SMART ROBOT SYSTEM: FOR DETECTION AND LOCATING DRAINAGE PIPE BLOCKAGES IN URBAN AREAS OF KARNATAKA

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Keywords:

Smart Robot System, Drainage Pipe Blockages, Urban Infrastructure, Detection and Locating, Robotics Technology, Smart Urban Solutions

Introduction/Background:

In today's fast-growing cities, drainage systems often get blocked due to trash, plastic, grease, and other waste. This leads to flooding, dirty water in the streets, and health problems, especially during heavy rains. With more people moving to cities and weather becoming more unpredictable, these issues are getting worse. Right now, clearing blocked drains takes a lot of time and effort because workers must inspect and clean them manually. This method is slow, and blockages often aren't found until they cause major problems like floods. To fix this, the goal of the project is to develop a robot that can move through drains and detect blockages using cameras and sensors. The robot will help find problems faster and send real-time data to maintenance teams. This will make it easier to keep drains clean and working properly, reducing floods and keeping cities healthier and safer. Figure 1 shows blocked drainage systems and Impact due to drainage overflow.

Objectives:

- Robot Development: Designing a compact, autonomous, or semi-autonomous robot capable of navigating through confined drainage pipes.

- Detection Mechanisms: Incorporating sensors (e.g., ultrasonic, infrared, or visual cameras) to identify blockages.
- Locating, Reporting and Communication: Using localization technologies (e.g., GPS and GSM Module) to accurately identify and report the position of blockages.
- Testing and Deployment: Conducting tests in controlled and real-world urban drainage environments. The proposed Robot system motive is to find the blockage in drainage pipes easily without wasting excess of time and manpower.

