Optimizing Water Supply Through IoT-Enabled Smart Distribution System

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Abstract- Humans value water more than any other commodity, but today's water supplies are experiencing a rapid decline in water levels. As a result of decreased rain, there is a greater need for water. Demand for water to meet daily demands has increased due to the rapid rise of residential areas. Everyone uses a varying amount of water depending on their needs and uses it in a multitude of ways. This approach focuses on streamlining water delivery using an IoT-enabled smart system. It makes use of a PIC controller, a temperature sensor, a flow sensor, a PH sensor, a relay, a solenoid valve, a GSM, an LCD, and the Internet of Things. Data is sent to the PIC controller from the sensors and collected by the system. The solenoid valve and relay are then controlled by the controller to manage the water flow. A monitoring and data-manipulating interface is provided via the GSM and LCD. The IoT is also utilized to connect the system to a bigger network for remote monitoring and management. The system is intended to manage water resources effectively and affordably while maximizing water supply.
Keywords: Internet of things (IoT), Water distribution system, IOT technologies, Measurement of flow; controlled supply.

I. INTRODUCTION

The demand for clean, safe water is rising steadily as the world's population is expanding at an alarming rate. Water delivery systems are consequently getting more complicated and challenging to operate. Many cities and regions are using IoT-enabled smart water distribution systems to optimize their water supply in order to address this difficulty.Here, the emphasis was on finding a solution to the problem of insufficient water supply and automatically maintaining the water level that flows to the customer. All clients will receive water automatically.

This system's monitoring, control, and automation of the entire water distribution process is intended to maximize the water supply. The PIC controller, along with the connected sensors and actuators, is used by the system to monitor and regulate the water flow from the source to the storage tank. The water temperature is measured by the temperature sensor, and the water flow rate is determined by the flow sensor. The pH sensor is utilized to continuously check the pH of the water and adjust the system as necessary. While the GSM is used to send a signal to the LCD so that it may indicate the status of the water supply, the relay and solenoid valve are used to manage the water flow.Also, the user can get real-time reports on the water supply situation and make the necessary modifications.In this work, a major problem for distributing an equal quantity, quality, and flow rate of water to all users is resolved.
The primary characteristics are:

- Automation of water distribution system.
- Using water flow sensors, reduce water leaks.
- Optimize the distribution of water.
- Set water tax regulations based on water usage.

A sustainable and effective solution to improve water supply is provided by an IoT-enabled smart water distribution system. The entire water distribution process may be monitored, managed, and automated with this system, which is made to be simple to use and safe for users. As a result, it provides a dependable and affordable alternative for raising the effectiveness and dependability of the water supply.

II. LITERATURE REVIEW

The management of water distribution networks has been completely transformed by the Internet of Things (IoT). Water distribution systems with IoT capabilities are being implemented in several cities throughout the world, including India. The IoT-enabled water distribution systems are compared technologically in this study by NibhKulangaraVelayudhan (2022). Velayudhan starts off by describing the different difficulties that cities confront in giving residents access to clean, dependable, and economical water. These encompasses issues like water contamination, water theft, and leakage. The benefits of implementing IoT-enabled water distribution systems, including higher water quality, better water management, and more effective water use, are then covered.

Velayudhan concludes by giving an overview of the potential for enhanced automation and the possibility for employing AI-enabled algorithms to estimate water usage and detect water-related concerns in IoT-enabled water distribution systems. Velayudhan's analysis offers a thorough and current summary of the condition of IoT-enabled water distribution systems as of right now. The assessment offers a helpful overview of existing systems, the difficulties in putting them into practice, and the possibilities for further development. Anyone thinking about installing an IoT-enabled water distribution system in their community will find it to be a useful resource.

The authors of the 2017 publication Water Quality Monitoring Using Wireless Sensor Networks: Present Trends and Future Research Directions are K. S. Ado-Manu, C. Tapparello, W. Heinzelman, F. A. Katsriku, and J.-D. Abdulai. They explore the current trends and future research directions in this field (WSNs). An overview of the various facets of WSNs, including their architecture, guiding principles, and communication protocols, is given in this study. The latest developments in data collecting and processing, as well as the creation of cloud computing platforms, are then discussed in relation to WSNs for water quality monitoring.The difficulties and potential paths for future study in WSNs for water quality monitoring are also covered in the report.

