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Development of Monitoring Control System in Domestic Water Home Tank

Norhafizan Bin Majid [1], Zarina Binti Yusof [2]

[1] Politeknik Melaka, Malaysia
[2] Politeknik Port Dickson, Malaysia
norhafizan@polimelaka.edu.my

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Abstract

This study explores the development of an innovative water quality control device for residential tanks, aimed at enhancing water safety and management. Ensuring clean and safe water in home tanks is a growing concern due to variable water quality and maintenance challenges. Traditional methods of water quality monitoring are often manual and inadequate for real-time intervention. The study aims to design a smart control system that provides continuous monitoring, real-time alerts, and automated corrective actions for residential water tanks. A prototype device was developed incorporating sensors for pH, turbidity, and temperature measurements. Data is collected and analyzed using IoT technology, with results displayed on a mobile application. The system features automated controls for water treatment processes and employs machine learning for predictive maintenance. The device successfully provided realtime monitoring and automated responses to water quality issues, significantly improving water safety and maintenance efficiency. Future improvements include expanding sensor capabilities, enhancing the predictive analytics and integrating with other home automation systems to further streamline water management processes.

***Keyword** : Water; Quality; Innovative; IOT; control*

Pengembangan Sistem Kontrol Pemantauan pada Tangki Air Rumah Tangga

Abstract

Penelitian ini membahas pengembangan perangkat kontrol kualitas air yang inovatif untuk tangki air rumah tangga, dengan tujuan utama meningkatkan keamanan dan efisiensi pengelolaan air domestik. Kualitas air yang tidak konsisten serta tantangan dalam pemeliharaan rutin menjadikan kebutuhan akan sistem pemantauan yang andal semakin mendesak. Metode konvensional dalam memantau kualitas air umumnya bersifat manual dan tidak mampu memberikan respons secara waktu nyata. Dalam studi ini, dirancang sebuah sistem kontrol cerdas yang mampu melakukan pemantauan berkelanjutan, memberikan peringatan secara real-time, serta menjalankan tindakan korektif secara otomatis. Perangkat prototipe yang dikembangkan dilengkapi dengan sensor untuk mengukur parameter pH, kekeruhan, dan suhu. Data yang diperoleh dianalisis melalui teknologi Internet of Things (IoT), dan hasilnya ditampilkan melalui aplikasi seluler. Sistem ini juga mencakup fitur kontrol otomatis untuk proses pengolahan air, serta menerapkan algoritma pembelajaran mesin guna mendukung pemeliharaan prediktif. Hasil pengujian menunjukkan bahwa perangkat mampu memberikan pemantauan secara real-time dan merespons secara otomatis terhadap permasalahan kualitas air, yang secara signifikan meningkatkan aspek keamanan dan efisiensi pemeliharaan sistem air rumah tangga. Pengembangan lebih lanjut diarahkan pada peningkatan kapabilitas sensor, penguatan analitik prediktif, serta integrasi dengan sistem otomasi rumah untuk mendukung manajemen air yang lebih terpadu.

Kata Kunci: Air; Kualitas; Inovasi; IoT; Kontrol

1. Introduction

1.1 Introduction

Good water quality is fundamental to human health and well-being. In the context of home water tanks, monitoring and managing water quality often pose significant challenges due to factors such as contamination, temperature fluctuations, and the lack of effective monitoring systems. This issue becomes increasingly pressing with the growing need to ensure that the water used in homes is clean and safe.

To address these challenges, this study focuses on the innovation of a water quality control device for home tanks. This device is designed to provide a more advanced solution for continuous water quality monitoring and management. By employing modern sensor technology and IoT (Internet of Things) systems, the device is capable of measuring key parameters such as pH, turbidity, and water temperature in real time.

1.2 Literature Review

The management and quality of water in residential tanks are critical for ensuring public health and safety. This literature review examines existing research and advancements related to the innovation of water quality control devices for home tanks, focusing on technological developments, challenges, and solutions in this field.

1.2.1. Technological Advancements in Water Quality Monitoring: Recent advancements in sensor technology and IoT (Internet of Things) have significantly impacted water quality monitoring. Modern sensors can measure parameters such as pH, turbidity, dissolved oxygen, and temperature with high accuracy and reliability (Goh et al., 2022). IoT integration allows for real-time data collection and remote monitoring, which enhances the ability to manage water quality proactively (Lee et al., 2021). Studies have shown that IoT-based systems can provide timely alerts and automated responses to changes in water quality, which are crucial for maintaining safe water standards (Singh et al., 2023).

