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River Depth Monitoring and Cleaning

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Abstract
In this paper River Depth Monitoring Robot with Waste Collection Feature is designed to monitor water depths in rivers and identify hazardous areas for water tourism, while also actively cleaning the river by collecting floating waste. The robot uses an Arduino microcontroller, a 100 RPM DC motor, and an L298N motor driver for propulsion, powered by an 8.4V Li-ion battery. The robot is equipped with a waterproof sonar depth sensor for measuring water depth and a GPS module for real time location tracking. The system will classify water depth as Normal (within 3 feet), Medium (3 to 6 feet), and Dangerous (greater than 6 feet), and it sends real-time alerts with GPS coordinates to a Bluetooth mobile app. Additionally, the robot features a net attached to its rear end, designed to collect floating waste and help clean the river as it moves. This dualpurpose robot not only ensures water safety but also contributes to environmental sustainability by removing waste from the water. This report discusses the design, implementation, and potential applications of this river monitoring and cleaning robot.

Keywords: Arduino, Bluetooth module, depth sensor

1. Introduction

Rivers play a crucial role in sustaining biodiversity, supporting livelihoods, and enabling various economic and recreational activities. However, maintaining their ecological balance and ensuring safety for human activities remains a challenge due to pollution and unpredictable water conditions. The presence of floating waste not only harms aquatic life but also diminishes the visual appeal of these water bodies, affecting tourism and local economies. Additionally, fluctuating water depth pose safety risks for boats, ferries, and other water-based transportation systems.

To address these challenges, advancements in automation and smart monitoring systems offer promising solutions. The integration of robotics in water management can significantly enhance efficiency by reducing manual labor and increasing real-time monitoring capabilities. Autonomous systems capable of navigating river environments can play a transformative role in making water tourism safer and more sustainable.

The River Depth Monitoring Robot is designed to be a smart, self-sufficient system that merges water depth analysis with waste collection. By leveraging sensor-based technology and mobile connectivity, it enables proactive management of river conditions. This project represents a step forward in utilizing robotics for environmental conservation and safety enhancement in water-based activities.

A. Objective of research

The goal of the River Depth Monitoring Robot with Waste Collection Feature is to design and develop a robot that combines depth monitoring with waste collection to improve both the safety and environmental health of river areas. Using a waterproof sonar sensor to measure the depth of the river at different points. Sending alerts and location data (via GPS) to the operator's Bluetooth mobile app when dangerous depths are detected.

B. Literature survey

A. Smith[1] presented an autonomous underwater robot designed specifically for waste collection in water bodies such as lakes, rivers, and ponds. The study introduces a modular design approach that enhances the robot's adaptability to different aquatic environments. The proposed system consists of multiple sensors, propulsion mechanisms, and a waste collection unit to ensure efficient navigation and debris removal.

T.S. Lee and M.H. Kim[2] Investigated the use of sonar sensors for accurate water depth measurement, a key aspect of underwater robotic systems. Their research, featured in the IEEE Transactions on Geoscience and Remote Sensing, highlights how sonar sensors achieve high-precision depth readings by emitting sound waves and analysing the reflected signals

R.S. Patel[3] conducted a comprehensive survey on the advancements in autonomous robotic systems for environmental monitoring. The study reviews various technological innovations in robotics that have been applied to pollution control, water quality assessment, and ecological conservation.

L.J. Williams and M.A. Mendez[4] explored the advancements and future trends in robotic waste collection systems. Their study, published in the Journal of Environmental Robotics, focuses on the integration of artificial intelligence (AI), machine learning, and advanced sensor networks to improve the efficiency of waste collection in aquatic and urban environments.

M. A. A. M. Shahrani et al.,[5] This paper presents the design and implementation of a real- time river monitoring robot to assess water quality.

A. S. S. V. Kumar et al.,[6] this paper introduces an autonomous robotic system for cleaning floating waste in small water bodies like lakes and rivers.