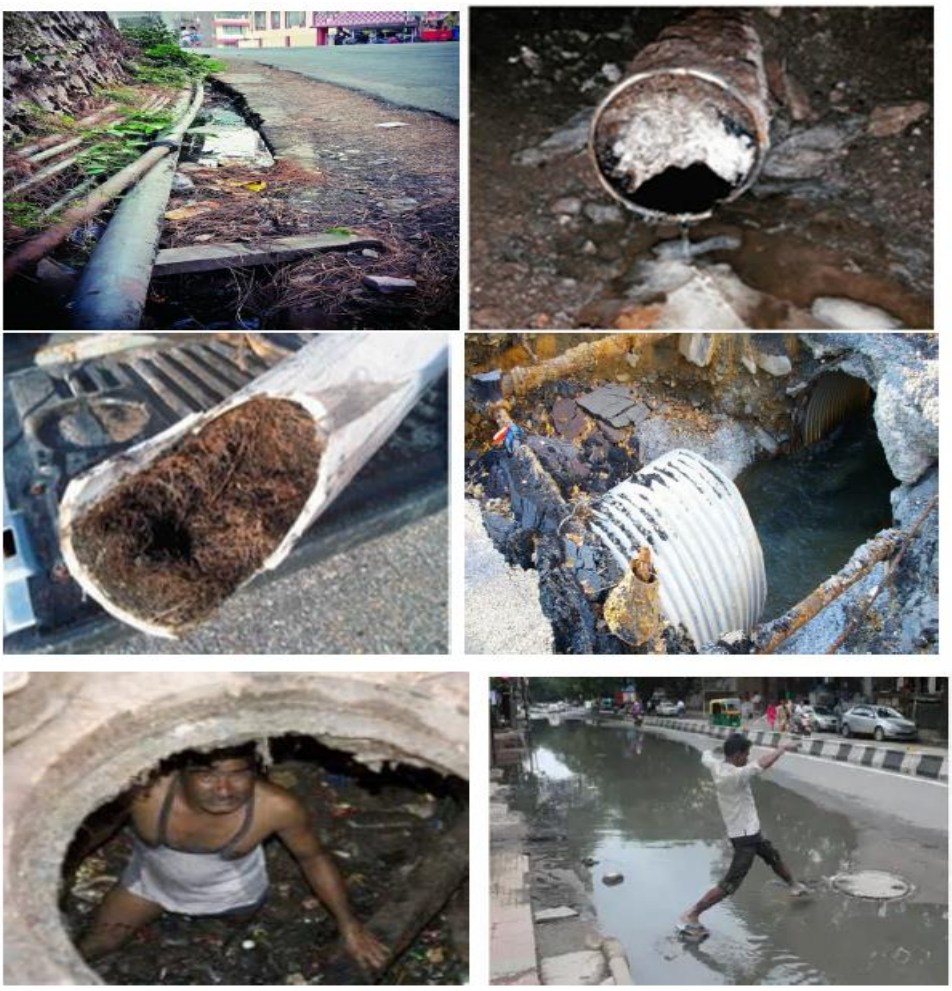

Figure 2: Blocked drainage systems and Impact due to drainage overflow

Methodology:

- Conduct a comprehensive study of urban drainage systems to identify key challenges (e.g., varying pipe sizes, materials, and blockage types).

- Define functional and technical requirements for the robot, including navigation, detection, and communication capabilities.
- Design a compact, waterproof robotic structure suitable for navigating drainage pipes of various dimensions.
- Equip the robot with appropriate sensors for detecting blockages:(Ultrasonic Sensors, Cameras and Water level sensor)
- Implement a localization module using GPS module which pushes the data to things peak cloud through GSM.
- Develop an Arduino UNO system to handle real-time data processing, navigation, and communication Build a user interface for monitoring and receiving real-time data.
- Test the robot in a simulated drainage network to assess navigation, detection accuracy, and communication reliability. Analyze sensor data to refine detection algorithms. Figure 2 shows methodology of drainage blockage identification and maintenance process

Development Process:

- **Phase 1:** Research and planning involved a literature survey and selection of appropriate components. The hardware and software were designed and integrated, with algorithms developed for navigation and blockage detection
- **Phase 2:** Prototyping and system assembly were followed by field testing to validate the robot's performance. Testing was carried out to ensure the robot could accurately detect blockages, navigate complex drainage systems, and

handle harsh environmental conditions like waterlogging.

