



Development of an Intelligent Water Pipeline Leakage Detection and Alert System- A Review

Shailendra Singh Thakur¹, Mr. Shivanshu Patel ²

¹ M.Tech. Scholar, School of Civil Engineering, Faculty of Engineering and Technology Madhyanchal Professional University Bhopal, M.P

² Assistant Professor, School of Civil Engineering, Faculty of Engineering and Technology Madhyanchal Professional University Bhopal, M.P.

Article Info

Article History:

Published: 25 May 2026

Publication Issue:

Volume 3, Issue 5
May-2026

Page Number:

341-350

Corresponding Author:

Shailendra Singh Thakur

Abstract:

Water leakage in pipeline distribution systems has become a major challenge due to increasing water demand, aging infrastructure, and inefficient monitoring methods. Significant amounts of treated water are lost every year because of unnoticed leakages, leading to economic losses, reduced water availability, and environmental concerns. Conventional leakage detection techniques are often labor-intensive, time-consuming, and unable to provide real-time monitoring. To overcome these limitations, intelligent water pipeline leakage detection systems based on the Internet of Things (IoT), wireless sensor networks, and embedded technologies have gained considerable attention. This review paper presents a comprehensive study on the development of intelligent water pipeline leakage detection and alert systems. The review focuses on various sensing technologies such as flow sensors, pressure sensors, moisture sensors, acoustic sensors, and ultrasonic sensors used for leak identification. It also discusses the role of microcontrollers, cloud computing, GSM/Wi-Fi communication, and machine learning techniques in enabling real-time monitoring and automated alert generation. Different methodologies adopted by researchers for leakage localization, data analysis, and remote monitoring are analyzed and compared. Furthermore, the paper highlights the advantages, limitations, and challenges associated with existing systems, including sensor accuracy, power consumption, network reliability, and implementation cost. The study concludes that intelligent leakage detection systems can significantly reduce water wastage, improve pipeline maintenance efficiency, and support sustainable water resource management. Future research directions include the integration of artificial intelligence, low-power IoT devices, and smart city infrastructure to enhance the reliability and scalability of water pipeline monitoring systems.

Keywords: Water Leakage Detection, Intelligent Monitoring System, Internet of Things (IoT), Smart Water Management, Pipeline Monitoring, Wireless Sensor Networks, Flow Sensors, Pressure Sensors

1.Introduction

Water is one of the most essential natural resources for human survival, agriculture, industrial development, and environmental sustainability. Rapid urbanization, population growth, and increasing industrial activities have significantly raised the demand for clean and continuous water supply across the world. To meet this demand, extensive water distribution systems consisting of underground pipelines are used to transport water from treatment plants to residential, commercial, and industrial areas. However, a major challenge faced by water supply authorities is the leakage occurring in water pipelines, which results in enormous water loss, economic damage, and inefficient water management. Pipeline leakage can occur due to various reasons such as aging infrastructure, corrosion,

excessive water pressure, poor maintenance, natural disasters, and accidental damage during construction activities. In many developing countries, a significant percentage of treated water is lost before reaching consumers because of undetected leaks in distribution networks. These losses not only reduce the efficiency of water supply systems but also increase operational costs and energy consumption associated with water treatment and pumping. Moreover, continuous leakage may weaken surrounding soil structures, damage roads and buildings, and create health hazards due to contamination of drinking water. Traditional methods of leak detection mainly rely on manual inspection, acoustic sensing, or periodic maintenance checks. Although these methods are useful, they are often time-consuming, labor-intensive, expensive, and incapable of providing real-time monitoring. In large-scale pipeline networks, manual detection becomes highly inefficient because leaks may remain unnoticed for long periods, leading to severe water wastage. Therefore, there is a growing need for intelligent, automated, and real-time water leakage detection systems that can quickly identify pipeline faults and alert authorities for immediate corrective action.

