CAPSTONE DESIGN EXPO | Multi-Departmental | MULTI 25-610

Smart Buildings: Sustainability and Efficiency

SIEMENS

Team members: Daniel Gubay, Esha Sharma, Jaime Gerardo Juarez, Grant Forest-Collins | **Faculty advisers:** Daniel Cranston Ph.D., Joao Soares Ph.D.
Sponsor: Siemens | **Mentors:** Kenneth Cossaboon, Byron Burns

Understanding The Problem

- Siemens provides HVAC equipment like sensors, valves, and actuators for VCU buildings.
- Breakdowns in HVAC systems are fixed after they occur, which can cause delays and increase costs.

Solution: Predictive Maintenance

Our predictive maintenance model will:

- Use operational data of a fan coil unit (FCU) in a VCU COE West Hall lab
- Prevent unexpected breakdowns of the FCU through fault detection

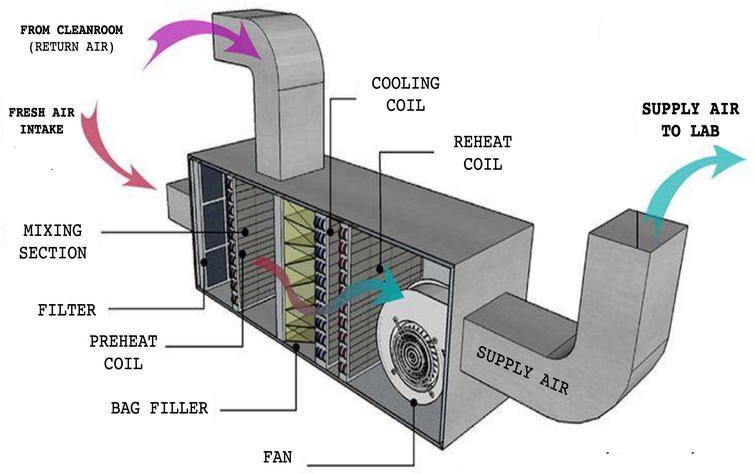

Figure 1. Fan Coil Unit Schematic
Source: https://thefurnaceoutlet.com

Model Architecture

- Feature data includes valve positions, temperature readings, occupancy status, and engineered time indicators (day, hour, season).
- The training data contains normal behavior, while abnormal patterns are set aside for the testing data.
- Data is normalized and encoded for consistent model input.

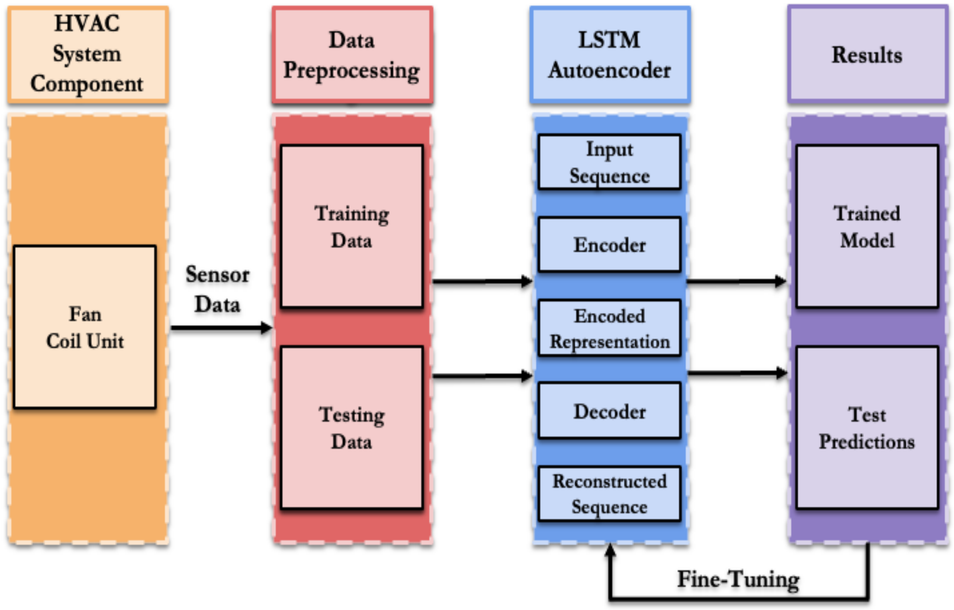

Figure 2. Model Architecture Overview

- The LSTM Autoencoder learns to reconstruct normal behavior. When it cannot, reconstruction loss increases.
- Faults are detected when test reconstruction loss exceeds the anomaly threshold.

Preliminary vs. Best Model

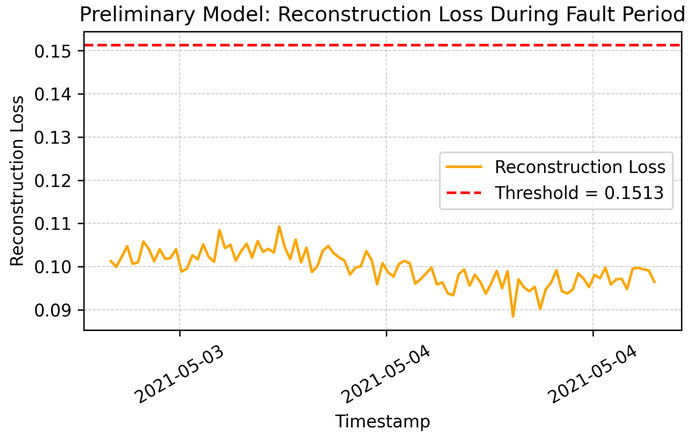

Figure 3. Preliminary Model: Reconstruction Loss

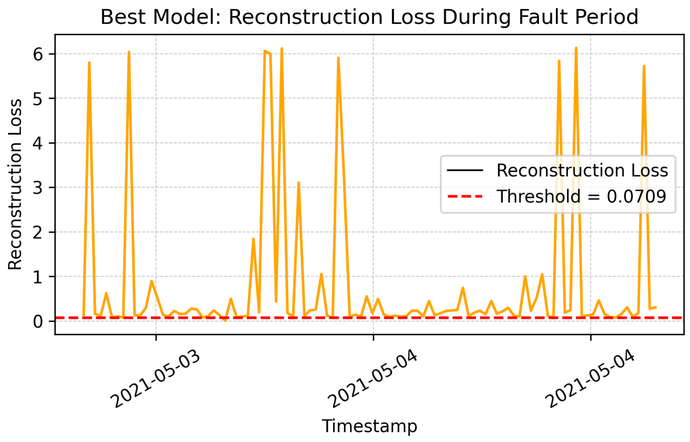

Figure 4. Best Model: Reconstruction Loss

Conclusions

- The model performs well on purely normal or purely faulty datasets but struggles to distinguish faults in mixed datasets. This suggests that sensitivity to faults in near-normal conditions needs to be improved.

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