Remote Usage of Laboratory Equipment Using Scada Technology

In the fulfillment of the minor degree course under CoC Automation technology: Rexroth Bosch

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Module Title: A Web Based Remote Access Laboratory Using SCADA

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1. Introduction

In today's educational landscape, traditional laboratory setups present significant challenges in terms of cost, accessibility, and scalability. The maintenance of physical labs demands substantial financial resources, including expenditures on space, equipment, and personnel. Leveraging modern technologies like Supervisory Control and Data Acquisition (SCADA) offers a transformative approach to remote access management and control of laboratory setups. This report delves into developing a web-based remote access laboratory using SCADA technology. Utilizing Programmable Logic Controller (PLC) systems with SCADA transcends traditional lab limitations, offering flexibility to access and interact with experiments from anywhere, reducing costs, and enhancing learning experiences.

2. Literature Survey

SCADA systems are widely used in industries for managing electrical and mechanical systems, offering economic advantages by minimizing costs and educating users about remote working and component handling. Implementing SCADA systems in educational settings benefits students by providing practical experiences and reducing traditional lab expenses. These systems also play a significant role in industrial automation, creating user-friendly interfaces for remote interaction.

3. Motivation

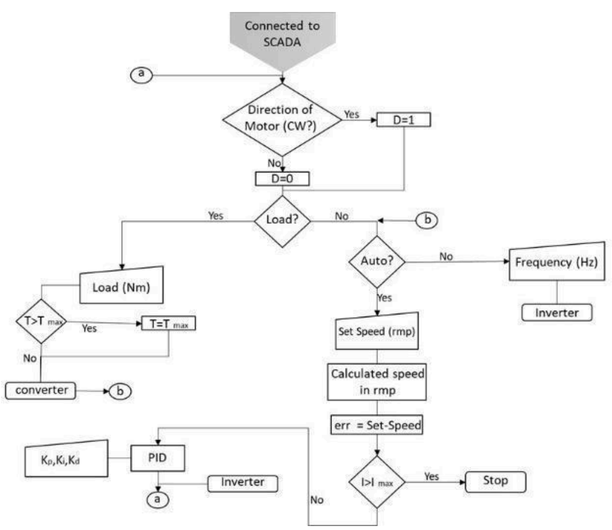
Adopting remote-controlled labs using PLC and SCADA technology can significantly reduce expenses associated with maintaining physical laboratories. Offering remote access to laboratory experiments enhances user satisfaction, allowing students to perform experiments at their convenience, leading to more engaging learning experiences. This flexibility allows for a better understanding of concepts and experimentation without time constraints.

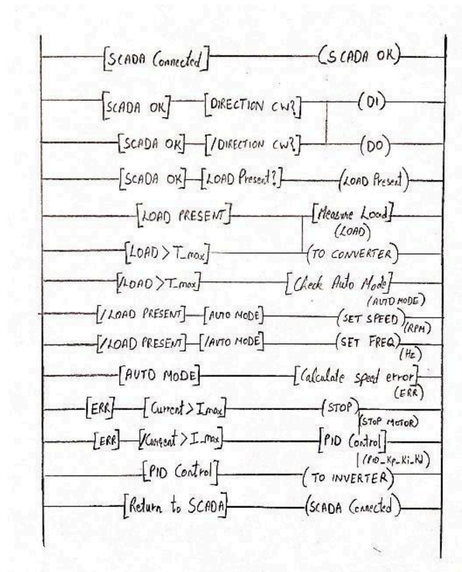
4. Objectives

The main objective of this project is to utilize Programmable Logic Controller (PLC) and SCADA technology to enable remote access, management, and control of laboratory experiments. By implementing these technologies, we aim to enhance the learning experience and improve the efficiency of laboratory operations.
Another objective is to enhance the user experience by providing a seamless interface for accessing and interacting with laboratory equipment remotely. This includes developing user-friendly interfaces, implementing real-time data exchange applications, and integrating video streaming capabilities.

5. Methodology

SCADA systems provide students with opportunities to experience their application in managing and controlling electrical and mechanical systems. The remote-controlled lab system consists of three main subsystems: the web client, laboratory portal, and measurement and control system. Manual control enables users to adjust parameters directly, while automatic control, facilitated by a PID controller, optimizes performance. A web-based control system allows real-time access to laboratory setups through a client-user web server and internet connection, with access restricted to one client at a time for security purposes.

