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# Automatic Control System For Thermal Comfort Robot

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***ABSTRACT :*** For human-centered automation, this study presents a wireless sensor network using predicted mean vote (PMV) as a thermal comfort index around occupants in buildings. The network automatically controls air conditioning by means of changing temperature settings in air conditioners. Interior devices of air conditioners thus do not have to be replaced. An adaptive neurofuzzy inference system and a particle swarm algorithm are adopted for solving a nonlinear multivariable inverse PMV model so as to determine thermal comfort temperatures. In solving inverse PMV models, the particle swarm algorithm is more accurate than ANFIS according to computational results. Based on the comfort temperature, this study utilizes feedforward–feedback control and digital self-tuning control, respectively, to satisfy thermal comfort. The control methods are validated by experimental results. Compared with conventional fixed temperature settings, the present control methods effectively maintain the PMV value within the range of and energy is saved more than 30% in this study.

***Keywords :*** Adaptive neurofuzzy inference system, automatic air conditioning control, particle swarm algorithm, predicted mean vote (PMV), self-tuning control.

## I. INTRODUCTION

Nowadays, most of environmental problems are closely linked to energy consumption. The energy consumed in buildings accounts for 40% of the total energy consumed in the entire world. Moreover, air-conditioning systems consume about 40%–50% of the total electricity use in buildings . Therefore, energy control of air conditioning systems in buildings deserves research. An air conditioning system is composed of a compressor, a condenser, an expansion valve or a capillary tube, and an evaporator. In order to improve efficiency and maintain indoor thermal comfort, a lot of research has been carried out to control compressors control the opening of expansion valves and control fan speeds of air conditioners . For the sake of effectively controlling air-conditioning units, the air conditioners may have to be dissembled and the units of air conditioners may be retrofitted or connected with extra devices by wire connection. The process may be difficult for occupants. In addition, temperature sensors are not always placed at demanded spots around occupants. By contrast, this paper presents a method by means of transmitting the temperature commands via a wireless sensor network to control air conditioner operation for occupants' thermal comfort. The wireless network is also utilized to obtain environment information including the temperature, humidity, and air velocity at spots around occupants. Therefore, using the proposed control setup does not have to change interior devices of existing air conditioners. To evaluate thermal comfort, most of researches have used predicted mean vote (PMV) model as the thermal comfort index and PMV is also adopted by ISO 7730. PMV takes into account six parameters, namely, metabolic rate, clothing insulation, air temperature, mean radiant temperature, air velocity, and humidity. According to these parameters, PMV values represent the extent of thermal sensation. Since the temperature is the primary variable in controlling air conditioners, an inverse PMV model is developed in this study to determine the thermal comfort temperature dealing with desired PMV values and indoor conditions. However, the inverse PMV model is a nonlinear and multivariable model and it is not easy to find the analytical solution of the inverse PMV model.

## II. IMPLEMENTATION

The system is entirely an automated design. The microcontroller plays a vital role in this project. The controlling section will be fixed to the process tank. The controlling contains the microcontroller, the device that will alert the user and the buzzer circuit. Even if the person is not available near the process tank premises, he should get an indication of the temperature and the smoke coming out. Thus, this process should be carried on using wireless communication. GSM is used in this project as an efficient wireless communication.
The microcontroller continuously monitors the temperature and the gas released using temperature sensor and smoke detector respectively. ADC is used to convert the analog temperature value into digital form, which the

microcontroller can understand. Whenever the temperature exceeds the set point or at the time of gases released, the microcontroller detects this and immediately sends this data to the user mobile through modem and at the same time alerts the buzzer. Thus, the user can attend immediately and take the necessary action immediately like start the cooling system or open the valves to let out the gases into air.

Robot exactly, is a system that contains sensors, control systems, manipulators, power supplies and software all working together to perform a task. Designing, building, programming and testing a robot is a combination of physics, mechanical engineering, electrical engineering, structural engineering, mathematics and computing.