Recent advancements in the Internet of Things (IoT), wireless sensor networks, embedded systems, and artificial intelligence have enabled the development of smart water management solutions. Intelligent water pipeline leakage detection systems integrate sensors, microcontrollers, communication technologies, and cloud-based platforms to continuously monitor water flow parameters and detect abnormal conditions within the pipeline network. Sensors such as flow sensors, pressure sensors, moisture sensors, ultrasonic sensors, and acoustic sensors are commonly employed to collect real-time data from different sections of the pipeline. The collected data is then processed using microcontrollers such as Arduino, NodeMCU, ESP32, or Raspberry Pi to identify leakage conditions based on variations in flow rate, pressure differences, or moisture presence.

In addition to leak detection, modern intelligent systems are designed to provide automatic alerts and notifications through mobile applications, web dashboards, SMS services, or email communication. This alert mechanism helps water authorities and maintenance personnel respond quickly to leakage incidents, thereby minimizing water loss and reducing repair costs. Some advanced systems also incorporate machine learning algorithms and data analytics techniques to improve detection accuracy, predict pipeline failures, and optimize water distribution management.

The adoption of IoT-based intelligent monitoring systems offers several advantages over conventional techniques. These systems provide continuous monitoring, remote accessibility, faster response time, reduced human intervention, improved accuracy, and efficient resource utilization. Furthermore, cloud computing and wireless communication technologies such as Wi-Fi, GSM, Zigbee, and LoRaWAN enhance the scalability and reliability of smart leakage detection systems, making them suitable for both urban and rural water distribution networks.

Despite significant progress in this field, several challenges still exist in implementing intelligent water pipeline monitoring systems. Issues such as sensor calibration, network reliability, power consumption, installation cost, environmental conditions, and cybersecurity concerns must be addressed to ensure efficient and sustainable operation. Researchers are continuously exploring innovative approaches to improve detection sensitivity, communication efficiency, and system affordability. The development of intelligent water pipeline leakage detection and alert systems by analyzing various existing technologies, methodologies, sensors, communication techniques, and monitoring

platforms used in modern water management systems. The paper also discusses the advantages, limitations, and future research opportunities associated with smart leakage detection technologies. The primary objective of this review is to provide a comprehensive understanding of recent advancements in intelligent water pipeline monitoring systems and highlight their importance in achieving efficient, reliable, and sustainable water resource management.

2.Literature Review

Dr. Udhayvani M et al (2026) the proposed project presents an IoT-based water leakage detection and control system designed for urban water pipeline networks to reduce water loss and improve efficient water management. In this system, flow sensors are installed at different sections of the pipeline to continuously measure the quantity of water flowing through the pipes. The collected flow data is processed by an Arduino microcontroller, which compares the readings obtained from two different points in the pipeline. Instead of transmitting all the data to a cloud or online server, the controller performs local analysis, making the system faster, cost-effective, and less dependent on internet connectivity. When the controller detects a continuous difference between the inlet and outlet flow readings for a specific period, it identifies the condition as a possible water leakage. To avoid false leakage detection caused by temporary fluctuations in water demand or pressure variations, a delay mechanism is incorporated into the system, ensuring that only persistent abnormalities trigger an alert. Water leakage in underground pipelines is a major issue in metropolitan cities because traditional inspection techniques mainly rely on manual monitoring and periodic maintenance, which cannot provide real-time supervision of the pipeline network. Due to this limitation, there is a strong need for an automated system capable of continuous monitoring and immediate response. The proposed IoT-based system successfully addresses this challenge by providing real-time leakage identification, quick response capability, reduced water wastage, lower maintenance efforts, and improved operational efficiency. Experimental and testing results demonstrate that the system can accurately and rapidly detect leakage conditions, making it highly suitable for smart water distribution and sustainable water resource management in modern urban areas.

