Literature Review - ESP Based Low Cost Modular PLC System

Introduction

This project investigates the development of a low-cost, modular PLC system using the ESP32 microcontroller, addressing the gap between basic microcontrollers (e.g., NodeMCU, Raspberry Pie) and expensive industrial PLCs. Traditional PLCs are often cost-prohibitive for education,prototyping and projects and small-scale applications, while microcontrollers lack industrial durability, standardized programming, and seamless integration. With increasing interest in open-source automation solutions, this study aims to provide an affordable, reliable, and programmable control system suitable for training, prototyping, and light industrial use.

Body

Masco (2022) developed an economical PLC module for student training, validating its basic functionality. However, the study did not evaluate environmental factors (e.g., temperature, vibration) or their impact on scan time—critical aspects for industrial reliability. This gap underscores the need for robustness testing, a key focus of this project.

Alves et al. (2014) introduced OpenPLC, an open-source automation platform that supports standard PLC programming (e.g., ladder logic) on low-cost hardware. Their work demonstrated that open-source solutions could replicate industrial PLC functionality but did not explore hardware modularity or real-time performance under varying operational conditions.

Rúnarsson (2016) explored open-source hardware and software alternatives to industrial PLCs, emphasizing flexibility and cost-efficiency. While the study confirmed the feasibility of using non-proprietary systems, it lacked comprehensive testing on wireless integration (e.g., IoT/SCADA) and real-time control precision—areas where the ESP32's capabilities can be leveraged.

Conclusion

Existing research confirms the viability of low-cost PLC alternatives, particularly in education and basic automation. However, key limitations remain, including:

- Insufficient environmental and real-time performance testing
- Limited modularity and scalability in hardware design
- Partial support for industrial-standard programming and wireless SCADA integration

This project addresses these gaps by developing an ESP32-based PLC system with

- Modular I/O
- Built-in PID control
- Ladder logic support
- Web-based SCADA connectivity.

And testing will assess stability under real-world conditions, ensuring reliability for both educational and industrial applications.

Reference

1. Alves, T.R., Buratto, M., De Souza, F.M. and Rodrigues, T.V., 2014, October. OpenPLC: An open source alternative to automation. In IEEE Global Humanitarian Technology Conference (GHTC 2014) (pp. 585-589). IEEE.

2. Masco, J.F.P., 2022. Development and Validation of a Less Expensive and Portable PLC Module for Students Training in Industrial Automation. Electronics/Elektronika (1450-5843), 26(2).

3. Rúnarsson, S., 2016. Open source hardware and software alternative to industrial PLC (Master's thesis, Høgskolen i Sørøst-Norge).

Literature Review: Using Machine Learning for Smarter Restaurant HVAC Control

Introduction

This project looks at using machine learning (ML) to optimize a control system (eg-: HVAC systems in restaurants). Normally, HVAC systems react to temperature and occupancy changes. Instead, this idea uses ML to predict things like busy times or weather changes before they happen, so the HVAC can adjust early. This could save energy and keep customers comfortable.

Body

One study (Esrafilian-Najafabadi & Haghighat, 2021) used deep learning to control HVAC in homes. Their system predicted when people would be home and adjusted the temperature accordingly. While this worked well for houses, restaurants have much more unpredictable crowds. Also, their system only planned ahead rather than making instant adjustments.

Another review (Dev et al., 2021) looked at how ML improves control systems like HVAC. They found ML is great for analyzing energy use and finding problems, but rarely used for real-time control. Most systems just study data instead of making quick changes when needed.

Conclusion

While ML has been used in HVAC systems for predicting energy use and detecting faults, it hasn't been integrated directly into control systems for real-time adjustments. This project proposes a new approach where ML predicts disturbances (like customer numbers or weather changes) and helps adjust HVAC settings dynamically. This could lead to better energy efficiency, improved comfort, and smarter automation for restaurants.

Reference:

1. Esrafilian-Najafabadi, M. and Haghighat, F., 2021. Occupancy-based HVAC control using deep learning algorithms for estimating online preconditioning time in residential buildings. Energy and Buildings, 252, p.111377.

2. Dev, P., Jain, S., Arora, P.K. and Kumar, H., 2021. Machine learning and its impact on control systems: A review. Materials Today: Proceedings, 47, pp.3744-3749.