IMPROVEMENT OF AN ENERGY AND ECONOMIC ASSESSMENT OF AN AUTOMATED CONTROLLER OF AIR CONDITIONER

This report is submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering (Hons.)

by

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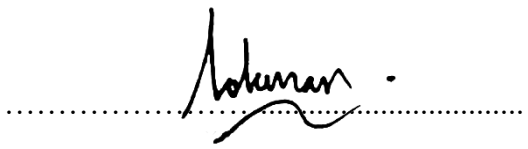
APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Bachelor Degree of Manufacturing Engineering (Hons). The member of the supervisory committee is as follow:



(Ir. Dr. Lokman Bin Abdullah)

ABSTRAK

Hari ini, masalah penggunaan tenaga adalah kritikal kerana salah satu sebab berlakunya peningkatan pemanasan global. Pelepasan gas rumah hijau dan kesan persekitaran global disebabkan penggunaan tenaga yang tinggi. Kerana kapasiti elektrik yang tinggi dan waktu penggunaan yang tidak terkawal, sistem penyaman udara adalah faktor terbesar penggunaan tenaga untuk peralatan elektrik di Malaysia. Untuk mengatur dan mengekalkan suhu persekitaran secara automatik, oleh itu projek ini bertujuan untuk menghasilkan pengawal suhu automatik bagi penghawa dingin. Di samping itu, pengawal suhu automatik ini mengurangkan penggunaan tenaga dan mengurangkan kos elektrik bagi pengguna. Selain itu, pengawal suhu ini mempunyai ciri kawalan suhu automatik bagi penggunaan penghawa dingin asas. Komponen elektrik seperti mikrokontroler dan sensor suhu digunakan dalam projek ini untuk mengukur suhu persekitaran sebelum mengawal sistem suhu penghawa dingin. Eksperimen dilakukan dan data suhu persekitaran dikumpulkan mengikuti perkembangan pengawal. Hasil eksperimen menggunakan algoritma Kawalan Logik Fuzzy untuk pengawal suhu automatik menunjukkan bahawa penggunaan tenaga penghawa dingin lebih efektif dengan 7605 Wh, berbanding 7991.1 Wh pengawal suhu automatik menggunakan algoritma If-Else dan 9360 Wh pengawal suhu manual. Hasil kajian menunjukkan bahawa pengawal suhu automatik algoritma Kawalan Logik Fuzzy ini merupakan penggunaan elektrik terendah dan penilaian eksperimen paling ekonomi. Kesimpulannya, alat kawalan suhu automatik telah dikembangkan yang menampilkan suhu lingkungan dan suhu penghawa dingin di mana sistem ini dapat memantau dan mengatur suhu demi kecekapan tenaga.

ABSTRACT

Today, the energy consumption issue is critical because it is one of reasons causing increases in global warming. Greenhouse gas emissions and global environmental effects result in a high energy consumption. Because of its high electricity capacity and unregulated usage time, the air conditioning system is the biggest factor of energy consumption for electrical appliances in Malaysia. In order to automatically regulate and maintain the ambient temperature, the project therefore aimed to create an automatic temperature controller for air conditioner. In addition, this automated temperature controller reduced energy consumption and decreased electricity cost for users. Additionally, this temperature controller has an automatic temperature control feature with use on basic air conditioner. Electrical components like the microcontroller and temperature sensor were used in this project to measure ambient temperature before controlling the system of air conditioning temperature. The experiments are performed and ambient temperature data is collected following the development of the controller. The results of the experiment using the Fuzzy Logic Control algorithm for the automatic temperature controller show that the energy consumption of the air conditioner is more effective with 7605 Wh, compared to 7991.1 Wh of the automatic temperature controller using If-else algorithm and 9360 Wh of the manual temperature controller. The findings show that this Fuzzy Logic Control algorithm automatic temperature controller is the lowest electrical consumption and the most economic assessment of the experiment. In conclusion, an automatic temperature control device has been developed that displays the ambient temperature and air conditioner temperature where this system can monitor and regulate the temperature for the sake of energy efficiency.