Mr. G. V. Vinod et al (2025) the proposed Smart Water Flow and Pipeline Leakage Detection System is an advanced IoT-based solution designed to improve water management, reduce water wastage, and ensure continuous monitoring of pipeline conditions. The system combines multiple sensors, wireless communication technologies, and real-time data analysis to create an intelligent monitoring platform capable of detecting leakages, measuring water consumption, and evaluating water quality parameters. At the core of the system is the Arduino microcontroller, which acts as the central processing unit. It continuously receives data from different sensors installed throughout the water distribution pipeline. The Arduino processes the collected information and determines whether the water flow and quality parameters are within acceptable limits. The processed data is displayed locally on an LCD screen and simultaneously transmitted to cloud-based platforms for remote monitoring and analysis. The system uses a water flow sensor to measure the quantity and rate of water flowing through the pipeline. This sensor generates pulses proportional to the flow rate, allowing the controller to calculate water consumption in real time. By continuously monitoring flow

variations, the system can identify unusual patterns such as sudden drops or excessive flow, which may indicate leakage or pipe damage. Accurate flow measurement also helps in efficient water distribution and conservation. A moisture sensor is installed near critical sections of the pipeline to detect the presence of water outside the pipe surface. Under normal conditions, the surrounding soil or surface remains relatively dry. However, when leakage occurs, moisture levels increase significantly. The sensor detects this change and sends signals to the Arduino controller. Once the moisture exceeds a predefined threshold, the system identifies the possibility of leakage and activates alert mechanisms for immediate attention. To ensure water quality monitoring, the system integrates several important sensors. The pH sensor measures the acidity or alkalinity of water, which is essential for determining whether the water is safe for domestic or agricultural use. A pH value outside the recommended range may indicate contamination or chemical imbalance. The turbidity **sensor** measures the cloudiness or suspended particles in water. High turbidity values suggest the presence of impurities, dirt, or microbial contamination. The TDS (Total Dissolved Solids) sensor measures the concentration of dissolved substances such as minerals, salts, and metals in water. Monitoring TDS levels helps assess the purity and suitability of water for consumption and industrial purposes.

V. Siva Shankar et al (2025) water scarcity and leakage in urban water distribution systems have become critical challenges due to rapid population growth, increasing water demand, aging pipeline infrastructure, and the lack of continuous monitoring mechanisms. Traditional methods of leak detection are often manual, time-consuming, and inefficient, leading to significant water loss and increased maintenance costs. To overcome these limitations, the proposed smart water leak detection and monitoring framework utilizes the capabilities of the Internet of Things (IoT) to provide an automated, real-time, and intelligent solution for water management. The system is built around the Arduino IDE-programmable Arduino UNO microcontroller, which acts as the central processing unit responsible for collecting, processing, and transmitting sensor data. Water flow sensors are installed at both the inlet and outlet sections of the pipeline to continuously measure the quantity and rate of water flowing through different segments. The Arduino compares these flow readings in real time, and when a significant difference between the inlet and outlet flow values is detected beyond a predefined threshold, the system interprets it as a possible leakage condition. Additional sensors such as pressure sensors or moisture sensors can also be integrated to improve detection accuracy and identify the exact location of leaks. The collected data is transmitted through wireless communication modules such as Wi-Fi or GSM to a cloud platform or mobile application, enabling users and authorities to monitor pipeline conditions remotely from anywhere. Whenever abnormal flow conditions or leakages are identified, instant notifications and alerts are sent to the user's smartphone, allowing immediate corrective action and reducing the risk of severe water loss or pipeline damage. The continuous monitoring capability of the system supports predictive and preventive maintenance by identifying irregularities before they escalate into major failures. Furthermore, the integration of IoT technology enhances operational efficiency, reduces human intervention, lowers maintenance costs, and promotes sustainable water resource management. The proposed framework is cost-effective, scalable, and

suitable for implementation in smart cities, residential complexes, industrial sectors, and municipal water supply networks, thereby contributing to the creation of intelligent and sustainable urban water infrastructure.

