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Device development for ceiling fan with sensor technology
to reduce energy consumption at home / Shaharrudin
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**DEVICE DEVELOPMENT FOR CEILING FAN
WITH SENSOR TECHNOLOGY TO REDUCE
ENERGY CONSUMPTION AT HOME**

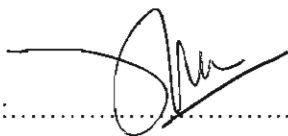
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JUNE 2012

"I hereby declare that I have read through this report entitle "Device Development For Ceiling Fan With Sensor Technology To Reduce Energy Consumption at Home" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Mechatronics with Honours"

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I declare that this report entitle "Development of Intelligent AC Ceiling Fan with Sensor Technology to Reduce Energy Consumption at Home" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature

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Name

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Shaharrudin bin Hj Syahid

Date

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25/6/2012

Dedicated, in thankful appreciation for support, encouragement and understandings to my beloved mother and family.

ACKNOWLEDGEMENT

Alhamdulillah, with the patience, strength and wisdom that has been given to me by ALLAH, I eventually manage to complete my final year project. This project has widen my view and given me opportunities to apply my knowledge and skills that I have learnt during 4 years study of Mechatronic course.

First of all I would like to thank to my parents, HJ Syahid Bin Abd. Rahman and Nasifa Binti Muhamad and other family members who nonstop supporting me. They are always with me when the time I need help. I will never forget all their contribution and especially in financial aspect. Without them I will not complete my project.

In order to complete my project, I had done a lot of studies and researchers from various types of sources. I explored many journals, books, article and internet sources to get larger view of my project and add more understanding of my project. Besides that I had consulted with many people, researchers and academician in order to make my project successful. They have contributed a lot towards my understanding.

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Last but not least, I would like to say thank to all my friends who always support me and sincerely sharing knowledge and view. All the assistances and advices are really appreciated and will be remembered always.

Thank you.

ABSTRACT

This project focuses more toward conservation of energy. This project is about improvement made to an ordinary AC ceiling fan by integrating it to the microcontroller as the main system so that it can use temperature sensor as the main speed controller. The fan will intelligently interact with the surrounding temperature change to control the speed of the fan. When in cold condition the speed of the fan will be in slow motion but still capable to cooling the room area. Then when the weather is hotter the speed of the fan will increase to the most suitable speed to maintain the room temperature area to make the user always feel comfortable and easy. User can choose whether to control the fan manually or automatically.

In this project the saving energy aspect focuses at night. As we know at night temperature is gradually decreasing from 12.00 pm until 7.00 am. Regularly user will set a certain speed to the ceiling fan at night before they get in to the bed. The power use by the fan is constant, since mostly we will not get up while in sleep time, thus we will not decrease the power consumption by decreasing the speed of the fan. With universal Smart Fan Controller AC fan concept power can be reduced a lot since the temperature at night is gradually decreasing. So the fan speed is also decreasing means the power consume by the fan is reduced. Intelligent aspect of the project is when the temperature sensor can read immediate surrounding temperature and feed it to the microcontroller. Then the fan will rotate according to signal sent by microcontroller. Due to the intelligent aspect of this system the energy consumption could be reduce from the usual type of ceiling fan.

From the results of the project it is proven that the hardware can reduce the power consumption up to 27%. So there is high improvement in term of energy saving after installation of the device. Beside the energy reduce it's improve the quality of sleep at night since the device control the speed of the fan and user will get the most suitable ambient temperature at night during sleep according to the temperature read by the temperature sensor.

ABSTRAK

Projek ini lebih tertumpu kearah penjimatan tenaga. Projek ini adalah penambahbaikan yang dibuat kepada kipas siling AC dengan mengintegrasikan mikropengawal sebagai system utama supaya ia boleh menggunakan sensor suhu sebagai pengawal kelajuan utama. Kipas pintar akan berinteraksi dengan perubahan suhu persekitaran untuk mengawal kelajuan kipas. Apabila dalam keadaan sejuk kelajuan kipas akan dalam kelajuan perlahan tetapi masih mampu untuk menyejukkan kawasan bilik. Kemudian apabila cuaca panas kelajuan kipas akan meningkat dengan kelajuan yang paling sesuai untuk mengekalkan suhu persekitaran bilik supaya pengguna sentiasa berasa selesa dan nyaman. Pengguna boleh memilih sama ada untuk mengawal kipas secara manual atau secara automatik.