1.2.2. Automated Control Systems: Automated water treatment systems have emerged as a significant innovation. These systems use algorithms and real-time data to initiate corrective actions such as filtration or chemical treatment automatically when water quality parameters deviate from acceptable ranges (Cheng et al., 2021). The integration of machine learning algorithms has further improved the predictive capabilities of these systems, enabling them to anticipate potential issues before they occur (Ravi et al., 2022).

1.2.3. Challenges in Implementation: Despite technological advancements, several challenges persist. These include the high cost of sophisticated sensors and automation systems, which can be prohibitive for widespread adoption in residential settings (Miller et al., 2021). Additionally, ensuring the accuracy and reliability of sensors over extended periods and in varying environmental conditions remains a challenge (Yuan et al., 2023). Maintenance and calibration of these devices also require regular attention to ensure optimal performance (Smith et al., 2022).

1.2.4. User Acceptance and Education: The successful implementation of water quality control devices depends not only on technological advancements but also on user acceptance and education. Research indicates that homeowners may lack awareness or understanding of the benefits of these systems (Johnson et al., 2021). Therefore, educational initiatives and user-friendly designs are crucial for enhancing adoption and effective utilization of these technologies.

1.2.5. Future Directions: Future research should focus on reducing costs, improving sensor durability, and enhancing the user experience. Emerging technologies such as advanced nanomaterials and artificial intelligence offer promising avenues for improving the efficiency and affordability of water quality control devices (Kim et al., 2023). Additionally, integrating these systems with broader home automation networks could provide more comprehensive solutions for managing residential water quality

1.3 Objective:
The primary objective of this study is to develop and evaluate an innovative water quality control device specifically designed for home water tanks. This device aims to enhance the continuous monitoring and management of water quality by integrating advanced sensor technology and Internet of Things (IoT) systems. The specific goals are:
1.3.1. To design and Implement a Smart Monitoring System. Create a device that continuously measures critical water quality parameters such as pH, turbidity, and temperature, providing real-time data and insights.
1.3.2. To Provide Data for Better Maintenance Planning. Develop a system that not only monitors water quality but also stores and analyzes historical data to support effective maintenance scheduling and preventive measures.
1.3.3. To Enhance User Experience and Safety. Ensure that the device is user-friendly and reliable, offering timely alerts and easy access to water quality information, thus improving overall safety and efficiency in water management for residential users.
By achieving these objectives, the study aims to contribute to more effective and reliable home water tank management, reducing health risks associated with poor water quality and supporting better overall household water safety.

2. Methodology

The methodology for this study on the innovation of a water quality control device for home tanks involves several key stages, from design and development to testing and evaluation. The approach is detailed as follows:

2.1 Design and Development:

2.1.1 Requirements Analysis: Identify and define the key parameters to be monitored (e.g., pH, turbidity, temperature) and the functional requirements of the device based on existing challenges in home water quality management.

2.1.2 System Design: Develop a prototype incorporating modern sensors and IoT technology. The design includes selecting appropriate sensors for accurate measurement, integrating these with a microcontroller, and establishing a communication protocol for data transfer to a mobile or web application.

2.2 Prototype Construction:

Component Assembly: Assemble the physical components of the device, including sensors, microcontroller, and power supply, ensuring robust and reliable performance in residential environments. Complete set of monitoring system shown in Figure 1

2.3 Testing and Calibration:

Field Testing: Deploy the prototype in real residential settings to assess its performance under actual usage conditions. This includes testing the system's ability to detect and respond to changes in water quality.

2.4 Data Collection and Analysis:

Performance Evaluation: Collect data on the device's accuracy. Analyses the effectiveness of the automated control mechanisms and the reliability of real-time monitoring.

2.5 Implementation and Improvement:

2.5.1 Refinement: Based on test results and user feedback, make necessary adjustments to the design, software, or hardware to enhance performance and usability.
2.5.2 Final Evaluation: Conduct a comprehensive evaluation of the improved device to ensure it meets the desired objectives and performs reliably across a range of residential settings.
By following this methodology, the study aims to develop a practical and effective water quality control device that addresses common challenges in home water management, ultimately enhancing safety and efficiency for residential users.

