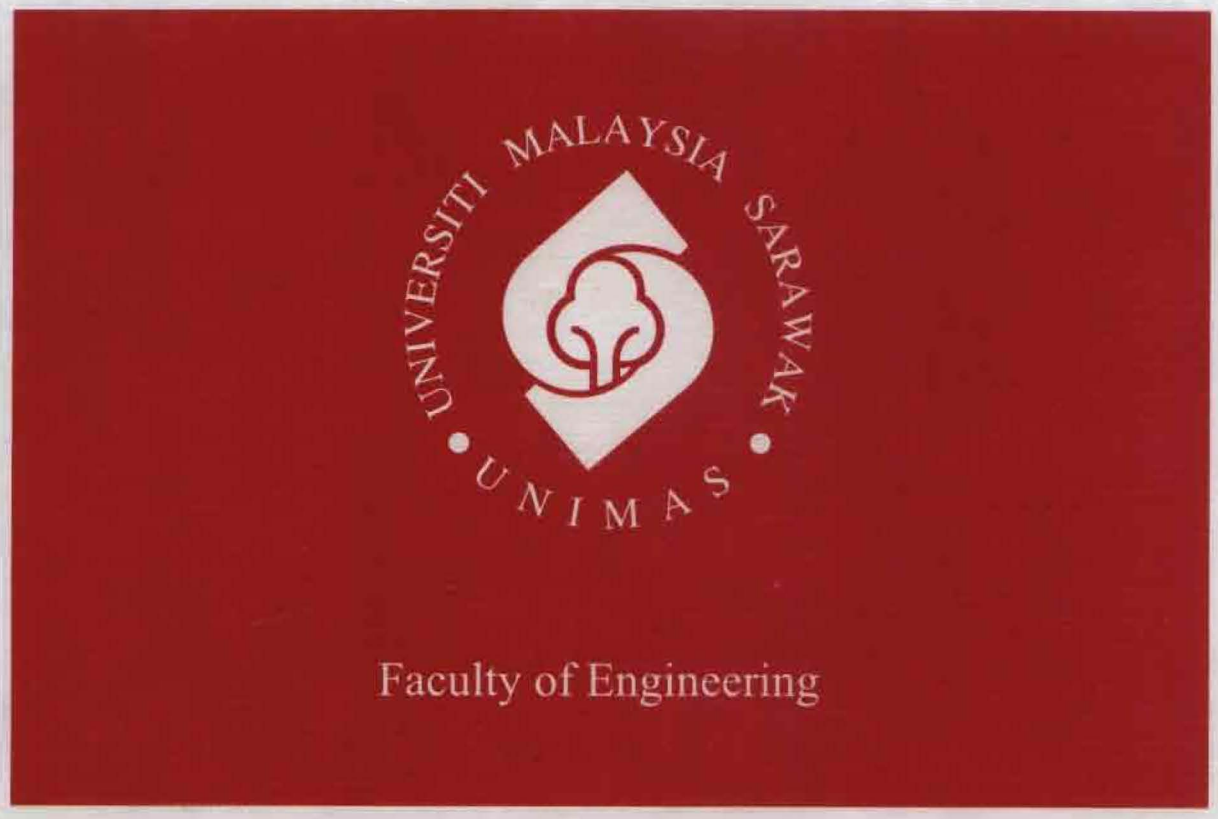

ADAPTIVE LOW-COST HOME COOLING SYSTEM

Chua Chee Kiong

Bachelor of Engineering with Honours
(Electronic and Computer Engineering)
2011/2012

UNIVERSITI MALAYSIA SARAWAK

Grade: _____

Please tick (√)

Final Year Project Report	√
Masters	
PhD	

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This declaration is made on the 7 day of July 2012.

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Date submitted

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I DR. WAN AZLAN BIN WAN ZAINAL ABIDIN (SUPERVISOR'S NAME) hereby certifies that the work entitled ADAPTIVE LOW-COST HOME COOLING SYSTEM was prepared by the above named student, and was submitted to the FACULTY OF ENGINEERING as a full fulfillment for the conferment of Bachelor of Engineering with Honours (Electronic and Computer Engineering) and the aforementioned work, to the best of my knowledge, is the said student's work.