Overall, the report offers a useful summary of how WSNs are currently being used to monitor water quality. The writers provide an in-depth analysis of the many facets of WSNs and the many trends in this area. The authors also offer an insightful analysis of the difficulties and potential future prospects for this field of study. Therefore, for academics interested in WSNs for water quality monitoring, this study is an invaluable resource.

The paper "Meeting WASH SDG6: Insights from Daily Practices in Dar es Salaam" by P. Hofmann, published in 2017, is the main subject of this literature review. The goal of Sustainable Development Goal 6 of the United Nations is to "Ensure availability and sustainable management of water and sanitation for all," and this article analyses how households in Dar es Salaam go about carrying out their daily routines in this regard (UN, n.d.). Hofmann investigates how knowledge, access, and resource availability play a role in reaching this aim using participatory research techniques such focus groups, semi-structured interviews, and participant observation.The analysis showed that knowledge, access, and resource availability are important factors influencing households' capacity to achieve WASH SDG6. The availability of resources, notably access to infrastructure for water and sanitation, was shown to be a significant obstacle to reaching the aim. Socioeconomic factors, such as poverty, gender, and ethnicity, also have an impact on access to water and sanitation. Awareness of the importance of hygiene, sanitation, and water safety was also found to be a key component for households to be able to receive and sustainably manage water and sanitation services. Finally, Hofmann discovered that traditional beliefs and practices can affect a community's capacity to manage water and sanitation services sustainably.

Overall, Hofmann's research illuminates home routines in Dar es Salaam in relation to achieving WASH SDG6. The results reveal that in order to accomplish the aim, it is crucial to address essential elements such as resource accessibility, knowledge, and availability. The study also emphasizes the value of preserving customs and beliefs in accomplishing the objective. Hofmann's research has significant policy and programming implications since it sheds light on Dar es Salaam households' daily routines and suggests the

actions that must be made to guarantee that everyone has access to and can benefit from sustainable management of water and sanitation.

III. BACKGROUND AND LOCALIZATION

In order to optimize the water supply, an IoT-enabled smart distribution system must take localization into account. It permits efficient resource utilization as well as monitoring, tracking, and administration of the distribution system.Localization is the process of pinpointing a person or an object's precise location inside a given space. Typically, GPS or other positioning technologies are used for this. Localization is utilized to pinpoint the precise position of a water source, the distribution network, and the water customers in an IoT-enabled smart distribution system. This makes it possible to manage the water supply more precisely and effectively.The system can precisely measure the water flow rate, pressure, and other parameters of the different distribution system components thanks to localization as well. By granting precise control over the system's operation, it also contributes to a decrease in energy use. For instance, localized sensors can be used to gauge the water's pressure and temperature, which can then be utilized to modify the water's flow rate to save energy.

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In order to optimize the water supply, localization is a key notion in the deployment of an IoT-enabled smart distribution system. It permits efficient resource utilization as well as monitoring, tracking, and administration of the distribution system. The system's efficiency can be increased while consuming less energy by utilizing localization as well as other technologies like GSM, LCD, and IoT, pH sensors, temperature sensors, flow sensors, and relays and solenoid valves.

IV. PROPOSED SYSTEM

3.1 Problem Statement

- Optimize water distribution.
- Decrease over exploitation of water
- Water distribution system that is clever and upgraded.
- The level of water distribution and the quality of the water through the mobile app interface, IoT is used.

3.2 Advantages of Proposed System

- Real-time data from IoT-enabled water distribution systems can be utilized to examine usage trends and spot inefficient areas. This can aid in lowering waste and enhancing the system's general effectiveness.
- IoT-enabled systems are able to offer comprehensive data on the water distribution network, including the quantity of water used, the flow rate, and other pertinent information. This might aid in making sure that the water is distributed effectively and properly.
- The water distribution network can be automatically controlled by IoT-enabled technologies. This can aid in lowering human mistake rates, increasing accuracy, and making sure the system is operating correctly and effectively.
- Systems with IoT capabilities can save money on installation and maintenance expenses. This may aid in lowering the water distribution system's total cost of ownership.

V. SYSTEM ARCHITECTURE

Figure.1 illustrates a block schematic of the system's hardware.A PIC microcontroller, flow sensor, pH sensor, relay, solenoid valve, GSM, LCD, and Internet of Things make up the system.