The need for a device that can detect and extinguish a fire on its own is long past due. Many house fires originate when someone is either sleeping or not home. With the invention of such a device, people and property can be saved at a much higher rate with relatively minimal damage caused by the fire. Our task as electrical engineers was to design and build a prototype system that could autonomously detect and extinguish a fire. Also aims at minimizing air pollution.

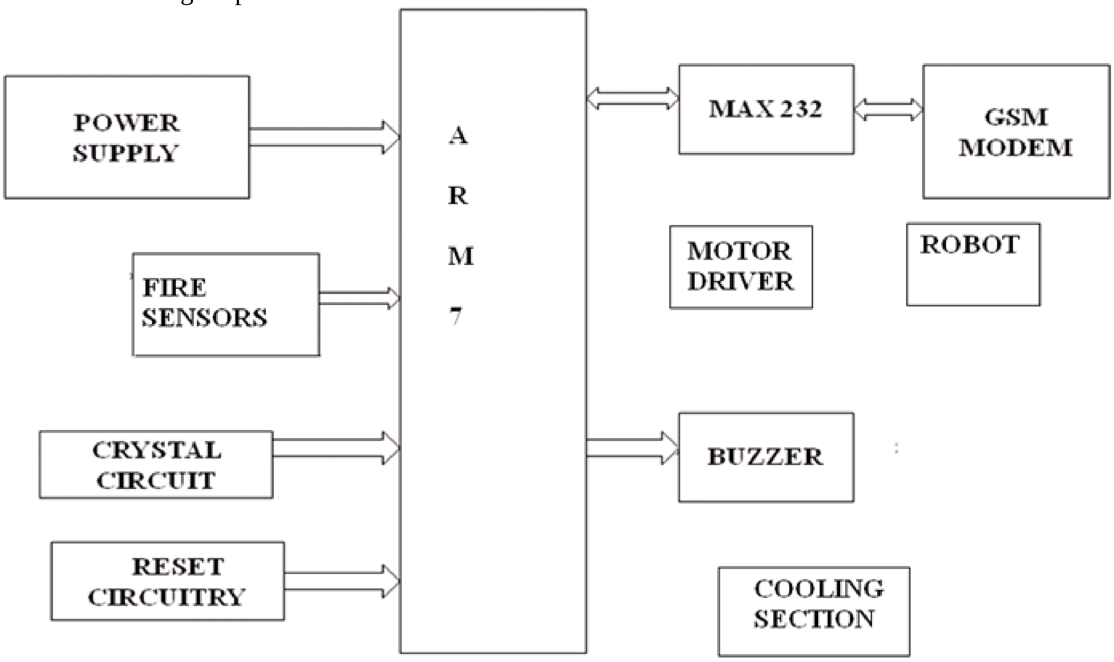


Figure 1: over all implementation

## III. CONTROL METHODS

In order to maintain building occupants' thermal comfort and avoid wasting energy, this study utilizes an inverse PMV model with a feedforward–feedback controller and with a digital self-tuning controller, respectively. The humidity and air velocity measured through the wireless sensor network are used in the inverse PMV model, whereas the measured temperature via the wireless sensor network is used in the feedback controller.

A. Feed forward–Feedback Control

The overall control action that determines the temperature setting equals the sum of the feedforward control output and the feedback control output. The feedforward control simply serves to generate a thermal comfort temperature setting. It is desired that the output value in feedforward control is the same as the thermal comfort temperature evaluated by an inverse PMV model. Therefore, the gain of the feedforward controller is prescribed as 1. However, the temperature sensor that has been embedded in air conditioners cannot reflect the temperature at spots around occupants. Therefore, the feedback controller is responsible for automatically adjusting the indoor temperature, compensating the difference between the temperature measured by wireless sensor network around occupants and the temperature sensed by the air conditioners, and preventing the temperature around occupants from overcooling or overheating. In this study, fuzzy control and Proportional-Integral-Derivative (PID) control are respectively adopted as the feedback controller.