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ADAPTIVE LOW-COST HOME COOLING SYSTEM

CHUA CHEE KIONG

This project is submitted in partial fulfillment of the requirements for the degree of

Bachelor of Engineering with Honours

(Electronic and Computer Engineering)

Faculty of Engineering

UNIVERSITI MALAYSIA SARAWAK

2011/2012

Dedicated to my beloved family and friends

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ABSTRAK

Penduduk Malaysia sentiasa mengalami ketidakselesaan termal di tempat tinggal mereka terutamanya rumah yang berkos rendah kerana Malaysia mengalami ciri-ciri iklim khatulistiwa, iaitu suhu yang tinggi dan seragam serta kelembapan yang tinggi. Jadi, tempat tinggal mereka amat memerlukan sistem penyejukan supaya dapat mencapai tahap keselesaan termal. Sistem penyejukan yang dapat memberikan penjimatan tenaga elektrik, kesan keselesaaan termal, dan berkos rendah menjadi keutamaan. Objektif kajian ini ialah menghasilkan sistem penyejukan yang sesuai untuk rumah yang berkos rendah dan sistem yang dapat mengawasi bacaan suhu and kelembapan dalam rumah. Fokus kajian ini ialah penggunaan rekaan litar sensor, rekaan litar sistem pengawalan dengan *Programmable Integrated Circuit* (PIC), rekaan sistem penyejukan, dan rekaan perisian untuk tujuan pengawasan. Apabila keadaan ketidakselesaan terma berlaku di rumah yang berkos rendah, sistem yang direka dapat mengaktifkan teknologi sistem penyejukan secara automatik dan ia dikawal oleh litar pengawal sensor dan program pengguna grafik yang boleh mengekalkan keadaan keselesaan terma dalam persekitaran rumah yang berkos rendah dengan suhu udara dalam julat daripada 26.0 °C kepada 30.7 °C dan kelembapan relatif adalah sentiasa lebih tinggi daripada 70.0%.

ABSTRACT

Malaysia's citizen is experiencing thermal discomfort in their homes, particularly low-cost houses because Malaysia experience the equatorial climate with high and uniform temperature as well as high humidity. So, they are in dire need of cooling system in their home to achieve the level of thermal comfort. Cooling system which can provide energy savings, the effect of thermal comfort, and low price are preferable. Thus, objective of the study is to develop a suitable cooling system for low-cost house and a system to monitor the temperature and humidity data inside the house. The focus of this study is the implementation of hardware by using sensor circuit, Programmable Integrated Circuit (PIC) circuit as controller system, cooling system, and the implementation of the software for monitoring system. When the thermal discomfort condition occurs in the low-cost house, the developed system is able to activate the cooling system technology automatically and it is controlled by a sensor controller circuit and Graphical User Interface program (GUI) that can maintain the thermal comfort condition in the environment of low-cost houses with the air temperature in the range of 26.0 °C to 30.7 °C and relative humidity is always higher than 70.0%.

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AC	-	Alternating current
ADC	-	Analog to digital converter
ASHRAE	-	American Society of Heating, Refrigerating and Air Conditioning Engineers
a.m.	-	Ante meridiem
CIBSE	-	Chartered Institution of Buildings Services Engineers
CIS	-	Construction Industry Standards
clo	-	Average clothing
DC	-	Direct current
ET	-	Effective temperature
ft^2	-	Square feet
GUI	-	Graphical user interface
HID	-	Human Interface Device
ID	-	Instruction detection
I/O	-	Input or output
ISO	-	International Standard Organization
ISO 7730	-	Thermal comfort standard
kΩ	-	Kilo ohm
m	-	Meter
m^2	-	Square meter
met	-	Metabolic rate
MRT	-	Mean radiant temperature

ms^{-1}	-	Meter per second
NEP	-	New Economy Policy
°C	-	Degree Celcius
PC	-	Personal computer
PIC	-	Programmable Integrated Circuit
PMV	-	Predicted Mean Vote
p.m.	-	Post meridiem
SLCHP	-	Special Low Cost Housing Programme
SMS	-	Short Message Service
µF	-	Micro farad
USB	-	Universal serial bus

CHAPTER 1

INTRODUCTION

1.1 Project Overview

Malaysia is one of developing countries in Asia and the government mainly focuses on development programme in the country. Since 1971, Malaysian government had introduced low-cost houses under New Economic Policy (NEP) by ex-prime minister, Allahyarham Tun Abdul Razak [1]. Thus, the policy of low-cost houses which known as Special Low Cost Housing Programme (SLCHP) is one of the main agenda for government to fulfill the housing demands of the citizens [2]. The purpose of this program is to provide Malaysian, particularly the low-income categories, accessibility to adequate and affordable housing.

Low-cost house is a popular political agenda worldwide because it related to social economic stability and implication in a country [3]. The cooperation of Malaysian government and private developers sectors in development of low-cost house is to provide Malaysian, particularly the low-income categories, accessibility to adequate and affordable housing [4].

