Create a Visually programmable PLC controller using WIFI Automation I/O Profile

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Abstract—The emergence of Internet of Things (IoT) technologies has fundamentally transformed factory automation by enabling precise, efficient, and scalable monitoring and control of industrial systems. This project focuses on the design and development of a visually programmable Logic Controller (PLC) using a Wi-Fi-based automation I/O profile, demonstrating a significant leap in enhancing the operational efficiency and adaptability of industrial processes. By leveraging an ESP32 microcontroller—a versatile and robust platform that supports wireless communication and real-time processing—this system integrates seamlessly with the Blynk IoT platform, a popular tool known for its user-friendly interface and ability to enable remote monitoring and control of connected devices

Keywords : Programmable Logic Controller (PLC),Visual Programming,Wi-Fi Automation,I/O Profile,Industrial Automation,Smart Factory,Wireless Communication,Internet of Things (IoT) Remote Monitoring.

I. INTRODUCTION

Industrial automation has evolved into a cornerstone of modern manufacturing, enabling efficient and precise control of complex processes. Among the tools driving this transformation, Programmable Logic Controllers (PLCs) have emerged as a critical component, allowing industries to automate processes and reduce manual intervention. Traditional PLCs, while reliable and robust, often depend on wired networks and proprietary programming languages, presenting limitations in flexibility, accessibility, and scalability. These limitations hinder their ability to adapt to rapidly changing industrial demands and technological advancements. In response to these challenges, this project proposes an innovative approach by leveraging Internet of Things (IoT)-enabled devices, Wi-Fi communication, and visually programmable interfaces.

This approach aims to revolutionize the traditional PLC framework, making it more flexible, accessible, and scalable for modern industrial applications. By focusing on a boiler temperature management system, the project demonstrates how IoT-based PLCs can enhance process efficiency, operational safety, and overall system performance in industrial environments.

II. PROPOSED AND BACKGROUNDS OF PLC SYSTEMS

The proposed methodology focuses on creating an IoT platform to streamline factory automation by integrating visual programming tools, centralized coordination, and Wifi -enabled PLC controllers. This system ensures efficient factory- wide operation, minimizes reprogramming errors, and reduces downtime during production transitions

Overview of the IoT Platform :

The IoT platform comprises three core components:

1. WIFI -Enabled PLC Controllers

o Each PLC controller is equipped with a Wifi module to enable wireless communication.

o The controllers run the Wifi Automation I/O profile/service, ensuring compatibility with the centralized server.

2. Centralized Server

o The server acts as a coordination hub, communicating with all PLC controllers via Wifi.

o It manages the execution of user-specified programs and monitors subsystem statuses

3. Visual Programming Interface

o The interface allows users to define factory workflows using open-source libraries like Google Blockly.

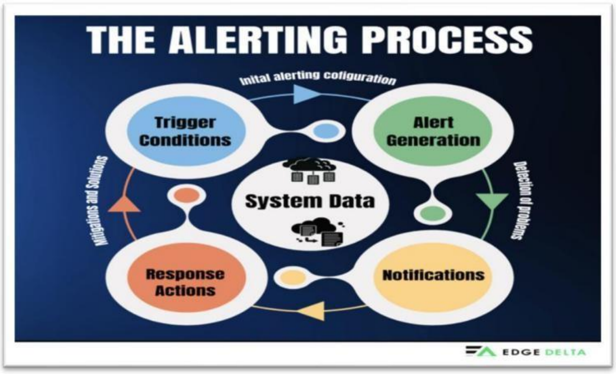
o Users can drag and drop blocks to specify commands, such as:

"When Boiler Input > 100°C, activate Cooling System."

4. Alert and Monitoring System

o A notification mechanism alerts operators of critical conditions, such as exceeding temperature thresholds.

o Wifi communication ensures real-time updates between the server and controllers, enabling dynamic responses to changes in factory conditions.



