Name: Ka Lung Ng
Degree of Master of Science in Computer Science (Mobile & Ubiquitous Computing)
Dissertation Title: Automating Distributed Domestic Heating Systems
Supervisor: Professor Siobhan Clarke
Year: 2017

Abstract

Domestic heating systems are major consumers of household electricity in European countries, occupying 19% of overall use. Since a domestic heating system takes significant time and energy to heat up, an intelligent planning solution is essential to maximize its energy use efficiency. Therefore, home heating automation is a solution and its goals are to maximize occupants' comfort level and minimize energy cost.

Model Predictive Control (MPC) supports periodic recomputation of optimal solutions to defined problems. MPC is robust to uncertainties and has been used in several research approaches for controlling domestic heating systems. On the other hand, heuristic approach promotes solutions sufficient enough to solve immediate objectives in order to speed up the process of development.

This dissertation investigates and implements a heuristic baseline solution based on thermal comfort, pricing scheme and energy consumption, and a MPC solution for coordinating distributed domestic heating systems. The solution balances between minimizing electricity cost and maximizing thermal comfort of occupants. Meanwhile, the non-critical electricity consumption is shifted from peak hours to off-peak hours to achieve demand response (DR) for distributed use.

Through simulation, the performance of the two solutions is compared with a default controller, which constantly maintains the temperature at 69.8°F. The results show that the cost of a typical manual controller is around 4.20% and 25.6% more than that of the default controller under flat pricing scheme and Time of Use (TOU) scheme respectively, while the cost of the heuristic baseline automatic control proposed in this dissertation is around 9.38% and 10.7% less than that of the default control under two pricing schemes respectively. MPC can produce similar performance as baseline controller in terms of cost but it can further reduce the thermal discomfort raised by the cost reduction. Both solutions have better performance in Peak-to-Average ratio (PAR) such that it is more suitable for the distributed use when comparing with the manual control.