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Solar Operated Underground Drainage Blockage Monitoring System in Urban using IoT

RanjithKumar.P[1], Harini.R[2], Balasankari.T[3] and Chinnammal.M[4]
[1]Professor, Electronics and CommunicationEngineering, P.S.R Engineering College, Sivakasi,Tamilnadu,India.
Email: ranjithkumar@psr.edu.in
[2-4]B.E Student, Electronics and CommunicationEngineering, P.S.R Engineering College, Sivakasi, Tamilnadu, India.
Email: harinist2002@gmail.com, balasankari149@gmail.com, chinnammalselvi4@gmail.com

***Abstract*— India has declared plans to create 100 smart cities. Since subterranean drainage systems are installed in the majority of Indian cities, it is critical that these systems function properly to maintain the cleanliness, safety, and health of the city. Thus, several types of work have been carried out in order to identify, preserve, and oversee these subterranean networks. A smart subterranean framework incorporating subterranean water pipelines, gas pipelines, electric flow, and interface wireswill be required. Adoption of subsurface drainage systems is crucial in India. The city is kept secure, clean, and healthy thanks to the correct operation of this system. In the event that the drainage system is neglected, clean water could become tainted with drainage water, which could spread infectious illnesses. Additionally, a variety of hazardous substances are released into the atmosphere, causing air pollution. As a result, a variety of tasks have been undertaken to identify, track, and control these subsurface systems. This project illustrates the implementation and design roles for several techniques to monitoring, detecting, and managing subsurface drainage systems. The suggested system embodies the design and execution duties for overseeing and controlling subterranean drainage systems using various methodologies. It also describes the water wise system and the technique for spotting blockages in drainage pipelines. For waste water networks to operate properly and to avoid flooding, urban drainage systems must be managed effectively. This project presents a comprehensive drainage monitoring and removal system that makes use of cutting-edge technologies including GSM, Arduino - based control, and ultrasonic sensors. The main goal is to provide continuous drainage operations by offering autonomous blockage identification and real-time drainage system monitoring.**

***Index Terms*— Water conductivity sensor, drainage monitoring, NodeMCU (key words)**

I. INTRODUCTION

In the wake of escalating urbanization, drainage systems in urban areas encounter escalating challenges, particularly in ensuring their functionality and resilience. The repercussions of inefficient drainage are far-reaching, leading to flooding, property damage, and environmental degradation. Conventional drainage monitoring methods often prove inadequate, lacking real-time insights crucial for proactive management. This paper introduces an innovative paradigm to address these challenges – a Solar Operated Drainage Blockage Monitoring System empowered by Internet of Things (IoT) technology. The integration of solar energy in this system serves a dual purpose. Firstly, it ensures sustained and eco-friendly power supply, overcoming the

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limitations associated with traditional electrical sources. Secondly, by utilizing IoT, the system enables real-time data collection, analysis, and communication. This combination revolutionizes drainage monitoring in urban environments, offering an efficient, sustainable, and intelligent solution. As urban areas grapple with the consequences of climate change and heightened precipitation events, the need for adaptive drainage systems becomes paramount. This paper elucidates the architecture and functionality of our proposed system, emphasizing its potential to transform the landscape of urban drainage management. Through rigorous experimentation and analysis, we showcase the effectiveness and reliability of this Solar Operated Drainage Blockage Monitoring System, providing a foundation for enhanced urban resilience and sustainable infrastructure.

