Autonomous System for Detecting Drainage Blockages in Urban Areas

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Abstract

Urban drainage blockages due to solid waste such as plastic and mud cause waterlogging, accidents, and health issues. Manually detecting and clearing such blockages is time-consuming and requires heavy labor. Our project introduces an autonomous robotic system that travels through drainage pipes, identifies blockages through sensors and cameras, and provides real-time information to the authorities. This reduces human effort, accelerates maintenance, and provides cleaner and safer urban spaces.
Keywords: Smart Robot System, Drainage Blockages, Urban Infrastructure, Automation, Robotics Technology.

Background

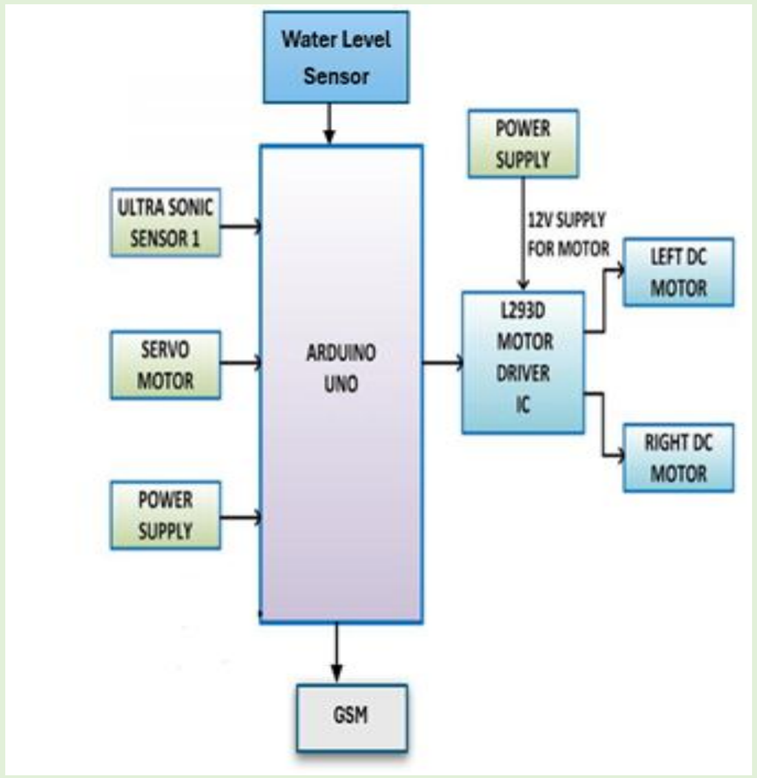
Urban blockage of drains is a significant problem created by solid waste such as plastic, mud, and trash. The blockages cause waterlogging, road destruction, accidents, and health risks by providing breeding sites for mosquitoes and transmitting diseases. As of now, it takes considerable time and manpower to detect and clear the blockages since authorities need to check several manholes to identify the issue.

This work proposes a Smart Robot System that self-detects and locates drainage obstructions. With sophisticated sensors, cameras, and, the robot is able to inspect drainage pipes, detect blockages, and provide real-time reporting to authorities. The proposed system will enhance urban drainage maintenance, mitigate flooding, and increase public health and safety.

Key Features

✅ **Autonomous Navigation:** Moves through drainage systems without human intervention.
✅ **Real-Time Detection:** Uses **ultrasonic, IR sensors, and cameras** to identify blockages.
✅ **Smart Communication:** Sends live updates via GSM to the control center for quick action.
✅ **Improved Efficiency:** Reduces manual labor, minimizes downtime, and ensures faster maintenance.

Methods



1. Robot Design & Sensors

- A robot equipped with **ultrasonic sensors**, **IR sensors**, and **cameras** is used to detect blockages in drainage pipes.
- It moves inside the drainage system using **wheels and tracks** for stability.

2. Blockage Detection

- The **IR sensor** detects solid objects blocking the path.
- The **ultrasonic sensor** measures water levels to identify potential clogs.

3. Data Collection & Transmission

- **GSM Module** sends alerts to municipal authorities.

