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SMALL WIND ENERGY CONVERTER

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A project report submitted in partial fulfillment of the requirement for the award of Bachelor Of Electrical Engineering(Industrial Power)

Faculty of Electrical Engineering

Universiti Teknikal Malaysia Melaka

June 2014

I declare that the project report entitled "Small Wind Energy Converter" is the results from my own research except as cited in the references.

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Date : 18 June 2014

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ABSTRACT

Wind power capacity has experienced tremendous growth in the past decade, thanks to wind power's environmental benefits, technological advance, and government incentives. Small wind energy which being used as a source to produce electric energy become significant nowadays. This study presents the recent developments in small wind energy conversion systems, and their social and environmental benefits. This report also provides a review of the interconnection issues of distributed resources including wind power with electric power systems. The overall studies are about the prototype of small wind converter energy. This prototype has been design with the direct current(DC) motor as a wind turbine that will produce a electricity using the concept of direct current(DC concept). The output used in this prototype are some load and a liquid crystal display(LCD). The purpose of using the LCD is to show the voltage level in the power storage and to record the increasing of the voltage level when the turbine is twisting. Futhermore, there is a support circuit design using arduino uno board, interfaced with a Grapical Unit Interface(GUI) in a computer to control a DC motor in the case of no primary source. The recorded results shows that the efficiency for the support system is between 91 percent to 94 percent. The results of this efficiency is refer to the measrement thats has gain from the results of the support systems thats has been build in this protype .

ABSTRAK

Kapasiti kuasa angin telah mengalami pertumbuhan yang besar dalam satu dekad yang lalu, terima kasih kepada faedah kuasa alam sekitar iaitu angin, kemajuan teknologi dan insentif kerajaan. Penggunaan tenaga angin kecil sebagai sumber untuk menghasilkan tenaga elektrik menjadi penting pada masa kini. Kajian ini membentangkan perkembangan terkini dalam sistem penukaran tenaga angin kecil, faedah dari aspek sosial dan kepada alam sekitar. Laporan ini juga menunjukkan kajian semula tentang isu-isu sambungan sumber diedarkan termasuklah sumber angin dan sumber elektrik. Kesuluruhan laporan ini membentangkan tentang prototaip penukaran tenaga angin kecil. Reka bentuk prototaip ini direkabentuk menggunakan motor arus terus sebagai turbin angin yang akan menghasilkan tenaga elektrik dengan menggunakan konsep motor arus terus. Keluaran yang digunakan dalam prototaip ini adalah beban dan paparan LCD (liquid crsytal display). Tujuan penggunaan LCD sebagai keluaran adalah untuk menunjukkan tahap voltan di dalam penyimpanan kuasa dan untuk merekodkan kenaikan tahap voltan apabila turbin berpusing. Tambahan lagi, litar sokongan direka dengan menggunakan papan arduino uno R3 yang akan berkomunikasi dengan graphical unit interface(GUI) di dalam komputer untuk mengawal motor arus terus jika tiada sumber utama iaitu angin. Keputusan yang direkodkan menunjukkan bahawa kecekapan sistem sokongan ialah antara 91 peratus dan 94 peratus. Data kecekapan yang direkodkan adalah berdasarkan data yang diperolehi daripada pengukuran yang telah dilakukan dalam sistem sokongan yang telah dibina untuk prototaip projek ini.

CHAPTER 1

INTRODUCTION

1.1 Project Background

Wind power is generated by moving air. As the sun heats the land, the air above also warms and rises. Cold air then replaces the rising air. This creates the winds that we feel most days of the year. The diagram below shows how this 'system' works. Air tends to warm at a faster rate over land because the land retains its heat. Over the sea the air warms more slowly as heated by the sun and slowly cooled by the cold water. If you visit the seaside or coastal area you will probably find that the weather is more breezy or windy than inland. This is because the warm air rises over the land and cold air over the sea replaces it.

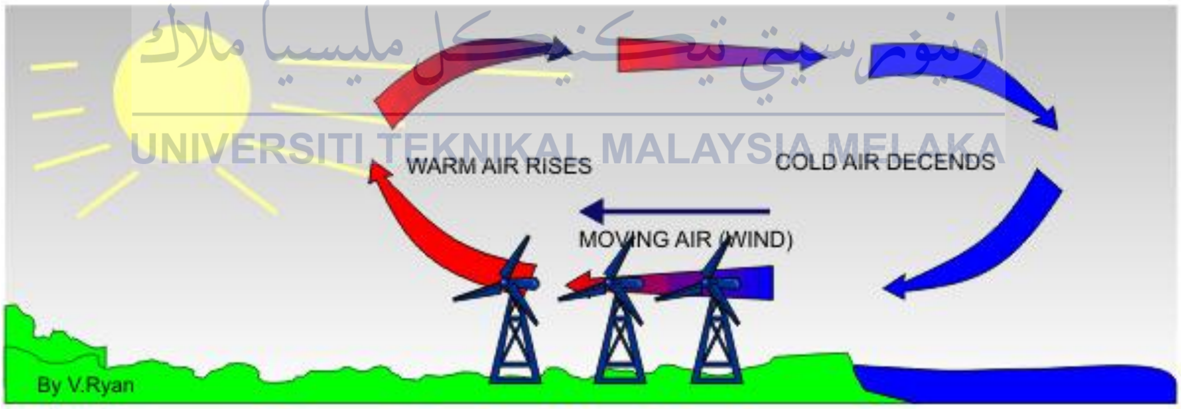


Figure 1 : Wind Turbine Concept

In east coasts of Malaysia, there have been a big potential to build wind power station. Since that there have enough wind moving for wind turbine. The wind turbine can be build at sea because dont't have enough space on land. Nowadays, lots of researchers try to find any alternative energy which is safe, friendly, renewal and useful in our daily life. Wind is one of the solutions which if we use it wisely the wind will be our alternative energy support for our life. Large wind turbine technology is already one of the larger future energy supplies and small wind turbines have a big potential. What is needed for a common use of wind are turbines that meet a specification that is flexible enough for general application and be possible to mount almost everywhere and plug-in to the grid. Wind turbines on the market are often larger, mounted on high towers and need plenty of space around them for safety and efficiency. The only way is therefore to specify flexible wind turbines which need a small space, cheap, low risk to install and high efficiency.

1.2 Problem Statement

Due to the wind is one of the renewable energy that have a high potential to be developed as a source of electrical energy. In addition, wind energy can reduce greenhouse effect when its compared with other sources of electricity such as hydro, coal, gas plant or other renewable energy that can be use to generate an electrical energy. This project about the development a small wind energy converter consists of DC motor as a wind turbine, lcd display(to measure a voltage in the power storage) and the arduino uno board that located in a support curcuit. This project has been devolep because the wind energy has a high potential and the small wind energy require a the detail development because it has high potential to be developed in our country.

1.3 Objective

The objective of this project is to build a small wind turbine which produce a rated power(1 Watt – 5 Watt) and to built a support systems using arduino controller for emergency situation (if there is zero wind).

1.4 Project Scopes

In this study, the development of a small scale wind turbine involved several scopes of work. The detail of the scopes was stated in the Table 1 .

Table 1 : Scopes of work

SPECIFICATION	RESULT
Power produce	Rated power(1 Watt – 5 Watt)
Voltage produce	Rated voltage
Support system efficiency	>91%
Total Grid currentTHD	<5%
Type of current produce	Direct current (DC)
Application	Small appliances
Support circuit component	Arduino uno board, breadboard computer(host).

1.5 Significant Of The Study

The overall study is about how to build the small wind energy converter with the support circuit that will make sure there are always has a supply from the turbine to the power storage. In this study the battery is used in the prototype small wind energy converter as a power storage. The support system was build using the arduino board and the computer as a host to control the input level to the turbine. In case there are no primary source to rotate the turbine, the input level speed for turbine will be control by the webserver that located in the computer and then the speed will be sent to the arduino board. Then , the arduino board will control the speed of turbine in order to generate electricity at the output terminal. Althought the support system use a small power to run the circuit system but the support system will provide a huge power to the turbine and it will produce a large power at the power storageThis systems has a high efficiency. The small wind energy converter has a high potiential in the renewable energy field. The small wind energy converter has many benefit compare to the the huge wind converter. It's more relative small, the cost to build it up is more cheaper than huge wind converter and no need a plenty space. The continued study in small wind energy converter is very important to make sure the electricity can be generated from the safe, friendly, renewal and useful in our daily life.

1.6 Thesis Out Line

There are five chapters in this report that consists of introduction, literature review, methodology, results and discussion and lastly the conclusion. The first chapter is introduction. This chapter was explained in detail about the concept of the wind, the objective and the problem statement of the study, project scope and the significant of the study. The second chapter is literature review. The related pass research about the wind energy conversion is stated in this chapter. The related researches are come from the international research's source. That's mean the related research in this chapter are from in the country and overseas. The next chapter are completely explain about how to build the prototype of the small wind energy converter from the basic till the end.All the recorded results for this study are stated in the next chapter that is chapter 4. In this chapter, all the results for the small wind energy converter are showed. Lastly, the conclusion about this study has been conclude in the chapter 5.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Wind is one of the renewable energy that can be used to produce electricity. The using of wind as a source to generate a electric energy become more significant nowadays. There are a lot of the benefit by using a wind as a main source to produce electric. This chapter will study the recent development on small wind energy converter , their social and environment benefit and interconnection issues of distributed resources including wind power with electric power systems.

2.2 Wind Speed Prediction

A.Kusiak, et.al [1] agree that one of the important aspect in handling the wind turbine energy converter is wind speed prediction. Wind speed is an important thing that must be consider because the power produced by the wind converter is totally depend on the wind speed. Determining the power generated by wind turbine at future times is important for unit commitment planning and maintenance scheduling. Wind speed must be predicted to estimate wind power generation capacity. Prediction of wind speed at three time scale, short, medium and long term is discussed. Short-term prediction aims at estimating wind speed in the time intervals such as 10 seconds or 10 minutes. Medium-term wind speed prediction studies usually focused on hourly predictions and long-term wind speed prediction involves days. Short-term wind speed prediction is important to control of wind turbines. Medium-term wind speed prediction support units commitment planning. Long-term wind speed prediction is used in determining generation mix and scheduled maintenance of power systems. Various approaches to wind speed prediction at different time scales have been developed in the past two decades.

2.3 Power Curve Of A Single Wind Turbine

Wind speed is the most influential factor on the power generated by a wind turbine. The theoritical power [2] that can be extracted from the wind is expresses by equation (1) :

$$P=0.5\pi R^2 Cp(\lambda,\beta)V^3 \quad (1)$$

Where P is the theoritical power captured by the rotor of a wind turbine, *p* is the air density, R is the radius of the rotor (blade's length) determining its sweeping area, Cp(λ,β) is the power coefficient and V is the wind speed. The air density *p* at the turbine's hub height remains usually constant over a long-time horizon. Thus the most important operation parameters impacting the generated power area Cp(λ,β) and V. The power coefficient indicates the efficiency of a turbine capturing the wind energy and its is optimized by the control system[3].

To analyze the perfomance of wind turbines, the SCADA data collected at a wind farm has been used. Table 2 shows data set 1 with the beginning time stamp "1/1/07 12:00AM" and ending time stamp "1/31/07 11:50 PM". Data set 1was divided into two data subsets, data set 2 and data set 3. Data set 2 contains 3476 data points and was used to develop a data-driven model estimating the power curve. Data set 3 inlcudes 871 data points and was used to test perfomance of the model learned from data 2.

Table 2 : Description of the data set

Data Set	Start Time Stamp	End Time Stamp	Description
1	1/1/07 12:00 AM	1/31/07 11:50 PM	Total Data Set : 4347 Observation.
2	1/1/07 12:00 AM	1/25/07 6:20 PM	Training Data Set : 3476 Observation.
3	1/25/07 6.30 PM	1/31/06 11:50 PM	Test Data Set : 871 Observation.

