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Design and Implementation of a Web-Based Control and Monitoring System using Siemens S7-1200 PLC

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Abstract: *This paper outlines the design and execution of a web-based control and monitoring system tailored for industrial process automation utilizing the Siemens S7-1200 Programmable Logic Controller (PLC). The system facilitates remote supervision and management of motors and temperature sensors through a secure web interface that requires login authentication for access. The proposed framework incorporates PLC–HMI communication, web server hosting, and real-time data visualization, enabling users to start and stop motors, monitor temperature readings, and oversee system performance from a distance. The design utilizes Siemens TIA Portal (V17) for programming and configuration, WinCC RT Advanced for HMI design, and an HTML–CSS–JavaScript front-end for the web interface. The experimental setup showcases effective control, minimal response latency (less than 100 ms), and dependable system operation during continuous use. This system offers an efficient, scalable, and secure solution for automation and remote process management driven by Industry 4.0.*

Keywords: Web-Based Control, Siemens S7-1500, PLC, Industrial Automation, Remote Monitoring, HMI, IoT.

I. INTRODUCTION

Industrial automation is rapidly advancing toward web-integrated control systems that enable remote monitoring and management through internet connectivity, enhancing flexibility, efficiency, and safety. This research presents the design and implementation of a web-based control and monitoring system using the Siemens S7-1200 PLC for motor operation and temperature management. The system incorporates Ethernet-based communication and a secure, responsive web dashboard, allowing authenticated users to access real-time process data and issue control commands from any network-connected device. By combining PLC automation with modern web technologies, the proposed system minimizes manual intervention, reduces downtime, and improves scalability compared to traditional HMI-based setups. Aligned with Industrial Internet of Things (IIoT) and smart factory principles, this approach supports future integration with cloud analytics, predictive maintenance, and mobile accessibility, contributing to the development of intelligent and sustainable industrial automation systems.

II. LITERATURE REVIEW

Recent research emphasizes the growing convergence of IoT and web technologies within industrial automation, aimed at enhancing monitoring, control, and data accessibility [1]–[4]. Systems that employ microcontrollers such as NodeMCU and Raspberry Pi have shown effective real-time data acquisition and visualization; however, they fall short in terms of robustness, reliability, and noise immunity necessary for industrial settings [1], [3], [12].

Comparative studies reveal that automation based on PLCs, particularly with Siemens controllers integrated with SCADA or HMI platforms, guarantees high levels of accuracy, safety, and reliability in process control [2], [7], [10]. Nevertheless, the majority of current configurations are limited to local monitoring and do not facilitate web-enabled control, which restricts flexibility and scalability [6], [8], [11].

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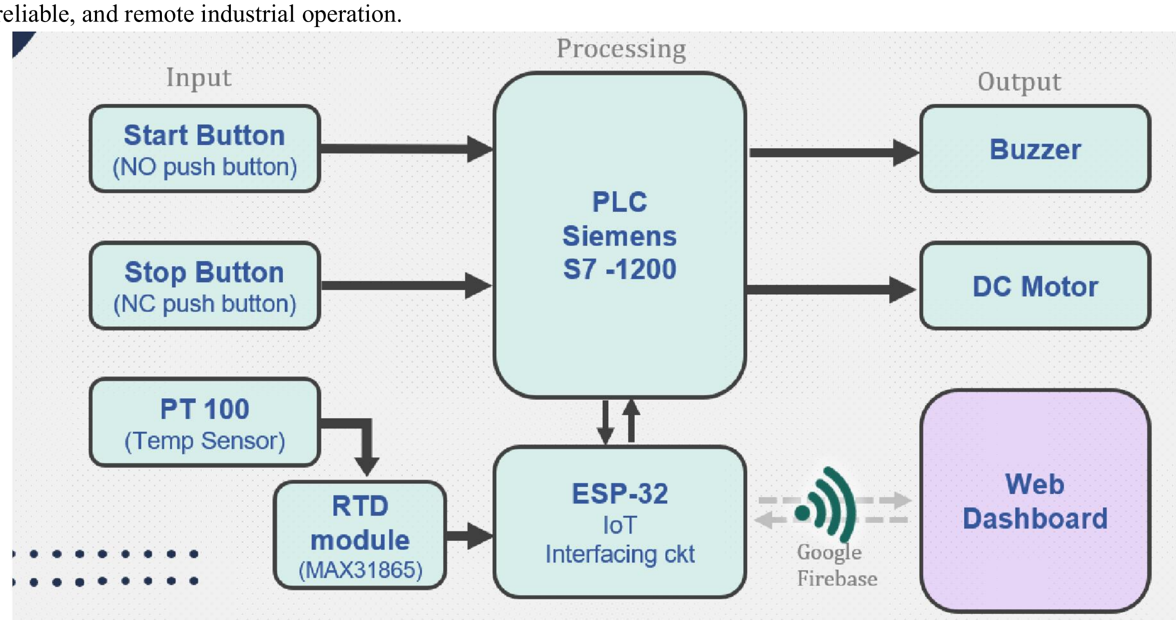
Hybrid and cloud-integrated methodologies that utilize communication protocols such as Modbus TCP/IP and MQTT have improved interoperability and remote supervision capabilities [4], [5], [9]. However, challenges remain in achieving secure, low-latency, browser-based PLC control with effective user authentication and real-time responsiveness that is appropriate for industrial environments [6], [8], [11].

