Academic Year of 2016, Submitted on January 30th, 2017

Graduate School of Science and Engineering, Aoyama Gakuin University

Title: Unified Air-Conditioner Control System and Thermal Discomfort Sensation Estimation with Bio-Information.

Student Name: Yuta SUZUKI
ID Number: 35615139
Degree: Master of Science
Course: Intelligence Information Course
Thesis Advisor: Associate Professor　Guillaume F. Lopez

Abstract

The energy consumption of environmental control heat source to operate comfortably with thermal sensation tends to increase. There is a report that electric power consumed by air conditioning accounts for about 50% of energy sources. In office-owned spaces, the proportion of electric energy consumed by lighting and air conditioning is high. Meanwhile, according to an opinion poll about office environment, 30% of males and 40% of females answered they were dissatisfied with the air conditioning temperature. Such, since the temperature is set without considering the individual discomfort, there is a concern about work efficiency decrease due to thermal discomfort. To reduce thermal discomfort, we propose a system that automatically sets air conditioning temperature based on quantified user's thermal discomfort, together with providing an effective environment for energy consumption.

Verification experiments on the differences in biological information measured in three environments: hot discomfort environment, cold discomfort environment, and comfortable environment have been conducted. It is known that human discomfort is reflected in the activity of the autonomic nervous system. In this research, we evaluate the activity of the autonomic nervous system by measuring electro-cardiogram and respiration signals, from which heart rate variability, expiration time and other evaluation indices were extracted to finally estimate discomfort sensation. We observed which of the calculated indices had the most differences among environments. As a result of experiments with 20 subjects, there were 18 people between cold - comfortable environment, 18 people between comfort and hot environment, 19 people in hot and cold environment, with significant differences in heart rate interval distribution for each environment.

In addition, we formulated the change in the power consumption accompanying the change of the outside / inside temperature when air conditioning is working. By formulating the relation between hygrothermal environment and individual thermal comfort evaluation according experimental results, a simulator to evaluate the relation between individual thermal comfort and air-conditioning energy-consumption has been developed.

Future development will consist in integrating the model of energy consumption according environmental conditions, and the physiological signal based model of individual thermal comfort variations according environmental conditions. By setting a discomfort model for each user and each environment, users could be symbolized by an agent to be used as an input of a distributed constraint optimization problem, such the environment control optimization would consist in minimizing this integrated model.