IJARSCT

International Journal of Advanced Research in Science, Communication and Technology

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

ISSN: 2581-9429

Volume 5, Issue 4, June 2025

Impact Factor: 7.67

A Review of Paper on Design & Implementation of Roadside Drainage System with Blockage Detection & SMS Facility

[1]Prof. Sandip Turkane, [2]Amarjeet Sude, [3]Ketan Bande, [4]Chandrashekhar Mahale, [5]Swami Maid

Assistant Professor, Department of Electronics & Telecommunication[1]

Students, Department of Electronics & Telecommunication[2,3,4,5]

Pravara Rural Engineering College, Loni India.

Abstract: *Efficient roadside drainage systems are crucial for preventing waterlogging, maintaining road safety, and reducing infrastructure damage. This project focuses on the design and implementation of an advanced roadside drainage system integrated with a blockage detection mechanism and SMS alert facility. The proposed system aims to monitor and manage drainage channels to ensure unobstructed water flow, which is especially critical during heavy rainfall or in areas prone to flooding. The drainage system is embedded with sensors to detect potential blockages caused by debris accumulation or sediment buildup. These sensors continuously monitor water flow rates, levels, and other key parameters within the drainage channels. When a blockage is detected, the system automatically sends an SMS alert to the responsible maintenance team, ensuring timely action and minimizing the risk of overflow or flooding. This smart drainage system reduces the need for manual inspections, promotes proactive maintenance, and enhances road safety. Additionally, the SMS alert feature ensures a fast response, facilitating efficient resource allocation for cleanup and repair. The project provides a scalable solution for urban and rural areas, contributing to resilient infrastructure and efficient water management practices.*

Keywords: Blockage, Drainage, Safety, Sensors

I. INTRODUCTION

Roadside drainage systems play a vital role in managing surface water runoff, preventing waterlogging, and ensuring road safety. However, these systems often face challenges due to blockages caused by debris, sediment, or waste materials. Blocked drainage channels can lead to water accumulation on road surfaces, causing hazardous driving conditions, increased risk of accidents, and potential damage to the surrounding infrastructure. The need for efficient drainage management systems is thus critical, particularly in urban areas and regions with high rainfall. Traditional methods of managing roadside drainage involve regular inspections and manual cleaning, which can be labor-intensive and inefficient. Blockages can often go unnoticed until they result in significant flooding or road damage, requiring costly repairs and disrupting traffic flow. To address these challenges, this project proposes a smart roadside drainage system with automated blockage detection and SMS alert functionality. This system integrates sensors within the drainage channels to monitor water flow levels and detect any obstructions in real-time. Upon identifying a potential blockage, the system automatically generates an SMS alert to notify maintenance personnel, allowing them to respond promptly and prevent further complications. By reducing reliance on manual inspection, this system offers a proactive approach to drainage management, enhancing road safety and operational efficiency.

II. LITERATURE REVIEW

Narayana, G. Lakshmi, et al. "Sensor-Based Open Channel Blockage Detection System. This study presents a sensor-based system for detecting blockages in open channels, a crucial aspect of maintaining effective drainage. Blockages in open channels can lead to the accumulation of water, which in turn causes flooding and facilitates the breeding of disease-carrying pests. By implementing sensor-based technology, this system allows for real-time monitoring of channel conditions, providing timely alerts to authorities for maintenance. This solution aids in mitigating health risks associated with poor drainage, especially in urban areas prone to flooding and blockage. Vardhan, KV Vishnu, et al. "A Framework for Intelligent Traffic Management System for Roads under Adverse Weather Conditions Using Smart Sensors. The study introduces an intelligent traffic management framework that uses smart sensors to monitor road conditions during adverse weather events, such as heavy rainfall and floods. By integrating sensors that monitor road and drainage conditions, this system enables authorities to manage traffic effectively and provide warnings about hazardous conditions. Such smart systems enhance urban infrastructure by supporting both traffic flow and public safety in challenging weather, which can exacerbate drainage issues.

III. TECHNOLOGY STACK

3.1 Embedded C :

Embedded C is most popular programming language in software field for devel- oping electronic gadgets. Each processor used in electronic system is associated with embedded software. Embedded C programming plays a key role in per- forming specific function by the processor. In day-to-day life we used many electronic devices such as mobile phone, washing machine, digital camera, etc. These all device working is based on microcontroller that are programmed by embedded C.