III. PROBLEM STATEMENT

Conventional industrial control systems rely heavily on on-site oversight, which restricts flexibility, accessibility, and response times. These systems frequently do not provide real-time monitoring or remote operation features, leading to slower decision-making processes and diminished efficiency. Consequently, there is a need for a web-based PLC control system that facilitates secure, real-time monitoring and control of industrial devices like DC motors via an online interface, thereby enhancing automation, productivity, and operational flexibility.

IV. METHODOLOGY

The proposed system monitors and controls industrial parameters such as motor operation and temperature using a Siemens S7-1200 PLC integrated with a web-based interface. The methodology involves both hardware and software components. The hardware setup includes the PLC connected to sensors and actuators for data acquisition and motor control. On the software side, the PLC communicates with a web server via Ethernet, allowing real-time data monitoring and control through a secure, user-friendly web dashboard. This integrated approach ensures efficient, reliable, and remote industrial operation.



4.1 Block Diagram

Power Supply: This unit delivers regulated electrical power to all subsystems. A 24V DC supply is utilized to energize the Siemens S7-1200 PLC along with its expansion modules. The ESP-32 IoT module and MAX31865 RTD interface are powered with 5V DC through a buck converter or regulated supply. Output devices, including the DC motor and buzzer, receive power via dedicated driver circuits, while the system is kept electrically isolated from high-voltage AC lines to guarantee operator safety and equipment longevity.

Central Processing Unit – Siemens S7-1200 PLC: The Siemens S7-1200 Programmable Logic Controller serves as the system's brain. It executes ladder logic or structured text programs to process input signals and produce control outputs. With real-time deterministic behavior, high-speed I/O processing, and modular expandability, the PLC guarantees

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robust automation performance. It supports industrial communication protocols (PROFINET, Modbus TCP/IP) and integrates effortlessly with external modules and cloud interfaces. Its durable design and fault-tolerant architecture render it suitable for continuous industrial deployment.

Input Interface: This block encompasses both manual and sensor-based inputs: • Start Button (NO): A normally open push button employed to commence system operation. • Stop Button (NC): A normally closed push button designated for emergency or manual shutdown. • PT100 Temperature Sensor: A precision resistance temperature detector utilized for thermal monitoring. It supplies analog input to the RTD module for digital conversion and is vital for process control applications.

RTD Signal Conditioning Module: The MAX31865 module connects with the PT100 sensor to transform analog resistance values into digital temperature readings. It employs a precision ADC and SPI communication to relay data to the PLC or ESP-32. The module features fault detection, linearization, and noise filtering, ensuring precise and dependable temperature acquisition in challenging industrial environments.

IoT Communication Module – ESP-32:

The ESP-32 microcontroller facilitates wireless connectivity and integration with cloud services. It gathers processed data from the PLC or directly from the RTD module and sends it to a web dashboard through Google Firebase. Featuring built-in Wi-Fi, dual-core processing capabilities, and compatibility with MQTT/HTTP protocols, the ESP-32 supports real-time remote monitoring, data logging, and user engagement. It serves as a link between conventional automation systems and contemporary IoT frameworks.