4.2 Execution Flow of User-Specified Programs

1. Input and Visualization

o The user interacts with the visual programming interface to design factory workflows.

o For instance, they can specify:

"If temperature exceeds 80°C, activate the cooling fan for 10 seconds."

o The designed program is compiled into machine-readable commands and uploaded to the server.

2. Program Distribution

o The server distributes commands to the respective PLC controllers over Wifi.

o Controllers acknowledge the receipt of instructions and prepare to execute them when conditions are met.

3. Condition Monitoring

o Each PLC controller continuously monitors its inputs (e.g., temperature, pressure).

o When a programmed condition is triggered, the controller sends an update to the server.

4. Action Execution

o The server processes the trigger and coordinates actions among relevant subsystems.

o For example, if a high-temperature condition is detected by the boiler PLC controller, the server activates the cooling fan through another PLC controller.

5. Feedback and Alerts

o The system provides real-time feedback on program execution.

o Alerts are generated for abnormal conditions, such as temperature exceeding safe limits.

6. Continuous Monitoring and Reprogramming

o The server monitors system performance and

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allows users to adjust programs
dynamically via the visual interface.

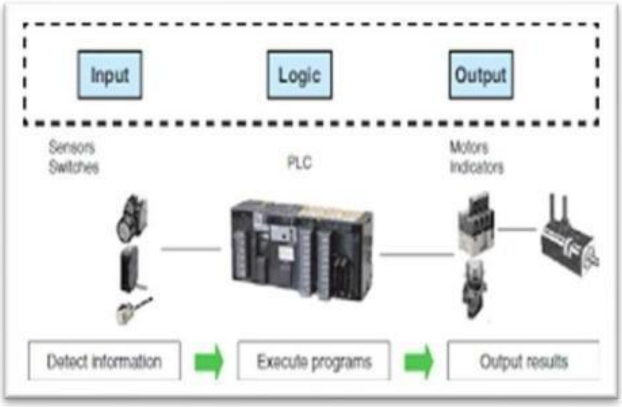
o This ensures that the factory remains adaptive to production changes or unexpected
conditions.

This methodology ensures an integrated, efficient, and user-friendly approach to factory
automation. By combining visual programming, Wifi-enabled communication, and centralized

II. Background of PLC Systems

Since their introduction in the 1960s, PLCs have been a fundamental element of industrial automation. They were initially developed to replace cumbersome relay-based control systems,

enabling industries to streamline processes and reduce complexity. Over the years, PLCs have evolved to manage increasingly complex operations, from basic logic control to advanced
process automation. Despite their advancements, traditional PLCs face several challenges that
limit their applicability in modern industrial settings. One of the primary limitations is the reliance on wired networks, which increases installation and maintenance costs while restricting system scalability. Furthermore, traditional PLCs often utilize proprietary programming languages, requiring specialized training and limiting accessibility for non-expert users. These systems also lack remote monitoring capabilities, which
are critical for real-time decision-making and operational flexibility. As industries increasingly adopt digital transformation strategies, these limitations highlight the need for more adaptable and user-friendly solutions. This project addresses these gaps by integrating IoT technologies, wireless communication, and a visually programmable interface, paving the way for next generation PLC systems.



III. IMPLEMENTATION AND HARDWARE

➢ **Hardware Design**

The hardware design for the Factory Automation System is composed of several key components, including the microcontroller, LCD, Wifi module, keypad, motor driver, potentiometer, and fan motor. Each component has been carefully chosen to ensure smooth operation and reliable performance in an industrial environment.

➢ **Microcontroller**

The heart of the system is the Arduino microcontroller, which acts as the central control unit. The
Arduino is responsible for reading sensor inputs, controlling actuators, and providing communication with the user interface. It uses a simple, easy-to-program structure that facilitates
rapid prototyping and debugging, making it an ideal choice for this automation system.

The microcontroller is connected to various peripherals such as the LCD, keypad, and motor driver.