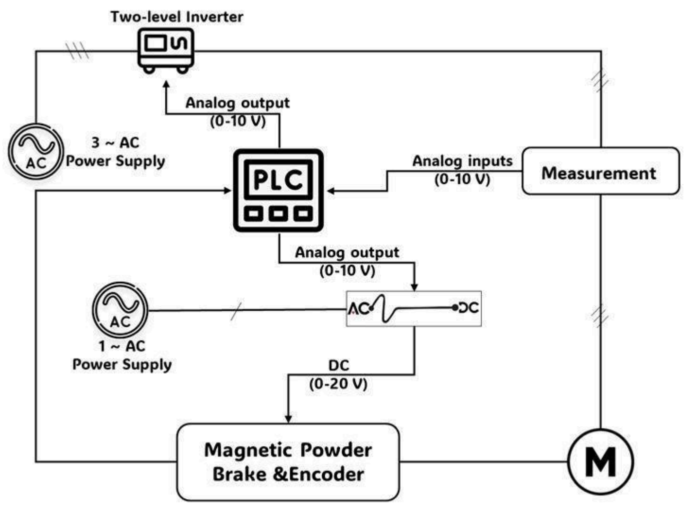




The program begins by connecting to the SCADA system, essential for receiving commands and sending monitoring and control data. It checks the motor's direction: if clockwise (CW), it sets D=1; otherwise, D=0 for counterclockwise (CCW). It then checks for a load on the motor; if present, it measures the load torque (T) in Newton-meters (Nm). If T exceeds the maximum allowable torque (T_max), the data is sent to a converter, and the process loops back to measure the load again. If there is no excessive load, or if no load is detected, the program checks if the system is in automatic mode. In automatic mode, it sets the desired motor speed in RPM, calculates the error between the set speed and actual speed, and checks if the current (I) exceeds the maximum allowable (I_max). If the current is too high, the motor is stopped to prevent damage. Otherwise, the program uses a PID controller with constants K_p, K_i, and K_d to adjust the motor control to minimize the error, sending the corrected control signal to the inverter and looping back to the SCADA connection check. If not in automatic mode, the program sets the frequency (Hz) for the inverter to achieve the set speed.

6. Hardware / Software tools used

The hardware components include a PLC, SCADA system, magnetic power brakes, encoder, AC/DC converter, frequency converter, RS-485 cable, PC, display unit, and a 1kw tri-phased motor. These components are essential for controlling and monitoring the experimental setup.
Software tools used in the project include PLC programming software, SCADA development software, web server application, and database management software. These tools enable the development and operation of the remote-controlled lab system.



The system comprises various interconnected components to ensure seamless operation. The "Two-Level Inverter" manages power control by linking to the "3AC Power Supply," while the "PLC" facilitates signal transmission and reception through connections to both "Analog Inputs" and "Analog Outputs." Data exchange is facilitated as the "Measurement" system is integrated with the PLC. Power provision is handled by the "1AC Power Supply," connected to the "AC/DC Converter." Speed regulation and measurement are managed by the "Speed" system, encompassing the "Magnetic Powder Brake" and "Encoder," interfaced with the PLC. Additionally, remote functionality is enabled through the "SCADA" system, communicating with the PLC via cable, while the "PC" operates the SCADA software and connects to the PLC through a "PC-PPI cable" for command transmission and data reception. Although the "Multifunction Display Unit" presents information, it likely doesn't directly influence the PLC. Similarly, the "3-phase measurement" system provides data to the PLC but doesn't control it directly. In essence, the PLC acts as the system's central processor, receiving inputs from various components and executing commands accordingly. The SCADA system and PC serve as overseers, allowing remote monitoring and control, ensuring efficient system functionality.

7. Budget estimate

- Hardware: The project requires several hardware components, including a PLC (Siemens S7-200 or similar), industrial frequency converter, variable AC/DC converter, PC, measurement devices (current and voltage sensors), a 1 kW 3-phase induction motor, magnetic powder brake, and an incremental shaft encoder. Each of these components ranges in cost from INR 20,000 to 2 lakhs.
- Software: Software expenses involve SCADA software (WinCC flexible RT) and web development tools (Visual Studio with ASP.NET), with costs spanning from INR 50,000 to 5 lakhs.
- Networking Infrastructure: Networking infrastructure includes an Ethernet interface and web server, with estimated costs ranging from INR 10,000 to 5 lakhs.
- Labor Costs: Labor costs for engineers, developers, and technicians are estimated to range from INR 2 lakhs to 50 lakhs, depending on the required expertise and project duration.
- Additional Equipment: Additional equipment, such as the control panel and trend views display, is estimated to cost between INR 20,000 to 1 lakh.

8. Project Outcomes

The project successfully implemented a remote-controlled lab system using PLC and SCADA technology. The system allows students to access and interact with laboratory experiments remotely, improving accessibility and flexibility.
The remote-controlled lab system offers several benefits for education and industry. It provides students with practical learning experiences, reduces expenses associated with maintaining physical laboratories, and enhances user satisfaction. Additionally, the system can be adapted for use in industrial automation, creating user-friendly interfaces for remote operation of equipment.
By providing remote access to laboratory experiments, the system enhances learning opportunities for students. It allows for experimentation without time constraints, facilitates better understanding of concepts, and enables students to apply theoretical knowledge in practical scenarios.

9. References

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