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RHTP Meter and Control for Industrial Automation

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Abstract: *The integration of environmental monitoring with automation plays a crucial role in optimizing industrial operations. This paper presents the RHTP Meter and Control for Industrial Automation, an advanced system designed to measure and analyze key atmospheric parameters, including humidity, temperature, and pressure, in real time. The system leverages Internet of Things (IoT) technology, enabling seamless data acquisition and remote access via a mobile application. This integration enhances user interaction by providing real-time insights and control over environmental conditions, ensuring improved accuracy, reliability, and efficiency. Additionally, the system aids in cost reduction by offering actionable insights that support informed decision-making and rapid responses to environmental fluctuations. The paper discusses the technical architecture, key benefits associated with implementing this system in industrial environments. Furthermore, various industrial applications of this technology are explored, including its role in process optimization, resource management, and sustainable operations. The findings highlight the potential of IoT-driven environmental monitoring systems in transforming industrial automation by improving productivity, ensuring regulatory compliance, and reducing operational costs.*

Keywords: RHTP METER, ESP-32, TFT Display, PCB Layout,Calibration, etc

I. INTRODUCTION

Industrial processes are highly influenced by environmental factors such as humidity, temperature, and pressure. Effective monitoring and control of these parameters are essential for optimizing performance, ensuring safety, and reducing operational costs. The *RHTP Meter and Control for Industrial Automation* is an IoT-based system designed to provide real-time measurement and remote control of environmental conditions. It integrates high-precision sensors with a mobile application, enabling seamless monitoring and adjustments. This system enhances industrial automation by improving accuracy, efficiency, and decision-making. The paper discusses the system's design, implementation, benefits in industrial environments.

II. LITERATURE SURVEY

Research in industrial environmental monitoring focuses on IoT, real-time control, and automation efficiency.

1. IoT-Based Monitoring:Wireless sensors are utilized to enhance data accessibility for temperature, humidity, and pressure tracking.
2. Real-Time Control: ESP32-based systems, integrated with Bluetooth and RS-485, are employed to enable cost-effective and reliable monitoring.
3. GUI & Mobile Integration: Mobile applications are implemented to improve data visualization; however, scalability challenges are addressed in this work.
4. Climate Automation: Automated heating and cooling systems are incorporated to enhance efficiency, with AI integration identified as a potential future enhancement.

Building on these advancements, a scalable and efficient monitoring system is developed.

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Lam and McBride [1] analyzed temperature, humidity, and pressure measurement in automotive connectors, emphasizing accuracy and reliability in harsh environments. The study demonstrated the role of real-time data acquisition in enhancing system performance and longevity, underlining the importance of precise environmental monitoring in industrial applications.

Novelan [2] presented an IoT-based monitoring system utilizing the DHT11 sensor with NodeMCU, focusing on real-time temperature and humidity measurement. The study highlighted the advantages of wireless sensor networks and remote monitoring, showcasing the effectiveness of IoT in improving industrial automation and decision-making.

III. SYSTEM DESIGN AND DESCRIPTION

The system design focuses on the seamless integration of multiple sensors and communication modules to achieve efficient industrial automation. The ESP32-S3 WROOM-2 microcontroller serves as the central processing unit, interfacing with various sensors, actuators, and a mobile application for real-time monitoring and control. The design ensures reliable data acquisition, processing, and wireless communication for enhanced operational efficiency.

