Project 2: Smart Industrial Infrastructure & Safety Management System (SIISMS)

1. Project Title

SIISMS – AI-Driven Integrated Infrastructure, Automation, and Safety Manager

2. Problem Statement

Industrial complexes with heavy mechanical systems, complex civil structures, and automated processes face challenges:

- Maintaining mechanical equipment reliability
- Monitoring civil/structural integrity (bridges, floors, tanks, supports)
- Managing PLC/automation workflows
- Ensuring safety compliance across operations

Current challenges:

- Disconnected monitoring across domains
- Manual hazard detection and safety reporting
- Delays in preventive maintenance actions
- Lack of integrated decision support for multi-domain engineering

3. Proposed Solution

Develop an AI system that:

- Monitors mechanical and civil assets using sensors and digital twins
- Analyzes automation/PLC system logs for anomalies
- Detects safety risks and provides compliance guidance

- Automates multi-domain task scheduling and reporting

4. Project Objective

- Real-time monitoring of mechanical, civil, and automation systems
- Early detection of risks and failures
- Automated compliance reporting
- Multi-domain workflow optimization
- Centralized engineering decision support

5. System Architecture

1. **Sensor & Data Layer**: Mechanical (motors, pumps), Civil (strain, tilt), PLC (input/output logs), Safety (alarms, PPE tracking)
2. **AI Orchestration**:
    - Multi-agent AI (Mechanical Agent, Civil/Structural Agent, Automation/PLC Agent, Safety Agent, Workflow Automation Agent)
    - LangChain + GPT-4 for reasoning and multi-agent coordination
3. **Knowledge Layer**: RAG system for SOPs, safety standards, design manuals
4. **Dashboard Layer**: React + Tailwind + D3.js for KPIs and alerts
5. **Backend**: FastAPI + Python + Vector DB + PostgreSQL for logs

6. Technology Stack

- Mechanical: Predictive maintenance, vibration/temperature analysis
- Civil: Structural load assessment, BIM integration, digital twin monitoring
- Automation: PLC anomaly detection, SCADA integration, workflow automation
- Safety: Risk scoring, SOP compliance, predictive hazard analysis

- Full Stack: React, Tailwind, FastAPI, Python, LangChain, GPT-4, FAISS/Chroma

7. Dataset Details

- Historical equipment logs
- Structural health sensor data
- PLC and automation workflow logs
- Safety incident reports and regulatory standards

8. Features

- Real-time multi-domain monitoring
- Predictive failure alerts for mechanical and civil assets
- Safety compliance alerts and recommendations
- Automated task and workflow assignment
- Integrated reporting for management

9. Sample Use Cases

User	Use Case
Mechanical Engineer	Receive predictive failure alerts
Civil Supervisor	Check stress levels of storage tanks and bridges
Automation Lead	Identify anomalies in PLC logic
Safety Officer	Track PPE compliance and hazard alerts
Manager	Generate unified operational health report

10. Metrics of Success

- Unplanned downtime reduction ≥ 50%
- Safety incident reduction ≥ 45%
- Task automation efficiency ≥ 65%
- Multi-domain system anomaly detection accuracy ≥ 90%

11. Future Enhancements

- Drone/robot inspection integration
- AR/VR visualization for structural safety
- Real-time IoT sensor fusion for predictive decision-making
- Integration with ERP/CMMS systems

12. Why This Project is Valuable to John Cockerill

- Comprehensive multi-domain industrial AI solution
- Supports mechanical, civil, automation, and safety engineering needs
- Demonstrates operational optimization, AI-assisted decision support, and Industry 4.0 innovation

13. Author

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