2. Working principle

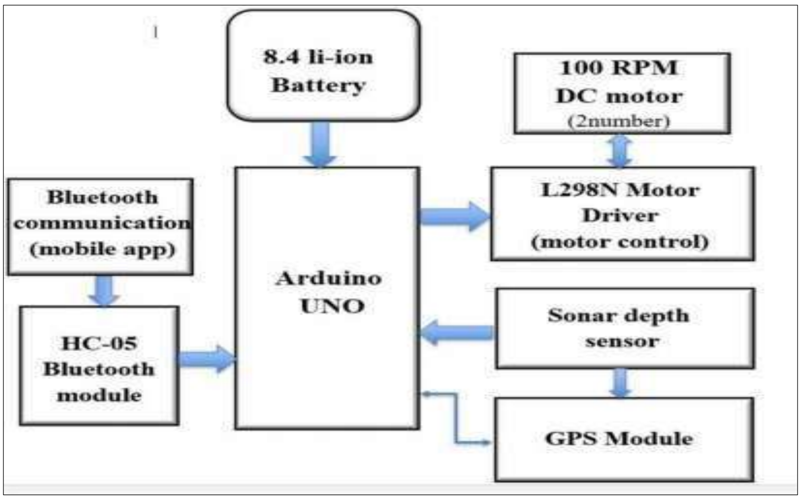

Fig.1: Block Diagram

The River Depth Monitoring Robot with Waste Collection Feature operates on the principles of sonar depth sensing, autonomous navigation, waste collection, and wireless communication. The sonar depth sensor emits ultrasonic waves, which reflect from the riverbed to measure depth accurately. The Arduino microcontroller processes this data and classifies the depth into Normal, Medium, or Dangerous levels. A

GPS module tracks the robot's location, while the HC-05 Bluetooth module transmits depth and location data to a mobile app for real- time monitoring. The robot moves using DC motors, controlled via an L298N motor driver, ensuring smooth navigation. A lightweight net attached to the rear collects floating waste as the robot moves. If dangerous depths are detected, the system sends an alert with GPS coordinates to mark hazardous zones. The robot is powered by an
8.4V Li-ion battery, optimized for continuous operation.
The Arduino microcontroller initializes all sensors, motors, and communication modules. The robot moves using DC motors, while the sonar depth sensor continuously measures water depth. The Arduino processes depth readings and classifies them as Normal, Medium, or Dangerous based on preset thresholds. The Bluetooth app allows users to control the robot, view realtime depth data, and track its movement.

3. Hardware description

A. ARDUINO

The Arduino Uno, shown in Fig. 2, is an open-source microcontroller board built around the Microchip ATmega328P microcontroller and developed by Arduino. It features multiple digital and analog input/output (I/O) pins, allowing easy integration with expansion boards (shields) and other electronic circuits. The board includes 14 digital I/O pins, six of which support PWM output, along with six analog input pins. It is programmed using the Arduino IDE (Integrated Development Environment) via a Type-B USB cable, making it a versatile choice for various applications**.**

Fig.2: Arduino

B. 100 RPM BO Motor

It is a BO Series 1 100RPM DC Motor Plastic Gear Motor shown in Fig.3 The BO series straight motor gives good torque and rpm at lower operating voltages, which is the biggest advantage of these motors.

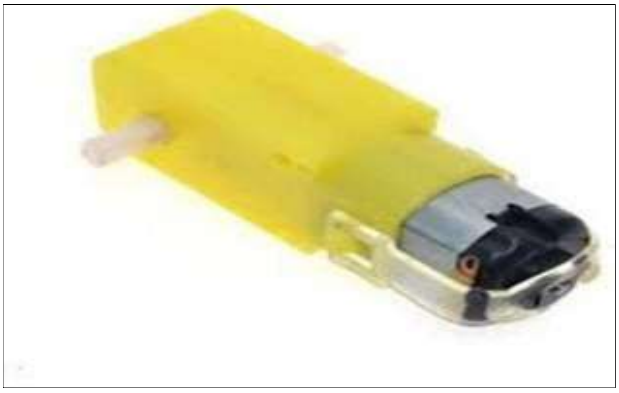

Fig.3: 100RPM BO motor

C. BATTERY

This 2600mAh Lithium-Ion battery, shown in Fig. 4, offers excellent value for money. It has a rated voltage of 3.7V and a capacity of 2600mAh. As a single-cell, compact, and high-performance battery, it provides reliable power for various applications. Its convenient design makes it easy to integrate into projects requiring a 3.7V power source with a high-capacity supply.

