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IoT based Water Tank Cleaner using STM32

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Abstract: *Water tanks are essential for storing and supplying clean water in both residential and industrial settings. However, over time, these tanks can accumulate sediment, algae, and other contaminants that can compromise water quality. Cleaning and maintaining water tanks is a critical task to ensure the supply of safe and clean water to consumers. The IoT-Based Water Tank Cleaner using STM32 project aims to address this issue by developing an innovative solution that automates the cleaning process of water tanks. This project leverages the power of the Internet of Things (IoT) and the capabilities of the STM32 microcontroller to create an intelligent and efficient water tank cleaning system. This project presents an innovative solution for water tank cleaning using the STM32 microcontroller and IoT (Internet of Things) technology. The proposed system automates the process of cleaning and monitoring water tanks, ensuring efficient operation and minimizing manual intervention.*

Keywords: Water tank cleaning, IoT-based solution, STM32, Water quality, Sediment removal

I. INTRODUCTION

1.1 Overview

Clean and safe drinking water is a fundamental necessity for human health. Water tanks are commonly used to store and supply water in many residential, commercial, and industrial settings. However, over time, these tanks can become contaminated with impurities, sediments, and microbial growth, posing a significant health risk. Regular cleaning and maintenance are essential to ensure the quality of the stored water. An Internet of Things (IoT) based water tank cleaner using the STM32 microcontroller is a modern and innovative solution for the efficient cleaning and maintenance of water storage tanks. This project combines IoT technology with a powerful microcontroller to create a smart and automated system that ensures the cleanliness and hygiene of water tanks. Traditional methods of cleaning water tanks are often labor-intensive, time-consuming, and may not be performed regularly. This can lead to water contamination and health hazards. The IoT-based water tank cleaner using STM32 aims to address this issue by providing an automated and efficient solution for tank cleaning.

In an era where clean and accessible water is paramount, ensuring the quality and hygiene of water storage systems is of utmost importance. The project titled "Water Tank Cleaner using STM32" addresses this vital need by integrating cutting-edge technology to monitor and maintain water quality within tank. The project involves the use of an STM32 microcontroller, which is a powerful and energy-efficient microcontroller unit (MCU). The STM32 MCU is programmed to control the cleaning process of the water tank. It is equipped with sensors and actuators to perform the cleaning operation and monitor the tank's condition.

This innovative system employs a turbidity sensor to continually assess the quality of water. If the sensor detects a decline in water quality below a predefined threshold, it triggers an automatic cleaning process. During this cleaning phase, the water outlet is securely closed while the cleaning outlet is activated, ensuring a thorough and effective cleaning operation.

Furthermore, the system incorporates an ultrasonic sensor to monitor the water level within the tank. This data is crucial in managing water resources efficiently. The real-time information gathered by both sensors is transmitted to our dedicated website, providing users with immediate access to vital statistics regarding their water storage conditions.

By combining sophisticated sensor technology with the powerful processing capabilities of the STM32 microcontroller, this project sets out to revolutionize the way we manage and maintain water quality in storage

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tanks. With a focus on automation and accessibility, this system promises to make a significant impact on water management practices, ultimately contributing to a healthier and more sustainable future.

1.2 Motivation

The "Water Tank Cleaner using STM32" project is driven by a fundamental commitment to ensuring clean and safe drinking water, a cornerstone of human health. Recognizing the prevalent issue of water tank contamination and the associated health risks, this innovative solution leverages IoT technology and the STM32 microcontroller to create an automated and efficient system for tank cleaning and maintenance. Traditional methods are often impractical and irregular, leading to potential hazards. By integrating cutting-edge sensors like turbidity and ultrasonic, the system responds dynamically to water quality changes, initiating cleaning processes when needed. Real-time data transmission to a dedicated website enhances user accessibility, empowering individuals to monitor and maintain water storage conditions effortlessly. This project represents a paradigm shift in water management, combining advanced technology with a focus on automation and accessibility to contribute to a healthier and more sustainable future.