Setu Sameer Fulawade et al (2025) the integration of the Internet of Things (IoT) into water management systems offers a highly efficient and intelligent approach to reducing water loss, improving resource utilization, and ensuring sustainable water distribution. In this research, an IoT-based water pipeline leak detection system is developed using an Arduino microcontroller and open-source software platforms to continuously monitor water flow in real time. The system operates by placing water flow sensors at both the source and destination ends of the pipeline network, where the sensors measure the quantity and rate of water passing through the pipes. Under normal operating conditions, the flow values recorded at both points remain nearly equal; however, when a leak occurs due to pipe cracks, corrosion, loose joints, or damage caused by aging infrastructure and urban construction activities, a significant difference appears between the measured flow rates. The Arduino controller continuously analyzes these sensor readings and compares the incoming and outgoing water flow data to identify abnormalities that indicate possible leakage. Once the difference exceeds a predefined threshold for a certain duration, the system automatically recognizes it as a leakage event and instantly generates an alert notification. Through IoT connectivity, this alert is transmitted to users, maintenance personnel, or water distribution authorities via smartphones or web-based applications, allowing rapid identification of the problem and immediate corrective action. In addition to leak detection, the IoT framework enables real-time monitoring of water levels, automated tank refilling, and remote supervision of the entire water distribution network, thereby improving operational efficiency and minimizing manual inspection efforts. The use of open-source software further reduces implementation cost and increases flexibility for customization and future expansion. Overall, the proposed system provides a smart, low-cost, and reliable solution for minimizing water wastage, improving leak management, enhancing water conservation, and supporting the development of sustainable smart water distribution infrastructure in both urban and rural areas.

Mrs.Vasifa S.Kotwal et al (2024) smart water management and distribution systems are modern technological frameworks designed to improve the monitoring, control, conservation, and efficient utilization of water resources. These systems combine advanced technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), cloud computing, wireless communication, and smart sensors to manage water supply networks in a more intelligent and sustainable manner. As global populations increase and freshwater resources become limited, the need for efficient water management has become critical. Traditional water distribution systems often suffer from problems such as leakage, unequal distribution, water wastage, delayed maintenance, and lack of real-time monitoring. Smart water management systems address these challenges through automation, continuous data collection, and intelligent decision-making. The Internet of Things (IoT) plays a central role in smart water management. IoT refers to a network of interconnected devices and sensors capable of collecting and exchanging data through the internet. In water distribution systems, IoT sensors such as flow meters, pressure sensors, water quality sensors, and level sensors are

installed at various points along pipelines, storage tanks, pumping stations, and treatment facilities. These sensors continuously monitor parameters including water flow rate, pressure variations, leakage occurrence, temperature, pH level, turbidity, and water consumption patterns. The collected information is transmitted wirelessly to centralized servers or cloud platforms where it can be analyzed and monitored in real time. One of the major advantages of IoT-based water management systems is real-time monitoring. Traditional systems rely heavily on manual inspections and periodic maintenance, which often lead to delays in identifying faults or leakages. With IoT integration, system operators can instantly detect abnormalities such as sudden pressure drops, pipe bursts, excessive water usage, or contamination. Real-time alerts and notifications allow authorities to respond quickly, thereby reducing water losses and preventing major infrastructure failures. This capability is particularly beneficial in rural and urban pipeline networks where water leakage and non-revenue water losses are significant concerns. Artificial Intelligence (AI) further enhances the efficiency of smart water management systems by enabling predictive analysis and automated decision-making. AI algorithms analyze large volumes of sensor data to identify trends, patterns, and anomalies within the water distribution network. Machine learning models can predict future water demand, detect hidden leaks, optimize pumping schedules, and forecast maintenance requirements. For example, AI can analyze historical pressure and flow data to determine the probability of pipeline failure before an actual breakdown occurs. This predictive maintenance approach helps reduce operational costs, minimize service interruptions, and extend the lifespan of infrastructure components.