A wind turbine is expected to produce a certain amount of energy given by the wind speed. In fact, all regions outsides of the logistic curve represent either power loss or power gain. The data points in region away from the logitic-curve region usually represent an anomaly leading to, for example, decrease perfomance[3].

2.4 Social And Economic Benefit Of Wind Energy Technology

Wind benefits brought by (Resources, Energy and Tourism) RET have been extensively evaluated, as well as economic costs and its contribution to energy security. However, a thorough discussion of the socio-economic impacts of these technologies is still limited. This discussion becomes even more important in periods of low economic growth [4,5]. One of the the social and economic benefits are technological innovation and industrial development distributed generation and universal access to energy regional and local development, especially in rural areas and job creation. According to Laitner et al. [6], assessments on the performance of climate and energy policies usually do not take into account the dynamics of technological innovation, and often associate reductions in energy consumption and GHG emissions with economic losses.

Frankhauser et al. [4] argue that technological innovation and the creation of new opportunities for investments and economic growth are both consequences of climate policies. Technological change and innovation, in the long term, increase the demand for labour and skills. The writer also emphasize the role of good policies aimed at motivating technological innovation. In this context, the pioneers in the development of clean technologies have the potential for regional leadership. The author also use the case of Germany, which today stands out as a leader in the export of clean technologies. RET are capital intensive, and most of the investment is concentrated in the initial phase of the project – the cost of wind turbines and other equipment can account for about 75% of the total investment of a wind farm [7]. Thus, implementation of renewable energy projects tends to offer an opportunity for developing equipment industries for domestic consumption and even for export [4,8,9].

Usually in the development country, the energy consumption per capital is usually much lower because the former are undergoing development . The inclusion of renewable energy and energy efficient technologies early in the development process accelerates the efficient use of resources, called leapfrogging, enabling development processes with lower environmental impacts [10]. The adoption of renewable energy development projects can meet the development goals without going through the intensity of fossil fuel consumption that marked the growth in developed countries [11]. The convergence between the fields of energy planning and economic development is present in various energy policies. Such convergence is known as energy-based economic development, whose main goals are to increase self-sufficiency and energy diversification, contributing to economic and industrial growth and development; to increase entrepreneurship and encourage technological innovation; and to increase the level of employment and training [12]. The presence of renewable energy projects in rural areas, especially those characterized by low economic development, can bring benefits to the community. High unemployment rates, lack of alternative economic development, and high rates of migration of economically active population, offer a worthwhile environment for investment in RET. Compared to traditional power plants, renewable energy units are often smaller, modular and decentralized and, therefore, they are often located in rural areas with low population density. Due to this feature, the construction of these plants demands high amounts of labour, and creates the potential for training and employment of rural populations in several locations [13].

Besides generating temporary jobs in construction, there are fewer but long lasting job opportunities in the operation and maintenance (O&M) of power plants. The deployment of renewable energy projects offers an alternative or complement to agricultural activities, and contributes to rural development [7]. Even though the number of jobs created in one location is not significant for the country, it might be regionally meaningful [14]. A study by Bergmann et al. [8] in Scotland showed that the rural population awareness regarding RET social benefits has increased, and is significantly higher than that from urban population. Another important aspect is land leasing by wind farms. Because wind turbines occupy only a small fraction of the area, the revenue from land renting can be invested in other productive activities in the property [7,15]. Futhermore the landowners and the workers in construction and O&M, other stakeholders benefit from renewable energy projects. During the construction stage there is an increase in demand of goods andservices, such as lodging and meals, due to the crew involved in the work. Suppliers ofgoods and services within communities can benefit from the project's installation, whichincreases total income of the community and creates temporary job opportunities.Depending on the project, other compensations such as school reforms and publicinfrastructure improvements also take place [7]. A summary of regional and local development benefits brought by investment inrenewable energy sources is illustrated in Figure 2.

Despite the potential to bring numerous benefits to the local and regional development, the incentive to renewable energy should not be considered as a development policy, but if applied in conjunction with other social policies, it can contribute to the local development of these communities [14]. Job creation is a key issue for the evaluation of economic development in a region. A concept that has been gaining ground in discussions of social and economic benefits in a low carbon economy is that of green jobs. According to UNEP [3], green jobs are those that contribute to preserving or restoring environmental quality. These jobs are located in diverse industries and include jobs in energy efficiency, clean technologies, efficient use of natural resources, and activities in low-GHG emissions. A discussion of job creation in RET, which gained momentum in the early year 2000, began due to uncertainties about the effectiveness of public policies for renewable energy and its effects on the economy, especially those based on heavy governmental subsidies. In addition to quantifying jobs and socio-economic impacts either locally or nation-wide, training and technological bottlenecks faced by the renewable energy sector also deserve attention. Studies with companies in the wind sector in the European Union have identified a lack of qualified professionals, especially for positions that require ahigher training level [16,17].

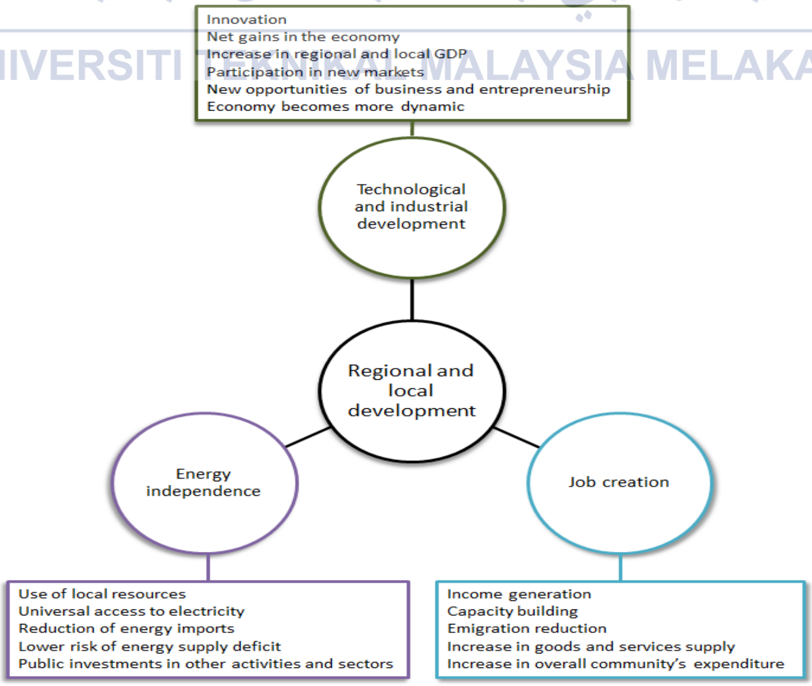


Figure 2: Regional and local aspects of RET. Own elaboration from [7,12,15,18]

Jobs generated by wind power and other RET can be grouped into three part according to their location, temporal nature, and level of expertise. The first part refers to jobs generated in technological development, and includes R&D and equipment manufacturing. The second part refers to jobs in installation and decommissioning of plants, and comprises planning, project management, transportation and power plant construction and decommissioning. The third part is operation and maintenance (O&M), and includes, besides the actual O&M of the plant, energy distribution and commercialization. The characteristics are summarized in Table 3.

Table 3 : Classification and characteristics of employment in RET [18]

Category	Volume Of Job Creation	Location	Temporal nature	Specialization level demanded
Technological devolepment	Medium	From non-local to local	Stable	Very high
Installation	High	From local to non-local	Temporary	High
Operation and maintenance	Low	Local	Stable	Medium

Employees' training is a key issue for renewable energy development [18]. At the same time, most of the local jobs generated by wind power is temporary for example during the installation of the project, policies aiming to maintain the stream of new projects each year should be considered.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter, a brief discussion on methodology approach performed in the study. It will be divided into several sections to give a detail explanation about the methodology of the development of small wind energy converter.

3.2 Flow Of Project

The flow of this project is showed in Figure 3. At first, after the selection of the final year project topic done, the researchers about the small wind converter energy topic and literature review done first in order to understand more details about the overall keypoint of this study. This research focused about the wind speed prediction, power produce by using a wind converter energy and benefits of the wind energy converter to social and economics and all the research is done with refer to the latest research. Figure 3 shows in detail about the flow of the project in the Final Year Project.

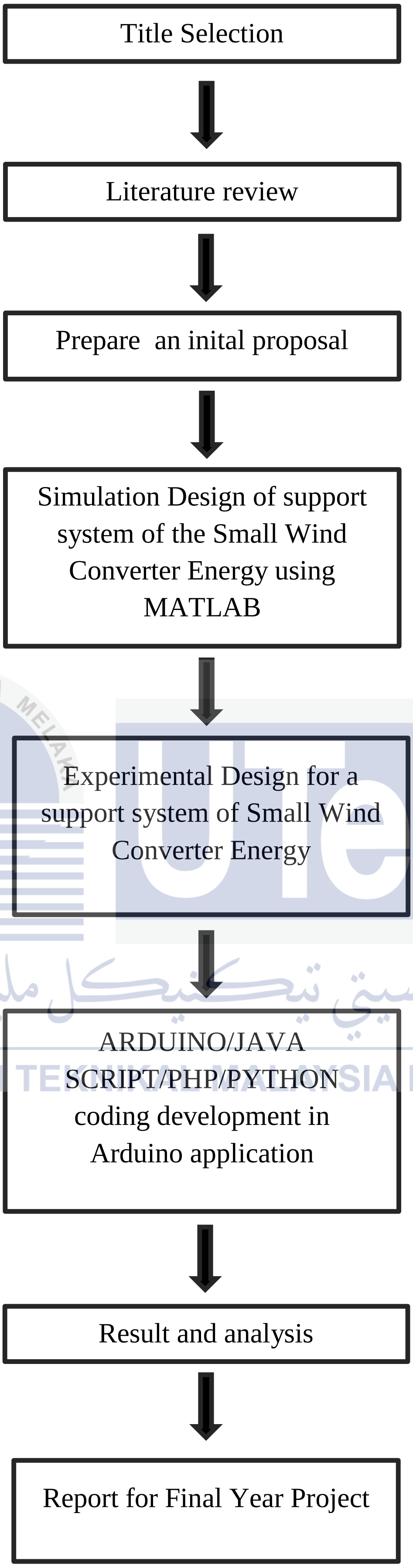


Figure 3 : Methodology flowchart

3.3 Simulation Design Circuit Of Support System Of The Small Wind Energy Converter

The simulation design of the support system is perfectly done in the proteus 7 professional. The proteus 7 professional is a microprocessor simulation software, printed circuit board(PCB) design and schematic capture. In the simulation case, the coding to install in the arduino uno board need to convert to the hex file before it can be installed in the board in the software. The simulation design in the proteus 7 professional is showed in the Figure 4 below and all the measurement of the voltage and current are recorded are showed in detail in chapter 4.