Dalam projek ini, aspek penjimatan tenaga tertumpu pada waktu malam. Seperti yang kita tahu pada waktu malam suhu beransur-ansur menurun dari jam 12 malam hingga ke 7 pagi. Pengguna akan menetapkan kelajuan tertentu pada waktu malam sebelum mereka tidur. Penggunaan kuasa kipas adalah malar, oleh kerana pengguna sering tidak terjaga ketika sedang nyenyak tidur, mereka tidak akan mengurangkan kelajuan kipas. Dengan Universal AC Smart Fan Controller penggunaan tenaga boleh dikurangkan kerana suhu pada waktu malam adalah beransur menurun. Jadi putaran kelajuan kipas juga berkurangan, bermakna penggunaan tenaga kipas dapat dikurangkan. Aspek pintar projek ini ialah apabila sensor suhu boleh membaca suhu persekitaran dan menghantar signal kepada mikropengawal. Kemudian kipas akan berputar mengikut isyarat dihantar oleh mikropengawal. Dengan aspek pintar system ini, penggunaan tenaga boleh dikurangkan.

Daripada keputusan projek terbukti bahawa perkakas ini boleh mengurangkan penggunaan tenaga sehingga 27%. Jadi terdapat peningkatan yang tinggi dari segi penjimatan tenaga selepas pemasangan alat ini. Selain tenaga dikurangkan, ia meningkatkan kualiti tidur pada waktu malam sejak ia mengawal kelajuan kipas dan pengguna akan mendapat suhu yang paling sesuai pada waktu malam semasa tidur mengikut suhu yang dibaca oleh sensor suhu.

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LIST OF ABBREVIATIONS

AC	-	Alternating current
DC	-	Direct current
LED	-	Light Emitting Diode
RTD	-	Resistance Temperature Detector
PCB	-	Printed Circuit Board

CHAPTER 1

INTRODUCTION

1.1 Problem statement

Nowadays there are many issues faced by Malaysian. First is tariff electricity is increased currently, it's burden the low income family in their everyday life. So this will affect their quality of life and their quality of work, thus indirectly will slow down the country's development.

Facts that we cannot escape is energy wasted a lot during sleep time at night by using ceiling fan. It is because the temperature at night until morning is decreasing; at the beginning before sleep, user will use the highest speed of the fan to cool down the room temperature. Normally user will forget and will not wake up while sleeping to decrease the fan's speed although the ambient temperature is at low speed. As speed of the motor rotating constant at high speed it will consume more power, thus create more power waste.

Indirectly power waste also create environment defect and create green house effect. The power production in Malaysia still using charcoal, more undesired gasses will be released during the production thus contaminate the air. It will affect the people health and create more diseases.

Fan controlling method today still use manual operation. User has to change the speed manually. So it will give problem for disable people and kids. Usually the ceiling fan regulator is placed at the middle of the wall so it is hard for those do not have enough tall to reach the regulator.

1.2 Project objective

The objectives of this project are:-

1. To develop a universal controller for conventional for AC ceiling fan capable of controlling the speed automatically based on the ambient temperature.
2. To analyze the energy consumption by using the standard AC ceiling fan and smart sensor plan.

1.3 Project scope

1. Develop a microcontroller based system that control ceiling fan using temperature sensor.
2. Analysis and experiment will be conducted in laboratory. The result will be compared to the initial power usage of the AC ceiling fan.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Recently on July 15 2011 we have been announced about the increase in the power tariff in Sabah and Labuan to go up by 15% [1]. These phenomena will affect our people daily activities. They are trying to use as less as possible energy to keep the daily works run as usual and will not waste their money. In our country we can see our people still lack awareness about energy saving.

Today, our country is going forward in creating green technology. In Malacca as example, the state already starts the step in going to greener environment. Solar technology is widely use and the government has invested a lot to get the objective of green state achievable. By year 2020 we can imagine how less energy wasted if we implement such technology.

