serial pins. After initializing communication, one can send AT commands to the GSM module to perform various functions, such as making calls, sending SMS messages, or connecting to the internet. These AT commands are simple text-based commands that instruct the GSM module on what actions to take. Upon receiving and processing these commands, the GSM module responds accordingly, providing status updates or executing the requested actions. It's essential to handle the responses from the GSM module appropriately, checking for errors or success indicators to ensure reliable communication. Additionally, consider implementing error handling and retry mechanisms to address communication issues that may arise due to network conditions or module malfunctions.

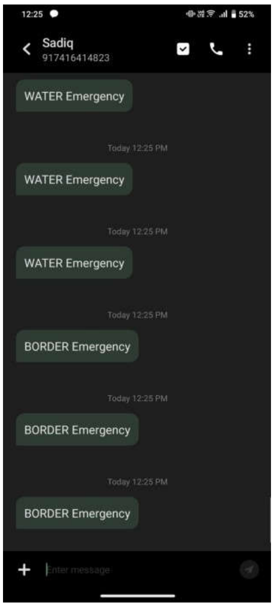

Fig. 10: Alert Messages

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