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Developing a Hidden Markov model for occupancy prediction in high-density higher education buildings

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ABSTRACT

The number of occupants in a building as well as the occupancy patterns and profiles have a significant impact on the building energy consumption associated with heating, cooling, ventilation, and lighting systems. A range of approaches has been used in previous studies for building occupancy prediction. However, there were limitations associated with the methods used for data collection. For instance, the prediction of occupancy based on the concentration of CO_2 level adds an additional level of uncertainty into the estimation of the building occupancy level. To avoid such uncertainties, high-resolution passive infrared video camera sensors were used to capture occupancy data for an extended period of one year. The collected occupancy data have then been used to develop a Hidden Markov Model (HMM), to predict the occupancy levels in a high-density higher education case study building. The model is trained under different scenarios to find the most appropriate set of attributes associated with occupancy data that can be used to develop the data driven HMM. The occupancy attributes considered include day, week, month, and term. Moreover, the collected dataset was optimally split into 70% for training and 30% for validation using cross-validation, which yields high prediction accuracy. The results of the prediction model under different scenarios were evaluated using root mean square error and Kullback Leibler (KL) divergence.