Real-Time Optimization Strategy to Minimize Simultaneous Heating and Cooling

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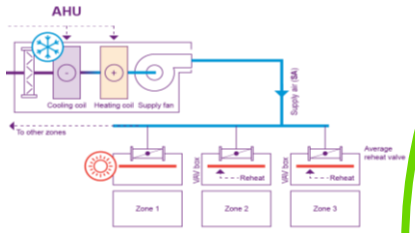
INTRODUCTION

- Heating, ventilation, and air-conditioning (HVAC) systems in large buildings centrally cool air streams but then often heat the air back up in rooms with lower heat gains → Up to 20% cooling energy is wasted!
- Building HVAC systems : Nonlinear characteristics + limited data

→ Model-based or learning-based control (e.g., MPC, reinforcement learning) is challenging.

→ This work proposes *a novel real-time optimizer that minimizes simultaneous heating and cooling while maintaining comfort.*



RESEARCH HIGHLIGHTS & IMPACT

Our proposed ESC-based real-time optimizer reduces simultaneous heating and cooling

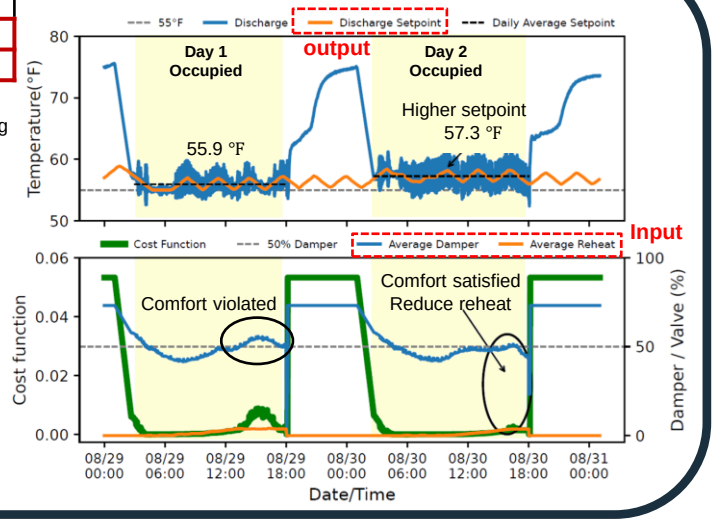
The algorithm does not need direct sensor measurements, models, or training data

The algorithm is resilient to poorly tuned PID controllers and sensor problems.

RESULTS

Avg. Value	Day 1	Day 2
Reheat (%)	2.04	1.19
Cooling (%)	40.31	40.03

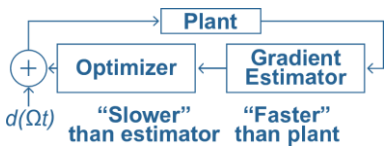
Day 2 reduced both reheat and cooling

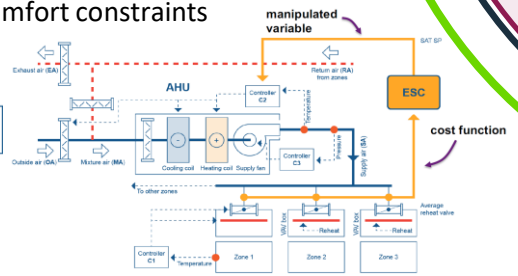


METHODS

ESC (Extremum Seeking Control) based real-time optimizer

- No model, no training data required
- Single Input Single Output → Ease of deployment
- Dwell time → Slower than dynamics in the zones
- Cost function = energy + comfort constraints
- Perturb and observe!





ESC-based real time optimizer applied to a real building with multiple rooms.

DISCUSSION/CONCLUSION

- The real-time optimizer continuously looks for opportunities to reduce energy.
- The algorithm made a sawtooth oscillation while searching for improvements in the cost function.
- The proposed algorithm is robust and was not affected by poor tuning of the PID controller.
- The comfort constraints must be met first before energy savings can be made. Thus, in day 1, the discharge temperature remained at its lower bound of 55degF.
- In day 2, the comfort constraints were satisfied and the setpoint temperature increases to reduce reheat energy.

The algorithm is successful in reducing simultaneous heating and cooling.