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IoT Based Water Monitoring and Conservation System

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Abstract: *An IoT based Water Monitoring and conservation system uses IoT, sensors, and data analytics for efficient water management. It provides real-time water monitoring, water flow rate tracking and leak detection technology. The sensor is used to detect the leakage & send the SMS to authorities. IoT-Water management remote water, access via web and mobile applications enhances control and visibility. Automated water alerts, help in quick issue resolution, reducing water loss and ensuring quality. With the help of Solenoid valve used to water flow within limit. WSMS improves efficiency, reduces manual intervention, and promotes sustainable resource use. It is widely applicable in urban, industrial, apartment and agricultural water distribution systems.*

Keywords: Leakage Detection, Pressure sensor, Solenoid valve, Flow

I. INTRODUCTION

Water management solution essential for life sustainable water supply and water monitoring technologies. However, industrial water management is efficient water distribution and water conservation methods in innovative water solutions. Ensuring a reliable, safe, and sustainable water supply requires innovative solutions that enhance monitoring, distribution, and conservation efforts.

Water Supply Monitoring System (WSMS) is an advanced technology-driven solution designed to monitor, analyze, and smart water distribution networks in real-time. This system leverages innovative technologies such as the Internet of Things, home automating sensor, cloud computing, and data analytics to provide accurate insights into various water parameters, including water levels, flow rates, quality, and leak detection.

One of the core components of WSMS is the flow sensor technology, which tracks flow rates and pressure sensor by analyzing the real-time water movement. These sensors transmit data to a centralized monitoring platform, where analytics tools assess system performance and identify issues before they escalate. IoT-water management, connectivity allows remote access to this data by using thing speak mobile applications, integration and Water distributing control by ultrasonic sensors &preventing the water tank overflow with the help of cloud computing.

A WSMS also includes automated alerts and notifications to the user and owner, which enable authorities to take immediate corrective actions, minimizing water loss and maintaining

quality assurance standards. These features significantly reduce manual intervention, lower operational costs, and improve overall efficiency in water distribution networks.

II. LITERATURE SURVEY

Water plays the most important role in day-to-day life. It is our prime responsibility to save, preserve and avoid the wastage in every possible manner. It has been observed that there are many chances of water wastage during water supply through the water pipelines. This section discusses few earlier works to detect and avoid the water leakage.

Manual monitoring of water flow is the most primitive and time consuming method of detecting the quality of water. It requires manual work with lot of human intervention. The in- charge should look for the damaged pipe & with tha help of smart meter when the person use more water, then detect manually by checking all the water pipelines in the area of leakage reported by any user. This is time-consuming due to which the amount of water being wasted in this process increases, hence this is a major drawback of manual method.

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The work proposed in [1] is based on acoustic leak-detection techniques that depend on external factors. The external factor is the sound produced from the turbulent jet of water that gushes through the pipeline which is timely measured and hence the leakage can be tracked. This article presents an investigation that addresses the feasibility and potential of in-pipe acoustic measurements for leak detection. This solution has few drawbacks as it depends on features of the pipe used to transmit the water as the acoustics highly depend on the pipe material.

The solution in [2] proposes leak detection as Many research have been conducted by both academia and industry and apartment, urban area smart water management using Iot to monitor and optimise the water management. For example the use of Iot based sensor network for monitoring water distribution network and water flow method presented in explains about the design of a water level sensor device that is able to detect and control the level of water in a certain water tank or water Lorries. The system initially senses the amount of water available in the tank by the level detector part and then adjusts the state of the. water pump in accordance with the water level information. It keeps checking the readings of the water level with the actual outlet usage obtained through the sensor data. factor. This method derives a theoretical variance of the time difference estimation error through the summation in the discrete frequency domain and finds an optimal regularization factor that minimizes the theoretical variance in practical water pipe channels. The vibrations that are getting generated may be disturbed or altered by external factors and this may give inaccurate results and hence is a drawback of this proposed solution. The method presented in [3] explains about the design of a water level sensor device that is able to detect and control the level The method presented in [3] explains about the design of a water level sensor device that is able to detect and control the level of water The water in a certain water tank The main objective of the paper [4] is to develop a leak and water monitoring system, using the concept of IoT, flow sensor that can be used for detecting the leak and solenoid valves placed in different parts of pipeline which can obstruct the water flow until the defective part of the pipeline is repaired. And further, the leak occurred shall be informed to concerned authorities wirelessly. This approach detects the leakage but fails to give an approximate location of the leakage in the pipeline.