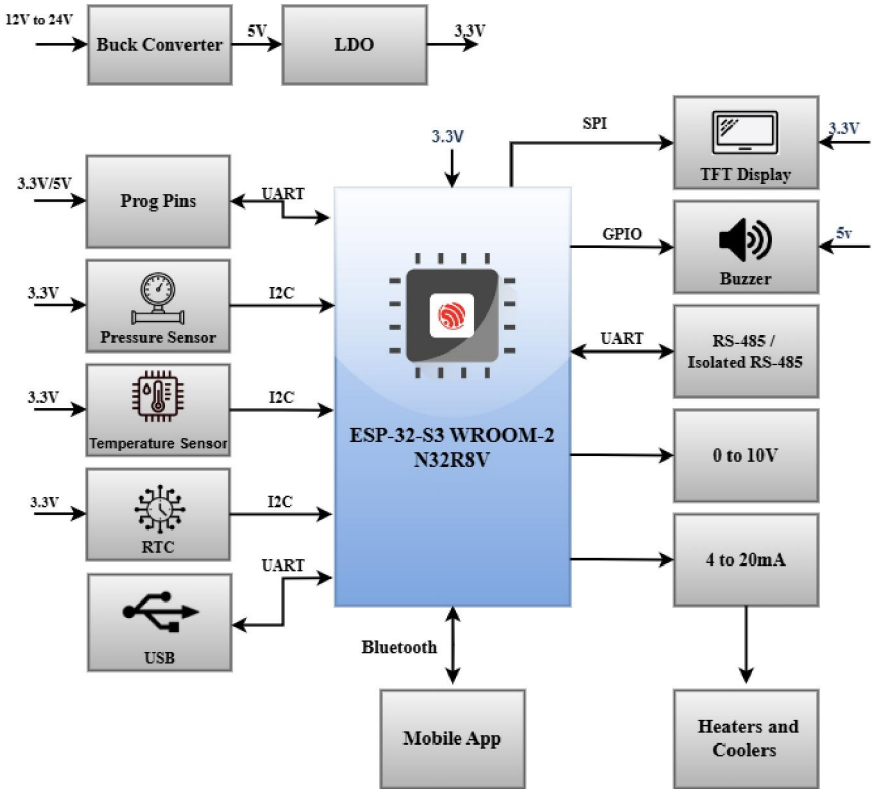

Fig.1: System Block Diagram

The Fig.1 represents the architecture of the *RHTP Meter and Control for Industrial Automation*, which integrates sensors, communication interfaces, and control mechanisms for real-time environmental monitoring. The ESP32-S3 WROOM-2 N32R8V microcontroller serves as the core, interfacing with various sensors such as the pressure sensor, temperature sensor, and RTC via I2C for accurate data acquisition.Power is managed using a buck converter and LDO, ensuring stable voltage regulation. The system communicates through SPI (TFT Display), GPIO (Buzzer), UART (RS-485, USB), and Mobile App for seamless monitoring and control. Additionally, analog output interfaces (0-10V, 4-20mA). The mobile application enhances remote accessibility, making the system efficient for industrial automation

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The flowchart of the work is showing in Fig. 2 below

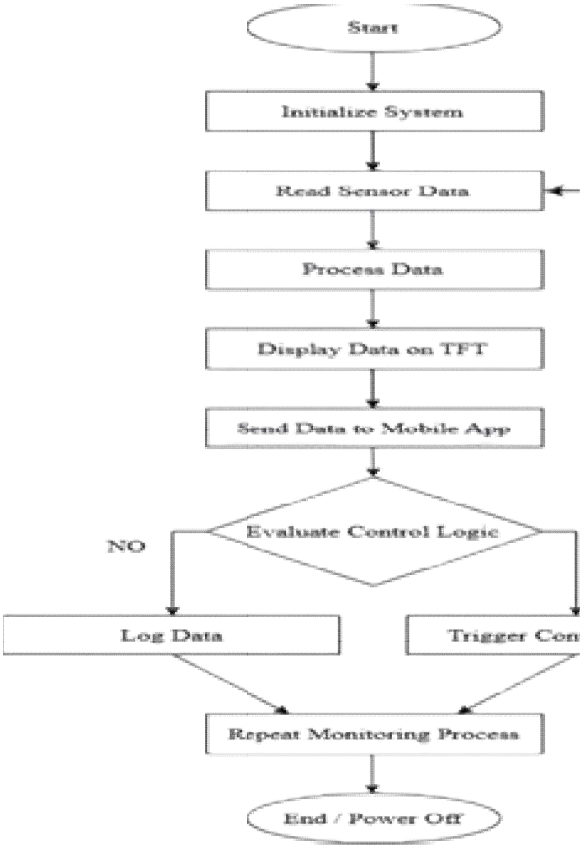

Fig.2: Flowchart of Work

The Fig.2 represents the operational workflow of the proposed system, starting with system initialization. It sequentially reads sensor data, processes it, and displays the results on a TFT screen while also transmitting the data to a mobile application. The system then evaluates the sensor readings against predefined threshold levels. If the threshold is exceeded, control signals are triggered to activate necessary actuators; otherwise, the data is logged for monitoring. This loop continues until the system is powered off, ensuring real-time monitoring and automated control for industrial automation.

IV. RESULTS AND DISCUSSION

In this paper, an efficient and cost-effective environmental monitoring system for industrial automation. Instead of relying on complex traditional systems, we utilized an ESP32-S3 WROOM-2 N32R8V microcontroller for real-time temperature, humidity, and pressure measurement. The system efficiently collects data via I2C and UART protocols, displays it on a TFT screen, and enables Bluetooth-based remote access.The integration of RS-485 communication ensures reliable data transmission in industrial environments. However, Bluetooth's limited range restricts remote monitoring, control and mobile application are still under development.

