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REMOTE USAGE OF LABORATORY EQUIPMENT USING SCADA TECHNOLOGY

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INTRODUCTION

In today's educational landscape, traditional laboratory setups present significant challenges in terms of cost, accessibility, and scalability. Maintaining 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 project focuses on developing a web-based remote access laboratory using SCADA technology, utilizing Programmable Logic Controller (PLC) systems to overcome the limitations of traditional labs. This approach provides flexibility for students to access and interact with experiments remotely, reduces costs, and enhances the learning experience by offering practical, real-world scenarios.

MOTIVATION

Challenges of Traditional Labs

- High costs for space, equipment, and personnel
- Limited accessibility and scalability
- Disparity between student numbers and lab resources

The Need for Innovation

- Essential to provide practical, hands-on learning experiences
- Overcome physical and financial constraints
- Prepare students for modern industrial environments

Solution

- SCADA Technology : Transformative approach to remote lab access
- Integration with Programmable Logic Controllers (PLCs)Allows 24/7 access to experiments from any location

SCADA IN EDUCATION AND INDUSTRY

Industry

- Widely used for managing electrical and mechanical systems
- Reduces operational costs and enhances remote working

Education

- Cost-effective alternative to physical labs
- Enhanced accessibility for students globally
- Provides substantial information and remote experimentation capabilities

Market

- SCADA market projected to grow from $11.0 billion in 2020 to $15.2 billion by 2025 (6.6% CAGR)
- It is driven by cloud computing and needs efficient infrastructure management

OBJECTIVES

Utilization of PLC and SCADA for remote access

Develop User-Friendly Interfaces

Implement applications that facilitate real-time data exchange

Incorporate video streaming capabilities to provide live visuals of the laboratory experiments

Reduce the costs associated with maintaining physical laboratories

Increase the efficiency of laboratory operations

IMPLEMENTING SCADA FOR REMOTE LABS

How It Works:

- PLCs integrated with SCADA systems
- Web-based access for real-time interaction with lab experiments

Advantages:

- Lower maintenance and equipment costs
- Students can perform experiments from anywhere
- Enhanced Learning with hands-on experiences without physical constraints

Preparing for the Future:

- Aligns with digital transformation trends
- Equips students with skills for industrial automation
- Creates an engaging and interactive learning environment

METHODOLOGY

Key Parts:

- A. Web Client
- B. Lab Portal
- C. Measurement/Control System

Essential for Remote Access and Control:

- Each part crucial for managing lab experiments remotely.

Control Modes:

- Manual: Users adjust parameters directly.
- Automatic: Utilizes a PID controller for optimized performance.
- Switching to automatic mode activates the PID controller.
- Reduces errors for precise control.

SCADA Systems in Industry:

- They are industry stalwarts, widely adopted for overseeing and controlling industrial processes with precision and reliability.

Educational Benefit:

- Provides hands-on experience with electrical and mechanical systems control.

