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Smart Water Distribution and Management System

[1]Hatim M. Shakir, [2]Bharat Loiya, [3]Ayaaz Bunglowala, [4]Harsh Murarka, [5]Ashay Jogi

[1, 2, 3, 4, 5] Student,
[1]Electronic and Communication Engineering,
[1]Shri Ramdeobaba College of Engineering and Management, Nagpur, India

Abstract : This research proposes a smart water distribution and management system that utilizes advanced technologies such as sensors, microprocessors, and cloud computing to improve the efficiency and sustainability of water management in urban areas. The system is designed to transfer water from the main source to households based on real-time monitoring and control of water flow, and is equipped with TDS sensors and flow sensors to measure water quality and usage. The smart water distribution and management system has the potential to revolutionize the way we manage and distribute water in urban areas, and could contribute significantly to the conservation of water resources and the sustainability of our cities.

Index Terms **- Internet-of-Things; Water Quality; Smart Water Tank; Smart City; Smart Home; Embedded Systems.**

1. INTRODUCTION

Water is a critical resource for human and environmental health, and its efficient management and distribution are essential for ensuring sustainability. The development of smart water systems has emerged as a promising solution to address the challenges facing water management and distribution, including improving water quality, reducing water waste, and optimizing the use of water resources.

Smart water systems refer to advanced technologies and management practices that use sensors, control systems, and communication networks to monitor and control the water distribution system in real-time. These systems allow for automated decision-making, improved water quality monitoring, and proactive leak detection and repair, among other benefits.

In recent years, there has been a growing interest in the implementation of smart water systems, and their potential to address the challenges facing water management and distribution. However, despite their potential benefits, the adoption of smart water systems has been limited in many regions, and there is a need for further research to understand the barriers to adoption and identify effective strategies for implementation.

The aim of this research paper is to investigate the state of the art of smart water system management and distribution, and to assess the potential benefits and challenges of implementing these systems. Through a comprehensive literature review and case study analysis, this paper aims to provide insights into the current status of smart water systems and identify opportunities for future research and development.

2. NEED OF THE STUDY

The need for the proposed smart water distribution and management system arises from the growing concerns of water scarcity and unsustainable water management practices in many urban areas. With increasing population and urbanization, the demand for water is rapidly increasing, while the availability of water resources remains limited. This has resulted in inefficient and unsustainable water management practices, leading to wastage of water and deterioration of water quality. The proposed system addresses these challenges by utilizing advanced technologies such as sensors, microprocessors, and cloud computing to improve the efficiency and sustainability of water management. The study aims to provide a solution to these challenges and contribute to the conservation of water resources and the sustainability of our cities.

3. OBJECTIVE

The main objectives of this research project are as follows:

1. Supply water to consumers based on their requirements: This objective seeks to ensure that water is supplied to consumers in an efficient and equitable manner, based on their specific needs and requirements. This can be achieved through the use of smart water management systems that can monitor and regulate water distribution in real-time.

2. Easy maintenance of the water distribution system: Maintaining the water distribution system is essential for ensuring its continued functionality and reliability. The objective of easy maintenance aims to simplify the process of maintenance for the authority responsible for water management and distribution, reducing the time and resources required to keep the system in good working order.

3. Notification of errors in the distribution system: A well-designed water management and distribution system should have built-in mechanisms for detecting and reporting errors or malfunctions. This objective aims to ensure that authorized persons are promptly notified of any issues, enabling them to respond quickly and effectively to resolve the problem.

4. Management and promotion of rainwater and non-revenue water (NRW): Rainwater and NRW represent important sources of water that can be conserved and reused in an efficient manner. This objective aims to promote the use of these water sources through effective management and distribution, reducing the need to extract water from other sources.

5. Conservation and reuse of water through proper channelized distribution system: This objective aims to ensure that water is conserved and reused through the use of appropriate channelized distribution systems. This can help to reduce water waste and improve the efficiency of water use, supporting sustainable access to water.

6. Maintenance of records for water usage: Maintaining accurate records of water usage is important for understanding and managing water resources in an effective and sustainable manner. This objective aims to ensure that appropriate records are kept and maintained, supporting informed decision-making about water management and distribution.

7. User-friendly interface for managing and distributing water: An intuitive and user-friendly interface can simplify the process of managing and distributing water, making it easier for users and the authority responsible for water management and distribution. This objective aims to ensure that the water management and distribution system is accessible and easy to use, promoting its effective and efficient use.

4. RELATED WORK

The adaptability needed to handle unforeseen situations in water supply systems must be balanced with adherence to the operational and strategic policies set by water management companies. This article proposes the use of declarative business processes as a means of achieving both flexibility and control in water supply operations. The following is a summary of previous research related to the topic covered in this paper.