II. REFERENCES

1. Y. Fucai et al. created a brand-new kind of dredging robot for drainage pipelines. The current situation, a number of methods for cleaning drainage pipelines both domestically and internationally, and the robot's walking mechanism were examined. The robot's moving parts, control systems, and operational device were created based on modular thinking, the operating environment, and technical specifications. When using an operational tool to accomplish cleaning tasks, the robot can move on its own and achieve design requirements through experimentation.
2. P. Wu et al. investigations using the finite elements method for municipal drainage dredging robots. It used a specific kind of robotic municipal drainage dredging system as an illustration. The two main structural components of the robot were studied using the most dangerous operating condition, in which the tank is subjected to the highest working resistance and just one front wheel is hanging, may be identified using ANSYS Workbench13.0 to calculate the equivalent stress and total deformationThe results of the research showed that the two components' structure made sense.
3. M. Cardona et al. shows off a mobile robot concept that may be applied to wastewater treatment plants to enhance cleanliness. It allows us to investigate the hard-to-reach drainage ducts and simultaneously look within pipes to find the cause of drainage extrusions. Regulations could demand that these devices be adjusted to meet certain measurements. They can also be operated from a surface-mounted portable control station via a cable or remotely. The design should be adapted to the sewer structure to move on a specific surface and be easily handled in order to guarantee that the accessories and electrical appliances do not impede the ability to observe the interiors and accurately capture what emerges from a deeper and more accessible level.
4. X. Yue, et al . proposed a robot inspection system that is dependent on the transmission line's transformation. An analysis is conducted on both the robot's configuration and the magnetic online charging equipment. A finite state machine is used to investigate how typical hurdles are surmounted. The obstacle crossing test is conducted and the test findings validate the design rationale and motion planning feasibility by showing the mechanism's capacity to maneuver around complex impediments like drainage lines and tension clamps. By altering the transmission line environment, the robot is able to swiftly and effectively navigate over common obstructions.
5. S. Bin, et al. examined the desilting robot's component design. This research focuses on driving the rotary blade to clear the silt and intelligently controlling the pneumatic operation based on the silt's state This work analyzes the key features of the desilting mechanism, enhances the desilting robot's mechanical component, and creates the budget-friendly variant.
6. C. Tao et al. created a system using the hardware development platform consists of a Raspberry Pi 3B, an infrared thermal imager, an infrared camera, and sensors for temperature, humidity, and other characteristics of combustible and explosive gases as well as dangerous and poisonous gases. The system creates a real-time monitoring system for an underground pipe gallery using robotics, image processing, and remote video surveillance technology. In addition to gathering the subterranean pipe gallery's operating environment data, the system is also capable of acquiring infrared images for the running environment and infrared camera images.
7. K. G. S. Apuroop et al. presents a system architecture for robots and clouds that can support many fleets and robots for drain inspection. Additionally, this offers a customizable setup for storing the massive amounts of sensor data produced by the robot fleet into designated databases. The current research presents the results of throughput testing that involved stress loading a development virtual computer in a private cloud and a Raspberry Pi from a drain inspection robot. Testing of latency under various networks was also conducted when the robot was being deployed in a drainage system.
8. L. Xue, et al. suggested a portable concentric tube robot for surgery to drain nasal cysts. The transmission system is made more compact for handheld use by using roller gears. Surgeons can operate the equipment more comfortably and easily when performing surgical duties thanks to the ball gear mechanism and the structure's ergonomic design. The Nitinol tube may be bent from the base thanks to the ball gear mechanism, significantly

increasing the end-effector's workspace. The device's ergonomic design promotes and facilitates the use of the technology in surgeries in a more compassionate manner. Furthermore, a simple operation pattern for steering the end-effector location in real-time is suggested.

9. Jidai Wang et al suggested a new bionic framework for the testing robot in this paper, fusing bionics principles with contemporary design techniques and primates' unique motion characteristics; the operating model is based on the three symmetrically distributed arms that it crosses on the power line to mimic the movement of a monkey suspension pendulum; the robot's obstacle-crossing operation is simulated and evaluated with ADAMS software, ultimately confirming the stability and logic of the bionic mechanism; and lastly, the virtual prototype and concept model of the robot are created and tested on a real power line.

10. S. Fu, et al. develop The computer with the bottom equipment layer and the computer with the higher monitoring layer, and the sensor layer at the bottom make up the designed The main drainage pumps' remote supervision and alert mechanism. Real-time monitoring data from the pump sensors might be collected by the equipment layer's multifunctional monitor and sent to the monitoring layer. The system will promptly notify users in the event that the operation status of the pumps is abnormal, therefore averting various unanticipated incidents. The monitoring metrics may offer unbiased standards for future pump maintenance decisions. The current system is highly scalable, adaptable, and performs dependably. It has also raised the bar for business security management.

III. METHODOLOGY (HEADINGS 3)

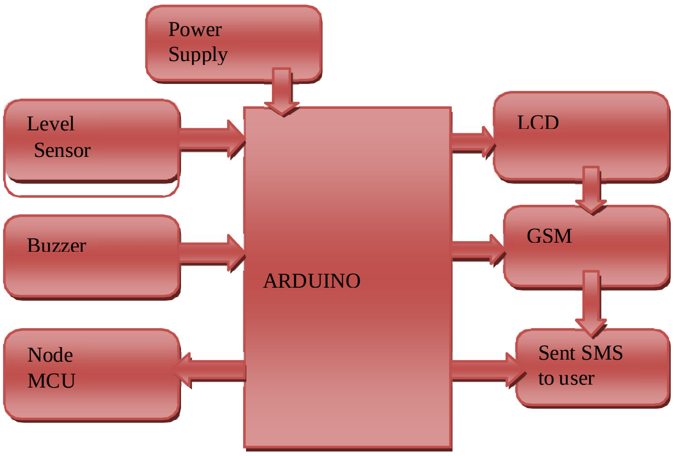


Fig:1 Block Diagram for the solar operated underground drainage monitoring system in urban using IOT

The methodology for the Solar Operated Underground Drainage Monitoring System in Urban Areas utilizing IoT involves a systematic approach to implementing and operating the system. Here is a brief overview of the methodology:

A. Sensor Deployment: The first step involves strategically placing IOT sensors inside the underground drainage network at key locations such as manholes and junctions. These sensors are designed to monitor water levels, flow rates, and detect blockages in real-time.