The method in [5] proposes a microcontroller (PID) based Water level monitoring system to indicate the water level in the tank. Water quality is also checked by using sensors which can check certain parameters such as temperature, pH level, turbidity in real-time will be monitored by an agent. The leakage detection is done by checking the pressure of water by applying it on force- sensitive resistors (FSR) this is indicated by an LED meter and a beep is generated which is heard by the controller. Though this system uses the devices like laptop, mobile phone but it lacks in providing the exact location where the leakage has occurred. Most of the methods given in the literature use man power or different devices [6-8] which are either expensive or not reliable and hence are difficult to adapt for real time implementations.

III. PROPOSED SYSTEM

A. System Architecture

Considering the solutions provided by various researchers for detecting the leakage of water pipelines with an idea which overcomes the drawbacks faced by the existing systems. The water leakage detection system using smart objects such as Solenoid valve and water flow sensors were implemented. The main objective of our work is to design a system which can detect the leakage of water in pipelines approximate the location of the leakage and automatically send this leakage detection as an alert message on an mega a r d u i n o device to the person in charge of the water management team. An open- source application like ThingSpeak, Blink app and software (Dash board) used to achieve the required objective.

A) Components

Water flow sensor: These are the devices used to measure the flow rate of water, with the help of water flow measurement sensor. It consists of a plastic valve body, and a hall-effect sensor. It has three wires namely +5V (Red), GND (Black) and Output (Yellow).When water flows through the rotor rate data collection, rotor rolls and its speed changes with different rate of flow. The hall-effect sensor outputs the corresponding pulse signal. This sensor works on5V, it can be interfaced with any microcontroller such as The water flow sensor is placed between the water pipelines, on the down of the sensor, there is a marking .The water flow sensor is placed between the water pipelines,

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on the down of the sensor, there is a marking in the form of an arrow, to indicate the required direction of flow of water through the sensor, water flows through the sensor and accordingly sends the flow rate values to the program.

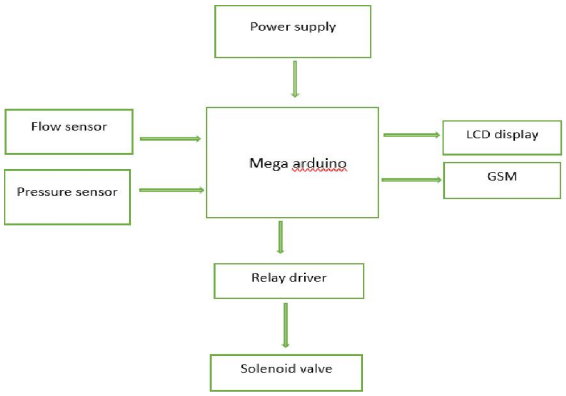

Fig 1 Block diagram of proposed system

Thingspeak: ThingSpeak is used in the IoT water monitoring and conservation system to provide a cloud-based water data storage and analysis. It allows for real-time water data collection and send to SMS to the owner & user from various sensors and its work. ThingSpeak API integration enables seamless system integration with the system's hardware and software used to connected mega Arduino.The platform's data analyzing for water usage patterns and trends. ThingSpeak also supports alerts and notifications, enabling prompt action in case of anomalies or leaks. Furthermore, water conservation of IOT platform's scalability and flexibility make it ideal for large-scale water monitoring systems ensures seamless communication between devices. The platform's ease of use and customization options also make it an ideal water conservation, real-time water data analyzing. Overall, ThingSpeak plays a crucial role in enabling data-driven insights and decision- making in the water monitoring and conservation **sys**tem**.**

