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Design of River Depth Plotting and River Cleaning Robots

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***Abstract*— Rivers play an important role in maintaining ecological balance, supporting agriculture, and supplying water. Increasing pollution and waste accumulation have created major environmental challenges, making traditional river monitoring and cleaning methods inefficient and time-consuming. This project presents a River Depth Plotting and River Cleaning Robot designed for real-time river depth measurement and waste collection. The system uses ultrasonic sensors for depth sensing, GPS for location tracking, and IoT communication for real-time data transmission. An automated cleaning mechanism collects floating waste such as plastic bottles, leaves, and debris. The robot is controlled using an ESP32/Arduino microcontroller and operates on rechargeable batteries with optional solar support. The proposed system reduces manual effort, improves river maintenance efficiency, and supports smart environmental monitoring. The robot continuously monitors river conditions and helps in maintaining cleaner water bodies.**

Keywords— River Cleaning Robot, River Depth Plotting, IoT-Based Monitoring, Ultrasonic Sensor, GPS Tracking, Environmental Monitoring, Waste Collection System, Smart Water Management, ESP32, Arduino, Autonomous Robot, River Pollution Control, Real-Time Data Transmission, Renewable Energy Support, Embedded Systems.

I. INTRODUCTION

The “Design of River Depth Plotting and River Cleaning Robots” project is developed to address the increasing problem of river pollution and the difficulty in monitoring river depth in real time. Rivers play a major role in supplying water for agriculture, industries, domestic usage, and ecosystem balance. However, due to rapid urbanization and improper waste disposal, rivers are becoming heavily polluted with plastic waste, floating debris, and industrial contaminants. In many regions, river depth information is also not regularly monitored, leading to problems such as flooding, navigation difficulties, and inefficient water management. This project aims to provide an automated and efficient solution for both river cleaning and depth analysis using robotic technology.

The proposed system consists of an autonomous robotic platform capable of floating and moving across the water surface while performing two important operations simultaneously. The first operation is river depth plotting using ultrasonic or sonar sensors that measure the depth of water at different locations. The collected data can be stored and displayed for monitoring purposes. The second operation involves collecting floating waste materials such as plastics, leaves, and small debris using a conveyor or collection mechanism attached to the robot. By integrating these two functionalities into a single system, the project reduces manual labor and increases operational efficiency.

Traditional river cleaning methods mainly depend on human workers and large boats, which are expensive, time-consuming, and sometimes unsafe. Similarly, river depth measurements are often conducted manually using specialized equipment, which requires skilled operators and periodic monitoring. The proposed robotic system overcomes these limitations by introducing automation and smart sensing technology. The robot can continuously monitor the river conditions and clean the water surface without direct human intervention. This improves safety, reduces maintenance costs, and enables regular environmental monitoring.

The project also demonstrates the practical application of embedded systems, robotics, and Internet of Things (IoT) technologies in environmental engineering. Sensor data collected by the robot can be transmitted wirelessly to monitoring stations or cloud platforms for real-time analysis. Authorities and environmental agencies can use this information to make quick decisions regarding river cleaning and maintenance activities. The integration of automation and communication technologies makes the system more efficient and suitable for future smart city applications. The rapid increase in water pollution and the accumulation of floating waste materials in rivers have become major environmental concerns in recent years. Rivers play an important role in maintaining ecological balance, supporting agriculture, providing drinking water, and sustaining aquatic life. However, due to urbanization, industrial waste disposal, and improper waste management systems, many rivers are heavily polluted with plastic bottles, garbage, chemical waste, and other floating debris. Wireless communication technologies are often integrated into the robot for monitoring and control purposes. Modules such as Bluetooth HC-05, Wi-Fi ESP8266, GSM, or RF transmitters allow

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users to remotely monitor the robot's movement, sensor data, and cleaning operations. Real-time depth information and system status can be displayed on mobile applications, LCD displays, or cloud platforms. This feature enhances user interaction and makes the system more intelligent and efficient. In IoT-based implementations, sensor data can even be uploaded to online databases for further analysis and remote monitoring.

