WASTE WATER MANAGEMENT AND WATER QUANTITY MONITORING USING IOT

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Abstract:- This comprehensive review explores IoT innovations in water, wastewater management, and water quality monitoring, emphasizing the transformative potential of these technologies. Combining sociometric and systematic review (SR) techniques, the study analyzes sciento metric trends and co- occurrence networks linked to review topics. Research primarily centers on these aspects, averaging 15 articles annually since 2017, peaking at 24 in 2021. The SR unveils the widespread use of multiple sensors in monitoring, particularly water level, flow, and pH sensors. Common wireless technologies are emphasized for their role in advancing real-time monitoring. Innovative protocols such as Sigfox and Zigbee enhance sensor- IoT connectivity, improving communication in infrastructure management. Common challenges hindering system efficiency and data flow include sensor accuracy, energy optimization, communication reliability, interdisciplinary collaboration, and sensor coverage. Addressing these gaps is crucial for advancing IoT driven water systems and enhancing decision- making. This study guides IoT practitioners in integrating automation and sustainability in water and wastewater management.

1. INTRODUCTION

1.1 GENERAL

Water is essential for human survival and various activities such as industry, agriculture, and household usage [1]. Efficient water and wastewater infrastructure, including dams, reservoirs, pipelines, and treatment facilities, is essential to ensure adequate and reliable water supply while minimizing wastage, especially in regions with water scarcity [2], [3], [4], [5],

[6], [7], [8]. The increasing demand for water resources due to economic development and population growth, coupled with the negative impact of human activities on the environment, has heightened the importance of sustainable water management practices [4], [9], [10], [11]. These practices aim to balance the competing economic development needs and environmental conservation while ensuring access to clean and safe water resources for future generations. As part of the Sustainable Development Goals (SDGs) related to water and sanitation, a paradigm shift is needed in managing water and wastewater infrastructure [12], [13], [14]. Sustainable water management practices, such as smart metering, water loss management, and demand-side management, can significantly contribute to reducing water wastage and promoting sustainability in the management and monitoring of water distribution networks [15], [16], [17], [18]. On the other hand, sustainable wastewater treatment, such as nutrient removal, resource recovery, and advanced treatment technologies, can reduce pollution and promote sustainability in smart cities [19], [20], [21]. Additionally, efficient drainage network management practices, supported by smart technologies and innovative approaches, can optimize the performance of the network, reduce energy consumption, minimize environmental impacts, and enhance overall sustainability [22], [23], [24], [25]. Therefore, adopting sustainable water and wastewater management practices is critical to ensure water resources' long-term availability and quality and achieve the SDGs related to water and sanitation. Recently, the integration of Internet of Things (IoT) technologies in WWM-WQM has revolutionized infrastructure management and has the potential to improve the effectiveness, efficiency, and sustainability of water and wastewater systems. IoT-enabled sensors and data analytics play a vital role in smart water management, allowing real-time monitoring of water quality, quantity, distribution, and data-driven decision-making [26], [27], [28]. With the help of IoT sensors, monitoring of real-time water consumption and usage can be afforded, detecting leaks or inefficiencies in the water supply system, and providing valuable insights into consumption patterns for water conservation efforts [29]. IoT sensors can also be utilized to monitor water quality parameters in real-time, including pH, temperature, and turbidity, enabling prompt detection of abnormalities or contamination, and facilitating timely corrective action [30].

2. LITERATURE SURVEY

2.1 EXISTING SYSTEM

Current applications of IoT in water and wastewater management typically involve sensor networks that monitor parameters such as water flow, quality, and infrastructure conditions. These systems provide real-time data to stakeholders, enabling more efficient management decisions and proactive maintenance strategies. However, integration across existing systems can be fragmented, limiting holistic management approaches.

2.2 PROPOSED SYSTEM

The proposed review identifies advancements in IoT for sustainable water and wastewater management, emphasizing integrated sensor networks that collect and analyze comprehensive data sets. Future directions include enhanced interoperability between IoT platforms and infrastructure, enabling seamless data sharing and analytics. This holistic approach aims to optimize resource allocation, improve water quality monitoring, and support sustainable development goals through informed decision-making and proactive environmental stewardship

3. BLOCK DIAGRAM

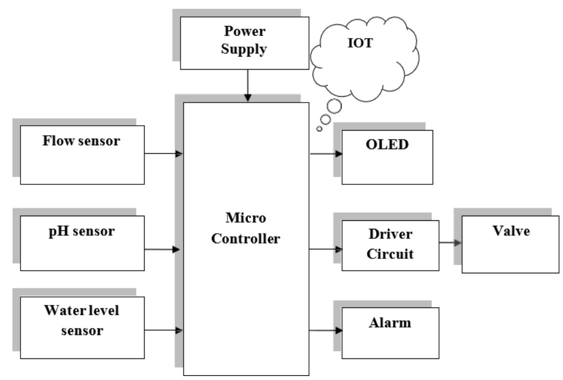

FIG: 1 Block diagram

3.1. HARDWARE COMPONENTS

- Regulated power supply.
- Flow sensor
- Water level sensor
- PH sensor
- Micro controller.
- IOT