3.2 KeilµVision:

Keil µVision (Micro Vision) is an integrated development environment (IDE) developed by Arm Keil that is widely used for developing embedded systems, particularly those based on ARM Cortex-M microcontrollers. It offers a comprehensive suite of tools to facilitate all stages of embedded software development, from code writing and debugging to compiling and flashing the firmware onto the target hardware. Known for its efficiency and versatility, Keil µVision is a preferred choice among embedded systems engineers for ARM-based microcontroller projects.

IV. PROPOSED SYSTEM

System Architecture:

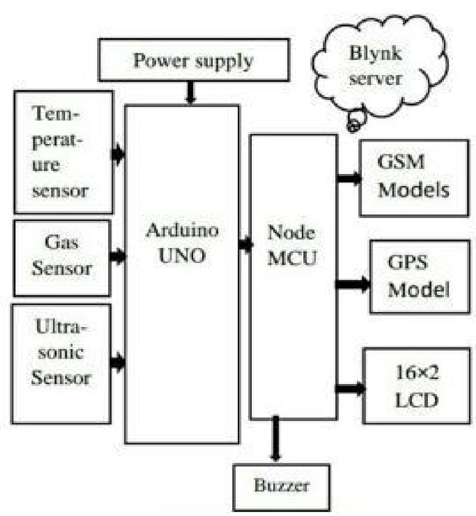

Fig .1 Architecture of roadside drainage system with blockage detection & SMS facility

Arduino UNO: It controls and processes data from the various sensors in the system. It interacts with other components such as GSM modules, ultrasonic sensors, and LCD displays to monitor and report any drainage issues. Node MCU: Node MCU is a Wi-Fi-enabled microcontroller board based on the ESP8266 chip. It provides connectivity to the internet, which can be used to upload drainage system data to a cloud server or send alerts using web-based services.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 4, June 2025
Impact Factor: 7.67

Node MCU can be used for cloud-based monitoring and sending web-based notifications when blockages are detected. It can also send data to a central monitoring system or mobile app for real-time tracking. Power Supply: A regulated 12V DC adapter is used to supply power to the Arduino UNO and Node MCU, as well as the sensors. A step-down regulator (e.g., 5V regulator) may be needed to provide the correct voltage levels for components like the Node MCU. Buzzer: The Buzzer provides an audible sound when a blockage is detected or when the system requires maintenance. It is controlled by the Arduino or Nedelcu to alert workers or users in close proximity. Can be a passive or active buzzer, connects to a digital pin on Arduino. GPS Module: Detects the exact location of the drainage system. The GPS module (e.g., NEO-6M) is used to provide real-time geographic coordinates (latitude and longitude) of the drainage system. Typically works on 3.3V or 5V, supports NMEA protocol, has a high-accuracy positioning system with 50 channels. GSM Module: Sends SMS alerts when a block or abnormality is detected in the drainage system. The GSM module (e.g., SIM900 or SIM800) is used to send SMS messages. It communicates with the Arduino UNO via serial communication (UART). Supports 2G/3G communication, requires a SIM card for sending SMS, can work with AT commands.16x2 LCD: Displays real-time information like sensor readings, system status, or error messages. The 16x2 LCD is an alphanumeric display that can show two lines of 16 characters each. It is commonly used in embedded systems for displaying text-based data. Works with I2C communication for reduced wiring complexity, easy to interface with Arduino. Gas Sensor: Detects the presence of gases that may indicate a blockage or malfunction (e.g., harmful gas accumulation due to stagnation). Common gas sensors like MQ-2, MQ-5, or MQ-7 can detect gases like methane, carbon monoxide, or smoke. These sensors help in detecting potential hazards in the drainage system. Ultrasonic Sensor (HC – SR04): The ultrasonic sensor (e.g., HC-SR04) is used to measure the distance between the sensor and the water surface. If the distance is too low, it could indicate a blockage or overflow in the system. Provides high accuracy in distance measurement, operates at 5V, uses sound waves for detection. Temperature Sensor: Monitors the temperature of the environment or water to detect abnormal conditions.