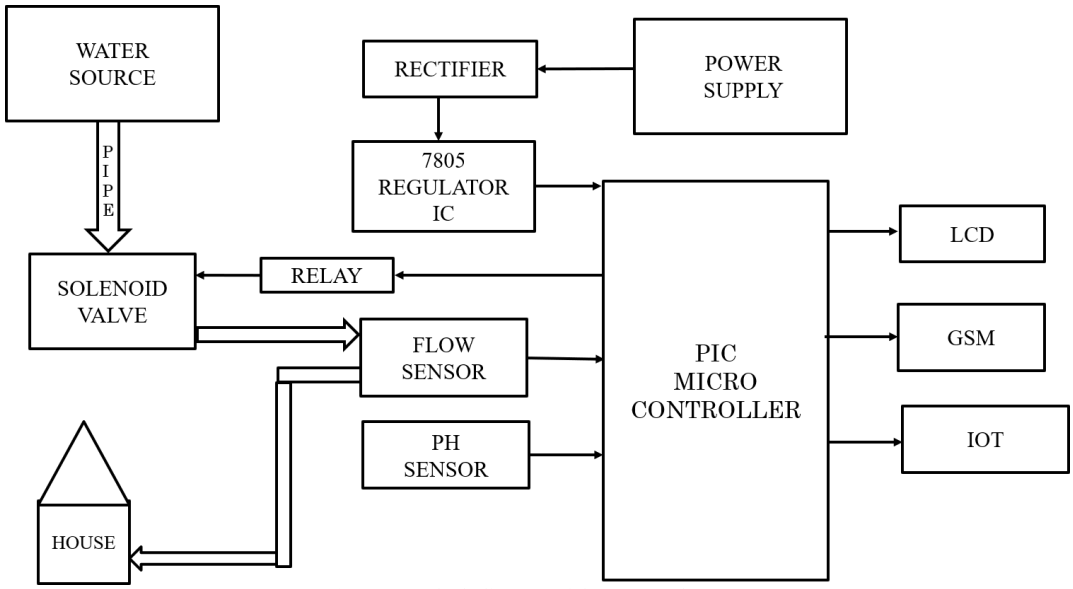

Figure 1. Block diagram of the proposed system

4.1 PIC Controller

Microchip Technology Inc. created the PIC (Peripheral Interface Controller) family of microcontrollers. They are extensively utilized in a wide range of electronic systems and devices, including those used in automobiles, industrial automation, consumer electronics, and medical equipment. Low power consumption, quick processing, and simple programming are the hallmarks of PIC microcontrollers. They are available in numerousmodels that have varied memory capacities, ancillary features, and interfaces to satisfy the needs of various applications.The PIC controller is an important component of a smart water distribution system. It is a microcontroller-based device that is used to control the various components of the water system, such as pumps, valves, and other actuators. The PIC controller can also be used to monitor and control the flow of water in an automated manner, and to provide real-time feedback on the flow rate, pressure, and other parameters.In comparison to other microcontrollers on the market, PIC microcontrollers are very inexpensive. PIC microcontrollers are generally a preferred option for embedded system designers because of their abundance of capabilities, low power consumption, simplicity of programming, and affordability.

4.2 Flow Sensor

The rate at which a fluid (liquid or gas) is flowing through a pipe or channel is measured by a flow sensor. Many technologies and processes, including automotive engines, medical equipment, and environmental monitoring systems, use flow sensors. The measurement and control of fluid flow in diverse systems makes flow sensors essential parts of many industries. They can be utilized for a variety of tasks, including as managing and monitoring the water flow in a plumbing system, measuring the fuel flow in an engine, and determining the air flow in HVAC systems. Flow sensors are used to measure the rate of flow of water in the distribution system. The flow sensor is connected to the PIC controller to provide real-time feedback on the rate of flow of water. This information can be used to optimize the flow rate of the water and to detect any abnormalities in the rate of flow. The type of sensor, the diameter of the pipe or channel, and the characteristics of the fluid being monitored are just a few of the variables that affect how accurate flow sensors are. Some flow sensors are better at sensing specific fluid types or flow rates than others, and some are more accurate than others.In general, flow sensors are a crucial instrument for monitoring and managing fluid flow in a variety of applications. They can assist prevent product quality problems or equipment damage by ensuring that systems run effectively and dependably.