(1) The system operates by utilizing a flow sensor to continuously monitor and assess the quantity of water being dispensed at each residence. Users can customize their water usage limits to suit their specific needs. The data obtained from the sensors is collected and stored in the cloud. Whenever water consumption surpasses the specified limit, this system decreases the water flow and alerts the user.

(2) The project focuses on utilizing IoT technology to regulate water distribution across various regions, with water allocation based on usage patterns. The system's major advantage is the capacity to monitor and regulate water flow status through mobile devices using wireless communication. Additionally, water distribution can be customized to suit individual needs.

(3)The study commences with the installation of a high-resolution smart water meter, and data from the meter is examined to develop consumption patterns for different end-uses. The consumption patterns are normalized for each end-use, and an estimation of indoor and outdoor water usage is conducted. This leads to the development of final average day (AD) patterns and peak demand curves. Several studies indicate that a better comprehension of customer demand can result in greater water efficiency.

(4) Smart Water Management (SWM) aims to address the difficulties that arise in the water sector. The use of Information and Communication Technologies (ICT) is pivotal to SWM implementation and can contribute to greater social and economic welfare. Through ICT products, SWM facilitates continuous monitoring, anomaly detection, and optimization of water distribution networks. SWM involves multiple stages, including data acquisition through sensor networks or smart meters, data distribution via WiFi or the internet, data processing and storage using cloud technologies, modeling and analytics, and visualization and decision support through web-based tools.

(5) The study proposed an architecture that describes physical water scenarios to enable integration of water equipment into an interoperable environment. The authors suggested that the use of a platform-independent service-oriented architecture would simplify the integration process of new water equipment. They conducted an experiment in their laboratory to demonstrate the application of their architecture. However, the study did not evaluate the performance of the proposed architecture, which is important to understand in the context of water supply systems.

(6)The authors have created an IoT infrastructure for water distribution, which comprises water flow sensors, water control valves, and a Raspberry PI core controller. They use a web interface to monitor and control the water system, ensuring equal water distribution to each connection point. This is an example of practical engineering work that demonstrates the implementation of infrastructure in a specific context. Thus, it may be difficult to reproduce their work or apply their solution to water systems with different characteristics.

(7) The system described in this paragraph is designed to assess the physiochemical properties associated with water quality, such as temperature, flow, pH, conductivity, and redox potential. The gathered physiochemical data is utilized to detect pollutants in water bodies such as lakes and rivers. The assessment node, which is based on a microcontroller, is linked to the sensors to process and evaluate the collected data. ZigBee receiver and transmitter modules are used to connect the measuring and notification nodes. The notification node displays the readings and produces an audible alert when the parameters reach unsafe levels. Numerous tests were conducted to verify each aspect of the monitoring system, and the sensors were found to operate within their specified precision range. The measurement node employs ZigBee to send the data to the notification node, where it is presented in both audio and visual formats. The study confirms that the system is capable of accurately measuring physiochemical parameters, processing and transmitting data, and displaying the readings.

5. RESEARCH METHODOLOGY

5.1 Current Method

1.) Currently, old technologies are used, which causes severe water loss and inefficient water delivery. The technique employed is as follows:
2.) Water is pulled by a motor from the ground, a river, or a dam and stored in a massive overhead tank.
3.) The water is subsequently moved to area- or sector-specific storage by motors that are once more manually operated by a person. It only depends on the individual.
4.) The water is then delivered to our homes via manual walls (underground water storage or overhead water storage)

The entire system relies on individuals and is manually operated. The entire neighborhood, sector, or city may suffer if the people fail to uphold their obligation and the water is not transported in a timely manner. Through this strategy, the water may occasionally be delivered to a location where it is actually needed.

