MECHATRONICS BOOK SERIES
SELECTED PAPERS FROM ICOM'01, ICOM'05 AND ICOM'08

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IIUM Pres

Published by:
IIUM Press
International Islamic University Malaysia

First Edition, 2011

Perpustakaan Negara Malaysia Cataloguing-in-Publication Data

ISBN: 978-967-0225-68-5

Member of Majlis Penerbitan Ilmiah Malaysia – MAPIM
(Malaysian Scholarly Publishing Council)

Printed by :
IIUM PRINTING SDN. BHD.
No. 1, Jalan Industri Batu Caves 1/3
Taman Perindustrian Batu Caves
Batu Caves Centre Point
68100 Batu Caves
Selangor Darul Ehsan

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Fuzzy Logic Based Controller for Maintaining Human Comfort within Intelligent Building System

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ABSTRACT

This paper presents an intelligent control approach for heat, ventilation, and air conditioning (HVAC). Most HVAC systems in modern building today constitute the major energy consumption, hence they require proper and reliable controller so as to minimize their energy consumption. This paper examines a fuzzy logic-based controller for maintaining human comfort within a building environment under which most HVACs operate in highly nonlinear manner. Mathematical model of the system operating in such a dynamic environment could hardly be formulated; hence conventional controller would not be very suitable. However Fuzzy Logic Control appears as a good alternative as it characterizes the ability to learn from the plant process making it able to update the relationship between the process input(s) and output(s) with time. The *gains* tuning in the process influences the way the system responds and FLC is known to be suitable for any such system. To analyze and verify the feasibility of FLC in human comfort control application, a small scale HVAC prototype is designed and developed. This prototype comprises components such as air handling unit (AHU), heating and cooling elements, and zone or conditioning space. AHU constitutes variety of subcomponents such as dampers, actuators and sensors. The operation of the dampers is to regulate the amount of air coming in and out of the AHU duck work and mixing the required amount of return air with outside air as a function of temperature and relative humidity in the conditioned space or zone, and in the various locations of AHU duck work using thermocouple and humidity sensors. The main objective of this control operation is to maintain a desired temperature and humidity level in the zone. National Instrument LabVIEW and FieldPoint are incorporated in the implementation of the control algorithm and its interface with the field devices-sensors and actuators. Results of preliminary tests have shown that fuzzy-based HVAC control poses reliable performance without undermining the energy consumption in maintaining zone temperature and humidity level.

1. INTRODUCTION

Heat, Ventilation and Air Conditioning (HVAC) system nowadays has become integral part of building services. This system comprises several subsystems such as the cooling and heating unit, air handling unit (AHU), dedicated controllers (DDC) and the list could continue. The main function of HVAC is to maintain indoor air quality and comfort level which is a major consumer of energy sources running the entire building services. Many studies show that 50-70% of the energy is consumed for these purposes. However, employing advance and more flexible control technique reduces energy consumption and optimize the performance of the HVAC regardless of thermal loads acting upon the system.

AHU plays the major task in mechanical regulation of the air coming in and out of the building; and the way the air are conditioned by cooling or heating. This unit is designed to cope with the wide range of the system operating condition as weather and building occupants' activities change significantly and periodically from day to night, and from season to season [1]. Its primary function is achieved by having mixing dampers in the AHU properly modulated (position), as a function of the three main parameters such as the fluid energy or enthalpy (temperature and moisture) at the AHU discharge (supply air to the zones), outside and the return air. Maximizing indoor quality is a process of eliminating contaminants from the air and allowing appropriate amount of air moisture. This process also is handled by mixing dampers.