II. LITERATURE REVIEW

Sharma, Rakesh, Priya Verma, Akash Singh, and Neeraj Kumar, "Autonomous River Cleaning Robot Using IoT and Embedded Systems", published in the 2024 IEEE International Conference on Smart Systems and Green Technologies. This paper presents the development of an autonomous robotic system designed for cleaning floating waste materials from rivers and lakes using IoTenabled monitoring systems. The proposed robot uses ultrasonic sensors, motor drivers, conveyor mechanisms, and wireless communication technologies for efficient river cleaning operations. The system continuously monitors water conditions and transmits collected information to remote monitoring stations for real-time observation.

Sharma, Rakesh, Priya Verma, Akash Singh, and Neeraj Kumar, "Autonomous River Cleaning Robot Using IoT and Embedded Systems", published in the 2024 IEEE International Conference on Smart Systems and Green Technologies. This paper presents the development of an autonomous robotic system designed for cleaning floating waste materials from rivers and lakes using IoTenabled monitoring systems. The proposed robot uses ultrasonic sensors, motor drivers, conveyor mechanisms, and wireless communication technologies for efficient river cleaning operations. The system continuously monitors water conditions and transmits collected information to remote monitoring stations for real-time observation.

Rao, Kiran, Bhavana Joshi, and Sandeep Kulkarni, "Design of Autonomous Floating Robot for Water Pollution Control", presented at the 2022 IEEE International Conference on Robotics and Automation Applications. This paper introduces a floating robotic platform developed for detecting and removing pollutants from rivers and lakes. The robot uses embedded controllers, water quality sensors, and mechanical collection systems to monitor pollution levels and clean the water surface effectively. The study focuses on reducing environmental damage caused by plastic waste and industrial contaminants in water bodies. It also discusses autonomous navigation systems and obstacle avoidance techniques for efficient robot movement. The paper contributed significantly to our project by providing ideas related to floating robot design, autonomous navigation, and waste collection methodologies. It also emphasized the importance of combining environmental monitoring with robotic cleaning systems. Gupta, Nitin, Ayesha Khan, and Rahul Mehta, "IoT Enabled Smart River Cleaning System with Real-Time Monitoring", published in the 2022 IEEE International Conference on Communication, Computing and Internet of Things. This research proposes a smart river cleaning robot integrated with IoT technologies for real-time environmental monitoring. The robot uses sensors and wireless communication modules to monitor pollution levels and operational conditions while collecting floating waste materials. The study highlights the need for intelligent systems capable of supporting smart city initiatives and sustainable environmental management. The paper explains how real-time monitoring improves decision-making and maintenance planning. It also helped in understanding remote data accessibility and automation techniques.