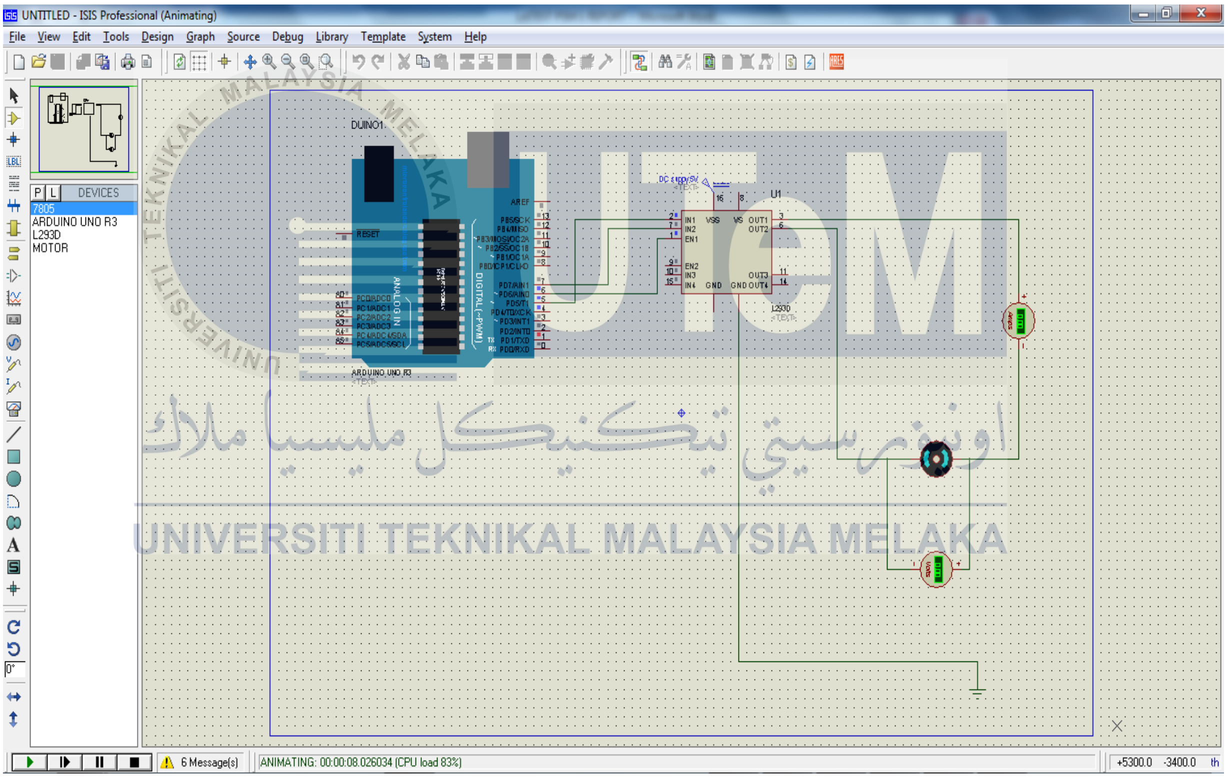


Figure 4 : Simulation design of support system of the Small Wind Energy Converter

3.4 Simulation Design Circuit To Determine The Output Current Based On The DC Motor Speed

The simulation design for determining the current output based on the dc motor speed also done prefectly in the proteus 7 professional. The main purpose of this simulation circuit is to make sure the current output that produced from the support system is accurate with the value of the dc motor output in the real hardware configuration. The Figure 5 below shows that the design circuit to determine the output current based on variable dc motor speed. In this simulation, the experimental value for dc motor speed used is 30 rpm, 90 rpm, 100 rpm, 200 rpm and 255 rpm.

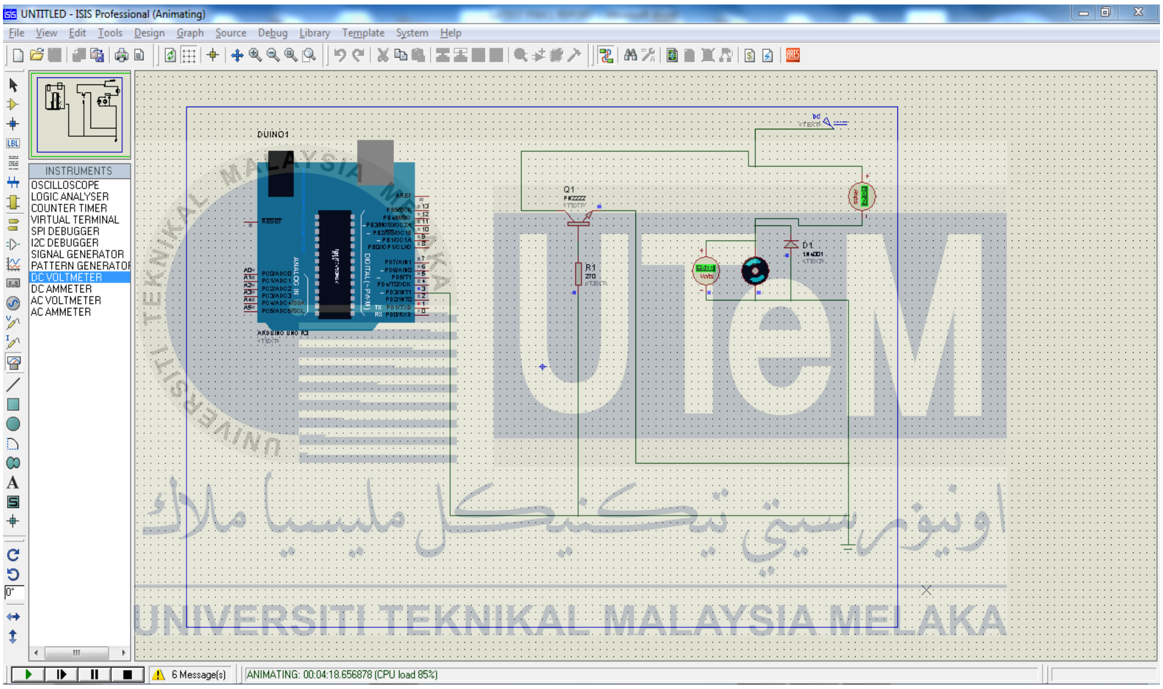
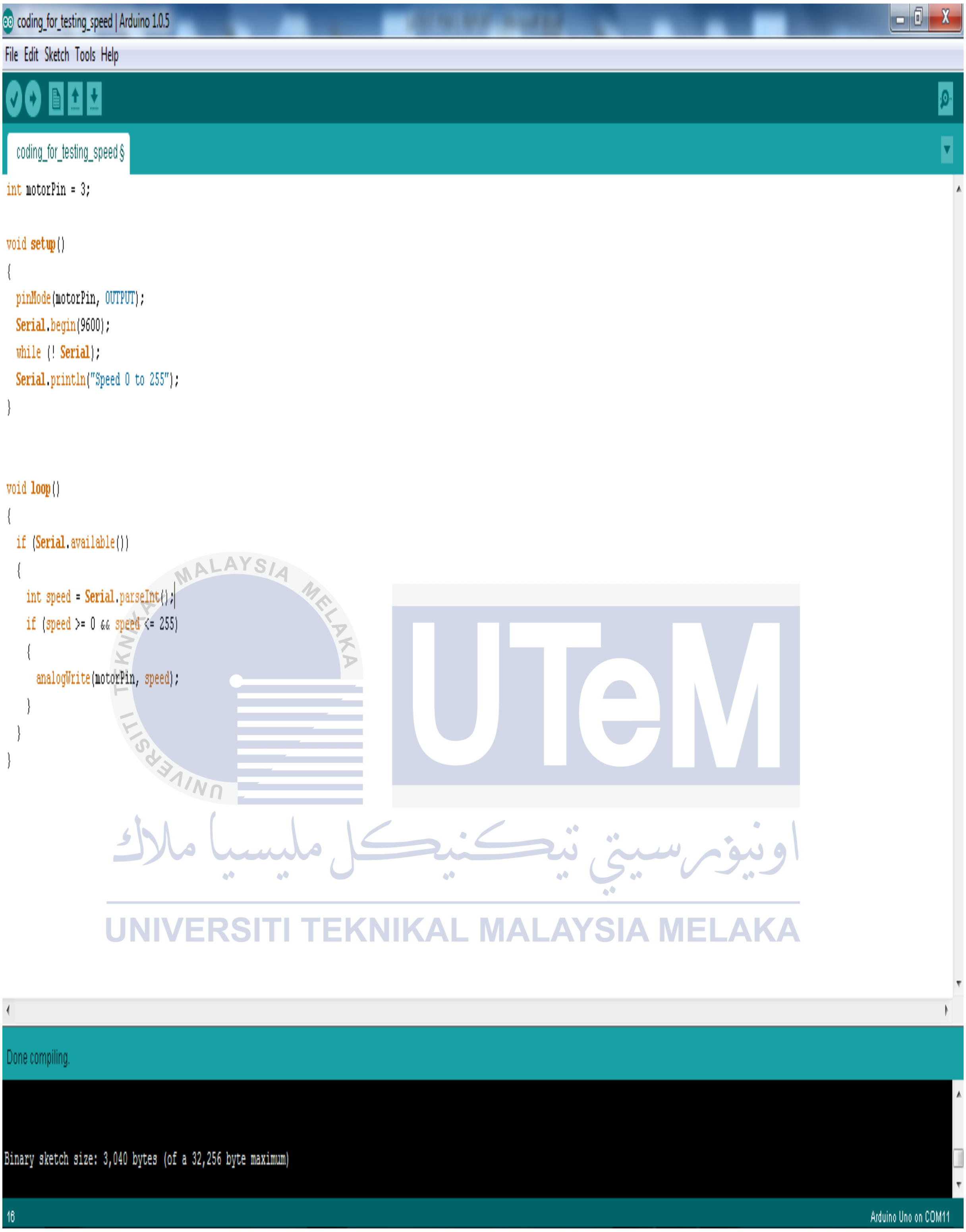


Figure 5 : Simulation output current based on the dc motor speed

The coding use to stimulate the circuit above is showed in the Figure 6. Before the coding can be install into the simulation arduino uno board, it has been converted to the hex file. The figure below shows that the coding that have been verify in the arduino.exe terminal beore it convert to the hex file.



```
int motorPin = 3;

void setup()
{
  pinMode(motorPin, OUTPUT);
  Serial.begin(9600);
  while (! Serial);
  Serial.println("Speed 0 to 255");
}


void loop()
{
  if (Serial.available())
  {
    int speed = Serial.parseInt();
    if (speed >= 0 && speed <= 255)
    {
      analogWrite(motorPin, speed);
    }
  }
}
```


Figure 6 : Coding for the simulation in figure 5

All the recorded value for the current output based on the experimental value of dc motor's speed are showed in the chapter 4.

3.5 Server System Development(Coding Development)

The local host development is using a hypertext preprocessor coding (php coding) to build up the webserver that are use to put the input speed of the dc motor to drive to motor . The coding are devolep in the Pspad editor software. Pspad editor software is a freeware of text editor and editor intended for use by a programmers. This software is designed as a universal GUI and can be used to handle variable type of coding such as a python, html,php, perl and java. In the process to design a webserver(local host), the basic of the html and php coding is use. There are almost three days taken to complete all the html and php coding to design a webserver. The screen shot of coding to design a webserver are showed in the Figure 7 below.