Fig.2 Architecture of roadside drainage system with blockage detection & SMS facility

V. FLOW CHART AND ALGORITHM

Flowchart is a type of diagram that represents a workflow or process. A flowchart can also b to solving a task. The flowchart shows the steps as boxes of various The system starts and initializes. The system starts by initializing all necessary components, including the ultrasonic sensor, gas sensor, temperature sensor, and GPS module. Additionally, the GSM module is set up for SMS alerts, the LCD display is initialized for real-time data visualization, and serial communication is activated for debugging purposes. Once the system is initialized, it enters the main loop, where it continuously reads data from the sensors. The ultrasonic sensor measures the water level, the gas sensor detects gas levels, and the temperature sensor records temperature readings. The gathered data is then displayed on the LCD, providing real-time monitoring of the drainage conditions. The system checks for abnormalities, particularly focusing on water levels. If the water level falls below a predefined threshold, indicating a possible blockage, the system triggers an alert. This includes sending an SMS notification via the GSM module, activating a buzzer for immediate on-site warning, and displaying a "Blockage Detected" message on the LCD. After executing the alert functions, the system pauses for a short delay (1-2 seconds) before taking new sensor readings. This loop continues indefinitely to ensure continuous monitoring of the drainage system, allowing for quick response to any detected blockages or anomalies. The system runs persistently unless manually stopped or powered down.

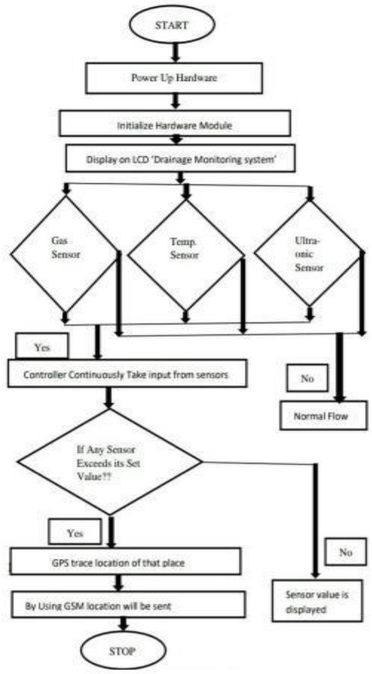

Fig 5. Flow chart

VI. CHALLENGES IN UGV DESIGN AND IMPLEMENTATION

Sensor Accuracy and Reliability Blockage Detection Sensitivity: The ultrasonic sensor must accurately detect blockages in the drainage system. Environmental factors such as debris accumulation, sensor misalignment, or false readings can affect detection accuracy. Water Level Measurement: Variations in water flow, turbulence, or sediment deposits may impact the reliability of ultrasonic sensors, leading to incorrect blockage detection. Gas and Temperature Sensors: Exposure to extreme weather conditions or sensor degradation over time may affect gas and temperature sensor accuracy, leading to inconsistent readings. Power and Energy Efficiency Continuous Monitoring Requirement: The system operates continuously, requiring efficient power management to ensure long-term performance without frequent maintenance. Battery Dependence: If the system is battery-powered, ensuring prolonged battery life while running multiple sensors, the GSM module, and an LCD display can be challenging. Energy Optimization: Balancing power consumption between sensors, communication modules, and display components without compromising system performance is crucial. Communication and Data Transmission: GSM Network Reliability: The system depends on GSM communication to send SMS alerts, but poor network coverage in remote or underground drainage systems can delay or prevent message delivery. Signal Interference: Electrical interference from surrounding infrastructure (e.g., power lines, underground cables) can affect GSM and GPS module performance, leading to communication failures. Real-Time Data Transmission: Ensuring that sensor data is transmitted in real time for immediate action can be challenging, particularly in cases where network congestion or interference occurs. Environmental and Structural Challenges: Harsh Weather Conditions: Heavy rainfall, flooding, or temperature fluctuations can impact sensor performance and system reliability, requiring robust waterproofing and insulation. Debris and Sensor Blockage: Drainage systems often contain solid waste, mud, and plant growth, which can obstruct sensors, reducing their

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 4, June 2025
Impact Factor: 7.67

effectiveness in detecting water levels and blockages. Installation and Maintenance Issues: Installing sensors and communication modules in confined or difficult-to-access drainage areas can be complex, requiring durable mounting solutions. Security and System Integrity: Unauthorized Access: The system must be protected against tampering or unauthorized modifications that could affect its performance. Cybersecurity Risks: If the system is connected to a remote monitoring interface, it may be vulnerable to hacking or unauthorized data interception. False Alerts and System Malfunctions: Unreliable sensor readings or software glitches could trigger unnecessary SMS alerts, causing confusion or reducing trust in the system's effectiveness.