III. METHODOLOGY

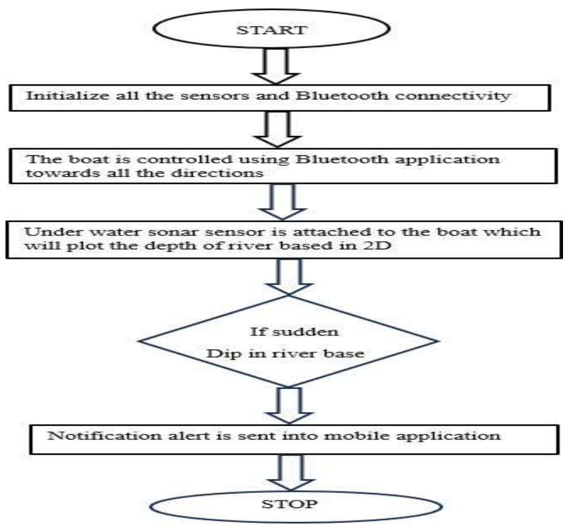

Fig 1: Flow chart of river depth plotting and river cleaning robot

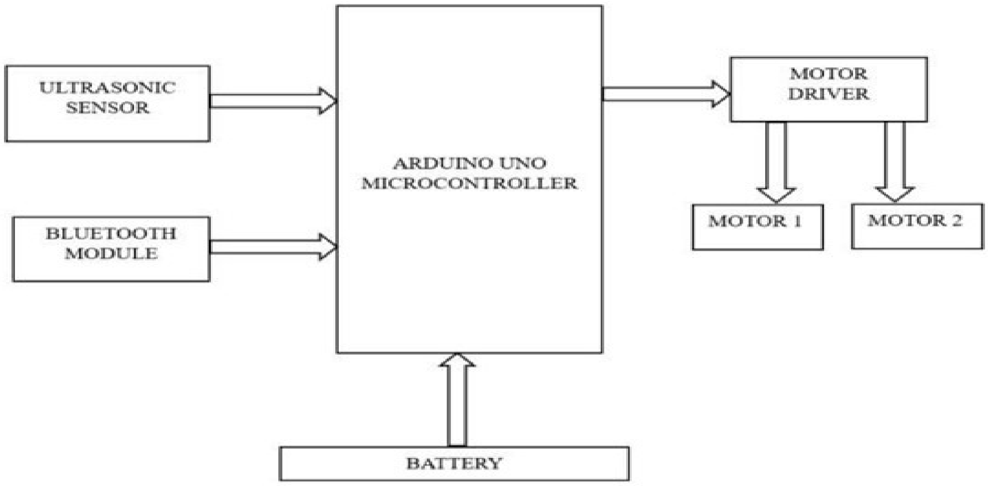

Fig 2: Block diagram of river depth plotting and river cleaning robot

The diagram consists of several important hardware and software components that work together to operate the robotic system efficiently. The main component is the Arduino UNO microcontroller, which acts as the central processing unit of the robot and controls all the connected devices by executing the programmed instructions. The ultrasonic sensor is used for measuring the distance between the robot and nearby obstacles by transmitting and receiving ultrasonic waves, helping the system avoid collisions and improve navigation. The Bluetooth module enables wireless communication between the robot and a smartphone or other Bluetooth-enabled device, allowing the user to control the robot remotely through the mobile application. The mobile app serves as the user interface where commands such as forward, backward, left, right, and stop are given to the robot. Since the Arduino UNO cannot directly supply enough current to operate the motors, a motor driver is connected between the microcontroller and the motors to provide sufficient power and direction control. The motor driver receives control signals from the Arduino and accordingly drives Motor 1 and Motor 2, which are responsible for the movement of the robotic vehicle. These motors convert electrical energy into mechanical motion, enabling the robot to move in different directions based on user commands or sensor inputs. The battery acts as the primary power source for the entire system and supplies electrical energy to all the components including the Arduino UNO, sensors, Bluetooth module, motor driver, and motors, making the robot portable and independent from external power sources. The NET block shown at the top represents network or internet connectivity, which can be used for advanced applications such as IoT-based monitoring, remote access, or cloud communication. Altogether, these components form an intelligent robotic system capable of sensing, wireless communication, processing, and controlled movement, making it suitable for applications such as obstacle-avoiding robots, river cleaning robots, smart surveillance systems, and automated vehicles.

Hardware Requirements:

Arduino Uno	Acts as the main control unit for processing sensor data and controlling the robot operations
Bluetooth Module (HC-05)	Used for wireless control and monitoring of the robot.
Power supply	Supplies power to the microcontroller, sensors, and motors.
Motor Driver Module (L298N)	Interfaces the DC motors with the Arduino and controls robot movement,
DC Motor	Provides movement for the river cleaning robot.
Ultrasonic Sensor (HC-SR04)	Used for measuring river depth and detecting obstacles

Software Requirements:

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Serial Bluetooth Terminal	Used to send commands, monitor sensor data, and control the river cleaning robot wirelessly through Bluetooth communication.