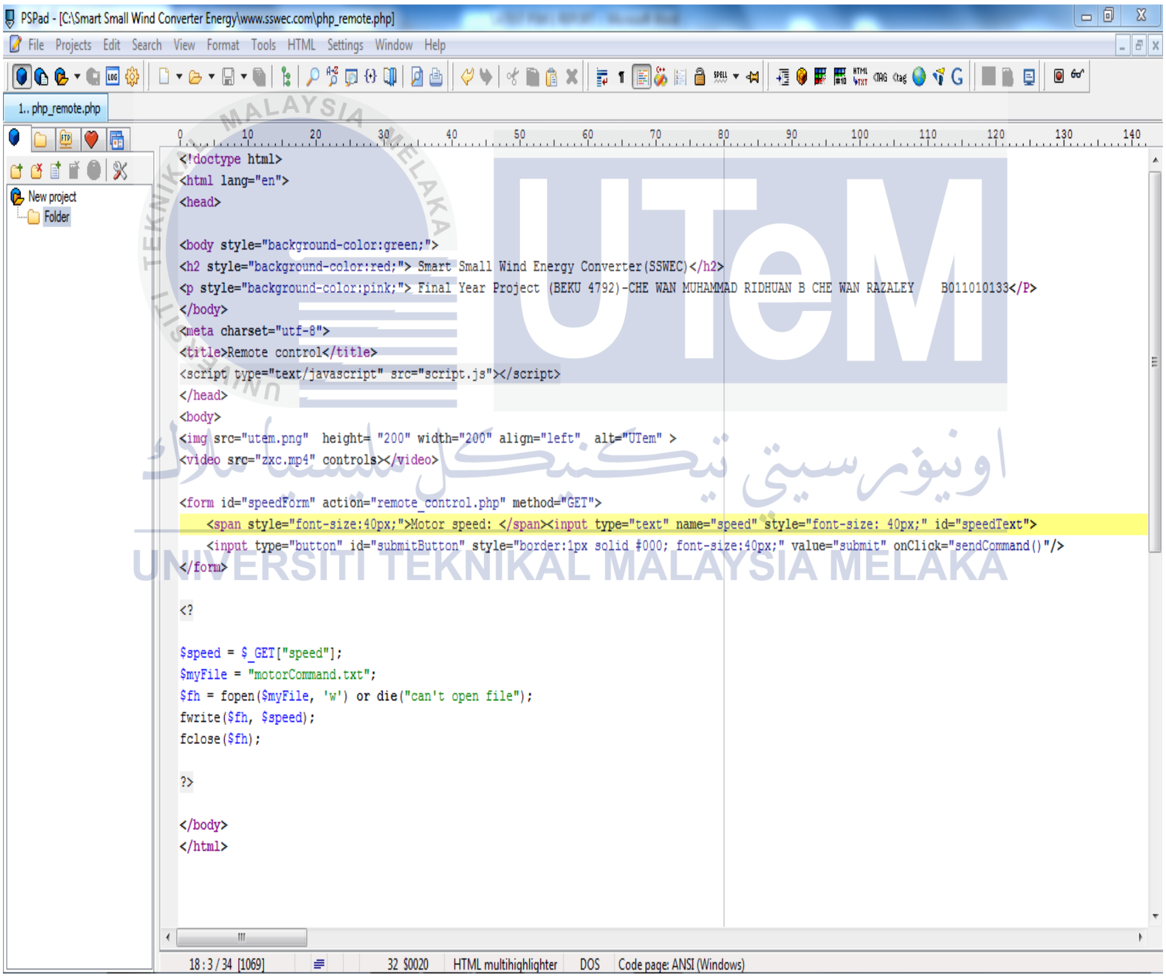


Figure 7: Coding to build up the webserver page

The Figure 7 above shows that the basic html and php basics coding to build up the webserver. All the coding above are using a PSpad editor to complete the compile process to check the error and to run the coding. When the coding is done properly, the software

EasyPHP Dev Server 13.1 VC11 is used to run the coding. All the detail about the EasyPHP is stated in the section 3.8 that is EasyPHP setup part . The domain name of the webserver(local host) is http://127.0.0.1/www.cwmr.com/php_remote.php. The complete webserver is showed in the Figure 8 below.

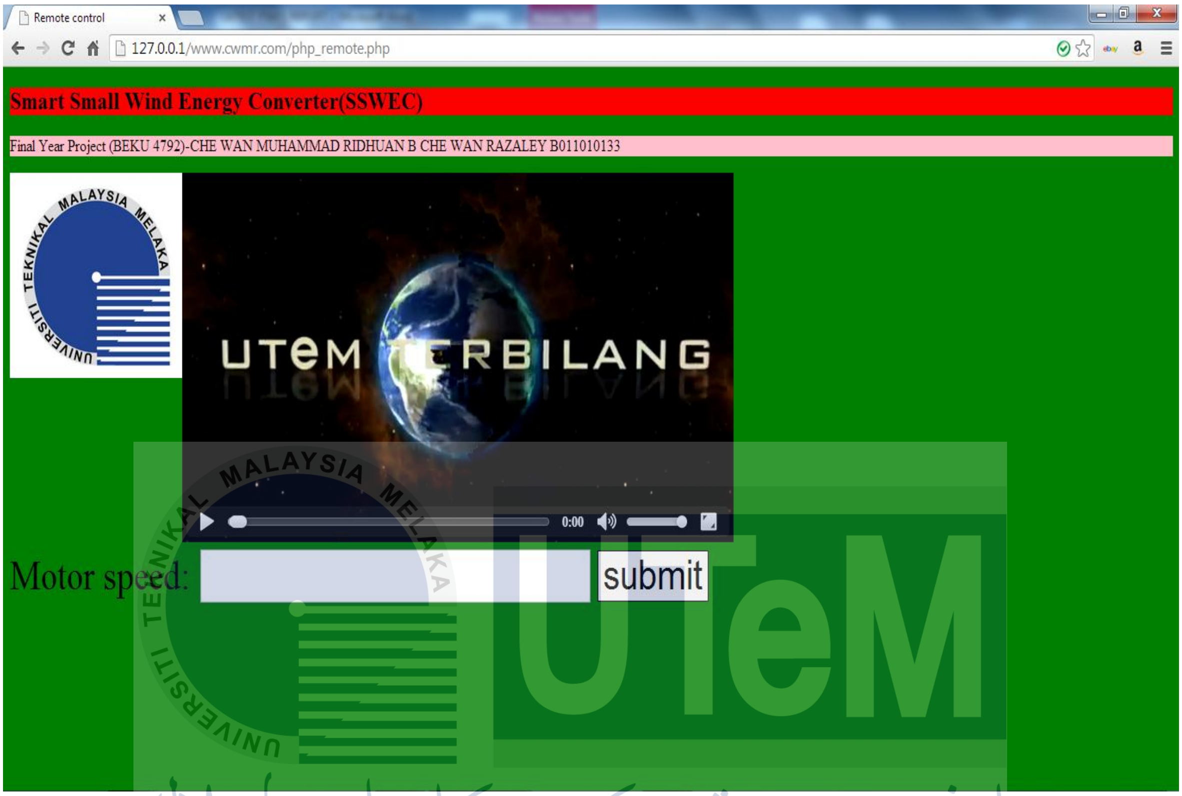


Figure 8 : Webserver(local host)

The Figure 8 above shows that the complete webserver that is needed to control the speed of the dc motor. The input of the dc motor speed will put at the motor speed text and the speed will be send to the next stage after the the submit button pressed.

3.6 Hardware Setup

The hardware used in the support system of small wind energy converter is arduino uno board, breadboard, arduino jumper, L293D motor driver and the dc motor. Arduino Uno board is a one of the device that can be use to interface between the host and the ouput. In this support system the output used is dc motor. The arduino uno board is used as a medium to sent a motor speed from the server to the dc motor that throught the arduino board and go to the breadboard and lastly to the dc motor. The arduino board hardware is shown in the Figure 9 below.

Figure 9 : Arduino Uno board

The Figure 9 above shows the arduino uno board structure in real life. Arduino uno board is a single board microcontroller. The hardware consists of an open-source hardware board designed around an 8-bit Atmel AVR microcontroller, or a 32-bit Atmel ARM. Besides that, this software consists standard programming language compiler and a boot loader that execute on the microcontroller. The arduino board needs a coding or a program to function. In this support system, the coding is uploaded to the arduino uno board using the the arduino.exe software. Arduino.exe is a terminal that a programmer use to upload a coding or the program to the arduino board. The coding that installed in the arduino uno board are verify in the arduino.exe terminal before it can be uploaded to the arduino uno board. Figure 10 to Figure 12 shown the coding use, the coding verify process in the arduino.exe and the uploading process coding to the arduino uno board process.

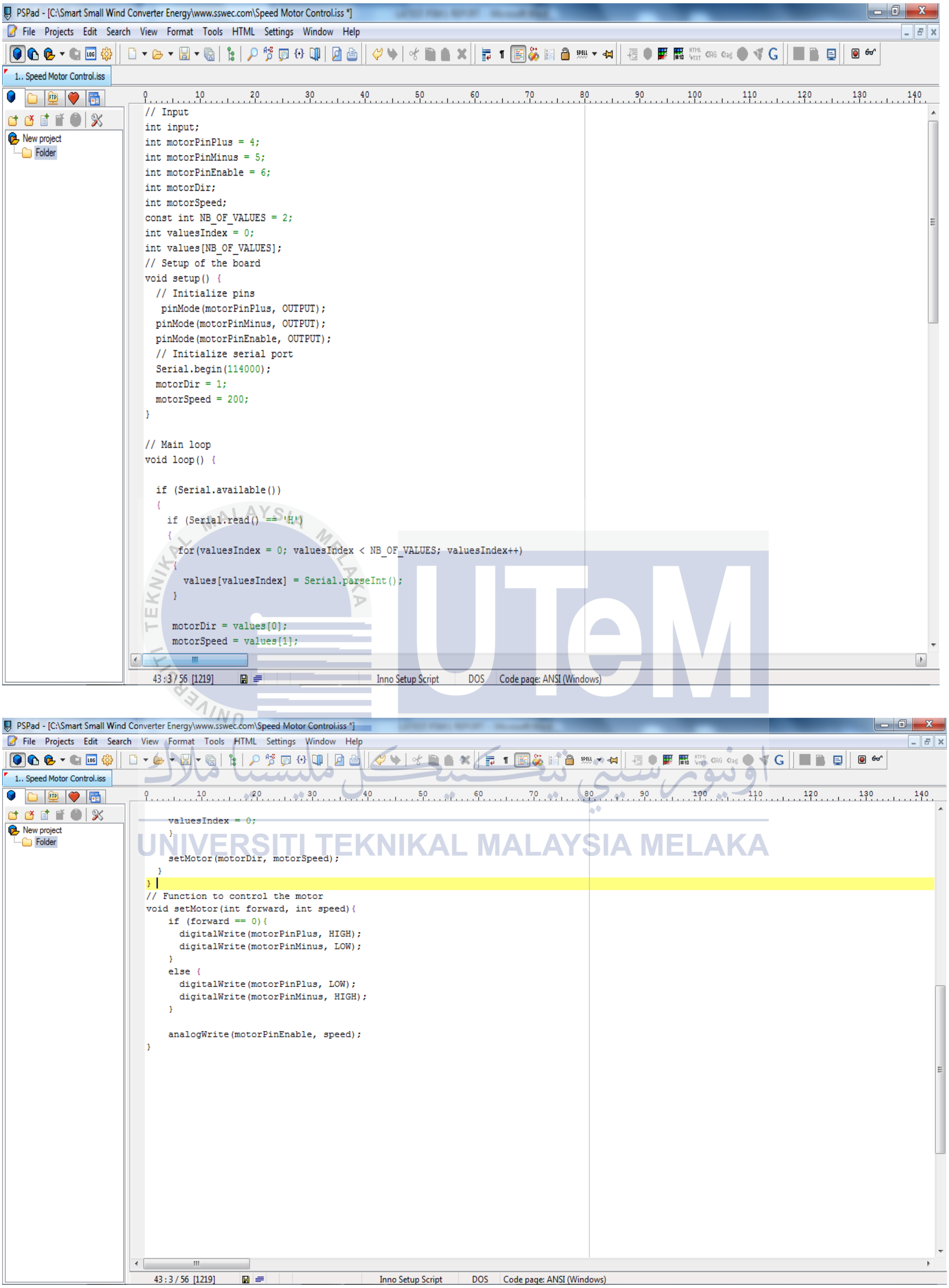


Figure 10: Motor speed coding that installed in arduino uno board

Figure 11 : Coding Verify Process

Figure 12 : Uploading the coding to the arduino uno board process

Figure 10 shows that the coding used to program the arduino uno board. All the coding or program must go through the verify process in the arduino.exe before it can be uploaded to the arduino board. Figure 10 also shows the detail about the process. After the verify process are done and there are no mistake in the coding, the arduino.exe terminal will stated "Done Compiling" as showed in the Figure 11. Thats mean there are no error in the coding. After the compiling process are prefectly done, the coding need to be uploaded to the arduino board by the same terminal thats is arduino.exe.If the uploading coding are successful, the terminal will stated that "Done Uploading" as showed in the Figure12.