Energy saving sometimes called efficiency energy use is using the same level of performance, comfort, and convenience. For example, an energy efficient compact fluorescent light bulb (CFL) uses 85% less energy than conventional incandescent bulb to produce the same amount of light. Thus much more energy efficient or energy saving and will use less power electricity. In general, efficient energy use is achieved by using more efficient technologies or process rather than changing human behavior [2].

The global warming also arouse the awareness of public in energy saving. Therefore new energy saving technologies is appearing and developing rapidly, at the same time energy regeneration or alternative technology is developing in large scale [3].

Basically energy problem can be classified into the following three solutions in general: energy saving, energy searching and energy recycles. Energy saving is an important item among the concept of environmental protection, economy and improved science and technology [3].

At the industry level, since our country is developing country many mega industries company have been based here by foreign company. There is lots of energy wasted that happen and trapped in our environment which lead to unhealthy life for our people. Carbon dioxide largely released to the atmosphere without control. For long term that can leads to

undesired phenomena to happen such acid rain, flood, landslide and others. Many devices invented to reduce all the waste in energy such power factor and inverter technology.

At the domestic level energy wasting also largely occurs everywhere. Energy is wasted although nowadays many technologies invented to reduce the power usage at home, especially home appliances. Energy efficient home is a home that uses less energy and is more comfortable and healthier than before. With today's technologies and professional services, just about every home's energy use can be improved in affordable way [2]. Many home appliances has been improved such voltage step-down ballast, voltage controller and others.

Table 2.1: Energy consumption by building type in Malaysia 2005(%) [4]

	Residential	Hotels	Shopping Complexes	Offices
Lighting	25.3	18.0	51.9	42.5
Air Conditioning	8.3	38.5	44.9	51.8
Total	33.6	56.5	96.8	94.3

The breakdown of energy used for lighting and air conditioning is shown in the table 2.1. More than half of the total energy used in commercial buildings is for lighting and air conditioning [12]. From the table we can say that residential usage contributes a quite high number in energy consumption in our country. So education and training should emphasized on effective public awareness on energy issue such energy saving and the use of renewable energy.

This chapter will discuss about the article that may related to the project. It is consisting of the products that are developing by institution before this project and some of them have been invented and available in the market. There are various ways to reduce power consumption at home from the usual method to the high technology method.

2.2 Alternating Current (AC) vs. Direct Current (DC)

There are two different ways that electricity is produced, and they are used widely in most cases for different purposes. They can be converted from one form to another.

The first type of electricity is called direct current, abbreviated as "DC". This type of electricity commonly used in many low-voltage applications, where they are powered by batteries which can produce only DC or solar cells power system, since solar cells can only produce direct current. For example in automotive most common cars use only 12V and most electronic circuits also require a DC power supply such microcontroller.

The second type is alternating current, abbreviated as "AC". Alternating means that the direction of current flowing in a circuit constantly being reversed back and forth. This alternating current comes from power plants that are operated by electric company such Tenaga Nasional Berhad (TNB). At home most appliances using alternating current since all the equipment at home is using high voltage where direct current cannot supply.

2.3 Energy saving devices

There are many energy saving products in the market nowadays. Their principles are varied and they have different energy saving principle. Most technology and products aim at the mechanism of tariff of electric power company. The charge of electric power can be reduced through improving power quality. [3]

2.3.1 Power factor compensator

Power factor is an electric power quality coefficient. When power factor equal to one, all of electric power flow into load from power supply. Many devices are inductive or capacitive, so power factor is less than one. When power factor is less than one, there is increased current flow through conductor that produces extra loss and increases the load of generator. If power factor of equipment can be increased, conductor loss will be reduced.

