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Research Article

A novel personalized thermal comfort control, responding to user sensation feedbacks

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Abstract

This paper presents a novel heating, ventilation, and air conditioning (HVAC) control architecture for office buildings, which uses the predicted mean vote (PMV) index of each occupant as feedback and offers them the opportunity to act on their own comfort level by signalling a possible thermal uncomfortable sensation to a personal user interface. A co-simulation EnergyPlus/Simulink has been used to test this new personalized and adaptive thermal comfort control in an office building for different seasons, up to two employees per office. Simulation results show that such a comfort control algorithm leads to sizeable energy savings as well as comfort improvement for each occupant. Moreover, after processing the order given by the user interface, the control algorithm makes the simulated thermal sensation match the actual thermal sensation of the occupant with a high accuracy, leading to a better consideration of his thermal comfort.

Keywords

thermal comfort control,
HVAC systems,
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user interface,
co-simulation

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Building Systems and Components

1 Introduction

Today, the huge majority of modern office buildings are equipped with room automation systems, as solution to answer occupant thermal comfort. These flagship products of major technological companies like Siemens or Honeywell operate with (programmable) thermostatic regulations, using ambient air temperature as set-point and feedback parameter so as to provide the occupants of a same building zone with an acceptable and uniform thermal environment, while keeping the energy consumption reasonable.

Meanwhile, such a regulation often does not achieve a general comfort satisfaction, since it ignores other environment parameters affecting the thermal sensation like radiant temperature or air velocity and does not take into account the psychophysical singularity of each occupant. Moreover, temperature controllers, which constitute the typical user interface devices in most office-buildings, are often hardly usable by occupants: "The difficulty is not turning the knob, but know how much we must turn it so as to reach dozens of minutes later the desired natural temperature change", explains R. Vastamäki, who developed a behavioural model for the usage of such devices (Vastamäki et al. 2005).

With regard to those observations, numerous innovative heating, ventilation, and air conditioning (HVAC) control solutions have been investigated during the two last decades. They were developed mainly for office building application where thermal satisfaction of the employees has shown to improve their productivity (McCartney and Humphreys 2002). These attempts to maximize the occupant's thermal satisfaction have followed mainly two directions. On the one hand, centralised HVAC controls based on thermal comfort models, whose control algorithm calculates dynamical temperature and air velocities set-points in real-time. On the other hand, individual comfort controls, which transfer the decision power to each occupant for the control of his immediate thermal microenvironment.

For the first category, a thermal comfort model is used as feedback by the control algorithm, so as to keep the user thermal sensation in the comfort zone, while minimizing the energy consumption with energy-saving functions coordinating the HVAC systems. Such human thermal

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