After the coding are prefectly installed in the arduino uno board, the next stage is to setup the connection between the arduino uno board to the breadboard and the dc motor. The Figure 13 shows the breadboard hardware, the Figure 14 shows the arduino jumper, the Figure 15 shows that L293D motor driver and the Figure 16 shows that the output of this system thats is the DC motor with the nominal voltage 5V.

Figure 13 : Breadboard hardware

Figure 14 : Arduino jumper

Figure 15 : Motor driver

Figure 16 : DC motor

Finally, to complete the hardware setup, a connection between all the component was created. In general, the simplify of the connection between all the component in the support system are showed in the block diagram in the Figure 17 below.

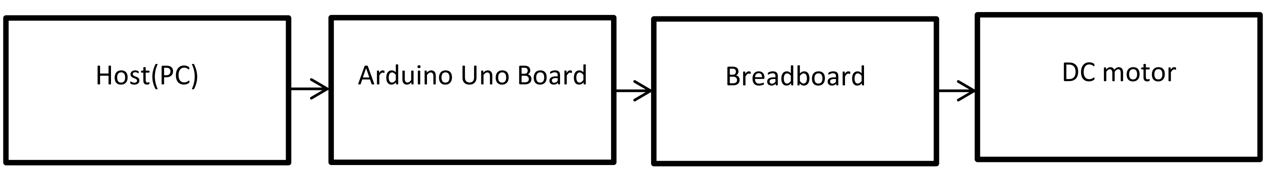


Figure 17 : Block diagram of the connection between hardware component

Figure 17 shows the flow of connection between the hardware connection between the component in the support system of the Small Wind Energy Converter. The connection is start from the computer as a server and the computer will connected to the Arduino Uno board that are already installed with the coding or program ro run the motor. After that, the arduino uno board connected to the breadboard and lastly the breadboard is connected to the our final output thats is dc motor with nominal voltage 5V. The Figure 18 shows that the real connection of the support system circuit.

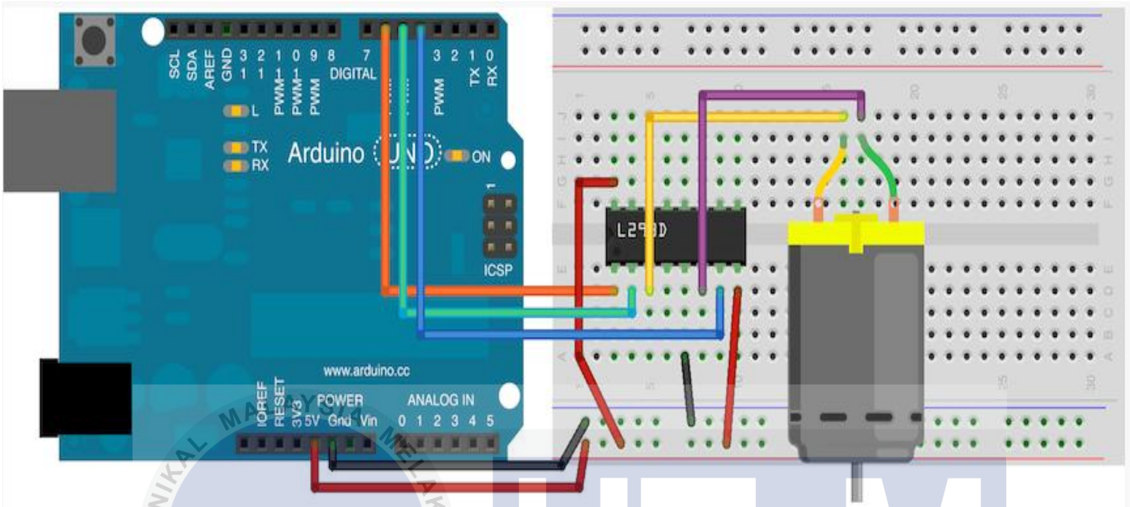


Figure 18 : Final connection between all the component in the support system

The connection above are designed using the fritzing software from the the fritzing.org. Fritzing is a open source hardware. The complete hardware will conneted to the computer(host) through the cable A to cable B. The figure 19 shows that the cable use to connect between the hardware to the pc(host).

Figure 19 : A to B cable

3.7 Python Coding Setup

The python coding or the python file is used to establish the communication between the pc with the arduino uno board. This coding using a same editor to build it that is a Pspad editor. The python program will send the content of the file to the arduino with the right protocol. The file will be generated by the webserver interface that already setup in the server system development. The Figure 20 below shows that the python coding that are verified in the Pspad editor.

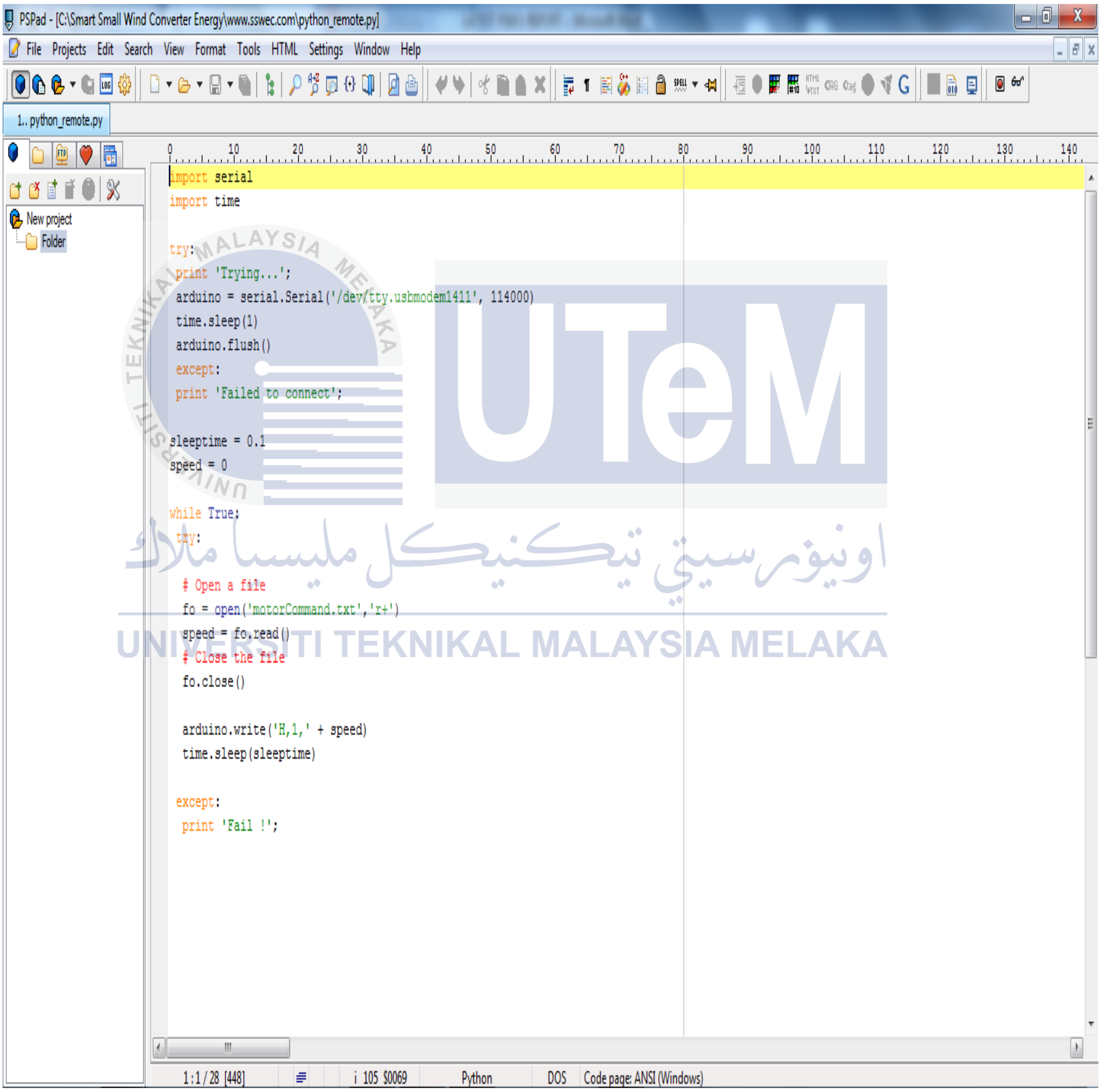


Figure 20 : Python cofiguration

3.8 EasyPHP DevServer Setup

EasyPHP is a software that are used in this support system to compile all the coding file in the one directory of the webserver. The EasyPHP DevServer 13.1 V11 are used in this project. The Figure 21 below shows all the coding file that already in the one directory of the webserver.

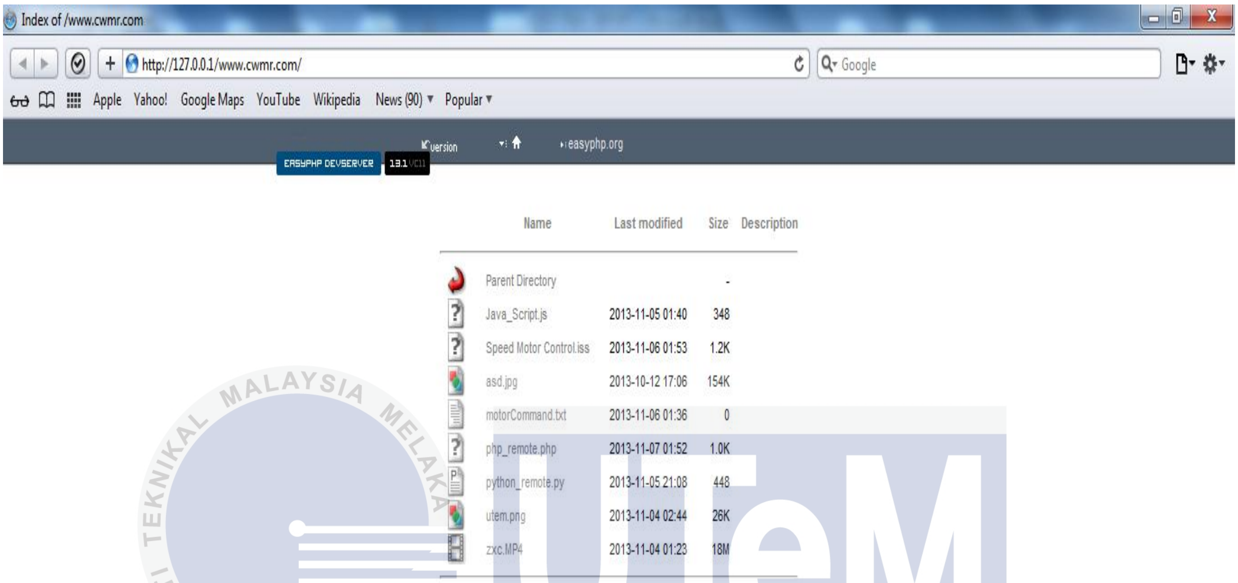


Figure 21 : Coding file setup in the webserver directory

The main page of directory for all the coding file is http://127.0.0.1/www.cwmr.com/. The php_remote.php is a file that will connect direct to the webserver main page as show in the Figure 21.

3.9 Experimental Design For Support System Of A Small Wind Energy Converter

This part of experimental design will go through in detail about the support system that will make sure the direct current(dc)'s motor will continuously rotate in the case there are no primary source for the small wind converter energy. The Figure 22 below shows the block diagram for the support system of small wind converter energy.