Fig.4: Battery

D. Neo GM GPS Module

The GPS module shown in Fig.5 utilizes advanced technology to provide highly accurate positioning data. It features a larger built-in 25 x 25mm active GPS antenna with a UART TTL socket for seamless connectivity. Additionally, a built-in battery ensures faster GPS lock acquisition. This upgraded GPS module is compatible with ArduPilot Mega V2, making it ideal for precision-based applications.

Fig.5: GPS module

IV. ADVANTAGES AND DISADVANTAGES

ADVANTAGES

1. The robot not only monitors water depth for safety but also collects floating waste, making it a multifunctional tool for water tourism areas
2. The system provides real-time alerts with GPS coordinates, helping operators quickly identify dangerous areas in the water
3. The robot operates autonomously, reducing the need for manual depth monitoring and waste collection
4. The robot can be controlled remotely via a Bluetooth mobile app, providing convenience and ease of operation.

DISADVANTAGES

1. The robot's battery life may be limited by the combined power requirements of the motors, sensors, and waste collection system.
2. The Bluetooth communication range is limited, which may restrict the robot's operational area

3. The waste collected by the robot needs to be manually disposed of or emptied from the net, requiring additional human intervention.

V. PERFORMANCE ANALYSIS

TABLE 1: RESULT COMPARISON

Authors	Technology	Proposed model
R.S. Patel [3]	Manual depth measurement, Echo sounding, survey boats, fixed sonar sensors	Arduino-controlled robotic system with sonar depth sensor, GPS, and Bluetooth
A. S. S. V. Kumar et al., [6]	Stationary sensors or boats requiring manual operation	Fully autonomous, mobile robot capable of real-time monitoring
L.J. Williams and M.A. Mendez [4]	Requires human intervention	Operates autonomy

The proposed model significantly improves upon existing technologies used for river depth monitoring and waste collection. Traditional methods, such as those described by R.S. Patel, rely on manual depth measurement techniques like echo sounding, survey boats, and fixed sonar sensors. These approaches require human intervention and are often time-consuming, limiting real-time monitoring capabilities. In contrast, the proposed model introduces an Arduino-controlled robotic system equipped with a sonar depth sensor, GPS, and Bluetooth connectivity, enabling automated and more efficient data collection.

Similarly, A. S. S. V. Kumar et al. describe the use of stationary sensors or manually operated boats, which restrict flexibility and responsiveness in changing water conditions. The proposed model overcomes this limitation by being a fully autonomous, mobile robotic system capable of real-time depth monitoring without human intervention. This ensures continuous and precise data collection while significantly reducing operational costs and human effort.

L.J. Williams and M.A. Mendez highlight technologies that require direct human involvement to monitor and collect river data. The proposed model enhances this process by incorporating autonomy, allowing it to function independently and efficiently over extended periods. The automation not only improves data accuracy but also enhances accessibility by integrating advanced communication technologies like Bluetooth and GPS for remote monitoring.

VI. CONCLUSION

This dual-functional robot serves as a proactive safety measure, preventing accidents caused by sudden depth variations, which are common concerns in water tourism and transportation. The real-time classification of water depth into predefined risk levels, combined with instant alerts and GPS-based tracking, ensures that hazardous areas are quickly identified, allowing for timely interventions.

Additionally, the robot contributes significantly to environmental conservation by autonomously collecting floating waste, thereby reducing water pollution, and enhancing the ecological health of rivers. This feature not only preserves aquatic ecosystems but also improves the aesthetic and recreational value of water bodies, making them more suitable for tourism, fishing, and other activities.

The system's wireless control via a Bluetooth mobile application offers users convenience and real-time monitoring capabilities, allowing for seamless operation and remote supervision. Moreover, the costeffective and scalable design makes it a sustainable alternative to traditional manual depth monitoring and waste collection methods.

In conclusion, this autonomous robotic system is an asset for both public safety and environmental management, offering a technologically advanced, efficient, and eco-friendly approach to maintaining clean and safe waterways. Its implementation in water tourism areas can lead to safer navigation, improved water quality, and a sustainable future for river ecosystems.

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