B. PID Controller

A PID controller is the most commonly used feedback controller in industrial processes. Because the control algorithm is implemented by a computer

C. Fuzzy Control

Fuzzy control based on the fuzzy set theory was developed initially by Mamdani . Fuzzy control was also adopted to improve the performance of air conditioning systems .

## IV. EXPERIMENTAL RESULTS

Experiments were performed for four control methods in Taiwan, where the climate is a hot and subtropical humid. The first control method is the conventional method, i.e., fixed temperature setting at 26 C. The other three control methods belong to the inverse PMV model with the feedforward-fuzzy feedback control, with feedforward-PID feedback control, and with digital self-tuning control. The air conditioner is operated to track the thermal comfort temperature by the last three controllers. The inverse PMV model computes thermal comfort temperature in real time based on the desired PMV, measured air velocity, and humidity. In order to ensure PMV in the range of and reduce energy consumption, this study prescribes the PMV input in the inverse PMV model depicted in Fig. 4 as 0.25 in the summer, during which experiments were conducted for 4.5 hours. By contrast, in the winter the PMV input of is suggested due to energy saving consideration. Performances of the four methods are compared based on PMV . The PMV value of the conventional method changes more severely than the other three controllers.The PMV values of the three nonconventional controllers maintain between 0 and 0.5. The three perform better than the conventional method because the inverse PMV model can real time generate proper comfort temperatures, which are in turn continuously tracked by each of three controllers. Furthermore, according to the measured indoor temperature around occupants and the thermal comfort temperature, the three nonconventional controllers appropriately change the temperature setting in the air conditioner, which is equivalent to adjusting cooling capacities at any time

## V. CONCLUSION

Experiments have been carried out by using four control methods. PMV response curves of every controller fluctuates due to 1 C increment of air-conditioner temperature commands. Therefore, it remains to develop methods and devices to maintain PMV near 0 and smooth responses while saving energy. In addition, since the comfort range of PMV may vary with different people's feeling, it may be required to modify the comfort range of PMV according to the questionnaire of occupants' preference or develop other thermal comfort indices for occupants. In this study, the values of the metabolic rates and the clothing insulation are assumed as constants. For accurate estimation, the clothing insulation can be determined by measurement on heated mannequins, and the metabolic rates can be estimated from measuring CO and O in a person's expired air.
Moreover, human activity changes with time. However, estimating metabolic rates and clothing insulation is not trivial. Therefore, it is desired in future work to devise wearable or non-contact sensors to measure the values of metabolic rates and clothing insulation and improve the human factor measurement process.

## REFERENCES

[1] B. Sun, P. B. Luh, Q. S. Jia, Z. Jiang, F. Wang, and C. Song, "Building energy management: Integrated control of active and passive heating, cooling, lighting, shading, and ventilation systems," IEEE Trans. Autom. Sci. Eng., vol. 10, no. 3, pp. 588–602, Jul. 2013.

[2] C. B. Chiou, C. H. Chiou, C. M. Chu, and S. L. Lin, "The application of fuzzy control on energy saving for multi-unit room air-conditioners," Appl. Therm. Eng., vol. 29, no. 2, pp. 310–316, 2009.

[3] X. D. He, S. Liu, H. H. Asada, and H. Itoh, "Multivariable control of vapor compression systems," HVAC&R Res., vol. 4, no. 3, pp. 205–230, 1998.

[4] N. Jain, B. Li, M. Keir, B. Hencey, and A. Alleyne, "Decentralized feedback structures of a vapor compression cycle system," IEEE Trans. Control Syst. Technol., vol. 18, no. 1, pp. 185–193, Jan. 2010.

[5] D. P. Finn and C. J. Doyle, "Control and optimization issues associated with algorithm-controlled refrigerant throttling devices," ASHRAE Trans., vol. 106, no. 1, pp. 524–533, 2000.

[6] T. J. Yeh, Y. J. Chen, W. Y. Hwang, and J. L. Lin, "Incorporating fan control into air-conditioning systems to improve energy efficiency and transient response," Appl. Therm. Eng., vol. 29, no. 10, pp. 1955–1964, 2009.