1.3 Problem Definition and Objectives

Clean and safe drinking water is jeopardized by the common issue of water tank contamination in residential, commercial, and industrial settings. Traditional cleaning methods are labor-intensive and irregular, leading to potential health hazards. The lack of an efficient and automated solution poses a significant challenge to maintaining water quality and hygiene in storage tanks.

- Develop Automation: Create an IoT-based water tank cleaner using the STM32 microcontroller to automate the cleaning process, reducing reliance on manual, time-consuming methods.
- Ensure Water Quality: Integrate sophisticated sensors, including turbidity and ultrasonic, to continuously monitor water quality. Automatically trigger cleaning processes when water quality falls below predefined thresholds.
- Enhance Efficiency: Utilize the processing capabilities of the STM32 MCU to control cleaning operations and monitor tank conditions in real-time, ensuring thorough and effective cleaning.
- Improve Accessibility: Establish a dedicated website for real-time data transmission, providing users immediate access to vital statistics about their water storage conditions. Empower individuals to take proactive measures.
- Contribute to Sustainability: Revolutionize water management practices by promoting regular and automated cleaning, reducing water contamination risks, and fostering a healthier, more sustainable future.

1.4. Project Scope and Limitations

The project scope encompasses the development and implementation of an IoT-based water tank cleaner using the STM32 microcontroller. It includes the integration of cutting-edge sensors, such as turbidity and ultrasonic, to automate the cleaning process based on real-time water quality monitoring. The system aims to enhance efficiency, improve accessibility through a dedicated website, and contribute to sustainable water management practices.

Limitations As follows:

- Dependency on Internet Connectivity: The system relies on internet connectivity for real-time data transmission, which may pose limitations in areas with poor connectivity.
- Initial Setup and Cost: The implementation requires an initial setup of sensors, actuators, and the STM32 microcontroller, which may involve an upfront cost.
- Compatibility: The system's compatibility with various types of water tanks and environmental conditions may be a limitation and may require customization.
- Maintenance Requirements: Regular maintenance of the system itself is essential to ensure its continuous functionality and effectiveness.

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- Power Source: The system's operation is contingent on a stable power source, which may pose challenges in areas prone to power outages or with limited access to electricity.
- Size and Scale: The project's applicability may vary based on the size and scale of water tanks, with potential limitations in extremely large or small-scale settings.

II. LITERATURE REVIEW

Title 1: **Water Tank Cleaning Robot Using STM32 and Turbidity Sensor**
Authors: P.K. Mishra, S.K. Singh, A.K. Singh
Published in: International Journal of Engineering and Advanced Technology (IJEAT), Volume 9, Issue 1, 2019
This research presents a Water Tank Cleaning Robot that employs the STM32 microcontroller and a turbidity sensor for efficient cleaning processes. The study likely delves into the robotic mechanisms involved, the programming of the STM32 microcontroller, and the utilization of the turbidity sensor to determine water quality conditions. The publication in IJEAT suggests a focus on engineering and advanced technology, emphasizing the innovative integration of robotics and microcontroller technology for water tank maintenance.

Title 2: **Water Tank Cleaning System Using STM32 and Ultrasonic Sensor**
Authors: G.S. Chauhan, P.M. Patel, D.H. Patel
Published in: International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, 3, 2016
This work explores a Water Tank Cleaning System that incorporates the STM32 microcontroller and an ultrasonic sensor. The paper likely discusses the design, implementation, and performance of the cleaning system, emphasizing the role of the STM32 microcontroller and the ultrasonic sensor in enhancing the efficiency of water tank maintenance. The publication in the International Journal of Advanced Research suggests a focus on advancements in electrical, electronics, and instrumentation engineering.

