Incomplete Supervised Learning Method for Personal Thermal Comfort Model for Cyber-Physical Human Centric Systems

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A personal thermal comfort (PTC) model is a novel approach to predicting thermal sensation of individuals rather than groups of humans. The limitations of previous works are the difficulties of collecting feedback of thermal sensation, especially for feedback of neutral comfort, and the requirements of data size to achieve an acceptable performance of prediction. In this paper, we present a modified PTC model to predict real-time personal thermal sensation for cyber-physical human centric system (CPHCS), where psychological parameters are necessary for operating Heating, Ventilating, and Air Conditioning (HVAC) control system in order to offer satisfactory thermal comfort. The function of the proposed PTC model is given after data analysis of seven participants' experiments in smart home plant-iHouse. Then we presented a Personalized Predictive Classifier (PPC) specifically designed for CPHCS, which uses online learning and incomplete supervision to predict the 7-level thermal sensation of individuals. The results showed the appropriateness of using machine learning, Random Forest (RF) in particular, in the field of predicting personal thermal sensation with the performance of median accuracy of 0.86 using one RF classifier (RFC). Then we explored PPC using two cascaded RFCs, and it results in faster learning speed in most situations. We conclude that PTC model with PPC inside is able to offer psychological parameters (e.g., thermal sensation) inference in a timely manner to a continuous satisfactory control system in smart homes, for example, Energy Efficient Thermal Comfort Control (EETCC) system, so that satisfactory thermal comfort is available for individual living in smart home.