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WATER PIPELINE LEAKAGE DETECTION SYSTEM USING GSM

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1. ABSTRACT

This paper introduces a smart monitoring system for water pipelines designed to detect and manage leakages. With the growing demand for water and its consequent wastage, effective water management has become increasingly crucial. To tackle this challenge, an IoT-based monitoring system is proposed. The system integrates several sensors to assess water flow and contamination levels. A water flow sensor utilizing the Hall effect principle monitors the flow within the pipeline, while a turbidity sensor identifies water contamination. The Nodemcu microcontroller, widely chosen for IoT projects due to its interrupt functionality, serves as the central processing unit of the system. The data collected by the flow and turbidity sensors is transmitted to the ThingSpeak cloud platform, an open-source platform that enables data storage and analysis. The measured values are displayed on the ThingSpeak web server, enabling easy monitoring of the water flow within the pipeline. This system offers a convenient and efficient way to track and manage water usage and quality.

2. INTRODUCTION

Only 3% of the Earth's water is fresh, and a third of that is not easily accessible. Over time, the demand for water has grown due to factors such as population expansion, fast-paced industrial development, and improved living conditions. The materials used in the construction of pipelines and their age often contribute to leaks. As pipelines get older, water loss can amount to as much as 50%. Locating the exact source of a leak can be difficult, and it can take several days for authorities to identify and repair the problem. Given the growing number of available wireless networks, selecting the optimal communication method for IoT devices has become increasingly critical. After the IoT device gathers data, it is transmitted to the cloud for further processing and analysis. The processed information is then made available to the end-user via different channels, such as mobile alerts or email notifications. Additionally, users can monitor their IoT device remotely via a dedicated app, allowing them to track the system's status from anywhere.

3. LITERATURE SURVEY

"An Enhanced Water Pipeline Monitoring System in Remote Areas using Flow Rate and Vibration Sensors" (The system introduced by Praveen M Dhulavvagol, Ankita K R, Sohan G, and Renuka Ganiger (2018) aims to enhance the monitoring of water pipelines, especially in areas that are difficult to access. The authors suggest that by integrating flow rate and vibration sensors, the system provides an affordable and effective approach for monitoring pipelines in difficult-to-reach areas. This approach ensures a more reliable and timely response to pipeline failures or issues, ultimately enhancing maintenance strategies. The system is especially valuable in sectors such as water distribution, where pipeline failures can cause significant disruptions, particularly in areas with limited infrastructureThe paper titled "Water Pipeline Monitoring and Leak Detection using Flow Liquid Meter Sensor," written by R F Rahmat, I S Satria, B Siregar, and R Budiarto, and published in the IOP Conference Series: Materials Science and Engineering, volume 190, 2016, introduces a system focused on monitoring water pipelines and identifying leaks through the use of flow liquid meter sensors. The integration of these sensors provides a reliable solution for tracking the condition of water pipelines. Continuous real-time monitoring allows for early leak detection, which aids in more efficient water distribution management and helps prevent wastage. This approach offers a significant advancement in pipeline maintenance, especially in areas where manual inspections are difficult or impractical.

4. EXISTING SYSTEM

At present, the monitoring of water pipelines is carried out by personnel from water distribution companies. However, it is not feasible for distributors in urban areas to assign workers to monitor every street. On average, each worker is responsible for monitoring 5 to 10 streets, resulting in a high demand for manpower. requires significant human resources to maintain effective monitoring.

DISADVANTAGE

- ✓ False alarms: Leak detection systems may generate a high number of false alarms, often due to uncertainty in detecting the leak signal. This can occur because of random variations or insufficient data for accurate detection.
- ✓ Inability to pinpoint leaks: Certain systems may struggle to accurately identify the precise location of a leak, limiting their effectiveness in targeted repairs.

5. PROPOSED SYSTEM

This system utilizes flow sensors for non-acoustic leak detection. The YF-S201 water flow sensor is utilized to measure the flow rate and track the volume of water passing through the pipeline. In addition, a turbidity sensor is used to evaluate the contamination level of the water, with its main purpose being to monitor the water's purity. If a leak happens and soil enters the pipeline, the water's purity is affected. As a result, it is important to monitor both the flow rate and water quality. IoT technology is used to deliver real-time updates, enabling the microcontroller to transmit data to a cloud server for processing. This method facilitates effective monitoring of water flow and quality, offering improved security and remote access for the system owner.

ADVANTAGE

- ✓ Quick detection: LDS can quickly detect leaks, minimizing the impact and reducing product loss.
- ✓ Accurate information: LDS can provide information about the location, size, and amount of product lost in a leak.
- ✓ Damage prevention: LDS can help prevent damage to people, property, and the environment.
- ✓ Reputation protection: LDS can help protect a company's reputation.
- ✓ Cost savings: LDS can help reduce the high costs of repair, renovation, and clean-up.
- ✓ Regulatory compliance: LDS can help meet official regulations related to pipeline leak detection.
- ✓ Remote control: Some LDS systems can be monitored remotely, allowing users to respond to leaks from anywhere.