B. Solar Power Integration: Solar panels are installed to power the IoT sensors and data transmission devices. The solar energy harvested is stored in batteries to ensure continuous operation of the monitoring system, even in low-light conditions.

C. IoT Connectivity: The sensors are equipped with IoT communication modules that enable wireless data transmission to a central monitoring station. This connectivity allows for remote monitoring and control of the drainage system from a centralized location.

D. Data Collection and Analysis: The IoT sensors collect data on water levels, flow patterns, and any anomalies detected within the drainage network. This data is transmitted to the central monitoring station for analysis and processing.

E. Real-time Monitoring: The central monitoring station receives and processes the data from the IoT sensors in real-time. Operators can view the status of the drainage system, identify potential issues such as blockages or overflows, and take immediate action to address them.

F. Predictive Maintenance: By analyzing historical data and trends, the system can predict potential drainage system failures or blockages. Automated alerts can be generated based on predefined thresholds, enabling proactive maintenance and timely interventions.
G. Remote Control and Intervention: The IoT-enabled system allows for remote control of drainage infrastructure, such as adjusting flow rates or diverting water flow in response to changing conditions. Operators can remotely manage the system to optimize performance and prevent disruptions.
H. Data Storage and Reporting: All data collected by the IoT sensors is stored in a centralized database for future reference and analysis. Reports and visualizations can be generated to provide insights into the performance of the drainage system over time.

IV. WORKING MODEL (HEADING 4)

The Solar Operated Underground Drainage Monitoring System in urban areas using IoT integrates solar power, IoT technology, and underground sensors to efficiently monitor and manage drainage systems. Solar panels are utilized to harness solar energy and convert it into electrical power, reducing reliance on grid electricity. IoT devices such as sensors, actuators, and communication modules are strategically deployed in the underground drainage network. These devices are interconnected wirelessly, forming a network that continuously collects and transmits real-time data to a central control system. Sensors placed in key locations within the underground drainage system monitor parameters like water levels, flow rates, and blockages. The collected data is wirelessly transmitted using IoT communication protocols to the central control system for analysis. Algorithms can be implemented to detect anomalies, predict potential issues, and optimize system performance. In case of abnormalities such as high water levels or blockages, the monitoring system generates alerts and notifications for timely authorities. The central control system allows for remote access and control, enabling operators to monitor the drainage system from anywhere through a web-based interface or mobile application. This remote access facilitates quick decision-making and response to critical situations. To escalate and optimizing system performance for better efficiency.
In the proposed method, we have developed an Arduino-based underground drainage monitoring system. This system has been designed to address several crucial aspects of drainage management, including blockage detection, overflow prevention, and lid position monitoring. Blockage Detection is the system incorporates sensors placed strategically within the drainage network. These sensors continuously monitor the flow of water within the pipes. If a blockage occurs, such as debris or other obstructions, the sensors detect this change and trigger an alert. Overflow Prevention is to prevent drainage system overflows, we have set maximum level sensors at critical points within the drainage network. These sensors monitor the water levels, and when they reach predefined maximum levels, they trigger a warning. IoT Integration is all the sensor data is sent to a central controller, which is connected to an IoT (Internet of Things) network. When any of the sensors detect an anomaly, the controller sends a signal to the IoT network. Alert Generation is the IoT network is responsible for generating alerts to the relevant personnel. These alerts can be in the form of messages, emails, or notifications on a dedicated monitoring platform. The alerts promptly notify responsible individuals of the specific issue detected within the drainage system.

