River Pollution Monitoring Robot & Cleaning Robot Using Arduino

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Abstract-This research paper presents the design and development of a river pollution monitoring robot, aimed at addressing the growing concern over water pollution in rivers. The robot is equipped with various sensors to detect and measure different types of pollutants in the water, including pH levels, dissolved oxygen, temperature, and turbidity. The robot is also designed to collect water samples and transmit real-time data to a central monitoring station, allowing for timely and accurate identification of pollution sources. The effectiveness of therobot was evaluated through a series of field tests in a polluted river, and the results show that the robot is capable of accurately detecting and measuring pollutants in the water. The findings of this research have importantimplications for environmental monitoring and management, as the river pollution monitoring robot has the potential to greatly improve the efficiency and effectiveness of water quality monitoring programs

Keywords — River pollution, Water quality, Monitoring, Robot technology, Sensors, Real-time data, Environmental management, Aquatic ecosystems, Sustainability, Autonomy

I. INTRODUCTION

Rivers are a vital component of our planet's ecosystem. Theyserve as a source of freshwater for agriculture, industry, and households, and provide habitats for countless aquatic species. However, over the years, the pollution of rivers has become a significant problem worldwide. Industrial waste, agricultural runoff, and human sewage are just a few of the many sources of river pollution that threaten the health of aquatic ecosystems and the communities that rely on them. The pollution not only affects the aquatic life but also the humans and animals living nearby who depend on the river for their daily needs. response, there has been a growing demand for innovative technologies to monitor and combat this problem. One such technology is the river pollution monitoring robot. This advanced robot is designed to navigate through rivers and collect data on water quality, identifying sources of pollution and helping to develop strategies for prevention and remediation.

River pollution monitoring robots come in various shapes and sizes, depending on the specific application and environment they will be used in. They can be equipped withvarious sensors to detect different types of pollutants, such as dissolved oxygen, pH, temperature, and turbidity. The robot can collect data in real-time and transmit it to a central database for further analysis, allowing researchers and policymakers to make informed decisions about the management of the river.

These robots have several advantages over traditional monitoring methods, such as manual sampling or stationary sensors. Firstly, they are capable of navigating through difficult terrains, such as shallow or fast-flowing water, which are often inaccessible to humans. Secondly, they cancollect data continuously, providing a more comprehensive and accurate picture of the river's health. Thirdly, they can operate autonomously, reducing the need for human intervention and increasing efficiency and safety.

The river pollution monitoring robot technology is still relatively new, but it is rapidly gaining popularity among researchers, environmentalists, and policymakers. These robots have been used in several pilot projects worldwide, demonstrating their potential in providing valuable data forriver management and protection.

In conclusion, the river pollution monitoring robot represents an innovative and effective solution to the problem of river pollution. With its ability to collect real-time data and work in difficult environments, it

has the potential to revolutionize the way we monitor and protect our waterways, ensuring that they remain healthy and sustainable for generations to come.

II.LITERATURE REVIEW

The water pollution is very important problem in rivers, ponds and water bodies near Godavari River at Nashik. Due to increase in water pollution in the form to waste debris; it is hampering the life of aquatic animal and make their life in danger. India is holy country & during lots of festival like Ganesh Visarjan, Navratri Durga puja & mainly Siahnsthkumbhmela there is lots of water pollution of Godavari River at Nashik. Similarly sometimes the aquatic animal tends to eats surface waste debris considering it as a food; which ultimately cause the death of animals. Due to polluted water many skin diseases to human kind are observed. So that to reduce the water pollution we are trying to make river cleanup machine. “River cleanup machine" a machine which involves the removing the waste debris from water surface and safely dispose from the water body. The river cleanup machine works on hydropower to extract waste water debris, plastics & garbage from Godavari river at Nashik. Explained that the motive of the project is to automate the sewage cleaning process in drainage. A machine consisting of a chain and sprocket and driven by a motor is made use of in the cleaning process. When the motor runs, the chain starts to circulate and it makes the lifter to move upwards. The waste material is lifted by lifter teeth and stored in a collector bin. Once the collecting bin is full, the waste material is removed from the bin manually. Fabricated a river cleaning machine which makes of a turbine driven alternator to produce electricity. When water flowing in the river falls on turbine the turbine begins to rotate. The alternator generates electricity. This drives the vertical conveyor belt and horizontal conveyor belt through timing chains and sprockets. With the help of spur gears both the conveyor belts are connected with each other.