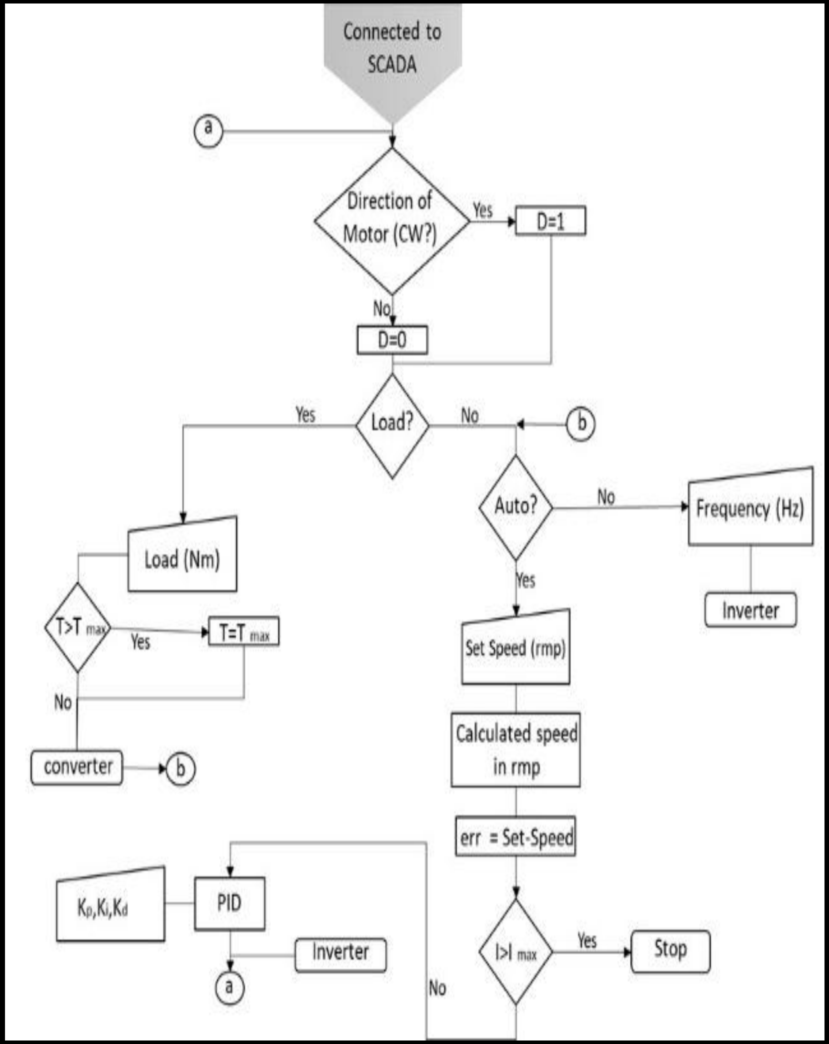
Real-Time Access:

- Access via web client, server, and internet.

User Management:

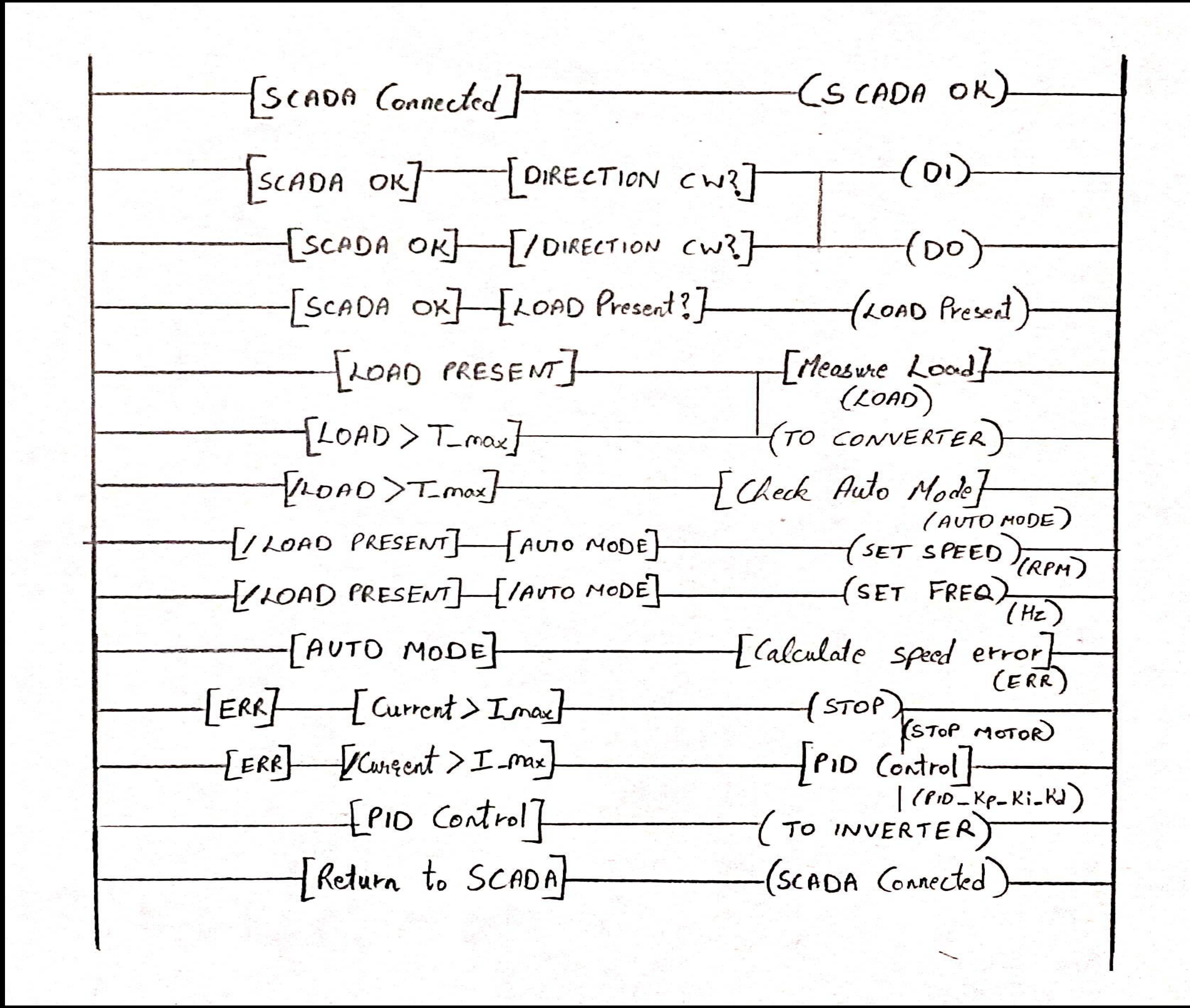
- Multiple simultaneous users allowed, with one controlling equipment at a time for security.