4. Monitoring & Action

- The system **sends alerts** to officials via SMS or dashboard notifications.
- A maintenance team can take **quick action** based on the exact blockage location.

Results

The Smart Robot System effectively identified and determined drainage blockages with IR sensors, ultrasonic sensors, and cameras for live monitoring. The correctly detected blockage positions, while the GSM module sent warning messages to maintenance teams through SMS,. The robot moved the drainage pipes independently with servo motors and obstacle detection algorithms, minimizing human labor and time. A real-time dashboard presented the drain status, allowing for immediate maintenance measures. It is economical, can be scaled up, and prevents urban flooding. The future can hold AI-based blockage analysis and an IoT-based monitoring application.

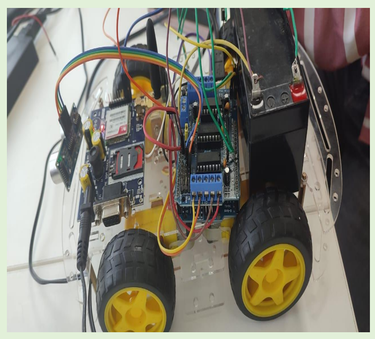


Fig: Robot

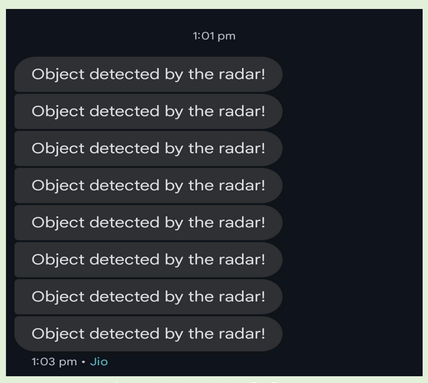


Fig: GSM Module

Conclusion

Effective blockage management of drainage calls for a blend of conventional manual approaches and innovative technologies. The use of a smart robotic system for the detection and identification of blockages in urban drainage pipes increases efficiency, lowers manual labor, and reduces downtime. Through the application of real-time monitoring and automated detection, the system guarantees rapid identification and resolution of drainage problems, which results in improved sanitation and prevention of flooding. The project contributes to city infrastructure development as it boosts the drainage maintenance level and lessens the health risk imposed by accumulated water. Combination with IoT, sensors, and the provision of real-time transmission enables improved response time and thereby more dependable drainage system.

Future Perspectives

The future perspectives of this project targets improving drainage maintenance through intelligent technologies. The use of IoT sensors for online monitoring will make it possible to detect blockages early, minimizing downtime and enhancing sanitation. The project plans to incorporate machine learning algorithms for predictive maintenance so that authorities can make proactive interventions before problems grow. A mobile app can be designed to enable citizens to observe drainage situations, raising the level of awareness and engagement among citizens. Automated waste filter systems in the future can be implemented to avoid clogging, mitigating the need for manual operation. Increasing the range of capabilities of the robot to perform under diverse environmental conditions, including high water pressure and harsh weather, will guarantee its efficiency in different urban environments. These developments will lead to an efficient and sustainable urban drainage system, diminishing flood risk and enhancing public health.

Impact on Society

The Smart Robot System for the identification of drainage clogging has an important influence on society by enhancing urban infrastructure maintenance. It helps to automate identification and positioning of clogging, minimizing dependency on manual checks and making the whole process quicker, safer, and more efficient. By avoiding urban flooding, it protects roads, buildings, and public areas as well as mitigating interruptions in daily life. The system also improves sanitation by averting sewage overflows, which cause water-borne diseases and environmental contamination. It is cost-reducing, with economic benefits from reduced infrastructure repair expenses, medical expenses, as well as manpower-intensive maintenance. By using real-time information and automating some processes, it also contributes to smart city policies, enabling sustainable urbanization and improving the quality of life for citizens.

To know more

GitHub link:https://github.com/kishorebathala/GROUP-A14
Video link: https://drive.google.com/file/d/1TW8c5QmMrW7IF6voelnJNb-8hdmQVu96/view?usp=drive_link