• Output Actuation Block:

This block comprises:

• DC Motor: Operated through PLC output signals, the motor executes mechanical tasks such as pumping or actuation. It is powered by a relay or a transistor-based driver circuit.

• Buzzer: Emits audible notifications for system events including temperature limits, start/stop commands, or fault occurrences.

• Web Dashboard: A cloud-based platform developed on Google Firebase that showcases real-time sensor information, system status, and control functionalities. It enables users to oversee and interact with the system remotely using mobile or desktop devices.

V. DESIGN & EXPERIMENTATION

The proposed system combines hardware and communication units to facilitate real-time monitoring and control. A regulated DC power source powers the Siemens S7 PLC, which functions as the primary controller. Start and stop buttons act as manual inputs, while the PT100 temperature sensor, connected through the MAX31865 RTD module, delivers precise temperature readings. The PLC processes these inputs and manages the DC motor through a relay bank and motor driver circuit that utilizes resistor-based speed regulation. A logic level shifter guarantees appropriate voltage compatibility among the modules. The ESP32 microcontroller supports wireless communication, sending data to the cloud for web-based monitoring and control. This setup ensures secure, efficient, and remotely accessible operation of industrial devices.

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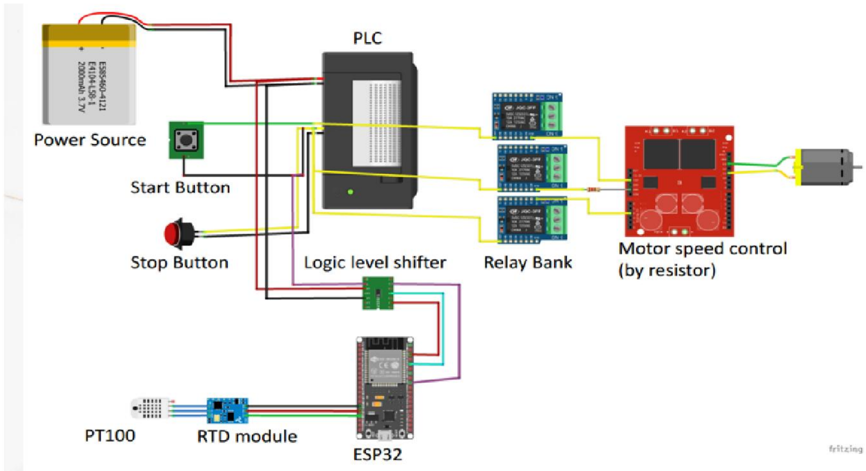
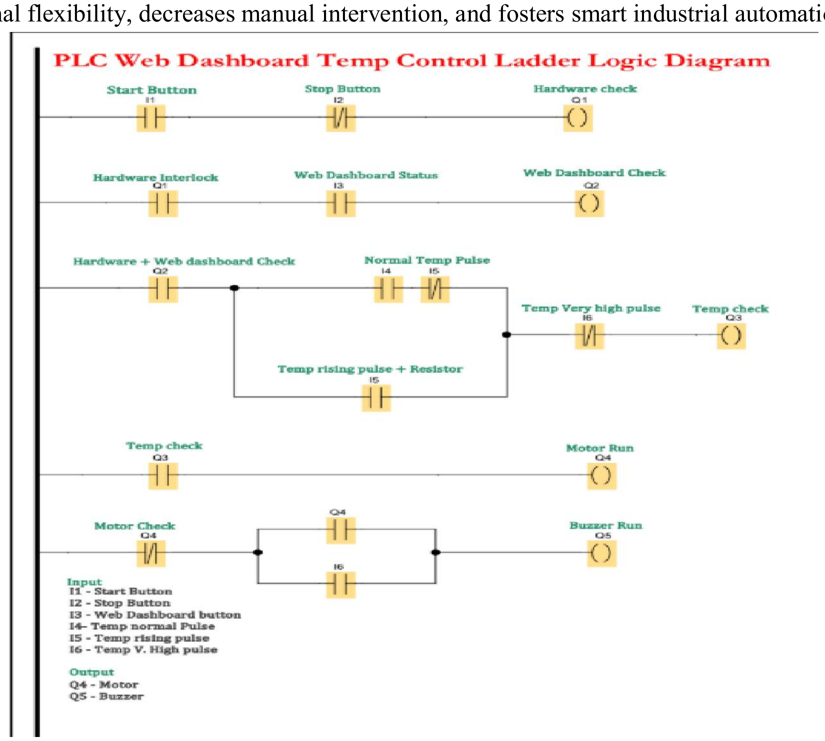