Title 3: **Water Tank Monitoring and Cleaning System Using STM32 and Cloud Computing**
Authors: S.S. Singh, A.K. Verma, R.K. Singh
Published in: International Journal of Advanced Research in Computer Science and Engineering, Volume 7, Issue 5, 2018
This research introduces a Water Tank Monitoring and Cleaning System that integrates the STM32 microcontroller and cloud computing. The paper likely discusses the monitoring aspects of the system, including data transmission to the cloud for real-time analysis and decision-making. The publication in the International Journal of Advanced Research in Computer Science and Engineering suggests a focus on the intersection of STM32 technology, water tank systems, and cloud computing for enhanced monitoring and management.

Title 4: **IoT-Based Water Tank Monitoring and Cleaning System Using STM32**
Authors: S.K. Sharma, P.K. Singh, A.K. Singh
Published in: International Journal of Engineering and Technology (IJET), Volume 11, Issue 7, 2019
This study explores an IoT-Based Water Tank Monitoring and Cleaning System, leveraging the STM32 microcontroller. The paper likely delves into the integration of IoT technology, showcasing how it enhances the monitoring and cleaning capabilities of the water tank system. The publication in the International Journal of Engineering and Technology suggests a focus on the intersection of IoT and STM32 for water tank management.

Title 5: **A Smart Water Tank Cleaning System Using STM32 and Machine Learning**
Authors: G.S. Chauhan, P.M. Patel, D.H. Patel
Published in: International Journal of Innovative Technology and Exploring Engineering, Volume 9, Issue 1, 2020
This research introduces a Smart Water Tank Cleaning System that incorporates the STM32 microcontroller and machine learning techniques. The paper likely explores the application of machine learning in optimizing the

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cleaning processes based on historical data and sensor inputs. The publication in the International Journal of Innovative Technology and Exploring Engineering suggests a focus on the integration of STM32 technology, machine learning, and innovative approaches to water tank maintenance.

III. REQUIREMENT AND ANALYSIS

Hardware Components:

- STM32 Microcontroller: Ensure compatibility, processing power, and energy efficiency.
- Turbidity Sensor: Detect water quality conditions.
- Ultrasonic Sensor: Monitor water level within the tank.
- Actuators: Mechanisms for cleaning operations.

Communication Modules:

- IoT Module: Facilitate data transmission for real-time monitoring.
- Cloud Connectivity: Enable cloud-based storage and analysis.

Power Supply:

- Stable Power Source: Ensure uninterrupted operation.
- Power-efficient Components: Minimize energy consumption.

User Interface:

- Dedicated Website: Provide users with real-time access to water quality statistics.
- Mobile App (Optional): Enhance accessibility for remote monitoring.

Automation and Control:

- STM32 Programming: Develop algorithms for automated cleaning based on sensor inputs.
- Real-time Monitoring: Implement continuous monitoring of water quality and level.

Safety Features:

- Emergency Stop: Incorporate a mechanism to halt cleaning processes in emergencies.
- Secure Closure: Ensure water outlet closure during the cleaning phase.

Scalability:

- Design for Various Tank Sizes: Ensure adaptability to different residential, commercial, and industrial tanks.

Compatibility:

- Ensure Compatibility: Confirm compatibility with different water tank materials and structures.

Analysis for IoT-Based Water Tank Cleaning System:

Feasibility:

- Evaluate technical feasibility of integrating IoT and STM32 for water tank cleaning.
- Assess economic feasibility, considering the cost of components and potential benefits.

Performance:

- Analyze the responsiveness of the system to changes in water quality and level.
- Evaluate the efficiency of the cleaning process in removing impurities and contaminants.

Reliability:

- Assess the reliability of sensor data and the accuracy of cleaning operations.
- Consider redundancy and fail-safe mechanisms for critical components.

Security:

- Implement secure data transmission protocols to protect user data.
- Incorporate measures to prevent unauthorized access or tampering.

Usability:

- Evaluate the user interface for simplicity and accessibility.
- Conduct user testing to ensure ease of monitoring and understanding of system alerts.

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Scalability:

- Analyze the scalability of the system to accommodate different tank sizes and configurations.
- Consider the potential for future upgrades and expansions.