DEDICATION

Only

my beloved father, Ahmad Fauzi Bin Md. Arif

my appreciated mother, Hanisah Binti Yasin

my adored brother, Muhammad Fahimi Hariz Bin Ahmad Fauzi

for giving me moral support, encouragement and also understandings

Thank You So Much

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LIST OF ABBREVIATIONS

AC	-	Air Conditioner
CFC	-	Chlorofluorocarbons
CPU	-	Central Processing Unit
EER	-	Energy Efficiency Error
FLC	-	Fuzzy Logic Control
FYP	-	Final Year Project
GND	-	Ground
HFC	-	Hydrofluorocarbons
I/O	-	Input/Output
IoT	-	Internet of Things
IR	-	Infrared
LED	-	Light-Emitting Diode
OLED	-	Organic Light-Emitting Diode
PID	-	Proportional-Integral-Derivative controller
PLC	-	Programmable Logic Controller
RF	-	Radio Frequency
RM	-	Ringgit Malaysia
RTD	-	Resistance Temperature Detectors
SDA	-	Serial Data
SCL	-	Serial Clock

SD	-	Storage Device
TSOP	-	The Sound of Philadelphia
Vcc	-	Voltage Common Collector

LIST OF SYMBOLS

°C	-	Degree Celsius
°F	-	Fahrenheit
%	-	Percentage
Btu	-	British Thermal Units
GB	-	Gigabyte
Hz	-	Hertz
kWh	-	Kilo-Watthours
W	-	Watt
Wh	-	Watt-Hours

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Many cities in Southeast Asia, are well-known for their hot-humid climate. Traditional Malay houses used lightweight materials such as wood and thatch for their construction to cope with this climate situation. Therefore, the house is usually cooled by natural ventilation. However, in urban areas, these traditional Malay houses are hardly seen, although many still exist in rural areas. Modern houses commonly used brick and concrete for their construction in Malaysian urban areas nowadays. According to the national census (Malaysia, 2000), 85% of existing housing stocks in urban areas are brick or brick and plank houses. In contrast to the traditional wooden house, this modern house basically requires air conditioning to deal with local tropical climate. Moreover, national census results (Malaysia, 2000) showed a significant increase in the total number of households with air-conditioning in Malaysia from 13,000 in 1970 (0.8%) to 229,000 in 1990 (6.5%) and 775,000 in 2000 (16.2%) (Kubota et al., 2011).

During the design of the improved air conditioning system, the modelling design of automatic control system must be considered. Essentially, the use of an automatic controller avoids air-conditioning inefficiency (Lizawati binti Jaafar, 2013). An automatic control system allows for maximum dynamic system performance,

enormous productivity increases, and prevents from performing the same task repeatedly. In example, a simple manually operated heating room. Control of electrical heating system current is necessary in order to maintain the desired temperature. User requires to periodically monitor and change the rheostat to maintain the temperature indicated by a thermometer. Apart from using the manual controller, the same process of calculating the temperature, estimating the error between the desired temperature and the actual temperature, this automatic controller can be used to precisely shift the rheostat arm. Since error is continuously obtained between the actual temperature and the desired temperature, it will be automatically taken care of to preserve preferred temperature (Subham, 2015).

Examine the speed control mechanism in a car as an example to gain some insight into the operation of an automatic control system. The driver typically needs to observe the speed meter and properly increase or decrease the fuel flow to the engine by using the gas pedal to keep the speed. While an automatic speed control system, also known as cruise control, operates by using the error between the actual and desired speed and the car's response information to increases and decreases in fuel to be calculated via an appropriates gas pedal location algorithm. Thus, drive the velocity error to zero. This decision process is referred to as a law of control and is implemented in the controller. There are, of course, many automatic control systems in the automotive industry today, such as the anti-lock brake system (ABS), emission control and tracking control (Leach, 2008).

Another automatic control such as machine vision, is an automatic extraction of information from digital images for process or quality control. This machine vision mostly used by manufactures because it is better suited to repetitive inspection tasks compared to human inspectors. It is quick, more objective and works continuously. Machine vision is capable to inspect hundreds or even thousands of parts per minute. Thus, more consistent and reliable inspection results can be obtained. Common applications for machine vision in manufacturing today are measurement, counting, location and decoding. By overcome defects, increasing yield, facilitating compliance

with regulations and tracking parts using machine vision, manufactures can reduce cost and increase profitability (Rosenfeld, 1985).

After all, the automatic controller available nowadays is effective to replace all manual tasks done by human. This can help to increase the standard level of a human's daily life and save time.