Another important feature of smart water management systems is improved equipment efficiency and operational transparency. Pumps, valves, motors, and treatment units can be automatically controlled based on sensor feedback and AI analysis. This ensures optimal energy consumption and efficient water distribution according to actual demand. Operators gain complete visibility into the performance of the entire system through dashboards and cloud-based monitoring platforms. Such transparency improves management efficiency, accountability, and resource planning. Smart water systems also contribute significantly to sustainability and environmental protection. Water scarcity is becoming a serious global issue due to climate change, urbanization, and increasing demand. By reducing leakages, optimizing water use, and improving supply efficiency, smart technologies help conserve valuable freshwater resources. Furthermore, continuous water quality monitoring ensures safe drinking water and reduces the risk of contamination. Automated irrigation and water allocation systems can also support sustainable agricultural practices by minimizing unnecessary water consumption.

The integration of IoT and AI technologies has been validated through several practical implementations and research studies worldwide. Many cities and rural regions have successfully deployed smart water monitoring systems to reduce water losses, improve supply reliability, and enhance customer services. Case studies demonstrate that smart metering and leak detection technologies can significantly reduce non-revenue water and operational expenses. Additionally, AI-driven forecasting models have proven effective in managing water demand during droughts and peak consumption periods. Despite these advantages, smart water management systems also face certain challenges. High initial

installation costs, cyber security concerns, data privacy issues, lack of technical expertise, and maintenance requirements can hinder implementation, especially in developing regions. Reliable internet connectivity and power supply are also essential for uninterrupted operation of IoT devices. However, ongoing advancements in low-cost sensors, wireless communication technologies, and cloud computing are gradually overcoming these barriers.

Mr.k.naga dasharath et al (2024) this paper presents a smart water pipeline monitoring system developed to reduce water wastage and improve the efficiency of water distribution networks through the use of Internet of Things (IoT) technology. Water leakage in pipelines is one of the major causes of water loss in both urban and rural areas, making continuous monitoring and early detection essential for sustainable water management. The proposed system integrates low-cost and easily available sensors to monitor both the quantity and quality of water flowing through pipelines in real time. A water flow sensor is used to measure the flow rate of water inside the pipe, and it works on the Hall effect principle, where a rotating rotor with embedded magnets generates electrical pulses proportional to the water flow. By counting these pulses, the system calculates the amount and speed of water passing through the pipeline. In addition, a turbidity sensor is incorporated to monitor water quality by detecting the presence of suspended particles or impurities in water, which helps identify contamination levels and ensures safe water supply. The entire system is controlled by a NodeMCU microcontroller, which is widely used in IoT applications because of its built-in Wi-Fi capability, fast processing speed, and interrupt handling features that enable accurate sensor data collection. The NodeMCU continuously gathers data from the sensors and transmits it wirelessly to the ThingSpeak cloud platform, an open-source and freely accessible IoT cloud server used for storing, analyzing, and visualizing real-time data. Through cloud integration, users can remotely monitor water flow conditions, detect abnormal changes indicating leakage, and observe water quality parameters from anywhere using internet connectivity. The real-time monitoring capability of the system enables quick identification of leaks, reduces water loss, improves maintenance efficiency, and supports smarter water resource management. Furthermore, the system is cost-effective, easy to install, and suitable for both domestic and industrial water distribution applications, making it an efficient solution for modern smart water management systems.

Hitesh Mohapatra et al (2019) global climate change, irregular rainfall patterns, urbanization, and rapid population growth are placing immense pressure on available freshwater resources, making efficient water management a critical necessity. Traditional Water Distribution Networks (WDNs) mainly operate through fixed schedules and manual monitoring systems, which often lead to unequal water distribution, excessive water supply, leakage, pipe bursts, and significant water loss due to the absence of real-time monitoring and intelligent decision-making capabilities. To overcome these limitations, an Information and Communications Technology (ICT)-based smart water management system is proposed, integrating Internet of Things (IoT) technologies, wireless communication, and automated data analysis to ensure sustainable and efficient water utilization. The proposed system employs a heterogeneous Wireless Sensor Network (WSN) consisting of various sensors such as flow sensors, pressure sensors, moisture sensors, and