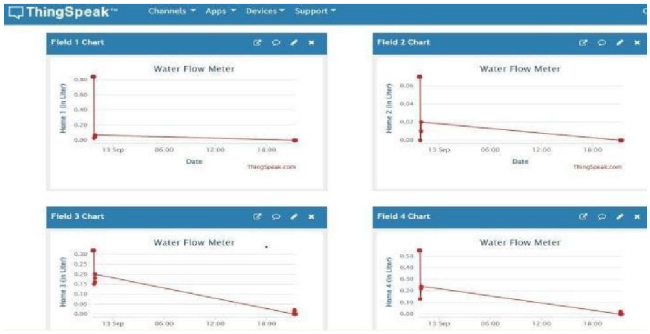

Fig 2 Output of Thigspeak

GSM Module: A GSM module is a specialized hardware device that allows electronic systems to communicate over a GSM network for SMS, and data transmission to user and the owner.It operates using GSM technology, enabling devices to send and receive information via mobile networks. These modules contain essential components such as a SIM card slot, antenna, microcontroller interface, and power supply circuitry to function effectively. GSM modules use frequencies like 850 MHz, 900 MHz, 1800 M and 1900 MHz to connect to cellular networks. They support AT commands, which allow users to control the module using a microcontroller or computer. These modules are widely used in IoT (Internet of Things), remote monitoring systems, GPS tracking, home automation, and industrial automation. They are essential in smart meters, vehicle tracking systems, security systems, and wireless data transmission applications. A GSM module typically supports GPRS (General Packet Radio Service) and EDGE (Enhanced Data rates for GSM Evolution) for internet connectivity. Popular GSM modules include SIM800, SIM900, and Quectel M66, known for their compact size and efficiency.

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Solenoid valve: A solenoid valve is an electromechanical valve used to control the flow of fluids in a system. It consists of a coil of wire (the solenoid) and a plunger that is controlled by an electrical current. When an electric current passes through the coil, it generates a magnetic field that pulls or pushes the plunger to open or close the valve, regulating the flow of fluid. Solenoid valves are commonly used in various applications, including heating systems, irrigation, pneumatic systems, and automation processes. The valve can be normally open (NO) or normally closed (NC), meaning it either allows or blocks the flow of fluid when the solenoid is not energized. These valves are highly reliable, fast-acting, and energy-efficient, as they require little power to operate. They can be made from various materials such as brass, stainless steel, or plastic, depending on the fluid being controlled. Solenoid valves are available in various sizes and configurations, including two-way, three-way, and four-way valves, offering versatility in control applications. Solenoid valves are widely preferred due to their simple design, ease of control, and ability to be integrated with automation systems. However, they may require regular maintenance to ensure long-term reliability, especially when used in harsh environments.

Relay driver: A relay drive system used to control the relay operation system. A relay is an electrically operation switch that can open or close a system under the control of an input signal, often from a low-power control system. Transistor relay drive consists of the components that energize or de-energize the relay coil enabling it to switch its contacts. In most relay drives, the control signal (such as from a microcontroller or a switch) activates a transistor or a similar electronic component that provides sufficient current to the relay coil. This current flow generates a magnetic field that moves the relay's internal switch mechanism in low power, either making or breaking the system controls.

Arduino Mega: Arduino mega is a microcontroller board and also open-source microcontroller, designed for large-scale arduino projects that require a higher number of input/output pins and more memory. It is part of the Arduino and offers advanced capabilities, making it suitable for complex tasks like automation, and sensor networks. Arduino mega board features 54 digital I/O pins, 16 analog I/P, and 4 UARTs (hardware serial ports), providing ample resources for interfacing with multiple devices simultaneously. It also has 256 KB of flash memory fo storing programs and 8 KB of SRAM, enabling the handling of more demanding software and data. This board is widely used in applications requiring high pin counts and robust performance.In robotics, it excels at controlling numerous servos and sensors. For IoT systems, it can act asa central hub for data collection and cloud communication. It is also a favorite for 3D printing projects, serving as the controller for machines like the RepRap series. Additionally, itscompatibility with a variety of Arduino shields expands its functionality even further. Getting started with the Arduino Mega is simple. By downloading the Arduino IDE from arduino.cc, users can write, upload, and run programs ("sketches") with ease. Its extensive community support ensures access to numerous libraries, tutorials, and forums, making it an excellent choice for beginners and professionals alike. The Arduino Mega 2560 stands out as a reliable and versatile tool for tackling complex, large-scale projects.

