RESEARCH ABSTRACT

Most current building mechanical systems are still controlled based on thermal comfort models based on the thermal responses of ‘average experimental subjects’. Since this ‘average’ process already contains deviations with error rates, the existing models disregard individual thermal preferences derived from variations in physiological characteristics - such as race, age, gender, health, clothing, activity - serious limitations for ensuring individual thermal satisfaction.

Building on several years of field studies and experimentation, this research effort is to create a wearable sensor/controller for individual thermal comfort and energy efficiency. This adaptive thermal comfort controller is triggered by an individual’s unique and changing bio-signals - such as skin temperatures and heart rates - which are physiologically ruled by human thermoregulation (homeostasis). In previous studies, our project team has carefully evaluated the viability of heart rate and skin temperatures at eight points on the body (forehead, chest, upper arm, wrist, waist, upper and lower leg, and foot) to determine an effective position for wearable sensors. Through human subject testing with measured and perceived comfort, sensors that track skin temperature at the wrist or ankle have proven to be the best at tracking the thermal comfort of individuals. To further develop the wearable sensor, sensor location, and control strategies, this research will continue human subject experiments. The experiments will be undertaken in the intelligent building space of our university since it is a test bed equipped with several types of mechanical systems and data acquisition structures. Iteratively improved through experimentation, both the wearable sensor and the adaptive thermal comfort control logic will be enhanced, incorporating artificial intelligence theory. Seven faculty researchers and graduate students engaged in high performance building systems and data mining will participate in this research.

The wearable sensor and expert controller will control a range of HVAC terminal units in all types of buildings to enhance human comfort and health, work productivity and energy savings by preventing thermal stress. In the first generation, the bio-sensing thermal comfort controller will be invaluable in healthcare and aged-care facilities where occupants are sensitive to thermal environments yet unable to adjust room temperatures without assistance. The BSA funding will provide this innovative research with an opportunity to contribute to human health and environmental sustainability in building environments.