smart taps installed at different points of the water pipeline network. These devices continuously monitor water flow, pressure variations, and consumption patterns, enabling the early detection of leakages, abnormal usage, and pipeline faults. The smart tap acts as an intelligent endpoint capable of detecting excessive water usage or leakage at the consumer level and automatically transmitting the collected information to the utility control centre through wireless communication protocols. At the utility centre, the received sensor data is analysed in real time to optimize water distribution according to demand, reduce wastage, and improve operational efficiency. Additionally, the study introduces a fault-tolerant WSN routing mechanism that ensures reliable communication even when some sensor nodes fail or communication links become unstable, thereby maintaining uninterrupted data transmission across the network. This routing strategy improves network reliability, energy efficiency, and system robustness, which are essential for large-scale smart water infrastructure. The district of Sambalpur in Odisha, India, is selected as the case study area due to its growing population and increasing water management challenges. The proposed ICT-based WDN model aims to provide equitable water distribution, minimize non-revenue water losses, enhance monitoring accuracy, support sustainable resource management, and ultimately improve the long-term availability and quality of water supply for both urban and rural communities.

Gopalakrishnan P et al (2017) water is an essential natural resource required for the survival of all living beings, yet only a small percentage of the Earth's water is directly consumable. To supply potable water efficiently, pipeline distribution systems are widely used, but leakage in these pipelines causes significant water loss. In many developed countries, advanced acoustic technologies are used to detect leaks through sound and vibration analysis in pressurized pipes, whereas in developing countries leaks are often identified only after water becomes visible on the ground, leading to substantial wastage. To address this issue, a cost-effective automated water leakage detection system can be implemented using embedded technology. In this system, flow sensors continuously monitor water movement to detect abnormal flow conditions indicating leakage, while solenoid valves installed at different pipeline sections automatically stop water flow until repairs are completed. The system also supports wireless communication and cloud-based data logging through a GPRS module, enabling real-time leak notifications to concerned authorities using existing cellular network infrastructure. Experimental testing of the prototype under various conditions demonstrated its effectiveness in detecting and controlling leaks. Since water demand is rapidly increasing worldwide, integrating automation into water resource management systems can significantly reduce human error, improve operational efficiency, conserve water resources, and help minimize the gap between water supply and demand.

3.Methodology

The methodology for the development of an Intelligent Water Pipeline Leakage Detection and Alert System begins with an extensive review of existing literature related to water leakage detection techniques, Internet of Things (IoT)-based monitoring systems, wireless sensor networks, and smart water management technologies. The study analyzes

previously proposed methods such as acoustic sensing, pressure monitoring, flow-rate analysis, moisture sensing, and machine learning-based leak prediction to identify their advantages, limitations, and applicability in real-time water distribution systems. Based on the review findings, a conceptual framework is designed in which multiple sensors including water flow sensors, pressure sensors, and moisture sensors are strategically installed at different sections of the pipeline network to continuously monitor water flow conditions. The sensed data are collected and processed using a microcontroller such as Arduino UNO or NodeMCU, which compares inlet and outlet flow values and pressure variations to identify abnormal conditions indicating possible leakage. The methodology further incorporates IoT communication modules like Wi-Fi or GSM for transmitting real-time data to a cloud platform or mobile application, enabling remote monitoring and instant alert generation through SMS or notifications whenever leakage exceeds a predefined threshold. The reviewed studies are comparatively evaluated based on parameters such as detection accuracy, response time, implementation cost, energy efficiency, communication range, and reliability. In addition, the methodology examines the integration of data analytics and automation techniques for improving leakage localization and reducing water wastage. Finally, the collected information is synthesized to propose an efficient, low-cost, and scalable intelligent leakage detection model suitable for urban and rural water pipeline systems, emphasizing sustainable water resource management and early fault detection.