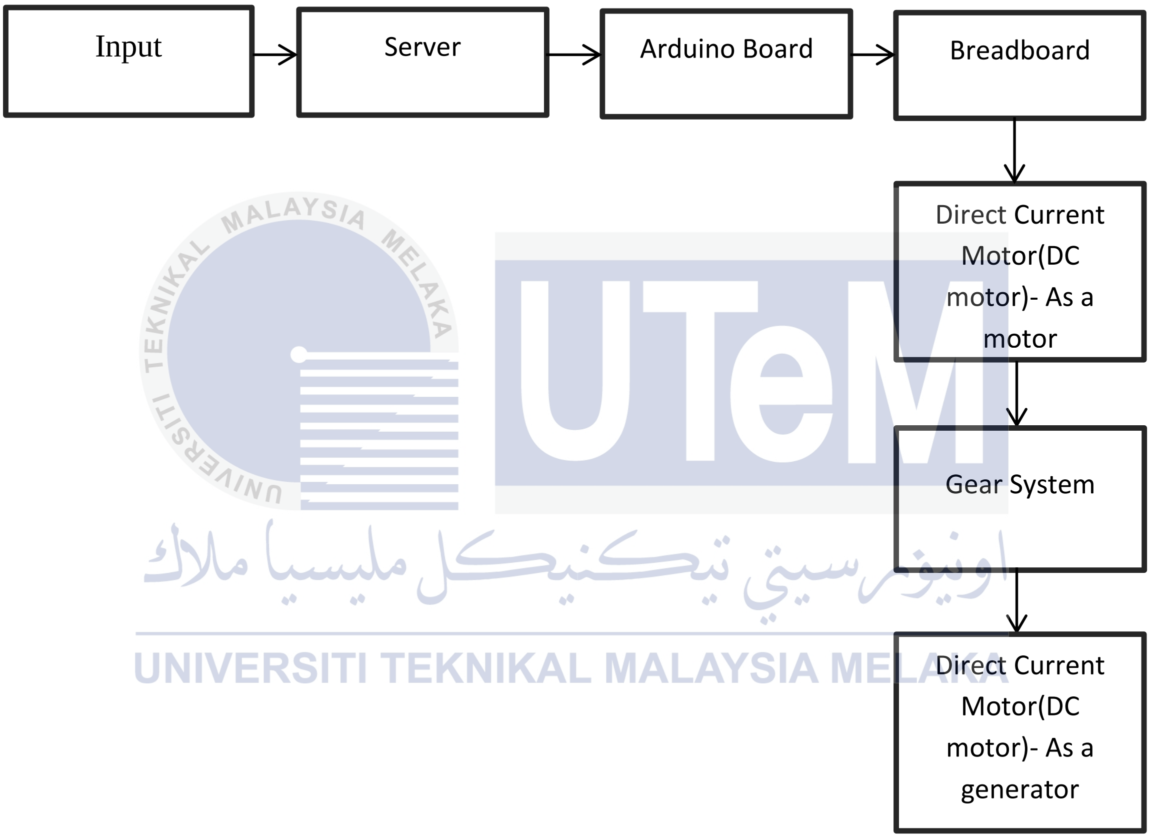


Figure 22: Block diagram for a support system

The block diagram shows how the support system for the small wind converter energy works. The input will be added in the server that are build up using the php coding. All the detail about the process to design a server are stated in the next section. The motor speed are put in the server website and the server will communicate with the python coding or python program that running in the host pc. When the actual input speed are completely sent from the webserver to the python program, the python program will sent the data input to the arduino uno board and then the arduino board will communicate with the breadboard that are connected to the direct current motor(DC motor). The motor will rotate depends on the input value that are put in the server. The range of dc motor’s speed is between 0 to 255. The range are already setup in the process of build up the server system. The Figure 23 below shows the experimental design for the whole system for the small wind energy converter energy.

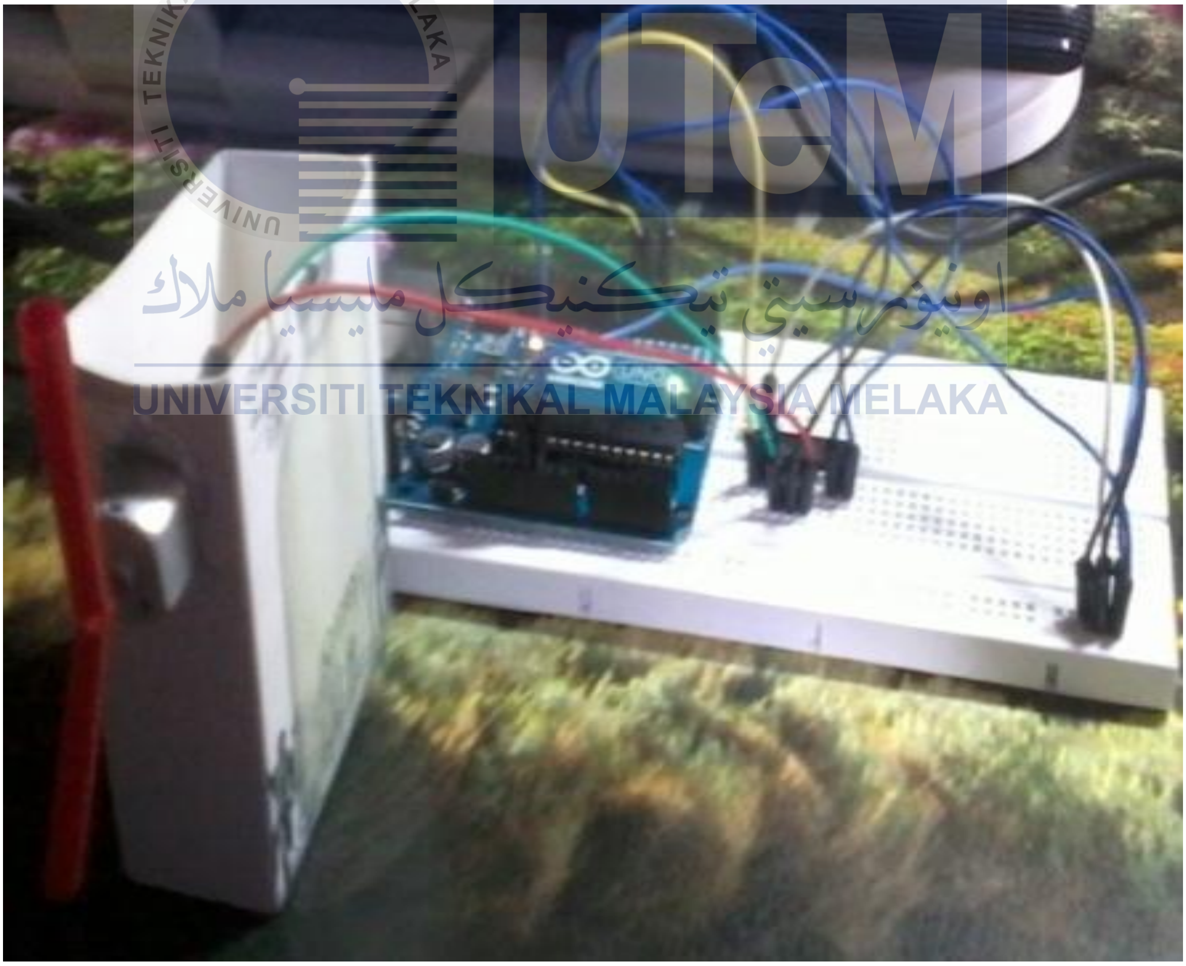


Figure 23 : Experimental Design For The Support Systems

3.10 Experimental Design For The Whole System Of A Small Wind Energy Converter

This part of experimental design will go through in detail about the whole system of the Small Eind Energy Converter. In the normal situation, the small wind turbine will be function by using a natural wind energy and in case there are no main source to rotate the wind turbine, the support system circuit will handle the rotation of the wind turbine. The main putpose of this support system is to make sure there are always have a power supply to the power storage. The Figure 24 below shows that the experimental design for the small wind energy converter project.

Figure 24 : Experimental Design For The Whole Systems

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

In the chapter 4, the result that gain from simulation and experimental result are stated in detail. This chapter have been divided into five section that is simulation result for main circuit of the small wind energy converter, experimental result for support system of small wind energy converter, simulation result for design circuit to determine the currrent output based on the motor speed, result for efficiency of the support system and discussion part.

4.2 Simulation Result Of Main Circuit Of The Small Wind Energy Converter

The simulation result is obtain from the simulation that has properly done in the MATLAB software. The design used in simulation is showed in the figure under section 3.3. All the recorded data that gain from the simulation are stated in the Table 4 below.

Table 4 : Simulation result for support system of Small Wind Energy Converter

Direct-Current motor speed(rpm)	Current produce(A)
30	0.02
90	0.10
100	0.23
200	0.39
255	0.42

4.3 Experimental Result For The Support System Of The Small Wind Energy Converter

In the experimental result, the hardware as showed in the figure 23 is used to obtain the current produced and current produce based on the speed rotation of the dc motor in the support system of the small wind energy converter. The measurement are taken using a multimeter. The Figure 24 below shows that the multimeter device that is used take the measurement from the support system of a small wind energy converter.

Figure 25 : Multimeter

All the measurement that are obtain from support system are recorded and all the data are showed in the Table 5 .

Table 5 : Measurement from the support system

Direct-Current motor speed(rpm)	Current produce(A)
30	0.01
90	0.09
100	0.22
200	0.36
255	0.40

4.4 Simulation Result For Design Circuit To Determine The Currrent Output Based On The Motor Speed

The main pupose of this simulation is to make sure the current produce from the dc motor speed is same with the actual hardware and the result from the simulation of the support system od the small wind energy convereter. All the experiment results and the simulation reults are based on the experimental value of the dc motor speed. The experimental value used is 30 rpm ,90 rpm,100 rpm,200 rpm and 255 rpm. All the reading that get from this simulation are show in the Table 6 below.

Table 6 : Result for current produce based on the dc motor speed

Direct-Current motor speed(rpm)	Current produce(A)
30	0.03
90	0.10
100	0.23
200	0.39
255	0.42

4.5 Result For Efficiency Of The Support System

The point of this part is to make sure that the support systems has a higher efficiency. By using the formula of efficiency ((power out/power in) x 100), the efficiency of the support system are recorded in the Table 7 below. The experimental value of the speed DC motor used is 150rpm, 200rpm and 255rpm.

Table 7 : Efficiency Of The Support System

DC motorSpeed (rpm)	V_I (v)	C_I(A)	P_I(w)	V_O(v)	I_O(A)	P_O(w)	E(%)
150	0.5	0.5	0.24	0.5	0.45	0.23	93.75
200	1.0	0.6	0.6	1.0	0.55	0.55	91.67
255	1.5	0.75	1.13	1.5	0.70	1.05	93.33

There are 7 parameters that's involved in this part. There are V_I, C_I, P_I, V_O,C_O,P_O and E. V_I is a volatge input , C_I is a current input , P_I is a power input , V_O is a voltage ouput, C_O is a current output , P_O is a power output and the E is a effieciency for the support systems.

From the resuts that recorded in the Table 7 above, it's shows that the support systems has a hugh efficiency that between 91 percent to 94 percent. All the detail about the results has been discussed in the discussion part below.

4.6 Discussion

The result from the table simulation design and the result from the simulation current produce based on the motor dc speed are perfectly same. Thats mean there are no problem in the design of the support system circuit. However the result that gain from the real hardware is slightly different from the both simulation. There are a lot of factor that maybe affect the reading that get from the real hardaware. The main factor that are make the result are different is the device used to take a reading from the real hardware. The calibration issue is the reason why the reading that get from real hardware by using a multimeter as show in the figure 24 above is slightly different from the simulation result. Besides that, the real hardware use a supply from the computer that act as a host in the support system. So that, a bit losses may occur in the circuit of the system before the reading of the current produce are taken. That's are a few factor that make a reading of the current produce from the real hardware is slightly different from the simulation relsult.