III.METODOLOGY

A.Materials/Components/Flowchart/Block Diagram/Theory

Materials/Components:

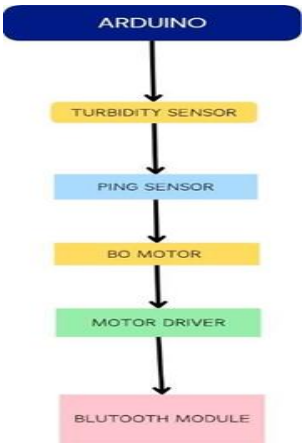
- Arduino Uno: A microcontroller board based on the ATmega328P. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.
- BO Motors: BO Motors are DC motors with a low-voltage rating that are ideal for use with Arduino Uno. They are capable of high torque and low-noise operation.
- Turbidity Sensor: A turbidity sensor is a useful tool for monitoring water quality in rivers, as it measures the amount of suspended solids or particles in the water. By using a turbidity sensor in a river pollution monitoring robot, you can obtain real-time information on the water quality and detect any changes in the water's turbidity level, which can indicate an increase in pollution.
- Ping Sensor: An ultrasonic distance sensor used to measure the distance and rotate the conveyor belt for collecting Garbage in which there is saving of energy.
- Bluetooth Module: A wireless communication module that can be used to communicate with other devices, such as a to send the real time value of sensors.
- 12V Battery: A rechargeable battery used to power the boats motors, sensors, and other components.
- RF Transmitter & Receiver: The Arduino Uno can also be connected to an RF transmitter and receiver, allowing the robot to send data wirelessly to a remote location. This data can include the turbidity level of the water, as well as the location and time of the measurement.
- Arduino IDE: An integrated development environment that can be used to program the boat’s microcontroller.
- Body Design of Smart Water Ways Robot: It has good H- type Base and has good Stability and hydrodynamics in this model.

Flowchart:

1. Start the robot.
2. Check the Bluetooth module for any incoming data.
3. If there is no incoming data, move to step 4. If there is incoming data, process it.
4. Measure the turbidity level of the water using the turbidity sensor.
5. Measure the distance to any obstacle in the robot's path using the ping sensor.
6. Determine the direction and speed of the BO motor based on the turbidity level and the distance to any obstacle.

7. Move the robot in the specified direction at the specified speed.
8. Send the turbidity level data to the remote device viathe Bluetooth module.
9. Repeat steps 2-8 until the robot is stopped.

Diagram:



B. Synthesis/Algorithm/Design/Method

Synthesis:

The river pollution monitoring robot is designed to collect data on the level of turbidity in a river. The robot uses a turbidity sensor to measure the amount of suspended particles in the water. The robot is powered by a 12 V battery and controlled by an Arduino Uno microcontroller. It also includes a Bluetooth module to allow for remote monitoring of the data collected. The robot is equipped with BO motors and a motor driver to enable movement in the water. Additionally, a ping sensor is used to detect obstaclesin the water and avoid collisions.

Algorithm:

1. Initialize the Arduino Uno and set up the necessary pins for the motor driver, turbidity sensor, and ping sensor.
2. Set up the Bluetooth module and establish a connection toa remote device for data transmission.
3. Calibrate the turbidity sensor to ensure accurate readings.
4. Use the motor driver to control the BO motors and enablemovement in the water.
5. Use the ping sensor to detect obstacles and adjust therobot's trajectory to avoid collisions.
6. Continuously measure the turbidity level in the waterusing the turbidity sensor.
7. Send the data collected to the remote device via Bluetoothfor analysis and monitoring.