4.3 pH Sensor

A pH sensor is a tool used to gauge a solution's acidity or basicity (alkalinity). The concentration of hydrogen ions (H+) in a solution is determined by the pH value of the solution. The pH scale has a range of 0 to 14, where a value of 7 indicates acidity and a value of 7 or higher indicates basicity (alkalinity). A glass bulb filled with a solution with a known pH value and a reference electrode submerged in the solution being measured make up the most typical type of pH sensor. A potential difference between the reference electrode and the glass electrode is created when the glass electrode is submerged in a solution, and it is inversely proportional to the pH of the solution.PH sensors are used to measure the pH of the water in the distribution

system. The PH sensor is connected to the PIC controller to provide real-time feedback on the pH of the water. This information can be used to adjust the flow rate and pressure of the water, as well as to detect any abnormalities in the pH of the water.A pH meter measures this potential difference and converts it to a pH value.By giving critical information about the acidity or basicity of solutions and assisting in the assurance of quality, safety, and efficacy in a variety of products and processes, pH sensors play a significant role in many businesses and scientific domains.

4.4 Relay and Solenoid Valve

Relays An electrical device called a relay is used to regulate the electricity that flows across a circuit. It operates by creating a magnetic field using an electromagnetic coil, and then switching a set of contacts to open or close a circuit.Relays are frequently employed in a wide range of applications, including home automation systems, automobile electronics, and industrial control systems. They are frequently employed to isolate one circuit from another or to switch high voltage or high current circuits and Fig.6.Solenoid valves are used to control the flow of water in the distribution system. The relays and solenoid valves are connected to the PIC controller to allow it to control the flow of water in an automated manner. The relays and solenoid valves can also be used to adjust the flow rate and pressure of the water, as well as to detect any abnormalities in the rate of flow. An electromechanical device called a solenoid valve regulates the flow of liquids or gases through a pipe or tubing. It is made up of a magnetic core and a coil of wire that, when powered by an electric current, creates a magnetic field that moves a piston or plunger inside the valve body, opening or closing a path for the fluid to flow.There are two basic categories of solenoid valves: direct-acting and pilot-operated. Pilot-operated solenoid valves employ a small pilot valve to regulate the flow of a larger valve, whereas direct-acting solenoid valves have a small aperture and work directly on the fluid.Moreover, solenoid valves are made to handle a variety of fluids, including water, air, gas, steam, and corrosive chemicals. Depending on the application and the kind of fluid they are intended to handle, they are built of various materials, including plastic, brass, and stainless steel. Solenoid valves have the basic ability to control the flow of fluids, but they can also include extra functions like manual override, position indicator, and customizable flow control. In the event of a power outage or an emergency, manual override enables the valve to be manually opened or closed. The valve's status, such as whether it is open or closed, is shown by the position indicator. With adjustable flow control, the valve's opening can be changed to change the flow rate.

4.5 GSM

Global System for Mobile Communications, or GSM, is an international standard for digital cellular networks that was created in Europe and is now utilized by numerous mobile phone networks throughout the globe. Short Messaging Service (SMS), which enables users to send and receive text messages up to 160 characters in length, is another feature that GSM supports in addition to speech.SIM (Subscriber Identity Module) cards, which may be quickly switched between devices and store the user's identity and personal data, were also introduced by GSM.General Packet Radio Service (GPRS) and Enhanced Data Rates for GSM Evolution (EDGE), which offer faster data transmission rates and support for mobile internet access, are two new technologies that have been added to GSM throughout time.GSM is an important component of a smart water distribution system. It is used to send data from the PIC controller to a remote location, such as a server or a smartphone. This allows for real-time monitoring and tracking of the water distribution system.Although though GSM is an outdated technology currently, several mobile networks still rely on it as the backbone of their cellular networks. However, more recent technologies have appeared, like 3G, 4G, and 5G, which offer faster data speeds, more sophisticated capabilities, and better support for mobile broadband.

4.6 Internet of Things (IoT)

IoT is an important component of a smart water distribution system. It is used to connect the various components of the system, such as the PIC controller, sensors, relays, and solenoid valves, to a remote location. This allows for real-time monitoring and tracking of the water distribution system. The components of an IoT-enabled smart water distribution system, such as the PIC controller, flow sensor, PH sensor, relays and solenoid valves, GSM, LCD, and IoT, are essential to optimize water supply. These components allow for real-time monitoring and tracking of the water distribution system, as well as automated control of the flow of water. This helps to reduce wastage and improve efficiency in the water distribution system.

VI. CONCLUSION

This system effectively monitors, controls, and identifies potential issues with the water supply before they d evelop into serious issues. It does this by using realtime sensor data. Also, this system can offer more effectiv e water distribution and resource management, which helps cut down on water waste and guarantee that wate r resources are managed sustainably. The technology can also assist in maintaining water safety by monitorin

g its quality. Longterm improvements in water resource availability, less water loss, and improved water man agement can all be attributed to this method.

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