VI. ADVANCEMENTS IN ROADSIDE DRAINAGE SYSTEM WITH BLOCKAGE DETECTION & SMS TECHNOLOGY

Advancements in the Design & Implementation of a Roadside Drainage System with Blockage Detection & SMS Facility have significantly improved the efficiency, accuracy, and reliability of drainage monitoring and maintenance. The integration of Artificial Intelligence (AI) and Machine Learning (ML) has enhanced the system's ability to detect blockages and predict potential drainage failures. AI-powered algorithms analyse sensor data, enabling real-time decision-making and automated response mechanisms such as activating alerts or triggering maintenance actions. Predictive analytics helps identify patterns in water levels, gas emissions, and temperature variations, allowing authorities to take preventive measures before severe blockages occur. Improvements in sensor and perception technologies have led to the development of more accurate and durable sensors, such as high-precision ultrasonic sensors for water level monitoring, gas sensors for detecting harmful emissions, and temperature sensors for assessing environmental conditions. Sensor fusion—the combination of multiple sensors—ensures more reliable data collection, reducing false alarms and improving the accuracy of blockage detection. Furthermore, IoT integration allows these sensors to transmit real-time data to cloud-based platforms, enabling remote monitoring and automated data analysis. Enhanced communication technologies, such as 5G and LPWAN (Low Power Wide Area Network), ensure seamless and reliable data transmission even in areas with weak GSM signals. This advancement enables faster and more stable SMS notifications to maintenance teams, ensuring prompt action when a blockage is detected. Additionally, the integration of cloud computing allows for real-time visualization of drainage conditions, making it easier for authorities to monitor and manage multiple drainage points from a central location. In terms of power management and energy efficiency, advancements in solar-powered systems and low-power microcontrollers have made drainage monitoring systems more sustainable, reducing dependency on external power sources. Smart Battery Management Systems (BMS) further optimize power usage and ensure continuous operation even in remote locations. Structural and environmental resilience has also improved with the introduction of ruggedized sensor enclosures that protect against harsh weather conditions such as heavy rain, floods, and extreme temperatures. Additionally, self-cleaning sensor mechanisms help prevent debris accumulation, ensuring consistent performance without frequent manual maintenance. Finally, automation and robotics are revolutionizing the way drainage systems are maintained. Autonomous drain-cleaning robots equipped with cameras and actuators can remove blockages without human intervention, reducing maintenance costs and improving efficiency. Drones with high-resolution and thermal imaging cameras are also being used for large-scale inspections, allowing authorities to quickly identify potential drainage issues across wide areas. These technological advancements collectively contribute to a smarter, more efficient, and proactive roadside drainage management system, reducing the risk of urban flooding and enhancing overall infrastructure resilience.

VIII. CASE STUDIES AND REAL-WORLD EXAMPLES

The Smart Drainage System in Singapore is a prime example of how automated monitoring technology can mitigate urban flooding. This system integrates ultrasonic sensors to monitor water levels in roadside drains, detecting blockages in real time. Upon identifying a potential clog, the system triggers an SMS-based alert mechanism, notifying municipal authorities for quick intervention. This initiative has significantly improved flood response times, reducing waterlogging in high-risk areas. Similarly, Mumbai's IoT-Enabled Drainage System leverages gas sensors and ultrasonic sensors to monitor underground drains. The system is particularly effective in detecting methane buildup, indicating possible blockages or waste accumulation. Once an abnormality is detected, a GSM-based alert is sent to maintenance teams, allowing for immediate action. This approach has helped in preventing drain overflows during heavy monsoons, enhancing urban water management. In Japan, an AI-Driven Drainage Monitoring System has been deployed to predict and prevent blockages before they occur. This system integrates machine learning algorithms to analyse historical drainage data alongside real-time sensor inputs. By identifying patterns leading to blockages, the system provides predictive alerts via SMS notifications, ensuring that preventive maintenance is carried out before a major issue arises. This innovation has played a crucial role in reducing urban waterlogging, especially during typhoon seasons. In the United States, Remote Drainage Monitoring Systems have been tested in cities like New York and Houston. These systems employ GPS tracking, cloud-based data storage, and automated alert mechanisms to monitor multiple drainage points. When a drain blockage is detected, an SMS notification is sent to municipal authorities, enabling a rapid response. The integration of mobile applications and cloud computing has further streamlined maintenance operations, improving urban flood management. These real-world examples demonstrate how sensor technologies, AI-driven analytics, and GSM-based alert systems have revolutionized roadside drainage monitoring. By enabling real-time detection, predictive maintenance, and automated SMS notifications, such systems enhance infrastructure resilience and prevent waterlogging in urban areas.

