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Procedia Technology 11 (2013) 99 – 106

Procedia Technology

The 4th International Conference on Electrical Engineering and Informatics (ICEEI 2013)

Intelligent Optimized Control System for Energy and Comfort Management in Efficient and Sustainable Buildings

Pervez Hameed Shaikh*, Nursyarizal Mohd. Nor, Perumal Nallagownden, Irraivan Elamvazuthi

Universiti Teknologi Petronas, Department of Electrical and Electronics Engineering, Bandar Seri Iskandar, 31750 Tronoh, Perak, Malaysia

Abstract

Building energy efficiency and management provides remarkable automation opportunities, which fulfills dwellers comfort index. The challenging issue of the building envelope is to save energy and achieve high comfortable environment simultaneously. In this study, control system behavioral model with its framework has been developed for smart buildings. The power consumption of the actuator system and comfort index are two control optimization objectives in the system design. Two functions utilize Multi-objective Genetic Algorithm (MOGA) to generate Pareto front, obtained from the Pareto optimal solutions for multi-dimensional problem. The acquired non-dominated solutions are significant for building energy and comfort management in informed decision-making.

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Selection and peer-review under responsibility of the Faculty of Information Science & Technology, Universiti Kebangsaan Malaysia.

Keywords: Energy efficiency; Energy management; Smart building envelopes; Optimization; Comfort management; Multiobjective.

1. Introduction

The notion of energy efficiency is important not only because it favors stable economy but to tackle climate change, progressive reduction of fossil fuels and develop awareness to reduce energy consumption. The efficient use of energy resources in building can provide decreased energy exploitation and manage desired comfort.

* Corresponding author. Tel.: +060-14-9971034.
*E-mail address:*engr.pervezhameed@gmail.com

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Selection and peer-review under responsibility of the Faculty of Information Science & Technology, Universiti Kebangsaan Malaysia.
doi:10.1016/j.protcy.2013.12.167

Buildings consume about 40 % of the primary energy supplied [1- 3] since, there is the growing concern about building energy consumption with rising comfort requirements.

The multi-dimensional conflicting aspect of building is to save energy and the achievement of indoor comfort conditions. Ensuring comfort conditions in building is important due to 90% of the world's population spend most of the time in buildings [4, 5]. These have a direct impact on dwellers productivity, health and efficiency and pose indirect impact on energy efficiency of buildings. Therefore, to make use of limited energy resources and to fulfill the occupants' comfort demands, an intelligent control system is intended.

The energy management of intelligent buildings is significant, since it contributes to the continuous management and thus saving energy and cost ultimately maintaining comfort. Active systems are generally being controlled, that is heating, cooling and ventilation (HVAC) systems, through building energy management system (BEMS) [5, 6]. Generally, ambient temperature in buildings indicates thermal comfort, whereas auxiliary heating and cooling system is applied to maintain the temperature in comfortable region.

Several building energy management systems have been developed and a number of studies conducted in [7-9] for modern intelligent control systems for buildings. Thus, revealing the ongoing interest of researchers and scientists to explore the balance (i.e trade-off) between the energy consumption and the comfort level.

This paper reports the behavioral model relationship between energy consumption and thermal comfort. The two objective functions of building automation are power consumption and comfort. A meta-heuristicoptimization algorithm termed Multi Objective Genetic Algorithm (MOGA) is employed to optimize building control system.

2. Control System Framework and Model

The Genetic Algorithm tunes and optimizes the set points of the indoor thermal information and the user preference range. Various occupants have set different comfort preference range. The fuzzy control is employed to compute the power demand in order to maintain the desired comfort level, controlling the actuator subsystem. The difference in the sensed value and set points are inputs, employed in the fuzzy inference control engine. The required power will be matched to the power availability of the system. The comfort level will be adjusted according to the power supplied to the system through the central control coordinator as determined in Fig 1.

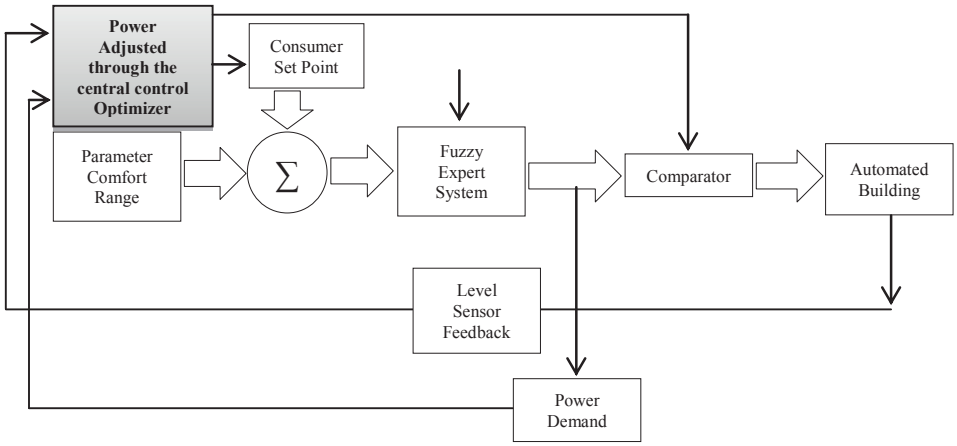

Fig. 1. Framework model proposed for automated building.

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