3.2. SOFTWARE REQUIREMENTS:

- Raspberry Pi Pico
- Embedded C

4. IMPLEMENTATION (WORKING PROCEDURE)

The SR unveils the widespread use of multiple sensors in monitoring, particularly water level, flow, and pH sensors. Common wireless technologies are emphasized for their role in advancing real-time monitoring. Innovative protocols such as Sigfox and Zigbee enhance sensor- IoT connectivity, improving communication in infrastructure management. Common challenges hindering system efficiency and data flow include sensor accuracy, energy optimization, communication reliability, interdisciplinary collaboration, and sensor coverage. Addressing these gaps is crucial for advancing IoT driven water systems and enhancing decision- making.

5. CIRCUIT DIAGRAM

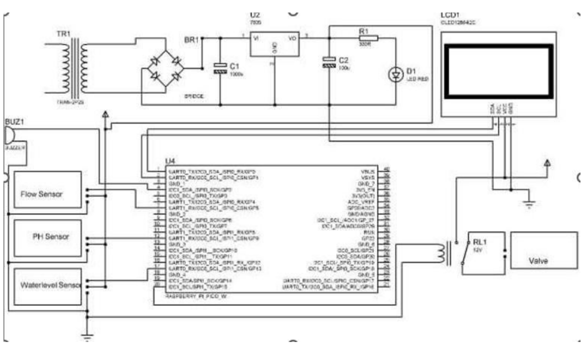

Fig : 2. circuit diagram

6. RESULT

This project is well prepared and acting accordingly as per the initia specifications and requirements of our project. Because of the creative nature and design the id of applying this project is very new, the opportunities for this project are immense. The practical representation of an experimental board is shown below:

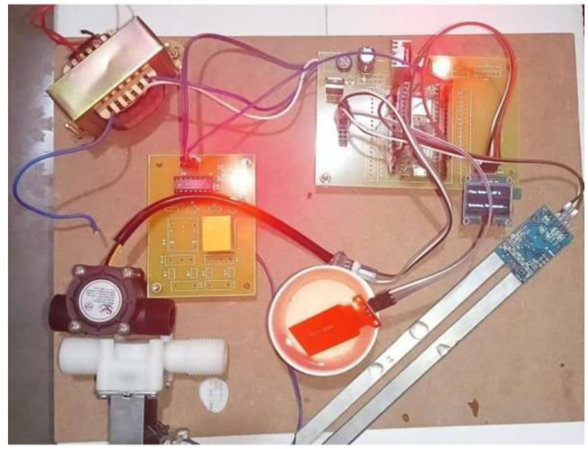

Fig:3. Project Model

7. CONCLUSION

This review highlights IoT's substantial potential in transforming water and wastewater management and water quality monitoring. Employing a hybrid methodology that combines ChatGPT and manual processes, we identified and analyzed 119 relevant articles from an initial set of 496 through rigorous screening and snowballing techniques. The SA explores IoT research in water-related domains spanning 2012 to 2023. Notably, IoT research witnessed a substantial surge in 2017, peaking at 24 articles in 2021. Since 2017, an annual average of 15 articles underscores the growing significance of IoT-based sensor technologies in three research domains. Employing keyword co-occurrence analysis, the study unveils trends and hotspots. Distinct keyword clusters emerged, particularly emphasizing IoT applications in water management and IoT-based water quality monitoring. Separate analyses for IoT-based wastewater management, water management, and water quality monitoring provide deeper insights into these domains. In the SR part, we categorized articles into three dimensions, which offer a nuanced understanding of the various applications of IoT within these realms. Each dimension further uncovers insights across subcategories, highlighting the significance of sensors and sensing technologies, data acquisition and transformation, data analytics and visualization, application and case studies, and existing limitations and research gaps. The SR results indicate equal research focus across the three domains. Many studies (20 for water management, 24 for wastewater management, and 32 for water quality) involve multiple sensors. Water level, flow, and pH sensors are frequently used (12, 15, and 17 articles, respectively). This detailed analysis enhances our understanding of IoT's multifaceted benefits and challenges. The prevalence of sensors, particularly flow and pH sensors, is crucial in the context of surface water monitoring, where real-time data acquisition plays a pivotal role in managing water quality and facilitating informed decision-making, thereby enhancing theeffectiveness of water and wastewater management practices in such environments. The findings of this comprehensive review have uncovered shared research challenges, gaps, and limitations across the three dimensions of IoT applications. Notably, the need for cost-effective and robust sensors capable of functioning in diverse conditions, the challenge of ensuring stable and reliable technical connections in remote or underground locations, and the pressing concern of addressing energy consumption and optimizing power sources are among these common hurdles.

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