V. RESULTS AND DISCUSSION

1. River Depth Measurement and Mapping System

The first major implementation in the river depth plotting and river cleaning robot project is the river depth measurement and mapping system. In this implementation, ultrasonic sensors or sonar sensors are mounted at the bottom of the robotic boat or floating platform to measure the distance between the robot and the riverbed. The sensor continuously sends ultrasonic sound waves toward the river bottom and receives the reflected signals back.

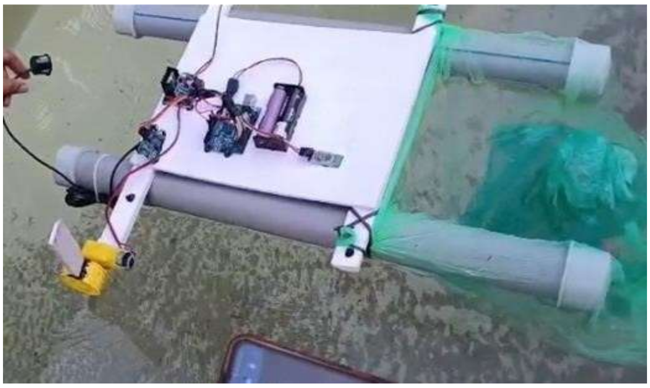

Fig 3: Implementation of river depth measurement and mapping system

2. Automatic River Waste Collection Mechanism

The cleaning mechanism works continuously while the robot moves on the water surface. DC motors and motor drivers are commonly used to operate the conveyor system and propel the robot. Sensors may also be included to detect obstacles or identify the presence of waste. Once the garbage reaches the collection container, the robot stores it until the container becomes full. In advanced systems, the robot can send notifications to the operator when the waste container reaches its capacity.

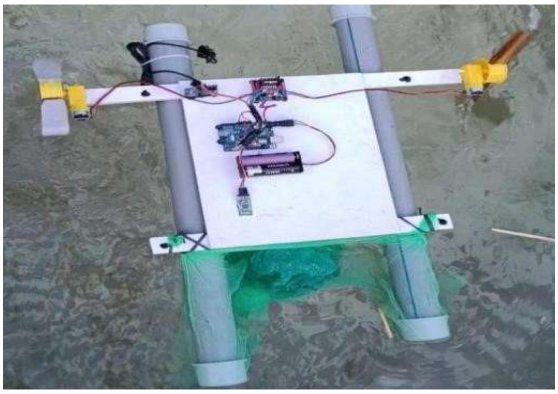

Fig 4: Implementation of Automatic-river waste collection mechanism

3.Wireless Communication and Monitoring System

The third major implementation is the wireless communication and monitoring system. In this implementation, the robot is connected to a remote monitoring station using wireless technologies such as Bluetooth communication. The operator can monitor the robot's movement, river depth readings, and cleaning status from a safe location. The monitoring system usually includes a display interface or mobile application where sensor readings are shown continuously. Important information such as water depth, robot speed, battery level, GPS location, and waste collection status can be viewed by the user. If the robot detects any abnormal condition such as low battery, obstacle collision, or excessive load in the waste container, alert messages can be transmitted instantly.

4. Autonomous Navigation and Obstacle Detection System

The fourth important implementation is the autonomous navigation and obstacle detection system. In this implementation, the robot is capable of moving automatically on the river surface while avoiding obstacles such as rocks, logs, plants, boats, or riverbanks. Ultrasonic sensors, infrared sensors, or camera modules are used to detect objects in front of the robot. The microcontroller processes the sensor data and controls the motors accordingly to change the robot's direction whenever an obstacle is detected.