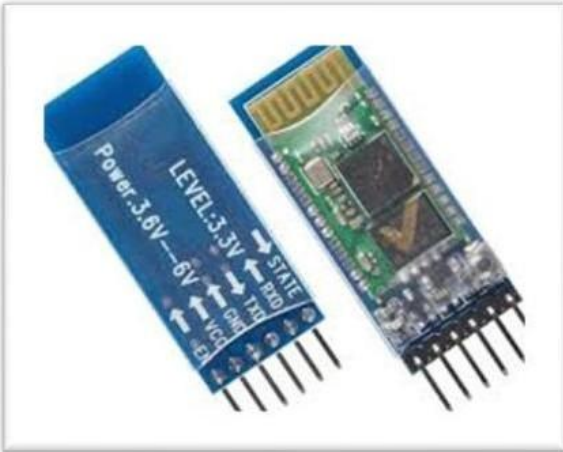
It is programmed to handle tasks like reading sensor values, controlling the motor, and managing communication with the Wifi module for remote

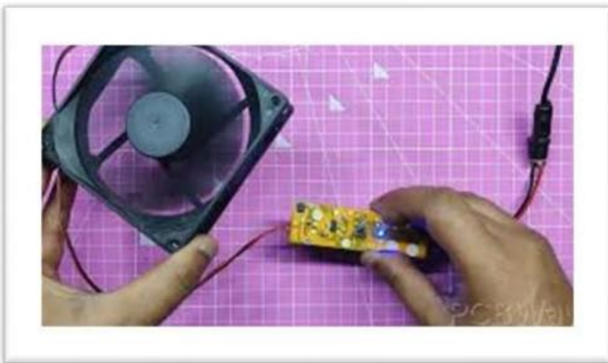
monitoring and control

➢ **Potentiometer for Temperature Sensing** A potentiometer is used as a simple analog sensor to simulate a temperature reading in the system.
The potentiometer is connected to the A0 pin of the microcontroller to provide a variable resistance that the Arduino reads as an analog value. This value is then mapped to a temperature range (0 to 100°C) for display purposes.
The temperature reading is displayed on the LCD screen in real time, providing feedback to the operator. If the temperature exceeds a certain threshold (in this case, 80°C), an alert message is displayed on the LCD, and a warning is sent over Wifi. This simple mechanism serves as a safety feature to prevent overheating and ensures the smooth operation of the system.

The fan runs for a set duration (e.g., 5 seconds) after the '1' key is pressed and is then turned off,
unless the user continues to interact with the keypad.
The fan control feature is critical for
maintaining the desired temperature and preventing damage to sensitive equipment.

➢ **WIFI Communication**
The Wifi module (HC-05) is used for wireless communication between the factory automation system and an external device such as a smartphone or computer. The Wifi module is connected
to the 6 and 7 pins of the Arduino, facilitating bidirectional data exchange. It operates at a baud rate of 9600 bps and allows the system to send real- time data, including temperature readings and alerts, to a mobile or desktop application.
This feature enables remote monitoring of the system's status, making it more versatile and accessible for factory operators or maintenance personnel who may be located far from the hardware. The system sends alerts when abnormal conditions such as high temperatures are
detected, ensuring that the staff can take timely action.





➢ **Motor Driver and Fan**

The motor driver is used to control the fan motor based on input from the user. The fan motor is connected to Motor IN1, Motor IN2, and Motor ENA pins of the microcontroller. The motor driver allows for bidirectional control (on/off, and speed control) of the motor.

When a key is pressed on the keypad, the system checks the input and responds accordingly. If the user presses the '1' key, the fan motor is turned on, and the system cools down based on the user's input. The Motor IN1 and Motor IN2 pins control the direction of the motor, and the Motor ENA pin is used to control the motor speed via PWM (Pulse Width Modulation). This allows the system to vary the cooling rate according to the environmental conditions.RESULTS AND DISCUSSIONS

The Factory Automation System was successfully implemented with the components of an
Arduino microcontroller, Wifi module, potentiometer for temperature sensing, LCD display, keypad, and motor driver for fan control. Upon execution, the system performs several key functions such as monitoring temperature, controlling fan speed, and providing user interaction
via the keypad.