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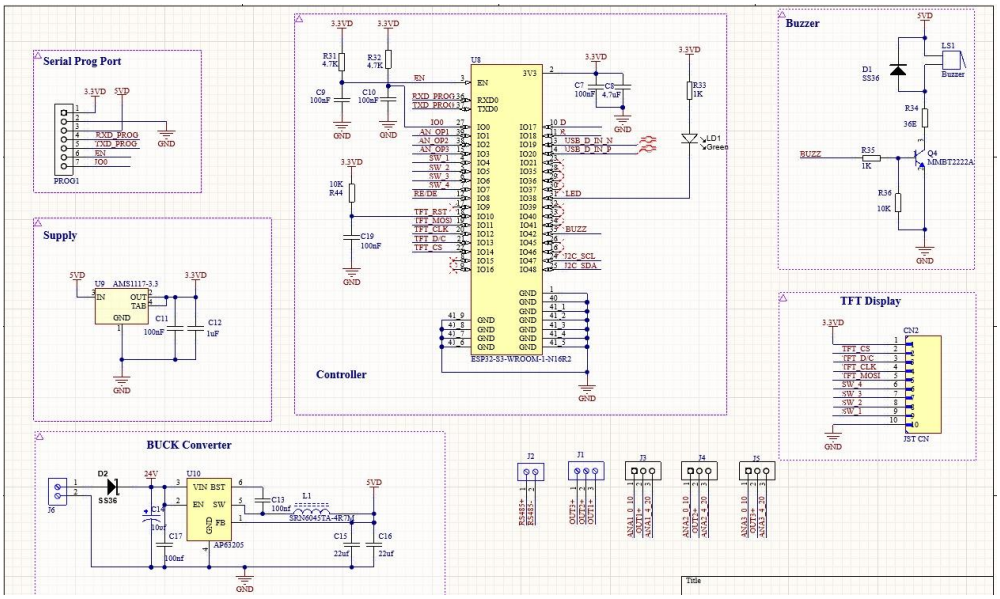

Fig.3: Schematic Of System

The Fig. 3 represents the schematic diagram of the designed system, illustrating the integration of the ESP32-S3-WROOM-1 microcontroller with essential components such as the power supply, buck converter, serial programming port, TFT display, and buzzer. The schematic ensures efficient power management, reliable communication interfaces, and proper signal routing for seamless system operation.

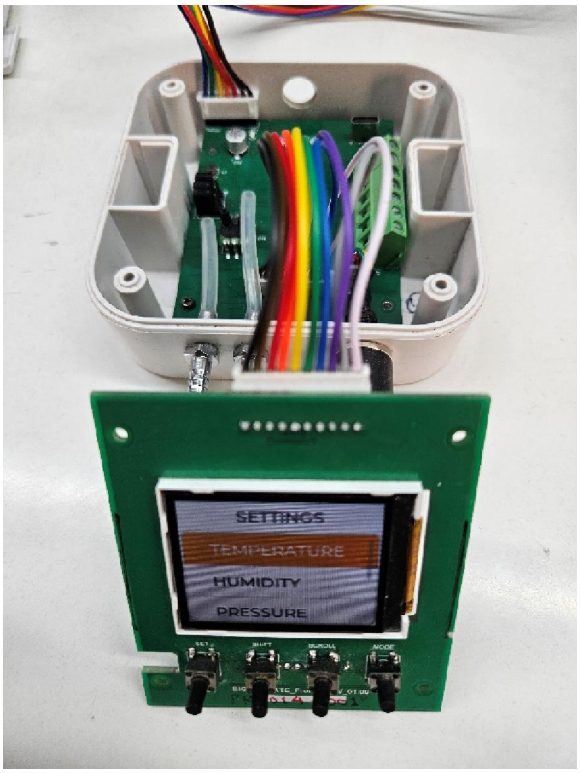

Fig.4: Hardware Result

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The Fig.4 shows the hardware prototype displaying a user-friendly interface for selecting measurement parameters such as temperature, humidity, and pressure. The TFT screen provides clear navigation options, ensuring efficient real-time monitoring. The backside of the hardware consists of sensor connections, power circuitry, and communication interfaces, enabling seamless data acquisition and processing for industrial automation applications.

V. CONCLUSION AND FUTURE WORK

The RHTP Meter and Control for Industrial Automation provides an efficient and reliable solution for real-time environmental monitoring by integrating temperature, humidity, and pressure sensors with an ESP32-based system. The implementation of wireless communication via Bluetooth enhances accessibility, allowing users to monitor data remotely. The system ensures cost-effectiveness, operational accuracy, and improved decision-making for industrial applications.

For future work, the system will focus on enhancing its mobile application to provide a user-friendly interface for real-time data visualization, remote control, and alerts. Additionally, advancements in control mechanisms will be integrated, enabling users to manage and adjust system parameters directly. These improvements will further optimize industrial automation by increasing efficiency, accessibility, and responsiveness to environmental conditions.

VI. ACKNOWLEDGMENT

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