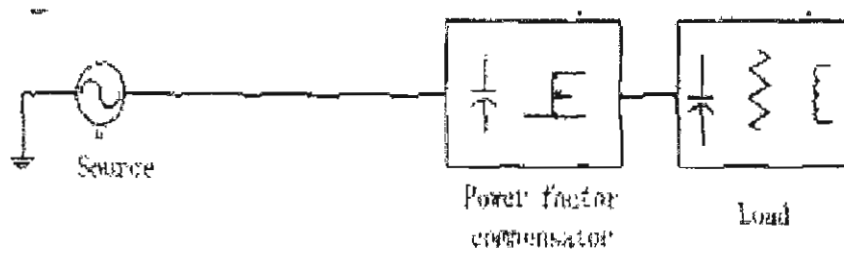


Figure 2.1: Power factor compensator close by load [5]

The above design figure 2.1 only meets the request of electric power company. Usually there is a certain distance between equipment and the distribution point of electric power company. If conductor is thin, loss could be 1 to 5 percent of the power flow. So power factor corrector is mounted on nearby equipment as shown in figure 2.1, the conduction loss due to increase in apparent power can be reduced.

2.3.2 Voltage Control

Other method is Voltage control. For example in lightning saving energy, Energy saving lighting device changes fluorescent lamps by another method. It is higher power ballast and can drive tens to hundreds of fluorescent lamps with existing magnetic ballast. The ballast is used to drive a number of fluorescent lamp, figure 2.2.

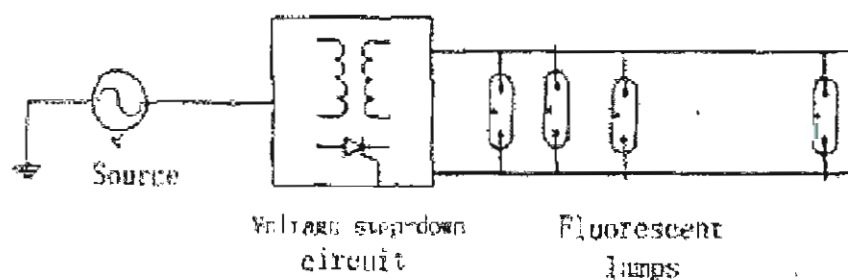


Figure 2.2: Voltage step-down ballasts [5]

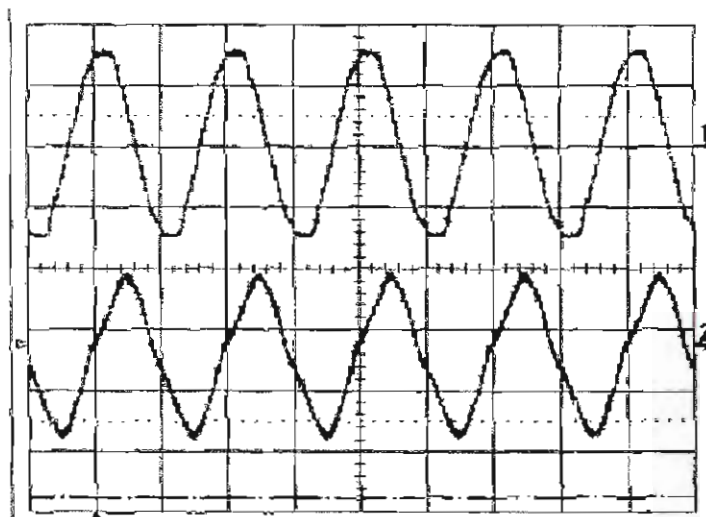


Figure 2.3: Output wave in standard mode (1. 200V/DIV, 2. 12.5A/DIV) [5]