➢ **System Operation and Performance** Upon powering the system, the LCD display provides an initial welcome message, confirming the
system is ready for operation. The potentiometer simulates the temperature sensor input, with the analog value read by the Arduino and mapped to a temperature range (0–100°C). This mapped
value is displayed in real-time on the LCD, providing a live update of the system's temperature condition.

The temperature value is continually monitored, and if it exceeds a preset threshold (80°C), the system triggers an alert. The LCD displays a high- temperature warning, and the Wifi module sends
a message to a paired device (such as a smartphone) indicating the temperature issue. This serves
as a critical feature for preventing overheating and ensuring safety in the automation process.

➢ **Keypad and Fan Control**

The keypad provides the user with direct control over the fan, which is simulated to cool the
system. When the user presses the '1' key, the fan is activated. The motor driver controls the fan,
with the Arduino adjusting the motor's speed using PWM (Pulse Width Modulation) through the motor's ENA pin. The system runs the fan for a predefined time (e.g., 5 seconds) and then automatically turns it off, simulating a cooling process.

The system works as intended, with the LCD showing the status of the fan ("Fan ON: Cooling...") when it is active, and Wifi communication sending feedback to the connected device. If no keys
are pressed, the fan remains off. The keypad interface proves to be intuitive, allowing quick user interaction and system management.

➢ **Temperature Monitoring and Alerts** The temperature feedback loop functioned correctly, with the system displaying the real-timetemperature on the LCD and triggering alerts when necessary. The Wifi module proved to be
effective in relaying real-time data, sending high-temperature warnings promptly to the mobile device. This remote monitoring capability is an essential feature in industrial automation systems, allowing operators to monitor the system from a distance and take action without needing to be physically present at the machine.

DISCUSSION

The system demonstrated good performance, with accurate temperature readings and effective fan control based on user input. The LCD and Wifi modules functioned well in presenting data and alerts, and the system successfully handled multiple tasks without any noticeable delay. The use
of a potentiometer as a temperature sensor, while not a

real-world sensor, provided a simple and effective simulation for testing the system.
However, a potential limitation is the lack of a real temperature sensor in the current setup.
Replacing the potentiometer with an actual temperature sensor like the LM35 or DHT11 would provide more accurate and practical readings.
Additionally, incorporating more complex controls, such as automatic fan speed adjustment based on temperature, could further enhance the system's functionalit

CONCLUSION

In the current stage of the Factory Automation System, the core functionality has been implemented using a combination of hardware components, including a potentiometer, LCD display, motor driver, keypad, and Wifi module. The system successfully reads temperature data from the potentiometer, displays it on the LCD, and allows manual control of the cooling fan via the keypad. Additionally, Wifi communication is integrated to send alerts and monitor system status remotely, enhancing its versatility and accessibility.
Looking ahead, we plan to integrate Wifi more extensively by incorporating it into the control mechanism, allowing for remote fan control, temperature monitoring, and real-time system updates through a smartphone or tablet. This will provide users with the ability to adjust settings and monitor performance without needing to be physically present at the system's location.
In the next phase, we will also explore visual programming using tools like Blockly or Scratch for programming the system. Visual programming will enable users to design and customize automation routines with a graphical interface, making it easier to adapt the system to different requirements without needing to write code. This approach is particularly beneficial for users with limited programming knowledge, as it simplifies the process of modifying and extending the system's functionality.
Through the integration of Wifi and visual programming, the Factory Automation System will become more user-friendly, accessible, and adaptable, with enhanced remote-control capabilities and greater ease of customization for various factory applications. These advancements will not only improve the operational efficiency of the system but also provide an intuitive experience for users, paving the way for future innovations in factory automation.

REFERENCES

1. • **Smith and J. Brown, "The Evolution of Programmable Logic Controllers"**
This paper discusses the historical development and advancements in Programmable Logic Controllers (PLCs), highlighting their growing role in industrial automation. It also examines future trends in PLC technology and their integration with modern systems.