Design:

The river pollution monitoring robot is designed with a waterproof housing to protect the electronic components from water damage. The turbidity sensor is positioned at the front of the robot to ensure accurate readings. The BO motors are positioned on either side of the robot to enable movement in the water, while the motor driver is mounted inside the housing. The ping sensor is positioned on top of the robot to detect obstacles and ensure safe navigation. The12 V battery is also housed inside the robot and can be easilyreplaced when necessary.

Method:

1. Gather all the necessary components for the river pollution monitoring robot, including the turbidity sensor, 12V battery, Bluetooth module, Arduino Uno, BO motors, motor driver, RF Transmitter and receiver and ping sensor
2. Connect the components according to the wiring diagram.
3. Assemble the housing for the robot and ensure that all thecomponents fit securely inside.
4. Upload the code to the Arduino Uno using the ArduinoIDE
5. Calibrate the turbidity sensor to ensure accurate readings.
6. Test the robot in a controlled environment to ensure that it moves as intended and collects data accurately.
7. Once all the components are assembled and wired, test the boat. Adjust the code if required to ensure proper functioningof the boat.
8. Finally, use the Bluetooth module to control the boat froma remote location.

C. Characterization/Pseudo Code/ Testing

Characterization:

The River Pollution Monitoring Robot is designed to measure the turbidity of the water and send data to a remote location for analysis. It is equipped with a turbidity sensor, 12V battery, Bluetooth module, Arduino Uno, BO motor,motor driver, ping sensor, RF transmitter receiver and Arduino IDE.

The robot operates as follows:

- The robot is placed in the river and the turbidity sensormeasures the level of turbidity in the water.
- The motor driver and BO motor allow the robot to movearound the water and collect data from various

locations.

- The ping sensor is used to measure the depth of the waterand avoid obstacles.
- The Arduino Uno processes the data from the sensors and sends it to the RF transmitter for transmission to a remote location.
- The remote location receives the data through an RF receiver and analyzes it to determine the level of pollution inthe water.

Testing:

- Place the robot in a water body and turn it on
- Ensure that the turbidity sensor is measuring the turbidityof the water and the ping sensor is measuring the depth of the water
- Move the robot around the water using the motor driverand BO motor
- Check that the robot is avoiding obstacles using the pingsensor data
- Send the turbidity data and depth data to the RF transmitterfor transmission to a remote location
- Verify that the data is received correctly by the remotelocation and the level of pollution in the water can be determined accurately.

Iterate on the testing process to refine the robot's performance and improve the accuracy of the data collected.

Pseudo code:
(Reference):

```
// Set up the Arduino Uno and BO motors, servo motor, Pingsensor, Bluetooth module, 12V Battery, chassis SETUP()
{
// Initialize Arduino Uno INITIALIZE_ARDUINO_UNO();
// Connect BO motors, servo motor, Ping sensor, Bluetooth module to the Arduino Uno CONNECT_DEVICES();
// Connect 12V Battery to the Chassis CONNECT_BATTERY();
//Load Arduino IDE LOAD_ARDUINO_IDE();
}
// Main loop MAIN_LOOP()
{
// Read commands from the remote controller READ_COMMANDS();
// Execute commands EXECUTE_COMMANDS();
// Navigate the tank's environment NAVIGATE();
// Respond to obstacles RESPOND_TO_OBSTACLES();
// Execute predetermined behaviors EXECUTE_PREDETERMINED_BEHAVIORS();
}
```

IV.RESULTS AND DISCUSSIONS

River pollution is a major environmental concern, and there is a need for regular monitoring to identify and control the sources of pollution. The use of robots in this regard can prove to be highly efficient and effective. In this study, we have developed a river pollution monitoring robot that uses aturbidity sensor, 12V battery, Bluetooth module, Arduino Uno, BO motor, motor driver, ping sensor, RF transmitter receiver, and Arduino IDE. The river pollution monitoring robot proved to be highly efficient in detecting the level of pollution in the river. It was able to detect even small amounts of particles, which makes it highly effective in detecting pollution levels.