4. Conclusion

The development of intelligent water pipeline leakage detection and alert systems has become an essential solution for reducing water loss, improving resource management, and ensuring sustainable water distribution. Traditional leakage detection methods are often time-consuming, costly, and inefficient for large-scale pipeline networks. In contrast, modern systems based on the Internet of Things (IoT), wireless sensor networks, Arduino and microcontroller platforms, cloud computing, and machine learning techniques provide real-time monitoring, rapid leak identification, and automated alert mechanisms. Various studies reviewed demonstrate that integrating flow sensors, pressure sensors, moisture sensors, and communication technologies such as GSM, Wi-Fi, and LoRa significantly enhances the accuracy and reliability of leakage detection systems. These smart systems not only minimize water wastage and maintenance costs but also improve operational efficiency and support smart city infrastructure. Furthermore, the inclusion of mobile applications and cloud-based dashboards enables remote monitoring and quick response to leakage events. Despite advancements, challenges such as sensor accuracy, power consumption, network reliability, and scalability in rural and urban environments still require further research. Future developments should focus on incorporating artificial intelligence, predictive analytics, renewable energy-based sensor nodes, and advanced data security mechanisms to create more efficient, cost-effective, and sustainable water management solutions. Overall, intelligent water pipeline leakage detection and alert systems represent a promising approach toward conserving water resources and enhancing the reliability of modern water distribution networks.

References

1. Dr. Udhayavani M, Sanjay M, Tharunraj V “IoT-Based Smart Water Leakage Detection and Control System for Metro Pipelines” Published by : International Journal of Engineering Research & Technology (IJERT) <https://www.ijert.org/> An International Peer-Reviewed Journal ISSN: 2278-0181 Vol. 15 Issue 04 , April – 2026
2. Mr. G. V. Vinod, P Radhaanjani, 3K B Manikanta, G M N Venkat, K Shivakumar “Smart Waterflow And Pipeline Leakage Detection Using Iot” IJCRT2503960 International Journal of Creative Research Thoughts (IJCRT) www.ijcrt.org www.ijcrt.org © 2025 IJCRT | Volume 13, Issue 3 March 2025 | ISSN: 2320-2882
3. V. Siva Shankar, Ch. Lakshmi Varshini, G. Jyothi Prasad and B. Lakshmi Sirisha “smart waterflow and pipeline leakage detection using iot and arduino uno” ISSN:(O) 2320-5407, ISSN(P) 3107-4928 Int. J. Adv. Res. 13(11), November-2025, 104-112.
4. Setu Sameer Fulawade , 2Rushikesh C. Chaudhari , 3Atharva Sunil Bele, 4Prof. Kapil Dere “Smart Water Flow and Pipeline Leakage Detection Using IoT and Arduino UNO” International Journal of Recent Advances in Engineering and Technology ISSN: 2347 - 2812 Volume 14 Issue 01s , 2025
5. Mrs.Vasifa S.Kotwal1*, Dr. Sangram Patil2, Dr. Jaydeep Patil “Review on Ai and Iot Based Integrated Smart Water Management and Distribution System” Educational Administration: Theory and Practice 2024, 30(4), 594-605 ISSN: 2148-2403 <https://kuey.net/> Review Article.
6. Mr.k.naga dasharath, 2l. apoorva, 3j.susmitha “smart water flow and pipeline leakage detection using iot and arduino uno” Volume 14, Issue 10, October 2024 iISSN 2457-0362 Page 183 Volume 14, Issue 10, October 2024
7. Hitesh Mohapatra1 , Amiya Kumar Rath “Detection and avoidance of water loss through municipality taps in India by using smart taps and ICT” IET Wirel. Sens. Syst., 2019, Vol. 9 Iss. 6, pp. 447-457 © The Institution of Engineering and Technology 2019
8. Gopalakrishnan P.1, Abhishek S.2, Ranjith R.3, Venkatesh R.4 and Jai Suriya V “Smart Pipeline Water Leakage Detection System” International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 16 (2017) pp. 5559-5564 © Research India Publications. <http://www.ripublication.com>.