5.1. Detailed Design

VI. RESULTS

Experimental findings indicate that the proposed web-based PLC control system effectively facilitates real-time monitoring and management of motor operations and temperature parameters via a secure web interface. The Siemens S7-1200 PLC exhibited dependable processing and communication with minimal latency, while the ESP32 module successfully relayed sensor data to the cloud for remote visualization. The system ensured consistent motor performance and precise temperature readings across varying load conditions. Remote users were capable of starting, stopping, and adjusting motor operations without the need for on-site supervision, thereby affirming the system's efficiency, responsiveness, and accessibility. In summary, the results confirm that the integrated PLC–IoT approach improves operational flexibility, decreases manual intervention, and fosters smart industrial automation.



6.1. Simulation Result of the system.

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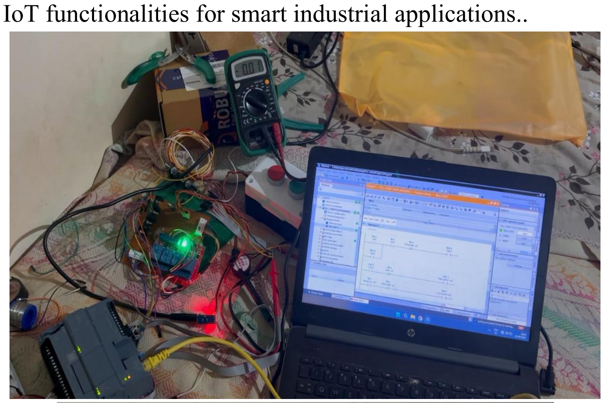
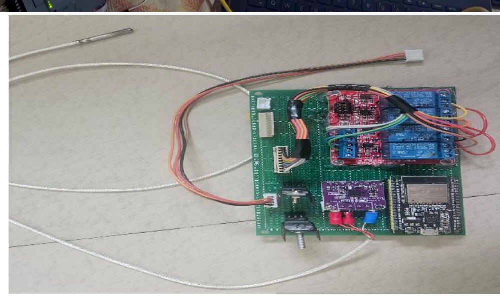
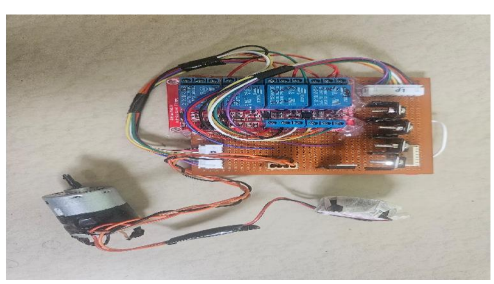
The ladder logic for the PLC-based temperature control system was successfully designed, simulated, and tested, demonstrating reliable automation and remote functionality. The start sequence effectively initiated real-time monitoring, while temperature feedback from the PT100 sensor via the MAX31865 module enabled accurate detection of high-temperature conditions. Upon threshold detection, the PLC activated the motor and heater to maintain optimal levels, confirming correct response of all output devices. Internet connectivity through Firebase ensured smooth synchronization between local control and the web dashboard, allowing continuous monitoring and status updates. The system maintained operational stability and followed standard industrial ladder logic conventions, ensuring scalability and practical deployment potential.

Hardware Setup and Final Output

The hardware implementation of the proposed PLC and ESP32-based industrial monitoring and control system successfully integrated all key components, including the Siemens S7-1200 PLC, ESP32 module, PT100 temperature sensor with MAX31865 interface, relay bank, and DC motor control unit. The system was powered through a regulated 24V DC supply, with logic-level interfacing ensuring safe signal communication between modules. The PLC executed the control logic accurately, initiating motor and heater operations based on temperature input conditions. The ESP32 enabled seamless cloud connectivity via Firebase, allowing real-time data visualization and remote operation through the web dashboard. During testing, the setup exhibited stable performance, precise temperature measurement, and prompt actuation response. Data synchronization between local and cloud systems was consistent, confirming reliable integration of automation and IoT functionalities for smart industrial applications..