5.Design of River depth plotting and river cleaning robots

This project is an advanced environmental monitoring and cleaning system designed to solve two major river-related problems: measuring river depth and removing floating waste from water bodies. The robot is generally designed in the form of a floating boat structure made using lightweight and waterproof materials. The body of the robot supports all electronic and mechanical components such as motors, sensors, batteries, microcontrollers, communication modules, and waste collection mechanisms. The entire system is controlled using a central processing unit like an Arduino Uno, which acts as the brain of the robot and coordinates all operations together. When the robot is powered ON, the microcontroller initializes all the sensors and modules connected to it and starts the functioning of the system. The robot then begins moving across the river surface using propellers or DC motors attached to the sides or bottom of the structure. These motors are controlled through motor drivers that regulate the speed and direction of movement. The floating robot is carefully balanced to maintain stability even in flowing water conditions.

Fig 5: Design of the model

6.Implementation of River depth plotting and river cleaning robots

The Bluetooth module connected to the Arduino allows wireless control through a smartphone or remote-control application, making the robot easier to operate from a distance without direct physical handling. As the robot moves on water, the waste collection mechanism begins its operation automatically. At the front-bottom section of the robot, a green mesh net is attached between the two PVC pipes. This net acts as a waste collector for floating garbage present on the water surface. During movement, floating waste materials such as plastic covers, paper pieces, leaves, wrappers, and small bottles enter the mesh net and become trapped inside it. The open structure of the mesh allows water to flow freely while retaining the solid waste materials.

Fig 6: Implementation of the model

7. Result

In the river depth plotting and river cleaning robot project, wireless communication and monitoring are performed using a mobile application called Serial Bluetooth Terminal. This application is used to establish communication between the smartphone and the

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HC-05 Bluetooth module connected to the robotic model. The Bluetooth module acts as a communication bridge between the mobile device and the Arduino controller mounted on the robot. To start the operation, the user first opens the

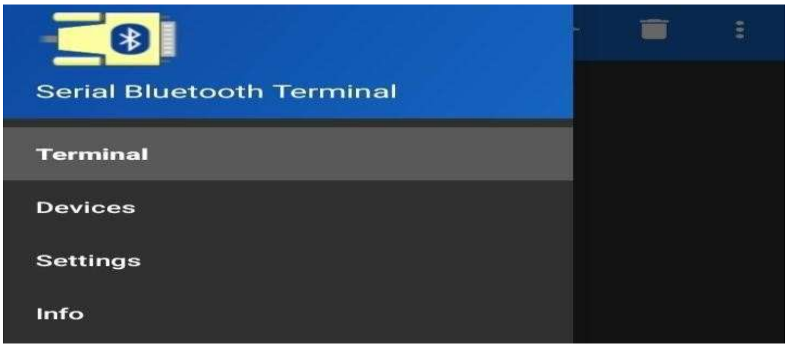

Fig 7: Snapshot of Software application

After opening the application, the user enters the terminal section where nearby Bluetooth devices are displayed. From the available device list, the HC-05 Bluetooth module connected to the robot is selected. Once selected, the application starts connecting to the HC-05 module, and after successful pairing, the status changes to “Connected.” This confirms that wireless communication has been established successfully between the robot and the mobile phone