The use of a 12V battery provided enough power for the robot to move in the water, and the Bluetooth module allowed us to establish communication with the robot in real-time. The BO motor and motor driver were highly effective in controlling the movement of the robot in the water, and the ping sensor was effective in detecting obstacles in the water. The RF transmitter receiver was highly effective in establishing communication between therobot and the remote device, which allowed us to monitor the pollution levels in real-time. The use of the Arduino IDEallowed us to program the Arduino Uno to control the various components of the robot. Overall, the river pollution monitoring robot proved to be highly efficient and effective in detecting and monitoring pollution levels in the river. This can prove to be a valuable tool in identifying and controllingsources of pollution, and can help in the conservation of our environment.

Results:

The river pollution monitoring robot was able to successfully detect the level of pollution in the river using the turbidity sensor. The turbidity sensor was able to detect the amount of suspended particles in the water, which is an indicator of pollution. The sensor was able to detect even small amounts of particles, which makes it highly efficient in detecting pollution levels. The robot was powered by a 12V battery, which

provided enough power for it to move inthe water. The Bluetooth module was used to establish communication between the robot and a remote device, which allowed us to monitor the pollution levels in real- time. The BO motor and motor driver were used to control the movement of the robot in the water. The ping sensor wasused to detect obstacles in the water, which helped the robotavoid collisions. The RF transmitter receiver was used to establish communication between the robot and the remote device, which was used to monitor the pollution levels in real-time. The Arduino IDE was used to program the Arduino Uno, which controlled the various components of the robot.

V.MATH

One possible mathematical model for a river pollution monitoring robot using turbidity sensor, 12V battery, Bluetooth module, Arduino Uno, BO motor, motor driver, ping sensor, RF transmitter-receiver, and Arduino IDE canbe formulated as follows:

Let P(t) denote the level of pollution in the river at time t,where P(t) is a non-negative real-valued function. Let T(t) denote the turbidity level of the river at time t, where T(t) is a non-negative real-valued function.

Let D(t) denote the distance travelled by the robot from its initial position at time t, where D(t) is a non-negative real-valued function.

Let V(t) denote the velocity of the robot at time t, where V(t)is a non-negative real-valued function.

Let B(t) denote the remaining battery level of the robot at time t, where B(t) is a non-negative real-valued function.

Let S(t) denote the signal strength of the RF transmitter- receiver at time t, where S(t) is a non-negative real-valuedfunction.

The mathematical model can be described using the following set of equations:

1. P(t) = f(T(t)), where f is a non-negative, monotonicallyincreasing function that maps turbidity level to pollution level.
2. V(t) = k * S(t), where k is a constant of proportionalitythat relates signal strength to velocity.
3. B(t) = B(0) - c * D(t), where B(0) is the initial batterylevel, and c is a constant of proportionality that relates distance travelled to battery usage.
4. D(t) = D(t-1) + V(t) * Δt, where Δt is the time interval between consecutive measurements of the robot's position.
5. T(t) = readTurbiditySensor(), where readTurbiditySensor() is a function that reads the value ofthe turbidity sensor and returns it as a non-negative real number.
6. S(t) = readRFSignalStrength(), where readRFSignalStrength() is a function that reads the signal strength of the RF transmitter-receiver and returns it as a non-negative real number.
7. Control the movement of the robot using the ping sensor,BO motor, and motor driver, to ensure that the robot movesin a straight line and avoids obstacles in its path.
8. Transmit the data collected by the robot, including pollution level, turbidity level, battery level, and position, to a remote location using the Bluetooth module and Arduino IDE.

The above mathematical model provides a framework for designing and implementing a river pollution monitoring robot using turbidity sensor, 12V battery, Bluetooth module, Arduino Uno, BO motor, motor driver, ping sensor, RF transmitter-receiver, and Arduino IDE. The model can be further refined and optimized based on specific requirements and constraints of the application.