2. • **S. P. Mohan, "IoT in Factory Automation: A Review"**
The review examines the use of Internet of Things (IoT) technologies in factory automation, focusing on how IoT enhances operational efficiency and system integration in industrial settings. It also outlines key challenges and opportunities in IoT-driven automation.

3. • **D. Johnson, "Wireless Communication in Industrial Automation"**
This article explores the role of wireless communication technologies in industrial automation, emphasizing their impact on system connectivity, data transmission, and real-time control. It also highlights various protocols used for wireless industrial communication.

4. • **Y. Zhang, Z. Li, and M. Wang, "Application of ESP32 in IoT Systems"**
The paper discusses the ESP32 microcontroller and its applications in IoT systems, particularly in industrial environments. It highlights the ESP32's capabilities for low cost, low-power IoT solutions in real-time systems.

5. • **H. Lee, "Blynk Platform: Simplifying IoT Integration"**
This paper focuses on the Blynk platform, which simplifies the integration of IoT devices into industrial systems by providing a user-friendly interface for controlling hardware remotely. It discusses how Blynk aids in developing efficient IoT solutions.

6. • **M. Gupta and R. K. Sharma, "Temperature Monitoring and Control Using IoT"**
The paper outlines the design and implementation of an IoT-based temperature monitoring and control system, showcasing how IoT can help maintain optimal temperature conditions in industrial processes. It also discusses challenges in system integration.

7. • **P. Kumar et al., "Improved Efficiency in Factory Automation Using IoT"**
This article explores how IoT technologies can be leveraged to enhance the efficiency of factory automation systems. It focuses on real-time monitoring, predictive maintenance, and optimization of industrial processes through IoT-driven insights.

8. • **R. Singh, "IoT-Driven Cooling Mechanisms for Industrial Systems"**
The paper investigates the role of IoT in developing cooling mechanisms for industrial systems, such as machinery or large-scale manufacturing setups. It discusses the benefits of IoT in monitoring and optimizing cooling efficiency to prevent overheating.

9. • **N. Patel and M. S. Rao, "Integration of Wireless Sensors in PLC Systems"**
This study explores the integration of wireless sensors with PLC systems in industrial automation, aiming to enhance system flexibility, reduce wiring costs, and improve data acquisition in real-time. It discusses practical implementation challenges.

10. • **L. Chen and P. Yu, "A Study on Manual Override Systems in Industrial IoT"**
The paper examines the role of manual override systems in industrial IoT setups, highlighting the need for human intervention in automated systems to ensure safety and performance under critical conditions. It explores various design considerations for manual override features.

11. • **J. White and K. Andrews, "Comparative Study of IoT Platforms for Industrial Applications"**
This paper compares various IoT platforms used in industrial applications, assessing their functionalities, scalability, and suitability for different industrial needs. It also evaluates their integration with existing automation systems.

12. • **V. Tan, "PLC Programming with Visual Interfaces: Challenges and Opportunities"**
The study investigates the use of visual interfaces in PLC programming, focusing on the potential benefits and challenges these interfaces bring to automation systems. It highlights the role of visual tools in improving user experience and system efficiency.

13. • **G. S. Park and S. J. Kim, "Bluetooth Applications in Low-Power Industrial IoT"** This paper discusses the application of Bluetooth technology in low-power industrial IoT environments, focusing on energy-efficient solutions for real-time data collection and control. It also examines the limitations and benefits of Bluetooth in industrial systems.

14. • **Khan et al., "Design and Implementation of Real-Time Monitoring Systems for Boilers"**
The paper presents the design and implementation of real-time monitoring systems for boilers in industrial plants using IoT technologies. It emphasizes the importance of continuous monitoring for improving safety and operational efficiency.

15. • **M. Ramesh, "Future Trends in Factory Automation: From WiFi to Bluetooth and Beyond"**
This paper explores future trends in factory automation, focusing on emerging wireless communication technologies such as Bluetooth, WiFi, and others. It discusses their potential to revolutionize industrial processes by enabling greater flexibility and efficiency

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