Leakage detection: Leakage detection refers to the process of identifying and locating leaks in systems such as pipelines, tanks, . It involves using various techniques and technologies to monitor and analyze systems to detect unintended escapes of materials, which could pose risks to the environment, safety, and operational efficiency.Effective leakage detection is crucial in industries like water distribution, chemic and where undetected leaks can lead to significant losses, environmental contamination, and safety hazards. Common methods include , pressure monitoring, .Leakage detection systems may involve continuous monitoring or periodic checks, depending on the application. The goal is to minimize downtime, prevent damage, and ensure that leaks are identified before they cause significant issues. The systems can be automated for real-time alerts or manually monitored. By accurately detecting leaks, companies can reduce operational costs, protect resources, and comply with environmental and safety regulations.

LCD display: The display shows real-time data on water pressure, flow rate, and quality. This allows operators to quickly identify any issues or anomalies in the water supply. The LED display is also easy to read, even in bright sunlight or from a distance. Additionally, the display is energy-efficient and requires minimal power to operate. The use of an LED display also enhances the overall user experience and makes it easier to monitor the water supply. Furthermore, the display can be programmed to show alerts and warnings in case of any abnormalities.and to measure the parameters in real time.

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Blynk app: Blynk app is used in the IoT-based water monitoring and conservation system to provide a user-friendly interface for remote monitoring and control. The app enables users to access real- time data on water quality, pressure, and flow rate from anywhere. Blynk's customizable dashboard allows users to create a personalized interface with widgets and graphs. The app also supports push notifications and alerts, enabling users to receive timely notifications of anomalies or leaks. Furthermore, Blynk's compatibility with various IoT hardware platforms, such as Arduino and Raspberry Pi, makes it an ideal choice for water monitoring applications. The app's ease of use and setup also make it accessible to non-technical users. Blynk's cloud-based infrastructure ensures scalability and reliability, making it suitable for large-scale water monitoring systems. Overall, the Blynk app plays a crucial role in enabling remote monitoring, control, and notification capabilities in the IoT-based water monitoring and conservation system. By using Blynk, users can stay informed and take prompt action to conserve water and prevent waste.

Fig 3 Blynk app

IV. METHODOLOGY

The system's hardware components include sensors, microcontrollers, and communication modules which work together to collect and transmit data on water quality, pressure, and flow rate. The system's software components include a cloud-based platform, mobile app, and data analytics algorithms, which provide a user-friendly interface for remote monitoring and control, as well as real-time insights into water usage patterns and trends. The system's advanced features include automated control, predictive analytics, and machine learning algorithms, which enable it to detect anomalies and leaks, predict water demand, and optimize water supply. The system also includes a mobile app, which allows users to receive notifications and alerts, view real-time data, and control the system remotely. The system's benefits include improved water conservation, reduced energy consumption, and enhanced operational efficiency. Additionally, the system provides a scalable and sustainable solution for water monitoring and conservation, making it an ideal solution for cities, industries, and communities looking to optimize their water resources. The IoT-Based Water Monitoring and Conservation System has numerous applications across various industries, including municipal water supply, industrial processes, and agricultural irrigation. The system can be used to monitor and control water treatment plants, distribution networks, and consumption patterns. It can also be used to optimize water usage in industries such as manufacturing, mining, and oil and gas. Furthermore, the system can be used to monitor soil moisture and optimize irrigation systems in agricultural applications. Overall, the IoT- Based Water Monitoring and Conservation System has the potential to make a significant impact on water conservation efforts worldwide.

The system is a combination of hardware and software components, working together to provide a comprehensive solution for water monitoring and conservation. Regular maintenance and updates are performed to ensure the system's continued functionality and effectiveness. The system's performance is continuously monitored and evaluated to identify areas for improvement. Additionally, the system provides a scalable and sustainable solution for water monitoring and conservation, making it an ideal solution for cities, industries, and communities looking to optimize their water resources.