In the process to build up the support system fo small wind energy converter, all the process are done properly except the small problem have occur in the python.py file. The coding in that file has a few problem. The actual function of the python.py file is to get the actual speed of the dc motor from the motorCommand.txt that are generated by the web interface. The input installed in the webserver and then the webserver will sent the value of the speed to the motorCommand.txt as showed in the figure 21. Then, the python.py file will take the value and sent to the arduino uno board during the communicate process between the computer(host) and the arduino uno board but in this case the pyhton.py file was not working properly in the first implementation stage. The file or the program cannot take the value from the webserver and sent it to the arduino board to proceed to the next stage. To overcome the problem, it was been refered to the internet and the coding has been examined by the expert. This is to verify where the problem that make the coding cannot run and do it function properly. All the process to to overcome this problem has done prefectly in one weeek only. For others stage in process to build up the small wind energy converter are running smoothly.

CHAPTER 5

CONCLUSION , RECOMMENDATION AND AWARDS

5.1 Introduction

This section is briefly explain about the conclusion of this small wind energy converter project as well as the award which was obtained under this small wind energy converter project.

5.2 Conclusion

All the process to build up the support system was done properly. Unfortunately the small problem has occur at the pyhton file that is the program that is used to make a host(pc) to communicate with the arduino uno board. For the coding use to complete the whole support system for a Small Wind Energy Converter are attached together in the appendices part. All the ways to overcome has been discussed in the discussion part. Besides that, the simulation of the main circuit also have done properly without any problem and the results as showed in the part 4.2.

By building up the support system like use in this project is very practical because in the real life and in the case there are no primary source(wind), the server that connected to the wind turbine will easy to handle the turbine by sent the speed input in the system and the input while directly control a wind turbine. The support systems has a higher efficiency. For this prototype, the efficiency of the support system is between 91 percent to 94 percent. In a real life, the wind detecter will needed to be connected to the server and the wind turbine or the server need the device that will always update and cheking the electrical supply at the load so that it can react faster if the electrical supply is shutdown. The success in the process to build up the support system of the small wind energy converter as showed in the figure 21 is show that the second objective of this project that are to build up the an additional arduino uno board in a support system in the case no main source(wind) is achieved. Generally, both objective that is to build up the small scale wind turbine that will produce rated power and to build the support system for the small wind turbine are achieved.

5.3 Recommendation

This project has a high potential to be applied in the real life. In the real life , this protytpe of the small wind energy converter need a sensor that's detect the power storage level in the system. This sensor is to make sure there are always have a voltage in the power storage and in case the storage level is achieve at the minimum level it's will send a signal to the support system and the support systems will take over to control the wind turbine in order to supply a voltage to the power storage. This project has a lot of benefit and it's convenient to applied in the real life.

5.4 Awards

Basically, this project has joined the three competitions that's is a UTeMEX 2013, INTERNATIONAL ENGINEERING INVENTATION AND INNOVATION EXHIBITION(i-ENVEX 2014) and POWER AND ENERGY CONVERSION SYMPOSIUM (PECS) 2014. The first competition has been held at UTeM on 12 December 2013.For this competition, this project has win a bronze medal. The next competition that's is i- ENVEX 2014 has been held at UNIMAP on 11 April to 13 April. This project also obtained a bronze medal for this competition and the last competition is POWER AND ENERGY CONVERSION SYMPOSIUM (PECS) 2014. For the PECS, the technical paper under this project has been accepted 14 April 2014 and the symposium date for this competiton is 12 May 2014. That's all the detail about the competition and the medal obtained under the small wind energy conveter project and all the certificate and the medal for for UteMEX 2013, i- ENVEX 2014 and PECS 2014 are attached together in the appendices part from appendix g until appendix o.

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APPENDICES

Appendix A

HTML and PHP Coding

```
<!doctype html>
<html lang="en">
<head>
<body style="background-color:green;">
<h2 style="background-color:red;"> Smart Small Wind Energy Converter(SSWEC)</h2>
<p style="background-color:pink;"> Final Year Project (BEKU 4792)-CHE WAN MUHAMMAD RIDHUAN B CHE WAN RAZALEY   B011010133</P>
</body>
<meta charset="utf-8">
<title>Remote control</title>
<script type="text/javascript" src="script.js"></script>
</head>
<body>
<img src="utem.png"  height= "200" width="200" align="left"  alt="UTem" >
<video src="zxc.mp4" controls></video>
<form id="speedForm" action="remote_control.php" method="GET">
  <span style="font-size:40px;">Motor speed: </span><input type="text" name="speed" style="font-size: 40px;" id="speedText">
  <input type="button" id="submitButton" style="border:1px solid #000; font-size:40px;" value="submit" onClick="sendCommand()"/>
</form>
<?
$speed = $_GET["speed"];
$myFile = "motorCommand.txt";
$fh = fopen($myFile, 'w') or die("can't open file");
fwrite($fh, $speed);
fclose($fh);
?>
</body>
</html>
```

Appendix B

Python Coding

```
import serial
import time

try:
 print 'Trying...';
 arduino = serial.Serial('/dev/tty.usbmodem1411', 114000)
 time.sleep(1)
 arduino.flush()
 except:
 print 'Failed to connect';

sleeptime = 0.1
speed = 0

while True:
 try:
 # Open a file
  fo = open('motorCommand.txt','r+')
  speed = fo.read()
  # Close the file
  fo.close()
 arduino.write('H,1,' + speed)
  time.sleep(sleeptime)
  except:
  print 'Fail !';
```

Appendix C

<u>Java Script</u>

```
window.onload = function(){
 button = document.getElementById('submitButton');
 button.onClick = sendCommand;
 }

function sendCommand(){
 speed = document.getElementById('speedText').value;

form = document.getElementById('speedForm');
 form.method = 'GET';
 form.action = 'php_remote.php';
 form.submit();
}// JavaScript Document
```

Appendix D

<u>Coding Installed In Arduino Uno Board To Run The Motor</u>

```
// Input
int input;

int motorPinPlus = 4;
int motorPinMinus = 5;
int motorPinEnable = 6;

int motorDir;
int motorSpeed;

const int NB_OF_VALUES = 2;
int valuesIndex = 0;
int values[NB_OF_VALUES];

// Setup of the board
void setup() {
  // Initialize pins
   pinMode(motorPinPlus, OUTPUT);
  pinMode(motorPinMinus, OUTPUT);
  pinMode(motorPinEnable, OUTPUT);

  // Initialize serial port
  Serial.begin(114000);

  motorDir = 1;
  motorSpeed = 200;
}

// Main loop
void loop() {
```

```
  if (Serial.available())
  {
    if (Serial.read() == 'H')
    {
      for(valuesIndex = 0; valuesIndex < NB_OF_VALUES; valuesIndex++)
     {
       values[valuesIndex] = Serial.parseInt();
     }

     motorDir = values[0];
     motorSpeed = values[1];

    valuesIndex = 0;
    }

    setMotor(motorDir, motorSpeed);

  }

}

// Function to control the motor
void setMotor(int forward, int speed){
    if (forward == 0){
      digitalWrite(motorPinPlus, HIGH);
      digitalWrite(motorPinMinus, LOW);
    }
    else {
      digitalWrite(motorPinPlus, LOW);
      digitalWrite(motorPinMinus, HIGH);
    }
   analogWrite(motorPinEnable, speed);
}
```

Appendix E

Coding For The Simulation To Get The Current Value Based On The DC Motor Speed

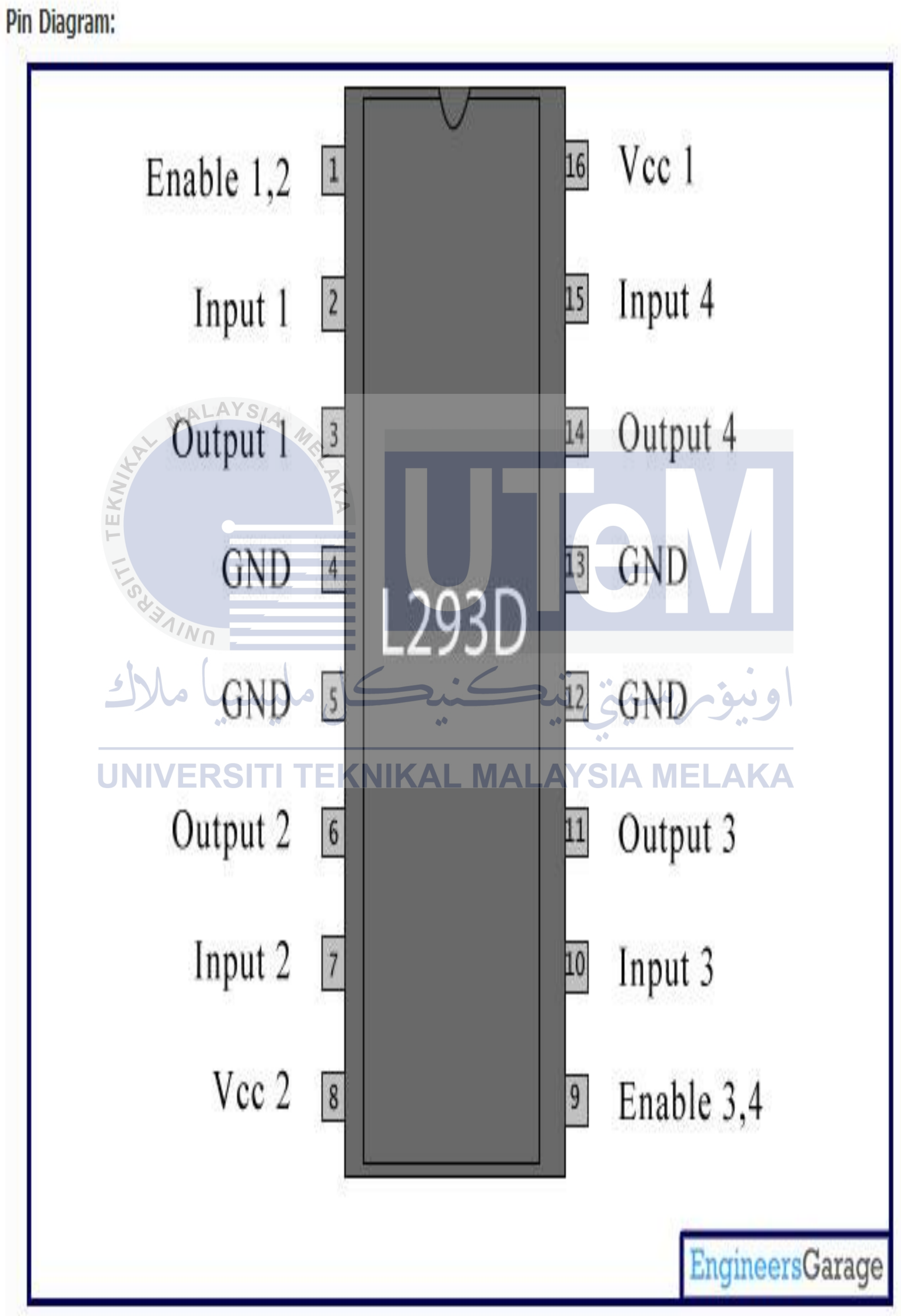
```
int motorPin = 3;

void setup()
{
  pinMode(motorPin, OUTPUT);
  Serial.begin(9600);
  while (! Serial);
  Serial.println("Speed 0 to 255");
}


void loop()
{
  if (Serial.available())
  {
    int speed = Serial.parseInt();
    if (speed >= 0 && speed <= 255)
    {
      analogWrite(motorPin, speed);
    }
  }
}
```

Appendix F

L293D Motor Driver DataSheet



Appendix G

Medal Certificate UTeMEX 2013

Appendix H

Bronze Medal UTeMEX 2013

Appendix I

<u>Certificate of Participation in I-ENVEX 2014</u>

certificate of Participation

Engineering For Society

This is to certify that

WAN MOHD BUKHARI BIN WAN DAUD; MUHAMMAD SYAHMI BIN JOHARI;
CHE WAN MUHAMMAD RIDHUAN BIN CHE WAN RAZALEY; MOHAMAD FANI SULAIMA