Although Malaysian government has work towards providing an adequate and affordable housing to the citizens, but most of the citizens still face some issues and challenges especially for low-cost houses. As an example, many low-cost houses are built without consideration on the issues such as thermal comfort and air ventilation inside the building.

The aim of this project is to design adaptive cooling system for low-cost houses. The designed cooling system is intended to reduce home temperature especially during daytime and maintain the thermal comfort in environment of low-cost houses. With adaptive system construction, graphical user interface (GUI) program is designed to control and monitor the cooling system technology though sensor controller circuit.

1.2 Problem Statements

Malaysia is one of developing countries in Asia which situated within the equatorial zone of the earth. The weather in Malaysia benefits from a tropical climate with high temperature and high humidity throughout the year. From *Annual Summary of Meteorological Observation* of Malaysia Meteorological Department, the weather temperatures are relatively uniform with average temperatures between 23.7°C to 31.3°C and the average relative humidity is in the range of 67.0% to 95.0% throughout a day [5]. Then, it may have an adverse impact on occupant in thermal comfort of environment. Additionally, most of modern buildings in country which is warm and humid climate have adverse effects on human discomfort [6].

The total population in Malaysia was 23 million persons in 2000 increased to 28 million persons in 2010 [7]. It proven that Malaysia is undergone a rapid growth of population and would causes the issues of housing shortage. Due to high demand of low-cost houses and low-cost houses are built with less profit, some irresponsible housing developers have built these houses without consideration of ventilation condition and air filtration for low-cost houses. Other than that, the competition among the housing developers, they prefer the design of houses that simple and faster to construct, and uncomplicated materials. Furthermore, the house owners mostly focus on the affordable prices and compound of the house when they buy low-cost houses. Then, the issues of thermal discomfort in environment would be noticeable after the house owners have occupied the houses.

Therefore, the occupants would find the solutions to achieve the level of thermal comfort in their houses. Since they are from low-income categories and their budgets are limited, they would not renovate their house to improve the air circulation in the house. Moreover, the installation of air-conditioning also is not their best solution because it increases their living cost and it is a burden for them. The impact of air conditioning on electricity demand is a significant problem since the peak electricity loads are increasing continuously [8]. Then, the design of this project is best solution for them to achieve the thermal comfort in the houses.

1.3 Project Objectives

The aim of this project is to design adaptive cooling system for low-cost houses. The objectives of this project are:

- To recognize and explore the issue and thermal comfort of low-cost house
- To design a sensor system for adaptive cooling system to measure the accuracy data
- To design an adaptive cooling system technology such that operation of the technology can be controlled by the sensor in low-cost house
- To design a monitoring system through graphical user interface (GUI) program for collecting the accuracy data in low-cost house

1.4 Expected Outcomes

According to this project, the main expected outcome is to develop a flexible and convenience cooling system technology. The designed cooling system is intended to reduce home temperature and humidity during daytime and maintain thermal comfort inside the low-cost houses. By mean of adaptive cooling system, the operation of the cooling system is controlled by GUI program though sensor controller circuit.

For controller system construction, sensor controller circuit that consists of microcontroller and sensors is designed. The purpose of designed circuit is to control and monitor the cooling system. Furthermore, the readings of temperature and

humidity would be received and sensed by sensors. The microcontroller converts analog input to digital output for GUI.

Other than that, sensor controller circuit should integrate with PC by serial port or *Universal Serial Bus* (USB) port method. The accurate data of air temperature and relative humidity would be presented by GUI program which is developed in Microsoft Visual Studio edition 2008 software. At the same time, the cooling system can operates properly and maintain the thermal comfort inside the house while temperature and humidity value out of the thermal comfort range. Overall, this project must be done with the cooling system technology, sensor controller circuit, and GUI program.

1.5 Report Outlines

This final year project report consists of five chapters. Chapter 1 gives an introduction of the entire project of adaptive low-cost home cooling system. At the same time, the objectives of this project also included. The problem statements and expected outcomes would be explained.

Chapter 2 gives a review of literature for issues and thermal comfort of low-cost house, and principles of cooling system. The theory of designed system is mentioned.

Chapter 3 explains the methodology during the project. The hardware and software designs are also discussed. It covers the flowchart of each sub-system of this project. The relevant components and software to be used are mentioned as well.

Chapter 4 discusses the architecture of controller system, data measurement system, and cooling system. The progress of system integration is explained in this chapter. The discussion and analysis on the result of air temperature and relative humidity readings are also done in this chapter.

Chapter 5 covers the conclusions for this project and some recommendations for implement of this project are included as well.