TECH OFFER

Model-Predictive Control For Smart Building Energy Management

KEY INFORMATION

TECHNOLOGY CATEGORY:
- Sustainability - Low Carbon Economy

TECHNOLOGY READINESS LEVEL (TRL): TRL6
COUNTRY: SINGAPORE
ID NUMBER: TO174096

OVERVIEW

Modern buildings are often equipped with building automation and control (BAC) systems for operational control and monitoring. Conventional BAC systems lack the level of intelligence to coordinate the control of complex building systems to achieve multiple targets (energy efficiency, occupant well-being). Most conventional BAC systems have the core control algorithm in a reactive manner such as on/off control or proportional–integral–derivative (PID) control. Due to the complexity of most modern buildings and their ACMV systems, reactive control can practically never achieve the desired control target based on the past measurement information. In addition, reactive control is typical for single-input systems (e.g., room temperature as a single input for ACMV system) but rarely capable of coordinating multiple systems. These limitations in the current reactive BAC systems could lead to low energy efficiency and unsatisfactory human comfort.

The proposed technology offers a model predictive control (MPC) solution that overcomes such limitations by employing a building model to perform optimal, predictive and coordinated control of various building service systems including air-
conditioning and mechanical ventilation (ACMV – FCU, VAV, ACB, PDV, etc), lighting (automated dimming) and shading (automated blinds and electrochromic windows), etc. The technology was test bedded in multiple buildings, achieving 20 – 60% of energy savings while greatly improving occupants' thermal and visual comfort. This could largely disrupt the BAC market to shift to a much more intelligent level with predictive (instead of reactive) control and real-time optimization.

A MPC system that is suitable for commercial deployment is now being developed. The technology provider is seeking for industry partners to collaborate through various modes including technology licensing, research project and test bedding in buildings.

TECHNOLOGY FEATURES & SPECIFICATIONS

- Predictive control based on detected/forecasted occupancy loads and weather conditions as well as physics-based/machine-learning-based building dynamic models.
- Integrated human comfort and energy efficiency optimisation by incorporating sophisticated thermal comfort (predicted mean vote) and visual comfort (daylight glare probability) models into building dynamic models.
- The core of MPC technology includes a physics-/machine-learning-based integrated building model, capturing the dynamics of the building, ACMV, lighting, shading systems, occupant thermal and visual comfort, as the basis for the forward prediction capability.
- A fast optimisation algorithm is developed to provide real-time integrated control of multiple building service systems with global optimisation.
- MPC could achieve substantial energy savings and improved thermal and visual comfort as compared to conventional reactive control.

POTENTIAL APPLICATIONS

The MPC technology can be applied to various types of buildings (offices, shopping malls, hotels, institutional, etc.) with centralised building management systems (BMS). The technology provides smart energy management to the BMS. It could work as a plug-in module to the existing BMS as a supervisory control layer or as a standalone BMS to the building. The technology also equips buildings with the level of intelligence necessary for cluster/district level control with demand side management (DSM) capabilities for future adaption of building digitalisation and building-grid integration.

UNIQUE VALUE PROPOSITION

- Reduce energy bills for building owners / facility managers with its capability to cut down building energy consumption by 20% to 60% as compared to conventional BAC systems
- Provide more comfortable indoor environments and more smart features (e.g., prediction, machine learning) than conventional BAC systems, making buildings more attractive to users.
- Provide integrated control of multiple building systems with real-time optimization for multiple control targets.
- Enable large-scale adoption in multiple green building technologies for achieving high-performance positive/zero/super low energy buildings.