Figure 1: Monitoring Control System Unit

3. Results and Discussion

pH is a crucial parameter in many scientific disciplines, indicating the acidity or basicity of a solution. It directly influences chemical reactions, biological processes, and environmental conditions. Monitoring pH over time can reveal important insights into the stability, reactions, and interactions within a system. pH measurements were recorded daily for a period of 14 days. The data is presented in a bar chart format, with the X-axis representing the sequential days and the Y-axis indicating the pH values, ranging from 0 to 10 shown in figure 1. This range encompasses the typical span of pH values in natural and controlled environments.
The pH starts at 7.08 on day 1, indicative of a neutral to slightly basic environment. A gradual decline is observed over the next four days, reaching a minimum pH of 6.53 on Day 5. This decrease suggests a shift towards a more acidic environment, which could be due to a variety of factors such as microbial activity, chemical degradation, or external influences like the addition of acidic substances.
The system shows resilience as the pH begins to rise, stabilizing around 7.04 to 7.05 by Day 8. This suggests a potential buffering capacity within the system, possibly due to the presence of buffering agents or the cessation of the factors causing the initial decrease in pH. The pH values exhibit minor fluctuations, staying within the range of 6.6 to 7.0. This stability in pH implies a return to equilibrium, with the system maintaining a near-neutral pH despite small daily variations. These fluctuations are likely caused by natural variations in the system's dynamics, indicating the absence of significant external disturbances during this period, as shown in Figure 2.

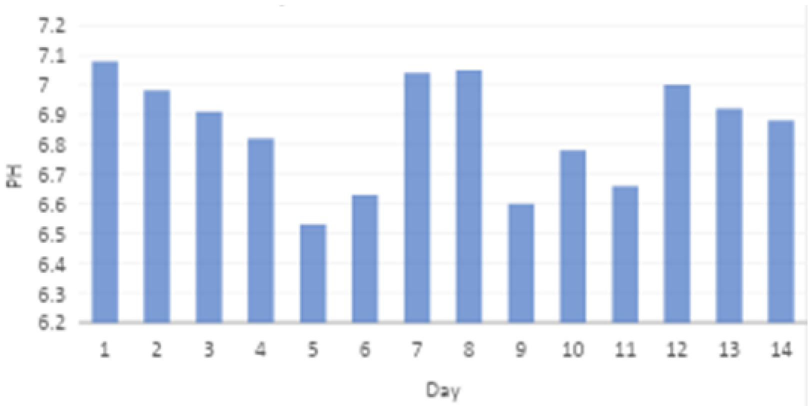

Figure 2: PH data for water tank in 15 days.

Total Dissolved Solid (TDS) is particularly essential since it is defined as the combined content of all organic and inorganic components that can exist in liquid form in molecule, ion, or micro-granular suspended form. The allowed TDS rate in treated water is below 100. Figure 3 shows the TDS data obtained within 14 days. The highest value is 92.5 and the lowest is 77.5. The value obtained is still within the allowed value.

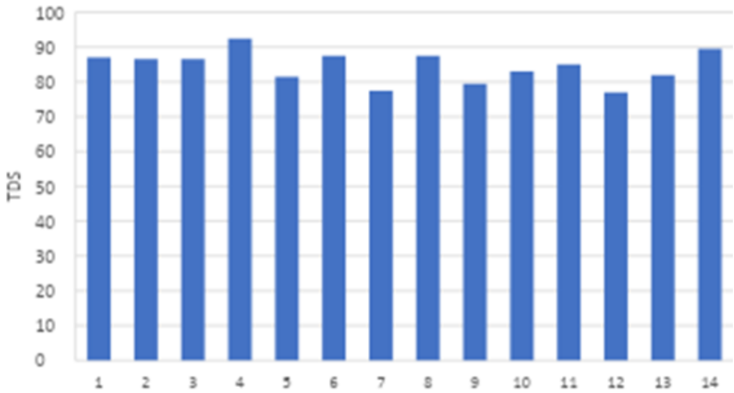

Figure 3 : Total Dissolved Solid (TDS) data for water tank in 15 days.

4. Conclusion

The development and implementation of an innovative water quality control device for home tanks represent a significant advancement in residential water management. The study successfully achieved its objectives by creating a sophisticated system that integrates modern sensor technology and IoT capabilities to provide continuous and real-time monitoring of critical water quality parameters, including pH, turbidity, and temperature.

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