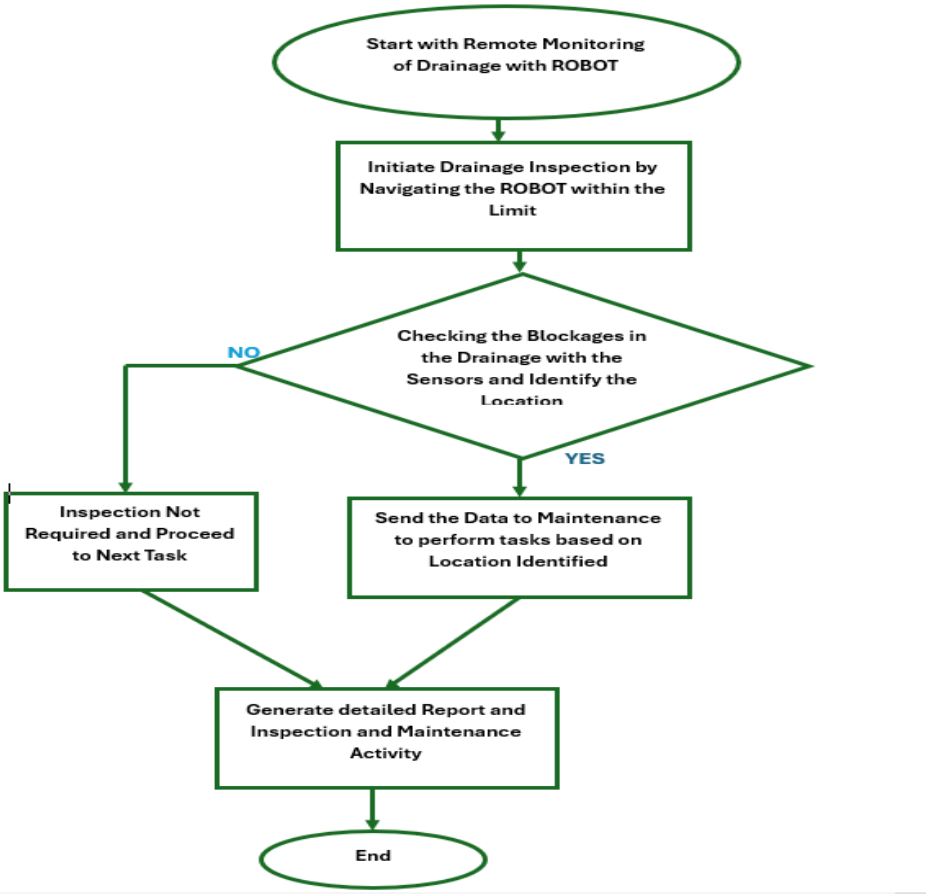

Figure 2: Methodology of drainage blockage identification and maintenance process

Results & Conclusions:

Effective drainage blockage management requires a multi-faceted approach that combines traditional manual methods with advanced technologies and preventive measures. By leveraging a combination of manual and mechanical cleaning, advanced inspection technologies, preventive strategies, and smart infrastructure management, cities can significantly reduce the occurrence and impact of drainage blockages. The implementation of this plan will be of great help to the government to Quick detection provides fast action to resolve the issue in less time and more work can be done. Minimize downtime in urban drainage systems, contributing to better sanitation and flood prevention. A good drainage system and repair and maintenance processes often have a positive impact on society and the life expectancy of human beings. Figure 3 shows Arduino based Robot system for drainage maintenance. Figure 4 shows the Prototype of Robot system.

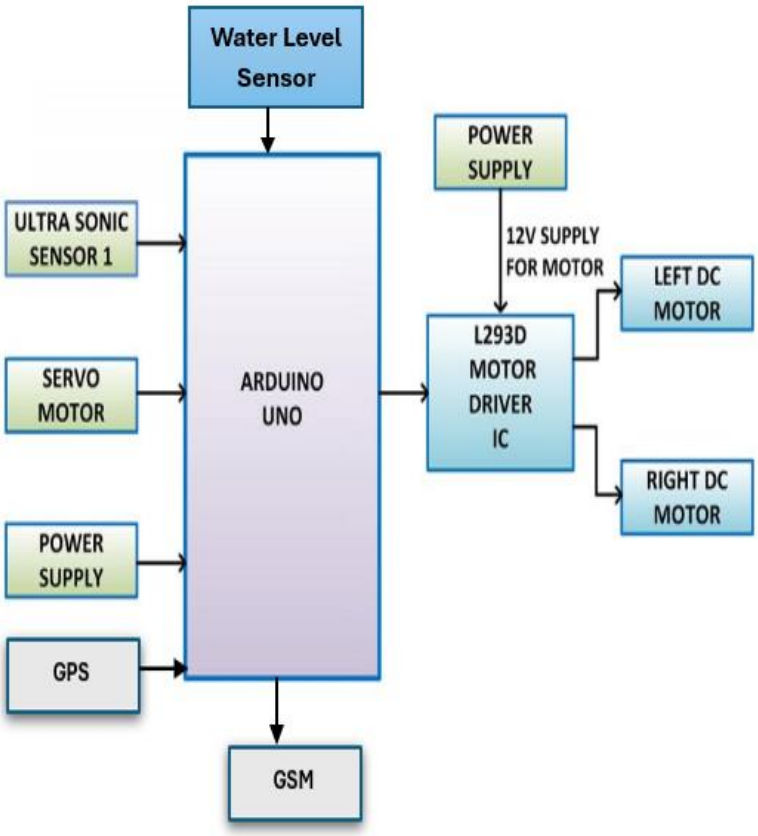

Figure 3: Arduino based Robot system for drainage maintenance.