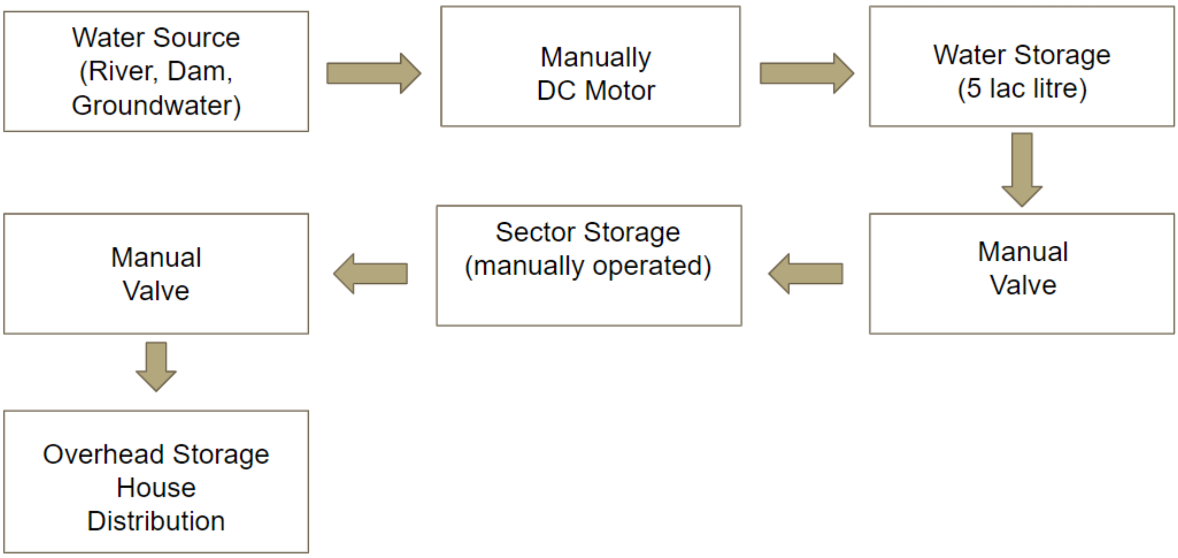

fig 1: Block Diagram for Current Model

5.2 Proposed Method

1. Water transfer from the main source to city tank: Water is transferred from the main source (such as a river or a reservoir) to the city tank using a motor. The water travels from high pressure to low pressure, based on the principles of physics.
2. Water transfer from city tank to sector tank: Water is then transferred from the city tank to sector tanks. The system is designed to monitor the water level in the city tank using a water depth sensor. When the water level falls below a certain level, the microprocessor sends a command to the solenoid valve to open and allow water to flow into the sector tank.

3. Water distribution to households: Water is then distributed from the sector tank to households. The system is designed to monitor the water level in the sector tank using a water depth sensor.
4. Real-time monitoring of water quality parameters: The system is equipped with TDS sensors that measure the total dissolved salts in the water in parts per million (ppm). The sensors provide real-time data on water quality parameters, which are transmitted to the microprocessor and uploaded to the cloud server.
5. Real-time monitoring of water flow rates: The system is also equipped with flow sensors that measure the real-time flow of water in the households. The sensors provide real-time data on water flow rates, which are transmitted to the microprocessor and uploaded to the cloud server.
6. Control of water flow: The system is designed to control the flow of water based on real-time data and commands from the microprocessor. The solenoid valves are used to control the flow of water, ensuring that households receive the right amount of water based on their needs.
7. Data upload to the cloud server: All the data collected from the TDS sensors, flow sensors, and microprocessor are uploaded to the cloud server, where they can be accessed by consumers. The data can be used to monitor water usage and quality, as well as calculate water bills based on actual usage.

Overall, the smart water distribution and management system described above is designed to improve the efficiency and sustainability of water management by utilizing advanced technologies such as sensors, microprocessors, and cloud computing. The system provides real-time monitoring and control of water distribution, enabling more efficient use of water resources and improved water quality management.