METHODOLOGY



1. Start: Program begins execution.
2. Connected to SCADA : Verify SCADA system connection. Important for receiving commands and sending data.
3. Direction of Motor (CW): Determine motor direction.
   - A. Yes: Set D=1 for clockwise rotation.
   - B. No: Set D=0 for counterclockwise rotation.
4. Load: Check if there's a load on the motor.
   - A. Yes : Measure load in Newton-meters (Nm).
     - a. T > T_max: Compare measured load torque with the maximum allowable torque.
       - i. Yes: If torque exceeds maximum, send data to converter and loop back.
       - ii. No: Continue to "Auto" check.
   - B. No : Skip directly to "Auto" check. Check if the system is in automatic mode.
     - A. Yes: in auto mode
       - I. Set Speed (rpm): Determine and set desired motor speed.
       - II. Calculated speed in rpm: Obtain actual speed from encoder.
       - III. err = Set-Speed: Calculate error (Set-Speed - Actual Speed).
       - IV. I > I_max: Check if current exceeds maximum limit.
         - a. Yes: If current is too high, stop motor to prevent damage.
         - b. No: Proceed to PID control loop.
           - i. PID Control (K_p, K_i, K_d): Adjust motor control using PID controller.
           - ii. to Inverter: Send control signal to inverter.
           - iii. Return to SCADA Connection: Loop back to SCADA connection check.
     - B. No: not in auto mode, set required frequency (Hz) for inverter to achieve set speed