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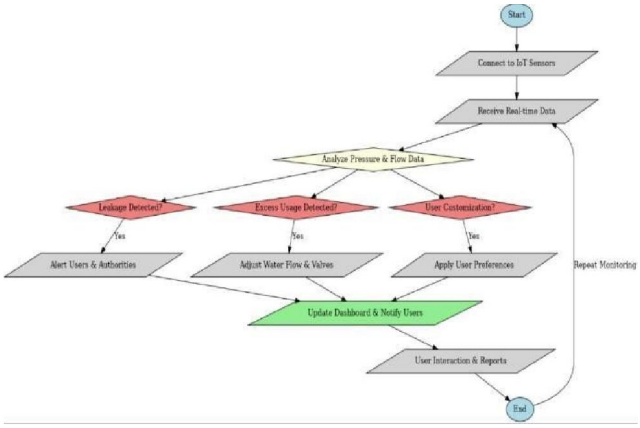

V. RESULTS

Real-Time Monitoring: IoT sensors provide real-time data on water flow, pressure, and quality, enabling immediate detection of issues like leaks, contamination, or irregular usage.

Reduced Water Wastage: Automated alerts and predictive maintenance capabilities have significantly reduced water wastage by identifying and addressing inefficiencies in the system. Improved Water Quality: Continuous monitoring of parameters such as pH, turbidity, and chemical content ensures compliance with safety standards and promotes public health. Optimized Resource Allocation: Smart water management systems enable better distribution of water resources, particularly in areas with limited supply. Cost Efficiency: Reductions in operational costs are achieved through minimized losses, proactive maintenance, and improved energy usage in pumping and distribution systems. Enhanced Decision-Making: The integration of analytics and cloud platforms with IoT devices provides actionable insights for stakeholders, supporting data-driven decision-making IoT can monitor water discharge and pressure, which can help water service providers evaluate their systems more precisely providers

IoT can monitor water discharge and pressure, which can help water service providers evaluate their systems more precisely. Water consumption IoT can provide real-time insights on how water resources are being used, which can help users make more informed decisions about their water consumption. Equipment maintenance IoT can predict equipment failures and schedule maintenance, which can reduce downtime and extend the life of water infrastructure. Water quality monitoring has become necessary work in environmental protection. Automating monitoring and telemetry is a trend for improving the ability of water quality monitoring system. With the help of sensors, we can check the water quality by use of Wi-Fi module.

Fig 4 Final Hardware Output

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Since the system is automatic therefore it is low in cost and does not require manpower so time and powers both are save. It has widespread application and extension value Data is transmitted to a cloud- based platform or mobile app. Users can visualize water usage trends, tank levels, and system performance in real time Alerts and Notifications he results of implementing such a system are significant. It enhances the efficiency of water distribution, reduces operational costs, and ensures sustainable resource management. Automated controls like valves and pumps optimize water usage based on demand, reducing energy consumption. Alerts and notifications enable timely intervention during anomalies, ensuring reliable water supply.

VI. CONCLUSION

The Internet of Things (IoT) based water monitoring and conservation system developed in this project has demonstrated its effectiveness in real-time monitoring of water supply parameters such as pressure, flow rate, and quality. The system's ability to detect anomalies and send alerts to authorities enables prompt action to be taken, reducing the risk of water scarcity, Kumar, V., & Tiwari, P. "IoT-based Water Usage Monitoring and Control System Journal of Applied Science and Computations, 6(5), 1053-1060(2019). contamination and wastage. The use of IoT sensors protocols has enabled the creation of a scalable, efficient, and cost-effective monitoring system. The system's data analytics capabilities provide valuable insights into water usage patterns, enabling data-driven decision-making for water resource management. and it is used for water leakage detection The successful implementation of this system has the potential to revolutionize the way water supply systems are managed, making them more efficient, sustainable, and resilient. Future work can focus on integrating this system with other smart city initiatives, explore the algorithms for predictive analytics, and expanding the system to include additional water quantity parameters. IoT-based solutions provide a scalable and cost-effective approach for urban and rural water systems, ensuring equitable distribution and improved decision-making for stakeholders. With continuous advancements in IoT technology, water supply .monitoring systems can play a crucial role in addressing global water scarcity issues and promoting smarter, more sustainable communities.

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