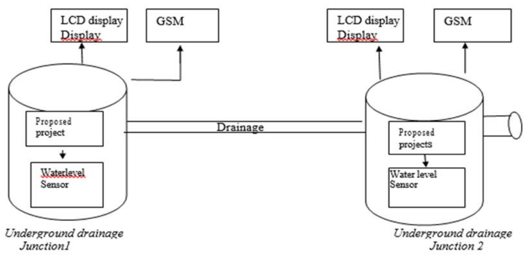


Fig 2: Proposed System of Solar Operated Underground Drainage Monitoring System

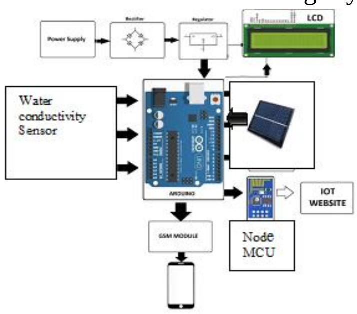
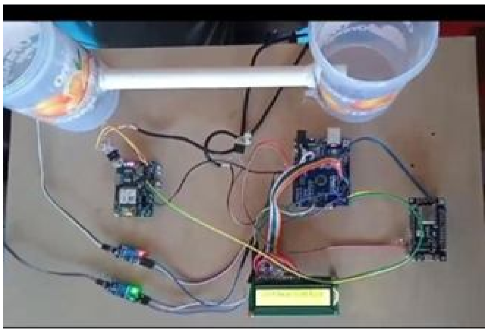


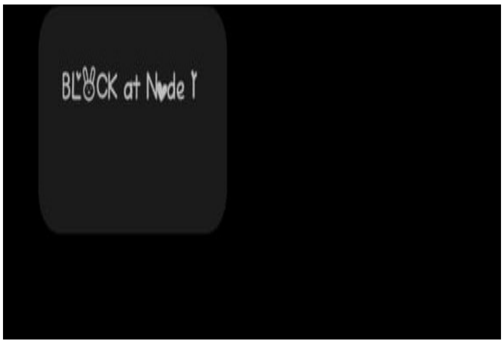
Fig: 3 Solar operated underground drainage monitoring system in urban using IOT

A. Solar Panel: Harvests solar energy to power the system, making it sustainable and reducing the reliance on external power sources.
B. Battery Storage: Stores the collected solar energy to ensure continuous operation, especially during periods of low sunlight.

C. IoT Sensors: Placed in subsurface drainage systems to monitor characteristics such as water level, flow rate, and quality. These sensors collect real-time data.
D. Microcontroller/Processor: Manages and processes the data collected by the sensors. It acts as the brain of the system, making decisions based on the received information.
E. Node MCU: The Node MCU serves as the intelligent heart of the local node. It plays a crucial role in data acquisition, processing, and communication.
F. Communication Module: Facilitates communication between the monitoring system and a central server or control unit. Common communication technologies include GSM, Wi-Fi, or LoRa for transmitting data.
G. Central Server/Control Unit: Gathers and stores data from multiple monitoring systems. It can be hosted in the cloud or a centralized location, providing a comprehensive view of the drainage network.
H. Data Analytics Software: Processes the collected data to derive meaningful insights. It can identify patterns, predict potential issues, and optimize drainage system performance.
I .User Interface: Enables users, such as city officials or maintenance personnel, to visualize the data, receive alerts, and take necessary actions through a user-friendly interface.
J. Alerting System: Sends notifications or alerts to relevant stakeholders in case of abnormal drainage conditions, potential blockages, or other critical events.

V. RESULT AND DICUSSION(HEADING 5)





The Monitoring and Removal System for Drainage relies on advanced technology to ensure efficient urban drainage management. The Water conductivity sensor, a key component, operates by emitting high- frequency sound waves that bounce back from the liquid surface within the drainage system. By measuring the time taken for these waves to return, the sensor provides real-time data on water level. Abnormal increases in water level, indicative of blockages or overflows, trigger the system to take action. The GSM module plays a crucial role in communication, utilizing cellular networks to establish links with relevant stakeholders or authorities. When the ultrasonic sensor detects issues, the Arduino microcontroller, acting as the system's central control unit, processes the data and commands the GSM module to send SMS messages or make calls to notify responsible parties. This rapid communication ensures timely responses to drainage system challenges, preventing flooding and ensuring the proper functioning of wastewater networks. The Arduino's decision-making logic distinguishes between normal operation and critical events, guaranteeing uninterrupted drainage operations and the well-being of urban infrastructure.

VI. ACKNOWLEDGEMENT

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VII. CONCLUSIONS (HEADING 6)

The Monitoring and Removal system for Drainage proposed in that project offered a comprehensive and innovative solution to the multifaceted challenges of urban drainage system management. By seamlessly integrating Arduino control, water level sensor, and GSM technology, the system provided an efficient, automated, and environmentally responsible approach to maintaining and optimizing drainage networks. This not only enhanced drainage system performance but also contributed significantly to environmental safety and sustainability in urban areas, ultimately safeguarding communities from the adverse effects of drainage system issues.

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