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Human behavior changing based on the simulation of the temperature control of a house

R. Bălan[1], V. Mureşan[1], R. Donca[1], A. Bălan[1], S. Stan[1]

[1] Department of Mechatronics
Technical University of Cluj-Napoca
B-dul Muncii 103-105, CP 400641 Cluj-Napoca (Romania)
Phone/Fax number: +0040 264 415490, e-mail: radubalan@yahoo.com

Abstract. To optimize the energy consumption in a house, the behavior of the occupants must be changed. This can be achieved by providing information and suggestions to the occupants. Based on a web application, some suggestions can be offered only if it is available a thermal model of the house. This paper presents a simple solution for thermal modeling of a house which includes experimental identification of the parameters of the model, using a less expensive and noninvasive measurement system (indoor and outdoor temperatures and thermal energy consumption). Such data are used to simulate the thermal behavior of the house, to estimate the energy consumption and to obtain solutions to reduce energy consumption. In simulation, the control of the thermal system is performed using a model predictive control algorithm.

Key words

Building management systems, modeling, grey-box model, parameter estimation, model predictive control.

1. Introduction

Reducing and optimization of the energy consumption in the residential sector is an important issue in the context of the global warming effect. An essential step in this direction is the implementation of a measuring system and monitoring of the electrical and thermal energy consumption. If these data are collected, analyzed, processed, systemized and memorized for a large number of households and if these data become available to the occupants of the households (based on a web application), then it's expected that based on the information, tips, comparison with the consumptions of the other similar households, comparison with its own previous energy consumption, and also other available data, occupants to be able to change the behavior in the sense of more efficient use of electrical and thermal energy.

DEHEMS project [1] aims realization of this objective based on a strategy that involves:
-measuring the energy consumption for each consumer;
-minimal installation costs of the additional equipments;
-non-invasive feature (e.g. it's avoided the significant modification of the measuring existent equipments or introduction of other new equipments or some invasive actions such as introduction of temperature sensors inside of a wall);
Some comments about restrictions referred to the costs and non-invasive features of the adopted solutions:
- for realization of the thermal model of the household and for experimental validation it was created a solution that involves the usage of two temperature sensors (indoor and outdoor temperature) as well as measuring the thermal energy consumption (at least in the identification of the thermal model parameters);
- the control system is of type 'man in the loop'; For example, in the case of a household with its own heating system, the temperature control of the household is realized by the existing control system. Based on the measured and/or estimated information, and based on the information received by the web application, it's expected that the occupant to actuate on the control system of the heating system so that the energy consumption to decrease in conditions of maintaining in acceptable limits the thermal comfort.
Of course, exists a large variety of software [2] that permits the obtaining of the thermal model of the household. In the most cases however, the user has to know more data regarding the household features (construction materials, different parameters etc.), data that can be difficult to obtain. Taken into account the specific of the DEHEMS project, it's obvious that it's not expected the obtaining of a very accurate model; the model will be used in the first place for obtaining useful information in the process of changing the occupant's