PLC LADDER DIAGRAM

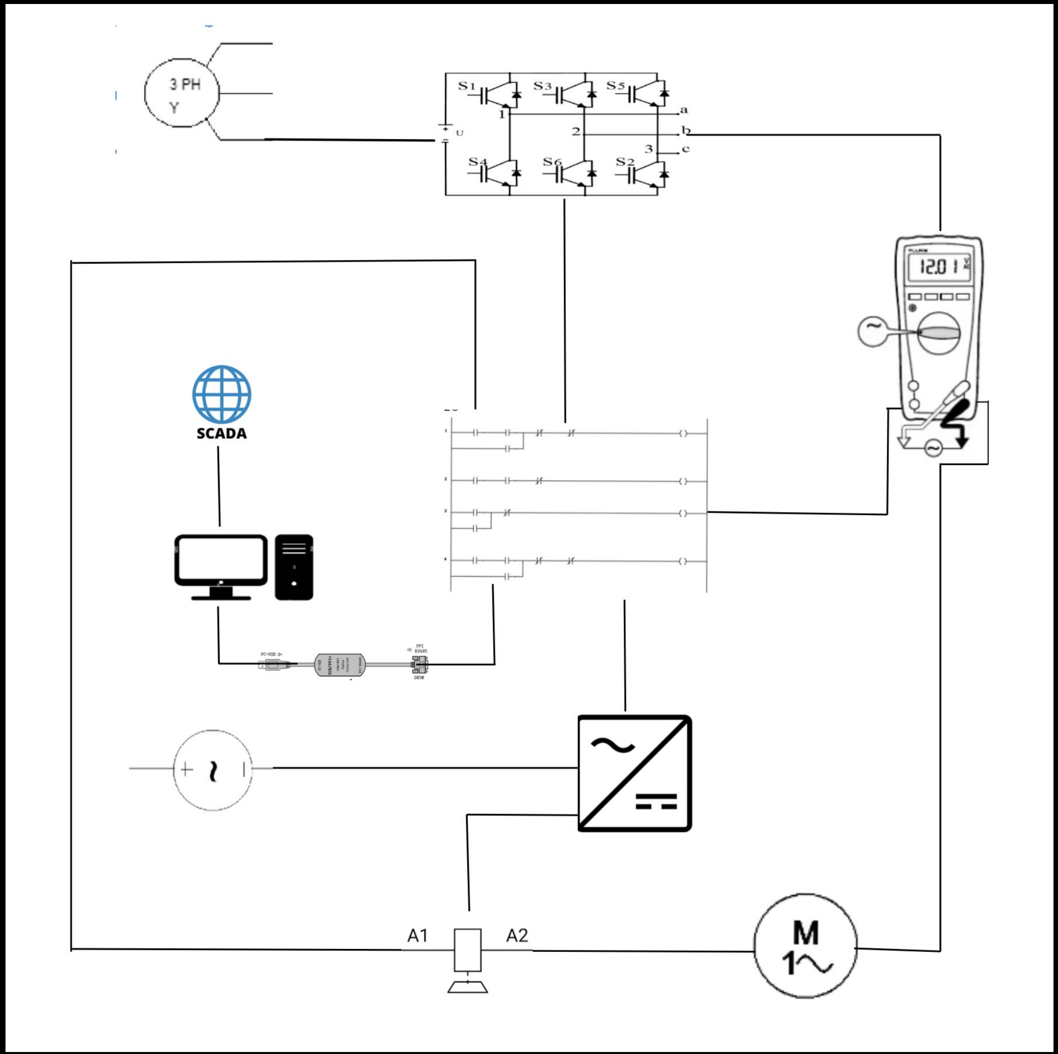


TOOLS

Hardware Components

Software Components

HARDWARE SET-UP



COMPONENTS:

1. Two-Level Inverter
2. 3~AC Power Supply
3. 1~AC Power Supply
4. 1 kW tri-phased Motor
5. PLC
6. Measurement Unit
7. PC-PPI Cable
8. PC
9. SCADA System
10. AC/DC Converter
11. Magnetic Powder Brake

CONNECTIONS:

1. The "Two-Level Inverter" connects to the "3AC Power Supply“.
2. The “Motor” is powered by the AC output from the inverter.
3. The "PLC" interfaces with "Analog Inputs," "Analog Outputs," and the "Measurement Unit".
1. The “Measurement Unit" provides data to the "PLC“.
2. The "1AC Power Supply" connects to the "AC/DC Converter" for power.
3. The "Magnetic Powder Brake" connects to the "PLC“.
4. The "SCADA" system communicates with the "PLC" via the "PC" and "PC-PPI cable“.
5. The "PLC" acts as the brain, controlling and receiving information, while the "SCADA" and "PC" enable remote monitoring and control.

BUDGET

Hardware Expenses INR 20,000 to 2 lakhs	• PLC, frequency converter, PC, sensors, motor, brake, encoder
Software Expenses INR 50,000 to 5 lakhs	• SCADA software, web development tools
Networking Infrastructure INR 10,000 to 5 lakhs	• Ethernet interface, web server
Labor Costs INR 2 lakhs to 50 lakhs	• Engineers, developers, technicians
Additional Equipment INR 20,000 to 1 lakh	• Control panel, trend views display

OUTCOMES

Benefits:

- Practical Learning: Provides students with hands-on learning experiences.
- Cost Reduction: Reduces expenses associated with maintaining physical laboratories.
- User Satisfaction: Enhances user experience through remote accessibility.
- Industrial Adaptation: Can be utilized in industrial automation for remote equipment operation.

Educational Impact:

- Experimentation without Constraints: Allows for experimentation without time limitations.
- Concept Understanding: Facilitates better comprehension of theoretical concepts.
- Practical Application: Enables students to apply theoretical knowledge in real-world scenarios.

THANK YOU

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