IX. FUTURE DIRECTIONS AND RESEARCH TRENDS

The future of roadside drainage systems with blockage detection and SMS alert mechanisms is poised for significant advancements through the integration of smart technologies, artificial intelligence, and IoT-based monitoring systems. One key research trend is the enhancement of sensor accuracy and efficiency, particularly in ultrasonic, gas, and temperature sensors, to provide more reliable and real-time data. Future drainage systems will likely incorporate AI-driven predictive analytics, allowing for early detection of potential blockages based on historical data, weather patterns, and sensor inputs. This will enable proactive maintenance, reducing the risk of severe drainage failures. Another major direction is the expansion of IoT-based drainage networks, where multiple drainage monitoring systems communicate through cloud computing and wireless networks. This will facilitate large-scale data collection and analysis, improving the efficiency of municipal drainage management. Additionally, 5G-enabled communication systems will enhance real-time data transmission, ensuring instant alerts and remote monitoring capabilities. The integration of autonomous robotic maintenance systems is also emerging as a promising research area. Future drainage systems may deploy robotic inspection units equipped with cameras and cleaning mechanisms to automatically detect and remove blockages, minimizing the need for manual intervention. Furthermore, renewable energy solutions, such as solar-powered drainage monitoring units, will be explored to enhance system sustainability and ensure uninterrupted operation in remote or disaster-prone regions. Advancements in geospatial technology and GPS tracking will allow authorities to pinpoint the exact location of blockages with greater precision, optimizing response times. The implementation of machine learning algorithms in drainage monitoring will refine anomaly detection, distinguishing between temporary obstructions and serious blockages, thus prioritizing maintenance efforts effectively. In the coming years, smart drainage systems will evolve to become more autonomous, interconnected, and environmentally sustainable. By integrating AI, IoT, automation, and advanced sensor technologies, future drainage monitoring frameworks will significantly improve urban water management, flood prevention, and real-time response systems, ensuring cleaner and more efficient drainage networks.

X. CONCLUSION

In conclusion, drainage systems integrated with SMS alert facilities represent a significant advancement in urban and rural flood management offering a reliable, accessible and cost-effective solution for real time monitoring. The use of SMS notification enhances response times during critical water level changes, enabling authorities and maintenance teams to act promptly to prevent or mitigate flooding and system blockages. This approach effective in areas with limited internet connectivity, as SMS is dependable even in low bandwidth environments.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 4, June 2025
Impact Factor: 7.67

Fig .6 Design & Implementation of Roadside Drainage System with Blockage Detection & SMS Facility

REFERENCES

[1]. Narayana, G. Lakshmi, et al. "Sensor-Based Open Channel Blockage Detection System." 2023 IEEE 12th International Conference on Communication Systems and Network Technologies (CSNT). IEEE, 2023.

[2]. Chandrasena, Dedimuni Charmaine Nadeesha. Development of Solid Waste Clog Resistent Open

[3]. Drain System with Improved Storm Water Conveyance. Diss. Universiti Teknologi PETRONAS, 2017.

[4]. Nleya, Magripa, et al. "Integrated Municipal Solid Waste Management System (IMSWMS)." Mauritius Int. Conf. on Biol., Chemical and Agric.(BCAS-16). 2016.

[5]. .Besley, Colin H., Graeme E. Batley, and Michele Cassidy. "Tracking contaminants of concern in wet-weather sanitary sewer overflows." Environmental Science and Pollution Research 30.43 (2023): 96763-96781.

[6]. Maghiar, Marcel, Mike Jackson, and Gustavo Maldonado. Warning systems evaluation for overhead clearance detection. No. FHWAGA-16-1521. Georgia Southern University, 2017.

[7]. Rashid, Bushra, and Mubashir Husain Rehmani. "Applications of wireless sensor networks for urban areas: A survey." Journal of network and computer applications 60 (2016): 192-219.Health Problems Caused By Sewer Gas,

[8]. Vardhan, KV Vishnu, et al. "A Framework for Intelligent Traffic Management System for Roads under Adverse Weather Conditions using Smart Sensors." 2022 IEEE Conference on Interdisciplinary Approaches in Technology and Management for Social Innovation (IATMSI). IEEE, 2022.

[9]. The Sun Daily: Poor drainage contributing factor to rise in dengue cases in Oduah,Uzoma Ifeanyi, Christopher M. Anierobi, and Olufemi G. Ilori. "Inventing a robust road-vehicle flood level monitoring device for disaster mitigation.