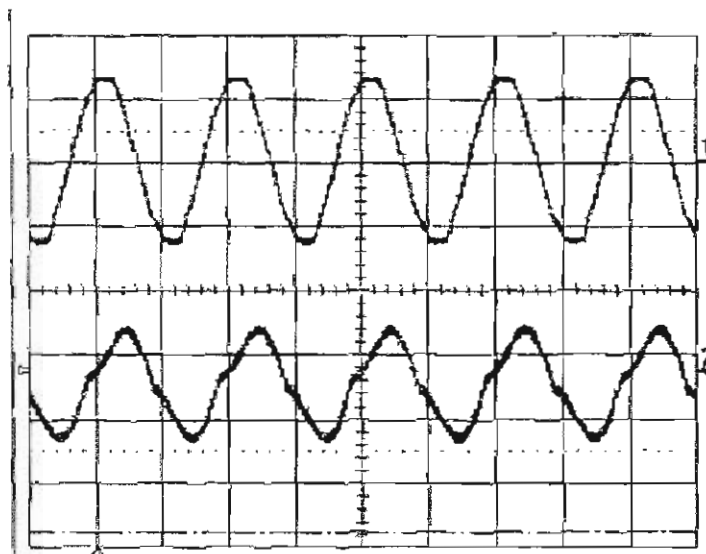


Figure 2.4: Output wave in saving mode (1. 200V/DIV, 2. 12.5A/DIV) [5]

Table 2.2: The difference between the Standard mode and saving mode of the voltage step – down ballast [5]

	Standard Mode	Saving Mode
Input Voltage	226V	226V
Input Current	11.4A	6.56A
Input Power factor	0.49	0.59
Input Power	1260W	880W
Output Voltage	226V	189V
Output Current	11.3A	7.42A
Output Power	1230W	840W
CF	1.53	1.53
THD	10.8%	13.5%

The basic principle is that it lights fluorescent lamps with normal voltage. It takes a few minutes to light the lamp steadily. Voltage can be reduced 5 or 20% percent by using transformer and contactor or using thyristor that saves energy. It has the advantage of simple fixing and very robust. It has also some drawbacks that it is not energy saving in reality and the system and efficiency of fluorescent lamps have not been improved, and in fact light output decreases. The device can be used in the place where low intensity of illumination is needed or sometime during the day. If the power line connects with other electric power device, voltage to other devices will decrease as well.

2.3.3 Inverter

There is also energy saving scheme mostly use beside the two methods mention previously. This technology is called inverter usually use in motor. For better performance motor will use inverter technology that can change voltage and frequency together. It sometime called Variable Speed Drive (VSD). The motor can be run in the optimal magnetic flux and its efficiency can be as high as 0.9.

The efficiency of motor, as commonly known is inversely proportional to slip frequency that is difference between motor stator frequency and rotor frequency. Using inverter to drive

motor, motor can work efficiently at any rotor speed. Motor system with inverter can save energy 30 or 40 percent, but inverter cannot save electrical power for example if motor runs under top speed condition; inverter is not effective to reduce energy consumption. The output power of inverter is PWM waveform, so higher frequency interference is produced. Therefore the choice of inverter and motor is very important. Figure 2.5 show the typical inverter schematic.

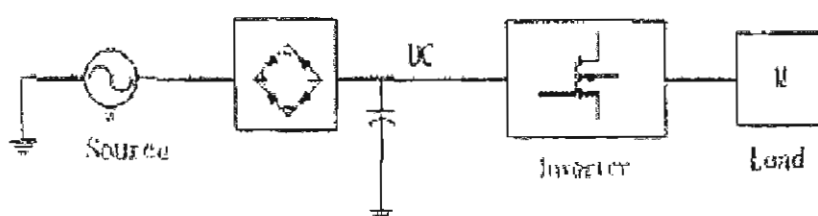


Figure 2.5: Typical Schematic of Inverter [5]

Firstly above system rectifies AC supply into DC, and then the DC is inverted into AC by adopting IGBT high frequency sinusoidal PWM. The switching mode of IGBT can change output voltage and frequency to control motor effectively.

Inverter has another advantage that surplus energy can be regenerated. When motor speed or load decreases or stop, kinetic energy can be fed back to power supply through inverter and known as power regeneration. The technology has been used in motor and elevator

2.4 Temperature Sensor

Temperature sensor is any type of devices that detect reading of changes in temperature or heat in surrounding and give output in term of digital or analog. There are many temperature sensor available in the market with own characteristic depend on the application we want to use. There are two basic physical types of temperature sensor. First is contact temperature sensor. These type of sensor required in physical contact with the object being sensed and need conduction to be happen to monitor the temperature changes. Second is non-contact temperature sensor. This type of sensor use convection and radiation to monitor temperature changes. From both of the types mentioned above they can also be sub-divided into the following three groups of sensors, Electro mechanical, Resistive and Electronic.