6. BLOCK DIAGRAM

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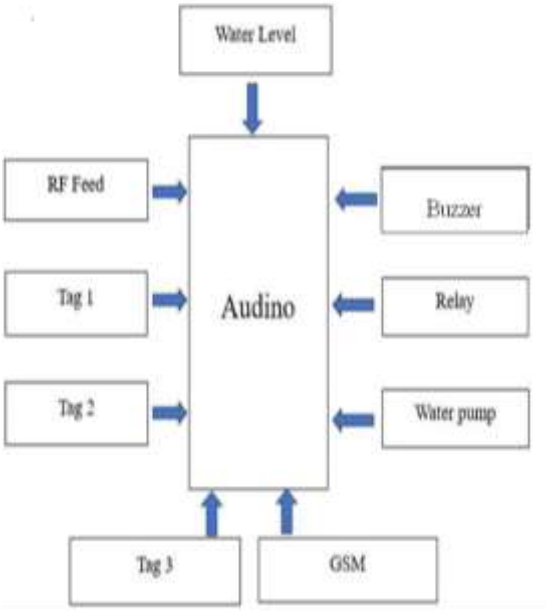
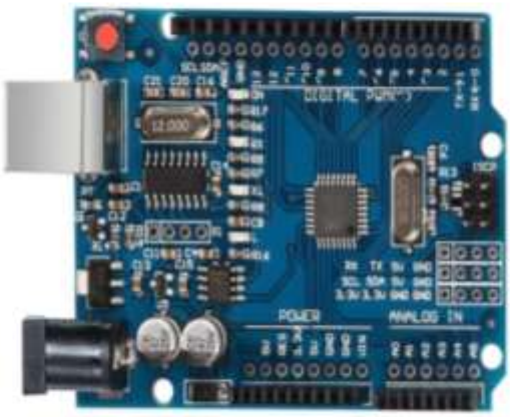


7.HARDWARE REQUIREMENT

ARDUINO:



The Arduino Uno is a well-known open-source microcontroller board featuring the Microchip ATmega328P microcontroller, developed by Arduino.ccIt provides a range of digital and analog input/output (I/O) pins, allowing connections to additional expansion boards (shields) and various circuits. The board features 14 digital pins and 6 analog pins, and it can be programmed via the Arduino IDE (Integrated Development Environment) using a type B USB cable. It can be powered either through the USB connection or an external 9-volt battery, with a voltage input range between 7 to 20 volts. The Arduino Uno shares several similarities with other Arduino models, such as the Nano and Leonardo. Programming is carried out by sending commands to the microcontroller using the Arduino programming language, based on Wiring, via the Arduino IDE, which is built on Processing.

WATER LEVEL SENSOR:

The water sensor brick is designed to detect the presence of water, making it suitable for various applications such as rainfall detection, water level monitoring, and detecting leaks. It consists of three primary components: an electronic brick connector, a 1 MΩ resistor, and a set of conductive wires. The sensor works by connecting exposed traces to ground, with sensor traces placed between them. A 1 MΩ pull-up resistor keeps the sensor value high until water bridges the gap between the sensor trace and the ground trace. This basic circuit can be connected to the digital I/O pins of an Arduino or analog pins to measure the amount of water completing the circuit between the sensor and the ground traces.

WATER PUMP:

A water pump is a device that utilizes both mechanical and hydraulic principles within a piping system to generate sufficient force for moving water to its intended destination. Water pumps have been in use in various forms since ancient civilizations. Today, they are widely employed across diverse sectors, including residential, agricultural, municipal, and industrial applications.

RFID:

An RFID (Radio Frequency Identification) reader is a device that collects data from an RFID tag, facilitating the tracking of individual items. Unlike barcodes, RFID technology doesn't require a direct line of sight or scanning of the tag, which enhances the flexibility and efficiency of tracking.

BUZZER:

A buzzer or beeper is a sound-producing device that can be mechanical, electromechanical, or piezoelectric (commonly known as piezo). These devices are widely used in applications such as alarm systems, timers, and to signal user actions like a mouse click or keypress. The sound they produce acts as a distinct alert or notification for different events.

GSM:

The GSM system was designed as a digital communication network that utilizes the Time Division Multiple Access (TDMA) technique. It converts and compresses data, sending it over a channel with two distinct data streams, each allocated a specific time slot. This digital system supports data rates from 64 kbps to 120 Mbps. GSM networks incorporate different cell sizes such as macro, micro, pico, and umbrella cells, each optimized for different deployment scenarios. The coverage area of each cell type differs based on the specific environment in which it is deployed.

RELAY:

Relays are used in cases where a low-power signal is required to control a circuit. They are also useful when one signal needs to control several circuits simultaneously. The concept of relays began with the invention of the telephone, where they were critical for switching calls at telephone exchanges. Relays were also used in long-distance telegraphy to direct signals between different locations. With the advent of computers, relays became essential in performing logical and Boolean operations. In high-power systems, relays are frequently employed to control devices such as electric motors, and these are called contactors.

APPLICATION

Urban Water Distribution Networks: The system can be deployed in urban water distribution networks to monitor pipelines continuously and detect any leaks in real-time. This ensures prompt action, minimizing water loss and preventing damage to infrastructure.

Smart Cities: In smart cities, where efficient water management is critical, the system can be integrated into the existing infrastructure. It helps reduce water wastage, optimize resource use, and ensure that water reaches all areas without interruption.

Industrial Water Supply: In industries that rely heavily on water supply systems (e.g., manufacturing plants, chemical industries), the leakage detection system can be used to safeguard against costly water wastage, contamination, and production downtime due to pipeline failures.

Agricultural Irrigation Systems: Agricultural sectors can benefit from this system by ensuring that irrigation pipelines are free from leaks, optimizing water usage in farming, and ensuring that crops are watered efficiently without wastage.

CONCLUSION

The main objective of this system is to detect leaks in water pipelines, offering significant benefits for smart cities where numerous pipelines are in place and leaks are common. By utilizing this system, leak detection becomes much easier, enabling quick identification and resolution of related issues. The system is also highly beneficial for water distribution networks in remote locations. Water flow sensors, as demonstrated through experimental results, are ideal for tracking and detecting leaks in pipeline control systems. With the widespread presence of water pipelines and frequent leaks in urban areas, this system provides an efficient solution. Currently, leak monitoring is done by water distribution staff, but this system facilitates faster problem resolution. Additionally, it can be applied to water delivery systems in remote areas.

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