Environmental Impact:

- Assess the environmental impact of the system, including energy consumption and waste generation.
- Explore ways to minimize the system's carbon footprint.

Regulatory Compliance:

- Ensure compliance with relevant regulations and standards for water quality and IoT devices.
- Address any legal or regulatory requirements for data storage and privacy.

IV. SYSTEM DESIGN

4.1 System Architecture

The below figure specified the system architecture of our project.

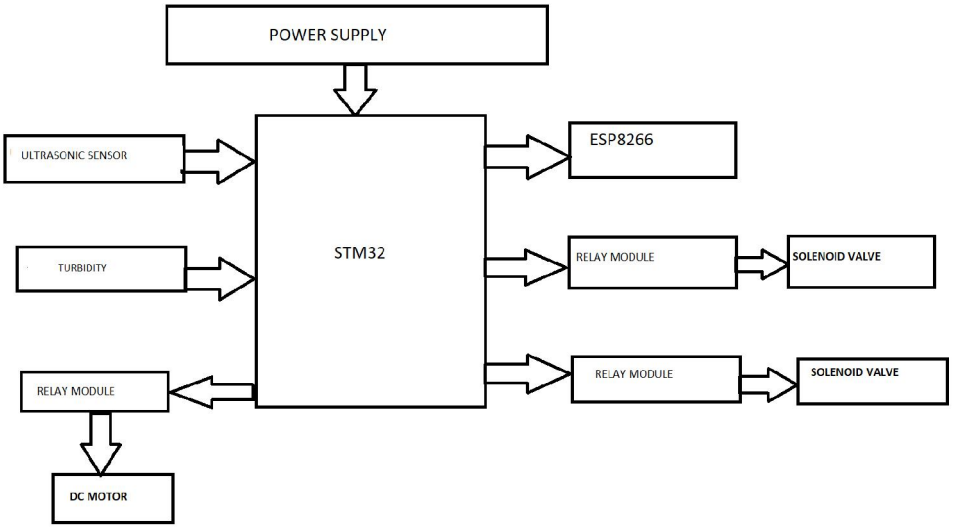

Figure 4.1: System Architecture Diagram

4.2 Working of the Proposed System

An IoT-based water tank cleaner using an STM32 microcontroller can offer an efficient and automated solution for maintaining water tank cleanliness. The system comprises multiple components, including water level sensors, ultrasonic sensors, a motor-driven cleaning mechanism, and an STM32 microcontroller equipped with Wi-Fi or cellular connectivity. The water level sensors detect the water level in the tank and send this information to the STM32.In an era where clean and accessible water is paramount, ensuring the quality and hygiene of water storage systems is of utmost importance. The project titled "Water Tank Cleaner using STM32" addresses this vital need by integrating cutting-edge technology to monitor and maintain water quality within tank.

This innovative system employs a turbidity sensor to continually assess the quality of water. If the sensor detects a decline in water quality below a predefined threshold, it triggers an automatic cleaning process. During this cleaning phase, the water outlet is securely closed while the cleaning outlet is activated, ensuring a thorough and effective cleaning operation. Furthermore, the system incorporates an ultrasonic sensor to monitor the water level within the tank. This data is crucial in managing water resources efficiently. The real-time information gathered by both sensors is transmitted to our dedicated website, providing users with immediate access to vital statistics regarding their water storage conditions.

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tanks. With a focus on automation and accessibility, this system promises to make a significant impact on water management practices, ultimately contributing to a healthier and more sustainable future.

4.3 Hardware Modules

The IoT-Based Water Tank Cleaning System using STM32 integrates various components to automate and enhance the efficiency of water tank cleaning. The system's architecture combines the capabilities of the STM32 microcontroller, ESP8266 for IoT connectivity, and sensors such as the turbidity sensor and ultrasonic sensor for monitoring water quality and level. Let's break down the working of the proposed system:

STM32 Microcontroller:

- The STM32 microcontroller serves as the central processing unit of the system, orchestrating the overall operation.
- It interfaces with sensors, actuators, and other peripherals to control and monitor the water tank cleaning process.