1.2 Problem Statement

Air conditioner is a device which helps to cool and provide humidity in obtaining comfort interior surroundings either for building or vehicle in improving thermal comfort and indoor air quality (Ahmad et al., 2018). As result caused by varying and changes on short intervals weather, the external conditions always have an influence on the indoor condition. Maintaining an ambient temperature of a room is quite challenging as current temperature control system required user to manually adjust the system whenever the external condition change. This is very tiring and challenging especially for disabled people as they might have some difficulties to control the temperature because this system requires used of physical contact or some hand remote device to operate them. To improve way in controlling current system, an automatic temperature control system needs to be put in place (Zungeru et al., 2018).

Room temperature apparently give impact to several human responses, including thermal comfort, perceived air quality, sick building syndrome symptoms and performance at work. A study investigating effect on task performance in office environment has shown that temperature could influence the productivity. There is performance increases with temperature up to 21-22°C, and productivity decreases with temperature above 23-24°C whilst the highest productivity is at temperature of around 22°C. A relation between performance and temperature shows a decrease in

performance by 2% per °C increase of the temperature in the range of 25-30°C, and no effect on performance in temperature range of 21-25°C (Seppänen et al., 2006). This study proves how important an ambient temperature can affect human responses.

Previous study on household energy consumption in residential buildings of Malaysia showed that electrical consumption caused by air conditioner recorded the largest amount among household appliances. Moreover, the air conditioner ownership in Malaysia is 65% and its daily use time was 6 hours on average (Kubota et al., 2011). With the frequent and uncontrolled use of air conditioners, electrical power consumption is simultaneously increased as it consumes a large proportion of energy. Not only it increases energy consumption, but also depletes finite resources such as fossil fuels.

To sum up, the main problems generated by the air conditioner are mentioned above. The uncontrolled use of air conditioner can give an impact to the environment and the nature of earth. The common system also does not have the capacity to modify the room temperature regardless of the ambient temperature. To address the problem, an automatic controller of air conditioner is developed to identify the ambient temperature and feedback the signal to adjust the temperature of air conditioner. The advantages of such a system are less energy usage and help to replace manual task by a human to control the temperature.

1.3 Objective

The objectives of this report are as follows:

i. To develop an automatic temperature controller that able to maintain an ambient temperature of 22°C.

ii. To increase energy efficiency of an automatic temperature controller.

iii. To compare and analyse the energy consumption between two different algorithm of an automatic temperature controller namely If-else algorithm and Fuzzy Logic Control algorithm.

1.4 Scope

The automatic temperature controller can be universally commercialized and used by consumer either for household, company or laboratory. Despite, the controller might have some limitations to work well under some condition.

This report basically focuses on the non-inverter split type air conditioner of specific brand which has its own IR receiver to allow the setting of the temperature. This means that the automatic temperature controller might not compatible on certain air conditioner. IR blaster in controller will transmit the signal to IR receiver of the air conditioner by using the programming code in the microcontroller. Without IR blaster as a central air conditioner, the air conditioner unable to detect and receive the signal transmitted from the IR blaster.

Apart from that, this automatic controller should only operate in close area rather than in open area. Close area such as laboratory, classroom or small lecture hall are relevant to place the automatic controller due to low temperature loss and the ambient temperature can be maintained in that area. If the automatic controller works in open area, it will have difficulty to achieve the desired temperature due to loss of the temperature though temperature sensor can still sense the temperature in that area.

Evaporator coil, blower fan, compressor, and condensing coil are the main components in air conditioning system. Throughout this project, the focus is only on the application of the compressor in the air conditioning system which affects the room temperature.

Thus, in developing an automatic temperature controller, a specific brand of split type air conditioner with its IR receiver and the temperature sensor should be used and will operate in close area for better performance and accurate result.

1.5 Significant of Study

The significance study for this project is to investigate the importance of automatic control. Maintaining an ambient temperature of a room is quite challenging as current temperature control system in air conditioner required user to manually adjust the temperature by using a remote control. This project works through innovation using technology and electrical knowledge with aid of the microcontroller, sensor, IR blaster and RF module replacing manual adjustment temperature controller of the air conditioner.

In this project, researches on advantages and disadvantages in developing an effective and smart temperature controller for air conditioner is carry on. The purpose of this automatic temperature controller is it able to detect the ambient temperature and maintain it. This control system helps to reduce energy consumption, hence lessen the emission of greenhouse gasses which can harm the ozone layer.

Nonetheless, there is some difficulties in developing the automatic temperature controller. The understanding in programming code is important to develop the system