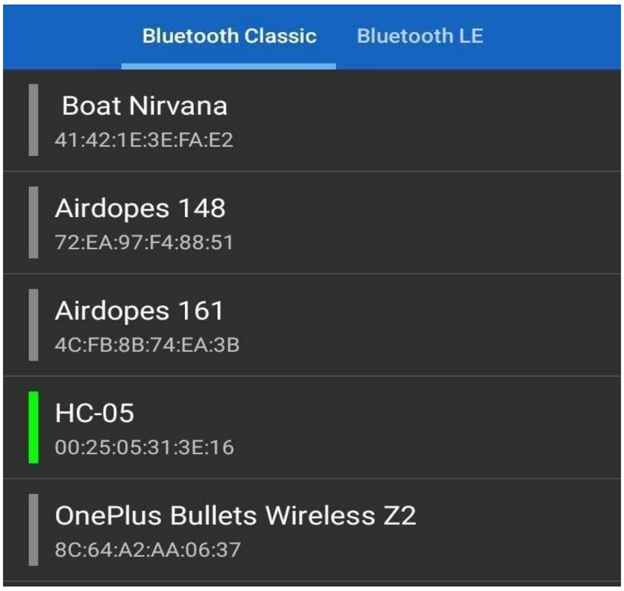

Fig 8: Snapshot of connecting device

After the Bluetooth connection is completed, the Serial Bluetooth Terminal application begins receiving live data from the robotic system. The Arduino controller continuously sends sensor readings to the mobile application through the HC-05 module. In the terminal window, the output displays the water depth values measured by the depth sensor attached to the robot. The readings are shown in real time in the format “Depth: value” along with safety indications such as “Normal,” “Medium,” or “Dangerous.”

Fig 9: Snapshot of connected device

Along with monitoring sensor outputs, the application is also used to control the movement of the robot through command buttons named M1, M2, M3, M4, and M5. These commands are transmitted wirelessly from the smartphone to the Arduino controller through the HC-05 Bluetooth module. When the user presses "M1," both motors rotate in the forward direction, causing the robot to move straight ahead on the water surface. This mode is mainly used for normal navigation and waste collection operations. When the "M2" command is selected, the motors rotate in reverse, making the robot move backward. This helps the operator reposition the robot whenever necessary. The "M3" command is used to turn the robot toward the right side. In this operation, the motor speeds are adjusted differently so the robot changes direction smoothly toward the right.

Fig 10: Snapshot of the depth monitoring system

The integration of the Serial Bluetooth Terminal application with the HC-05 Bluetooth module creates a simple and efficient wireless control system for the project. The mobile application performs two major functions simultaneously: it monitors live sensor outputs such as river depth readings and also provides movement control through M1, M2, M3, M4, and M5 command.

Fig 11: Snapshot of model controlling buttons

M1 – Forward
When the M1 button is pressed, the command is sent to the Arduino through Bluetooth. Both motors rotate forward, and the propellers push the robot straight ahead on the water.
M2 – Backward
When the M2 button is pressed, the Arduino makes both motors rotate in reverse. This creates reverse thrust and moves the robot backward. **M3 – Right Turn**
The M3 command turns the robot to the right. One motor runs faster than the other, creating uneven thrust that rotates the robot right.
M4 – Left Turn
When M4 is pressed, the robot turns left. The Arduino changes the motor speeds so the robot rotates smoothly toward the left side.
M5 – Stop
The M5 command stops the robot completely. The Arduino turns off both motors, and the robot stays still on the water.

vi. CONCLUSION

The successful design and implementation of this River depth plotting and river cleaning robot project is an innovative and environmentally beneficial system developed to address the growing problems of water pollution and river monitoring. The completed model demonstrated the ability to float stably on the water surface using PVC pipe support structures while carrying all the required electronic and mechanical components. The robot successfully performed controlled movement operations using DC motors and propellers, allowing smooth navigation across the water surface. The integration of the Arduino Uno, HC-05 Bluetooth module, motor driver, and mobile-based wireless communication system enabled efficient control and monitoring of the robot in real time. The project proved that embedded systems and robotics technologies can be effectively combined for environmental protection applications. The implemented system was able to perform river depth plotting successfully by

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measuring water depth values and transmitting the information to the mobile application. The depth readings displayed through the Serial Bluetooth Terminal helped monitor river conditions continuously during operation. In conclusion, the river depth plotting and river cleaning robot project was successfully completed and achieved its main objectives of river monitoring and waste collection. The project proved to be an eco-friendly, low-cost, and efficient system for maintaining cleaner water bodies and monitoring river conditions. It reduced manual effort, improved safety, and provided real-time operational control through wireless communication. The successful implementation of the project highlights its future potential in smart environmental monitoring systems, automated water management, and advanced river cleaning technologies.

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