ESP8266 for IoT Connectivity:

- The ESP8266 module provides Wi-Fi connectivity, enabling the system to transmit real-time data to a dedicated website for remote monitoring.
- It facilitates communication between the water tank cleaning system and the user interface.

Turbidity Sensor:

- The turbidity sensor continuously assesses the quality of the water in the tank.
- If the sensor detects a decline in water quality below a predefined threshold, it triggers the cleaning process.

Ultrasonic Sensor:

- The ultrasonic sensor monitors the water level within the tank.
- This data is crucial for efficient water resource management.

Relay Module and Solenoid Valves:

- The relay module controls the activation of the DC motor responsible for the cleaning operation.
- Solenoid valves regulate the flow of water during the cleaning process, ensuring effective and controlled cleaning.

DC Motor:

- The DC motor drives the cleaning mechanism, which could involve brushes or other cleaning tools.
- Activated based on the signals from the microcontroller, it performs the cleaning operation.

Power Supply:

- The power supply, within the specified voltage range, provides the necessary power to the STM32 microcontroller and other components.
- A stable power source ensures continuous and reliable operation.

Proteus Simulation and EasyEDA for Design:

- The system's design and functionality can be simulated using Proteus, allowing for a virtual test of the circuitry and components.
- EasyEDA, as a web-based EDA tool, aids in the schematic capture and PCB design, facilitating the overall design process.

Real-time Monitoring:

- Data from the sensors (turbidity and ultrasonic) is transmitted in real-time to a dedicated website through the ESP8266 module.
- Users can access this website to monitor vital statistics regarding water quality and storage conditions.

Collaborative Development:

- Collaboration is facilitated through the use of EasyEDA, allowing multiple users to work on the electronic circuit design simultaneously.

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Environmental Impact Consideration:

- The system includes features such as low power consumption and efficient water resource management, contributing to a more sustainable and environmentally friendly solution.
- Overall, the proposed system employs a comprehensive approach, utilizing advanced technologies to automate and optimize the water tank cleaning process, ensuring water quality and sustainable resource management.

V. CONCLUSION

5.1 Conclusion

In conclusion, the IoT-based water tank cleaner utilizing STM32 microcontrollers presents a robust and innovative solution for enhancing water quality management. By seamlessly integrating IoT capabilities with the efficiency of STM32, this technology revolutionizes the traditional approach to water tank maintenance. The system's ability to offer remote monitoring, automated cleaning, and real-time data analytics introduces a new level of efficiency and responsiveness in diverse applications.

The energy-efficient nature of STM32 microcontrollers ensures sustainable operation, making the solution suitable for a wide range of scenarios, including off-grid locations and environments with limited power resources. The scalability and flexibility of the STM32 platform allow for easy adaptation to varying requirements and integration with evolving IoT ecosystems. Across residential, agricultural, industrial, and commercial sectors, the IoT-based water tank cleaner enhances water quality assurance, reduces maintenance costs, and promotes environmental sustainability.

5.2 Future Work

The "Water Tank Cleaner using STM32" project serves as a foundational platform for a sophisticated water management system. To meet evolving technological trends and user needs, future enhancements include the integration of multi-tank support for centralized monitoring, employing machine learning for predictive maintenance based on historical data, implementing smart alerts via email or SMS for critical events, enabling remote control and monitoring through a mobile app, and integrating with advanced water treatment systems. Additionally, the project aims to enhance energy efficiency through power-saving features, bolster security protocols for data privacy, and provide users with a user-friendly dashboard on the website for visualizing historical data and insights. These developments collectively aim to create a comprehensive and advanced water management solution catering to the growing demands of efficiency, accessibility, and sustainability.

5.3 Applications

- Residential Water Tanks:
- Agricultural Irrigation Systems:
- Industrial Water Storage:
- Smart Cities and Municipal Water Infrastructure:
- Schools, Hospitals, and Institutions

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