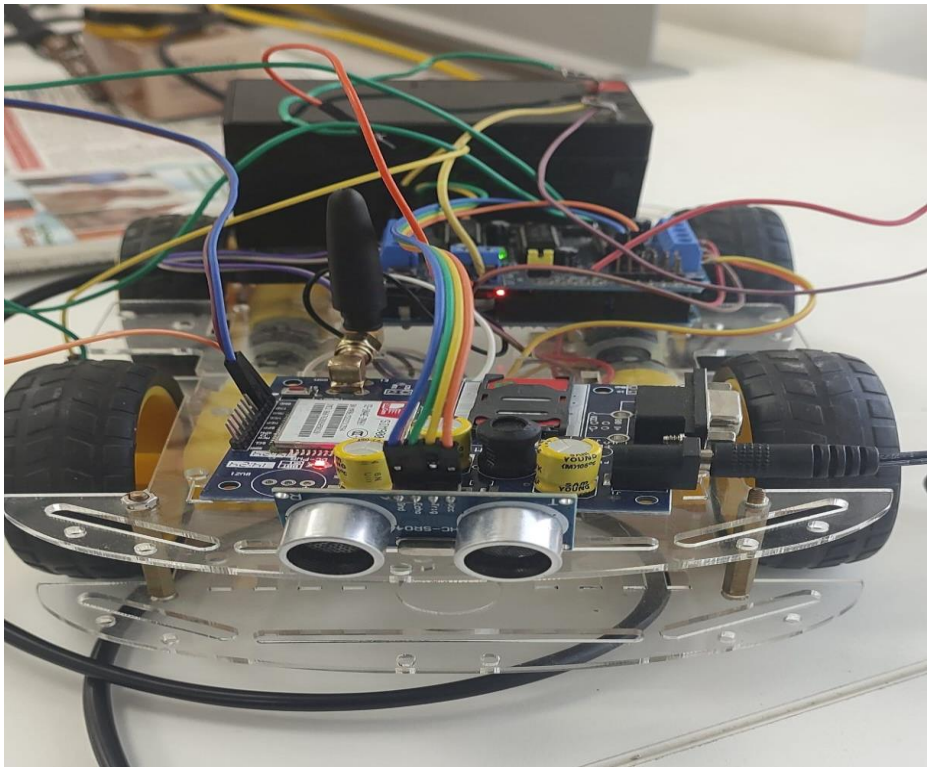

Figure 4: Prototype of Robot system.

Project Outcome & Industry Relevance

Project Outcome:

- The proposed Robot system is developed to create a platform where the public and the officers at the city corporation will get instant access to information of drainage conditions inside the drain.
- The Robot predicts the possibility of a clog inside the drainage during rainy season and displays the conditions of blockage location for maintenance.
- The Robot reduces the manual labour and safety risks associated with traditional drainage maintenance.
- The implementation of this plan will be of great help to the government to Quick detection provides fast action to resolve the issue in less time and more work can be done.
- Minimize downtime in urban drainage systems, contributing to better sanitation and flood prevention. A good drainage system and repair and maintenance processes often have a positive impact on society and the life expectancy of human beings.
- In the future, solid waste inside the drain should be filtered out to reduce the possibility of clogging. A software application (App can be developed) should be built so that general people could keep track of the conditions of the drainage at any time from any place.

Industry Relevance:

- The project provides a cutting-edge, cost-effective solution for industries managing urban infrastructure, particularly drainage and sanitation.
- Technological Adoption: integration of robotics, IoT, and AI in urban drainage maintenance, aligning with the Indian and Karnataka Government vision of smart cities.

Working Model vs. Simulation/Study

This project involved the design and construction of a physical working model to validate the system's performance under real-world conditions.

Project Outcomes and Learnings:

Project Outcomes:

- The project successfully developed a smart robotic system equipped with sensors and cameras to autonomously detect and locate blockages in urban drainage pipes.
- Integrating IoT and GPS technologies enabled real-time monitoring and precise localization of issues, enhancing maintenance efficiency.
- This innovation not only improved worker safety by reducing exposure to hazardous environments but also facilitated data collection for predictive maintenance strategies.

Learnings:

- Through this project, we gained valuable insights into the integration of multidisciplinary technologies, the complexities of urban infrastructure, and the importance of real-time data in proactive urban management.

Future Scope:

- The future direction for managing drainage blockages in India emphasizes the adoption of smart technologies like IoT sensors for real-time monitoring and early detection.
- In the future, solid waste inside the drain should be filtered out to reduce the possibility of clogging.
- A software application (App can be developed) should be built so that general people could keep track of the conditions of the drainage at any time from any place.