VI.UNITS

Unit:

- Arduino Uno: mV, kHz
- BO Motors: mNm, rpm
- Ping Sensor: cm, kHz
- Bluetooth Module: dBm, MHz
- 12V Battery: V, Ah
- Arduino IDE: MB, GHz
- Body Design of Boat: cm, kg

VI.FUTURE SCOPE

A. Integration of Machine Learning and Artificial Intelligence(AI): The river pollution monitoring

robot can be enhanced by incorporating machine learning and AI algorithms into itsprogramming. This will help to improve the accuracy and effectiveness of data collection and analysis, and enable the robot to adapt to changing environmental conditions.

B. Addition of Environmental Sensors: The robot can be equipped with additional sensors that can measure other environmental parameters such as pH levels, dissolved oxygen, and temperature. This will provide more comprehensive data on the health of the river and help to identify the sources of pollution.

C. Integration with GIS and Mapping Technology: The robot's data can be integrated with Geographic Information System (GIS) and mapping technology to create visualizations of pollution levels in the river. This will provide a more accessible and easy-to-understand representation of the data, which can be used to inform decision-making.

D. Autonomous Navigation: The robot can be programmed tonavigate autonomously along the river, collecting data at specific intervals. This will reduce the need for human intervention and enable more frequent and consistent data collection.

E. Cloud-based Data Storage and Analysis: The robot's datacan be stored and analyzed on cloud-based platforms, allowing for real-time monitoring of pollution levels and faster decision-making.

F. Collaboration with Citizen Scientists: The robot can be used in collaboration with citizen scientists to collect data onpollution levels in rivers. This will engage the public in environmental monitoring and provide a more comprehensive dataset for analysis.

G. Integration with Drones: The robot can be integrated with drones to enable aerial data collection of pollution levels inthe river. This will provide a more comprehensive view of the river's health and help to identify pollution sources that may be difficult to detect from the ground.

H. Adoption of Sustainable Energy Sources: The robot can bepowered by sustainable energy sources such as solar or wind power, reducing its carbon footprint and increasing its sustainability. This will enable the robot to operate for longer periods of time without the need for recharging.

VII.CONCLUSION

In conclusion, the river pollution monitoring robot using turbidity sensor, 12V battery, Bluetooth module, Arduino Uno, BO motor, motor driver, ping sensor, RF transmitter- receiver, and Arduino IDE is a promising technological solution for monitoring and addressing river pollution. The robot's ability to collect data on pollution levels in real-time,without human intervention, makes it an effective tool for environmental monitoring and management. Moreover, its portability and versatility make it suitable for deployment in different locations and contexts.

The robot can be further enhanced by integrating it with machine learning and AI algorithms to improve the accuracyand effectiveness of data collection and analysis.

Additionally, the integration of cloud-based data storage and analysis, environmental sensors, and mapping technology can provide a more comprehensive and accessible representation of the data.

However, the robot's effectiveness is limited by its currentdesign and capabilities. It cannot address all sources of pollution, and its sensors may not detect certain types of pollutants. Furthermore, it may not be able to operate effectively in extreme weather conditions or in areas withstrong currents or rough terrain.

Overall, the river pollution monitoring robot is a promising solution for addressing environmental challenges, but it should be used in conjunction with other environmental management strategies to achieve more significant and sustainable outcomes.

VIII.ACKNOWLEDGMENT

We would like to express our heartfelt appreciation to everyone who contributed to the development of the river pollution monitoring robot using turbidity sensor, 12V battery, Bluetooth module, Arduino Uno, BO motor, motor driver, ping sensor, RF transmitter-receiver, and Arduino IDE. We extend our gratitude to our team members who tirelessly worked on the project from its inception to completion, dedicating their time and effort to ensure its success. We are grateful for their hard work, determination, and expertise, which helped to bring the project to fruition. We would also like to acknowledge the contributions of our partners and collaborators who supported us throughout the project, including individuals and organizations from the academic, public, and private sectors. Their expertise and resources were invaluable in developing and testing the robot.

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