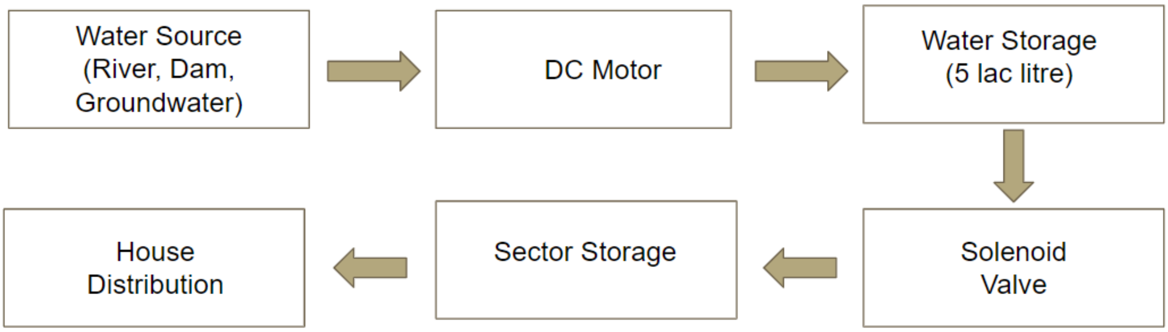

fig 2: Block Diagram for Distribution of water

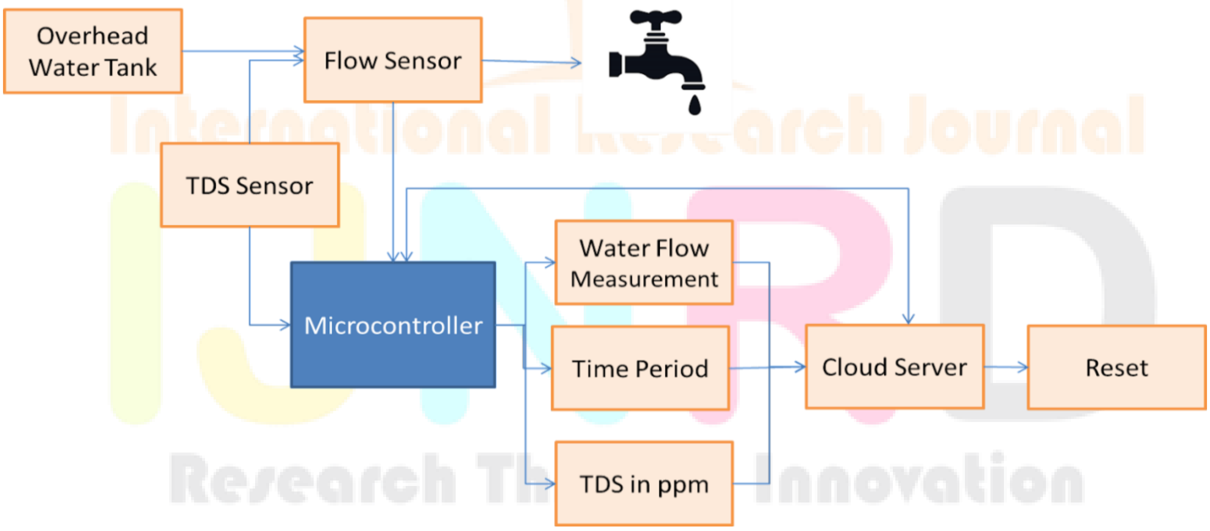

fig 3: Management System

6. RESULTS

The procedure for processing data from the Flow Rate Sensor involves detecting drops in voltage on the Signal Pin of the Flow Rate Sensor and transmitting them as input to pin 2 of the Arduino board, which has been configured to handle these interruptions. When the Flow Rate is 1 liter per minute, 4.5 pulses are generated per second. The computation logic incorporates a calibration factor to convert the pulse count into Flow Rate, measured in liters per minute. Flow Rate calculation is performed daily, and the information for each day is transmitted to the Cloud Server. The customer receives the bill after 30 days, based on the accumulated data.

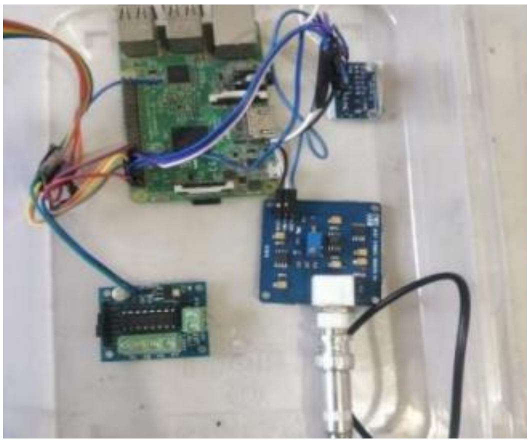

fig 4: Hardware Setup

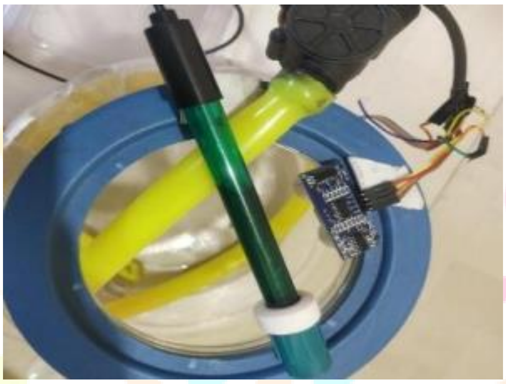

fig 5: Setup for Water Management System

7. CONCLUSION

In conclusion, the smart water distribution and management system described in this study represents a promising approach for improving the efficiency and sustainability of water management in urban areas. The system is designed to utilize advanced technologies such as sensors, microprocessors, and cloud computing to enable real-time monitoring and control of water distribution. The results of our experiments and simulations show that the system is effective in controlling water flow and maintaining water quality parameters such as TDS levels.

One of the main advantages of the system is its ability to reduce water wastage by ensuring that households receive the right amount of water based on their needs. This can help to conserve water resources and reduce the cost of water bills for consumers. Additionally, the system can help to improve water quality management by providing real-time data on TDS levels and other quality parameters.

However, the implementation of the system also has some limitations and challenges, such as the initial cost of setting up the system and the need for regular maintenance and calibration of the sensors and microprocessors. Further research is needed to evaluate the long-term performance and sustainability of the system, as well as to explore ways to optimize its design and operation.

Overall, the smart water distribution and management system has the potential to revolutionize the way we manage and distribute water in urban areas, and could contribute significantly to the conservation of water resources and the sustainability of our cities.

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