https://doi.org/10.31871/WJRR.19.2.14
World Journal of Research and Review (WJRR)
ISSN: 2455-3956, Volume-19, Issue-2, August 2024 Pages 01-02

Integration of AI based Solar Tracking Control System (FCS) with plant based Programable Logic Controller System (PCS)

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***Abstract*— Solar tracking systems are essential for optimizing the efficiency of concentrated solar power (CSP) installations by continuously adjusting the orientation of mirrors to maximize sunlight capture. Traditional tracking methods often rely on predetermined algorithms based on sun position calculations. However, advancements in artificial intelligence (AI) present opportunities to enhance tracking precision and efficiency by incorporating real-time data and adaptive control strategies. This paper explores the integration of AI based solar tracking Field control system (FCS) with Programmable Logic Controller (PLC) based control system (PCS), focusing on the design considerations, implementation strategies, and operational benefits of this synergy.**

***Index Terms*—CSP, AI, PCS, PLC.**

I. INTRODUCTION

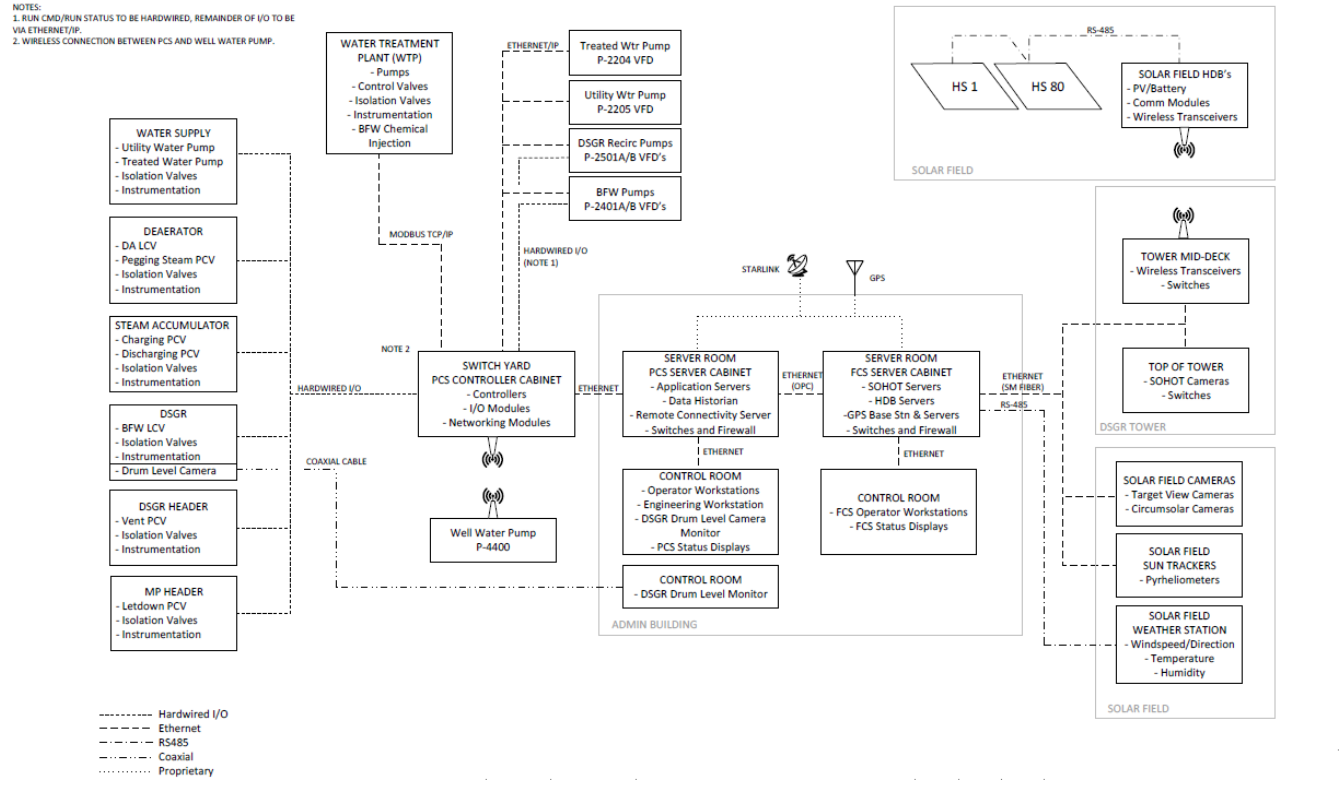
Solar tracking systems are pivotal in maximizing the energy output of solar installations by optimizing the angle and orientation of solar panels or mirrors to capture maximum sunlight. Programmable Logic Controllers (PLCs) provide a robust platform for automating and controlling these tracking systems, offering real-time monitoring, precise positioning, and adaptive control capabilities.

II. RESULTS AND OBSERVATIONS

Below architecture shows the integration of AI based FCS with PLC based PCS for steam generation plant using solar heat. This integration represent a promising avenue for optimizing solar mirror tracking in CSP plants, offering enhanced efficiency, reliability, and cost-effectiveness.

Benefits of PLC Integration

- Real-Time Control: PLCs offer high-speed processing capabilities for real-time tracking adjustments, ensuring precise alignment with the sun's position.
- Reliability: Industrial-grade PLCs are designed for robust operation in harsh environmental conditions, ensuring reliability and minimal downtime.
- Flexibility: PLC programming allows for easy customization of control algorithms and adaptation to varying environmental factors, enhancing operational flexibility.
- Diagnostic Capabilities: Built-in diagnostics and fault detection features facilitate proactive



maintenance and troubleshooting, minimizing downtime.

Design Considerations

- System Architecture: Selection of PLC hardware and communication protocols (such as Modbus or Ethernet/IP) compatible with solar tracking components.
- Safety and Redundancy: Implementation of safety interlocks and redundancy measures to prevent system failures and ensure personnel safety.
- Integration with SCADA Systems: Integration of PLC-based tracking systems with Supervisory Control and Data Acquisition (SCADA) systems for centralized monitoring and remote control.

Implementation Strategies

- PLC Programming: Development of ladder logic or structured text programs to implement tracking algorithms and control logic.
- Commissioning and Testing: Rigorous testing and commissioning procedures to validate system performance and ensure compliance with design specifications.
- Training and Maintenance: Operator training and documentation for routine maintenance tasks to optimize system performance and longevity.

Operational Benefits

- Enhanced Energy Yield: Improved solar tracking accuracy leads to higher energy capture and increased overall system efficiency.
- Cost Efficiency: Reduced operational costs through optimized energy production and proactive maintenance scheduling.
- Scalability: Scalable solutions for large-scale solar installations, accommodating future expansions and technological advancements.

Future Directions

- Advanced Control Strategies: Integration of machine learning and AI techniques for predictive tracking control and adaptive optimization.
- IoT Integration: Incorporation of Internet of Things (IoT) devices for enhanced data analytics and remote monitoring capabilities.
- Regulatory Compliance: Adherence to industry standards and regulations for safety, environmental sustainability, and grid integration.

III. SUMMARY

The integration of solar tracking control system (FCS) with PLC based (PCS) offers significant advantages in terms of efficiency, reliability, and operational flexibility for solar energy applications. By leveraging PLC technology, solar installations can achieve optimal performance and maximize the return on investment, contributing to the global transition towards sustainable energy solutions.

IV. REFERENCES

Books:

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2. **"Process Dynamics and Control"** by Dale E. Seborg, Thomas F. Edgar, and Francis J. Doyle III

Standards:

1. ISA Standards: ISA-95: Enterprise-Control System Integration

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