A Deep Reinforcement Learning Approach to Using Whole Building Energy Model for Energy Efficient and Thermal Comfort Control of a Radiant Heating System

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Abstract: Heating, ventilation, and air-conditioning (HVAC) system is the major source of energy consumption in non-residential buildings. While significant improvements have been achieved in system design and equipment efficiency, HVAC control strategies are relatively less studied and almost all commercial HVAC systems use experience and static rule-based control (RBC) strategies. HVAC energy efficiency can be potentially improved if the RBC strategies are replaced with optimal control. This study uses deep reinforcement learning (DRL) to develop an optimal control strategy for the radiant heating system supply water temperature setpoint of the Intelligent Workplace (IW) of Carnegie Mellon University. A DRL agent is trained off-line using the whole building energy model of IW as the simulator to minimize the heating energy consumption while maintain the acceptable indoor thermal comfort level. The trained agent is tested using simulation and shows 15% heating energy saving compared to the existing RBC strategy. After that, the trained DRL agent is deployed in the IW building automation system. A mobile app is developed to allow the occupants to submit their thermal comfort sensations to the agent in real time. Energy efficiency and thermal comfort performance of the DRL agent in the real-life deployment are analysed.

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