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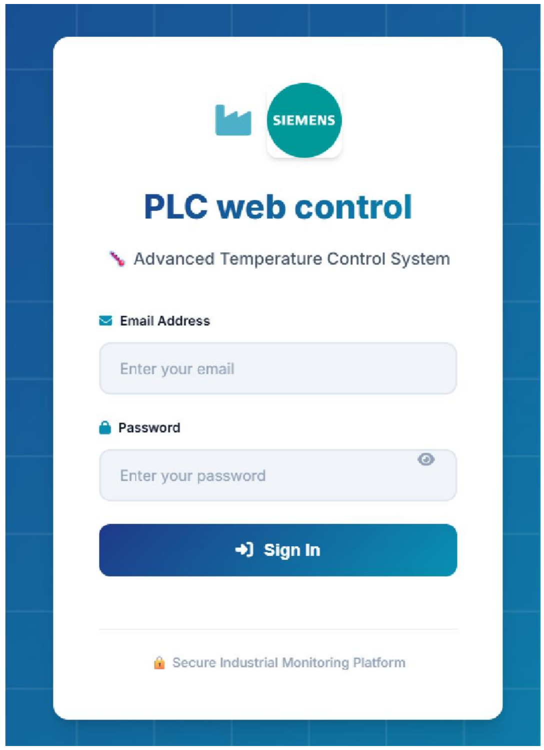

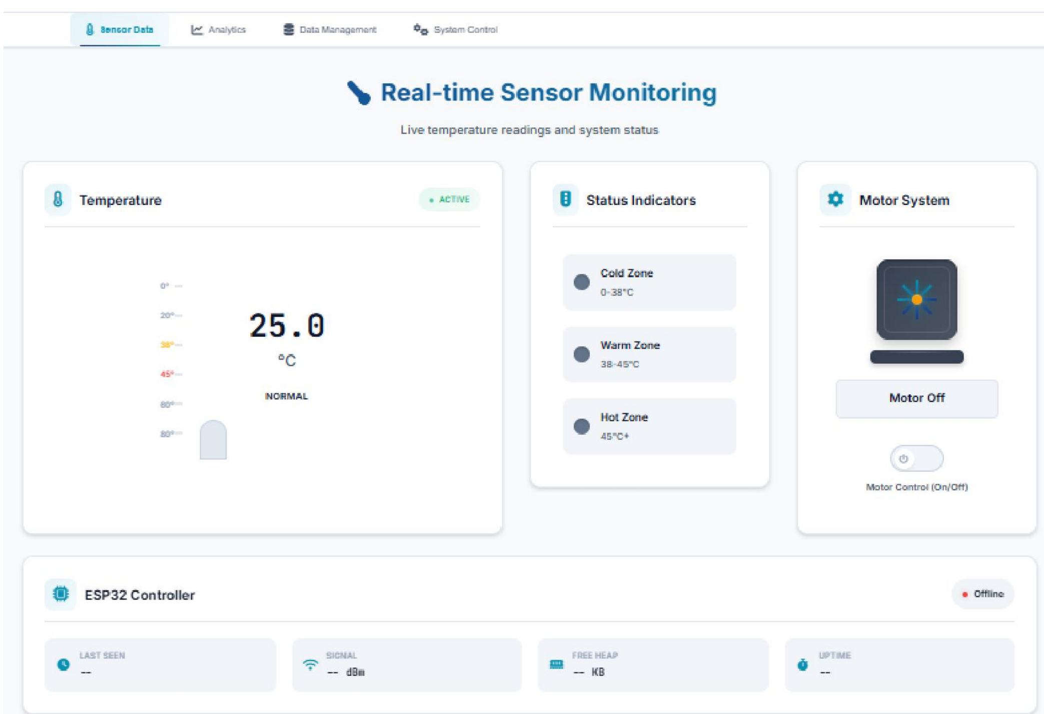

6.2. Web Interface

VII. CONCLUSION

The suggested web-based PLC control system successfully combines automation, monitoring, and IoT functionalities into a cohesive framework. Utilizing the Siemens S7-1500 as the controller guarantees industrial dependability, while the web interface offers real-time visualization and remote management. This methodology improves water and motor management systems, industrial temperature monitoring, and intelligent process automation. Future developments will involve the incorporation of cloud-based data storage, mobile alerts, and AI-driven fault prediction for predictive maintenance.

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