HYBRID ENERGY HARVESTING AND CONTROL USING WIND AND SOLAR SUPERCAPACITOR FOR POWER STORAGE

has participated in

INTERNATIONAL ENGINEERING INVENTION & INNOVATION EXHIBITION (i-ENVEX) 2014

held on

April 11TH-13TH, 2014
UNIVERSITI MALAYSIA PERLIS

Brig. Jen. Datuk Prof. Dr. Kamarudin Hussin
Vice Chancellor
Universiti Malaysia Perlis (UniMAP)

Academician Tan Sri Emeritus
Prof. Dr. Augustine S H Ong

Appendix J

Medal Certificate I-ENVEX 2014

Appendix K

Bronze Medal I-ENVEX 2014

Appendix L

Certificate of Participation in PECS 2014


UTeM

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Certificate of Participation

It is hereby certified that

CHE WAN MUHAMMAD RIDHUAN B CHE WAN RAZALEY

has contributed as

PRESENTER

in conjunction with

THE 2nd POWER AND ENERGY CONVERSION SYMPOSIUM (PECS) 2014

held on

12th May 2014

at Faculty of Electrical Engineering,
Universiti Teknikal Malaysia Melaka (UTeM)

jointly organized by

Faculty of Electrical Engineering, UTeM,
UMPEDAC, Universiti Malaya,
Universiti Tun Hussein Onn Malaysia,
Universiti Malaysia Perlis
and
Universiti Malaysia Pahang

PROFESOR DATUK DR. AHMAD YUSOFF BIN HASSAN
Vice Chancellor
Universiti Teknikal Malaysia Melaka

Appendix M

Paper of Smart Small Wind Energy Converter in PECS 2014

Smart Small Wind Energy Converter (SSWEC)

Abstract– **This paper is about the smart small wind energy converter (SWEC) that's use a wind as a primary source to generate electricity. This wind energy converter uses a support system circuit to rotate the blade of the wind turbine. The main purpose of this support system is to make sure the storage of electricity always get a supply from the turbine. The support systems use a small power of electricity and will supply a huge power to storage. This conservation from a low input power used in a support system to huge output power at storage is done properly by a gear system. That's mean the support system of the wind turbine has a high efficiency. The first rotation of the DC motor with speed 150 revolution per minute (rpm) use 0.24 Watt power and produce 0.23 Watt power, the second experimental speed of DC motor is 200 rpm with use 0.6 W power and produce 0.55 W power and the last experimental speed is 255 rpm that use 1.13 W power and produce 1.05 W power. All the results for efficiency show that the support system has 90% and above efficiency for produce a variable speed of DC motor.**

Keywords: ***Wind Turbine, Support Systems, Energy Efficiency***

I. Introduction

Wind is the natural source and most powerful source that's has many benefit and the most important is wind is the source that's will not extinct. Wind power is generated by moving air. As the sun heats the land, the air above also warms and rises [1]. Cold air then replaces the rising air. This creates the winds that we feel most days of the year. The diagram 1 below shows how this 'system' works. Air tends to warm at a faster rate over land because the land retains its heat. Over the sea the air warms more slowly as heat by the sun is slowly cooled by the cold water. This is because the warm air rises over the land and cold air over the sea replaces it.

Figure 1: Wind Turbine Concept

Although the wind in Malaysia is generally slow but there are changes in the wind patterns. The changes in the wind patterns are occur because Malaysia has four seasons that's southwest monsoon, northeast monsoon and inter monsoon two shorter. For the northeast monsoon, it usually starts in early November and ends in March [4]. During this season, the prevailing winds are from the east or northeast at a speed between 10 and 20 knots. East coast states of Peninsular Malaysia and the northern and north-eastern coast of Sabah are more affected by the wind that can reach speeds of 30 knots. So in east coasts of Malaysia, there have been a big potential to build wind power station. Since that there have enough wind moving for wind turbine. Nowadays, lots of researchers try to find any alternative energy which is safe, friendly, renewal and useful in our daily life. Wind is one of the solutions which if use it wisely wind will be an alternative energy support for the life. Large wind turbine technology is already one of the larger future energy supplies and small wind turbines have a big potential. What is needed for a common use of wind are turbines that meet a specification that is flexible enough for general application and be possible to mount almost everywhere and plug-in to the grid. Wind turbines on the market are often larger, mounted on high towers and need plenty of space around them for safety and efficiency. The only way is therefore to specify flexible wind turbines which need a small space, cheap, low risk to install and high efficiency.

II. Problem Statement

Due to the wind is one of the renewable energy that has a high potential to be to be developed as a source of electrical energy. In addition, wind energy can reduce greenhouse effect when it's compared with other sources of electricity such as hydro, coal, gas plant or other renewable energy that can be used to generate an electrical energy. In this study is about the development a small wind energy converter consists of double DC motor as a motor and wind turbine, liquid crystal display (LCD) (to measure a voltage and current output) and the Arduino Uno board that located in a support circuit. The study has been proposed to enhance the quality of small scale wind turbine with the alternative way of control system if there is zero wind.

III. Methodology

It will be divided into several sections to give a detail explanation about the methodology of the development of small wind energy converter.

A. Experimental Setup

The flow of the study is showed in Figure 2.

1

Figure 2: Flow of study

B. Simulation Design Circuit to Determine the Output Current Based On the DC Motor Speed

The simulation design circuit was used to determine the current output based on the dc motor speed using Proteus 7 professional software. The main purpose of this simulation design circuit is to verify the current output that produces from the support system is accurate with the value of the dc motor output from the real hardware configuration. Figure 3 below noted that the simulation design circuit to determine the output current based on variable dc motor speed. In this simulation, the experimental value for dc motor speed used is 30 rpm, 90 rpm, 100 rpm, 200 rpm and 255 rpm.

Figure 3: Simulation design of support system of the Small Wind Energy Converter

C. Simulation Design Circuit to Determine the Output Current Based on the DC Motor Speed (support circuit).

The simulation design in the support system is to determine the current output based on the dc motor speed. The main purpose of this simulation circuit is to make sure the output current from the support system is accurate with the value of the dc motor output in the real hardware configuration. Figure 4 show that the design circuit to determine the output current based on variable dc motor speed. In this simulation, the experimental value for dc motor speed is used.

Figure 4: Simulation output current based on the dc motor speed (support system)

The coding use to stimulate the circuit above has been already set to run the speed of the DC motor between 0 revolutions per minute (rpm) to 255 rpm. Before the coding can be installed into the simulation Arduino Uno board, it has been converting to the hex file because in the simulation Arduino Uno board only the hex file coding can be used to run the board. All the output value for the current output based on the experimental value of DC motor" speeds are showed in the results and discussion part.

D. Server System Development (Coding Development).

2

Appendix N

Paper of Smart Small Wind Energy Converter in PECS 2014

The local host development are using a hypertext preprocessor coding to build up the webserver that are used to put the input speed of the dc motor to drive to motor . The coding is developing in the PSpad editor software. Pspad editor software is a freeware of text editor and editor intended for use by a programmers. This software is designed as a universal GUI and can use to handle variable type of coding such as a python, html, php, perl and java. In the process to design a webserver (local host), the basic of the html and php coding is use.

E. Hardware Setup

The hardware use in the support system of small wind energy converter is Arduino Uno board, breadboard, Arduino jumper, L293D motor driver and the dc motor. Arduino Uno board is a one of the device that can be used to interface between the host and the output. In this support system the output use is dc motor. The Arduino Uno board is use as a medium to send a motor speed from the server to the dc motor that through the Arduino board and go to the breadboard and lastly to the dc motor. Arduino Uno board is a single board microcontroller. The hardware consists of an open-source hardware board designed around an 8-bit Atmel AVR microcontroller, or a 32-bit Atmel ARM. Furthermore, a Arduino Uno board consists a standard programming language compiler and a boot loader that execute on the microcontroller. The Arduino board needs a coding or a program to function. In this support system, the coding is upload to the Arduino Uno board using the arduino.exe software. The coding that installed in the Arduino Uno board are verify in the arduino.exe terminal before it can upload to the Arduino Uno board. All the coding or program must go through the verify process in the arduino.exe before it can be upload to the Arduino board. Finally, to complete the hardware setup, a connection between all the components was created. In general, the simplification of the connection between all the components in the support system is showed in the Figure 5.

In Figure 5, the connection between the hardware connections between the components in the support system of the small wind energy converter. The connection is start from the computer as a server and the computer will connected to the Arduino Uno board that are already installed with the coding or program to run the motor. After that, the Arduino Uno board connected to the breadboard and lastly the breadboard is connected to our final output that is DC motor with nominal voltage 5V. The Figure 5 shows that the real connection of the support system circuit.

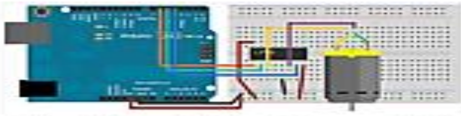


Figure 5: Final connection between all the components in the support system

F. Python Coding Setup

The python coding or the python file is use to establish the communication between the computer with the Arduino Uno board. This coding is use a same editor to build it that is a Pspad editor. The python program will send the content of the file to the Arduino with the right protocol. The file will be generated by the webserver interface that already setup in the server system development. The figure 6 below shows that the python coding configuration that are verify in the Pspad editor.

Figure6: Python coding configuration

G. Experimental Design for a Support System of a Small Wind Energy Converter

This part of experimental design will go through in detail about the support system that will make sure the direct current motor will continuously rotate in case there is no primary source for the small wind converter energy. The figure 7 shows the support system of small wind converter energy. The input will be added in the server that are build up using the php coding. The motor speeds are put in the server website and the server will communicate with the python coding or python program that running in the host computer. When the actual input speed are completely sent from the webserver to the python program, the python program will sent the data input to the Arduino Uno board and then the Arduino board will communicate with the breadboard that are connected to the direct current motor. The motor will rotate depends on the input value that are put in the server. The range of dc motor's speed is between 0rpm to 255rpm. The range is already setup while in the process to build up the server system. The figure 7 below shows the experimental design for the support system for the small wind energy converter energy.

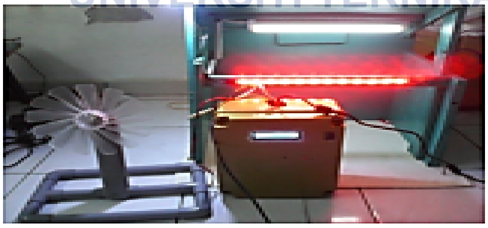


Figure 7: Experimental Design for the support systems

IV. RESULTS AND DISCUSSIONS

Table 1: Preliminary Simulation Result of Main Circuit of the Small Wind Energy Converter

Direct-Current motor speed(rpm)	Current produce(A)
30	0.02
90	0.10
100	0.23
200	0.39
255	0.42

Table 2: Preliminary Experimental Result for the Support System of the Small Wind Energy Converter

Direct-Current motor speed(rpm)	Current produce(A)
30	0.01
90	0.09
100	0.22
200	0.36
255	0.40

Table 3: Simulation Result for Design Circuit To Determine The Current Output Based On The Motor Speed

Direct-Current motor speed(rpm)	Current produce(A)
30	0.03
90	0.10
100	0.23
200	0.39
255	0.42

Calculation for efficiency of the support system

By using the formula of efficiency ((power out/power in) x 100), the efficiency of the support system are recorded in the table below. The experimental value of the speed DC motor used is 150rpm, 200rpm and 255rpm.

Table 4: Efficiency of the Support Systems

DC motor Speed (rpm)	V_I (v)	C_I (A)	P_I (w)	V_O (v)	I_O (A)	P_O (w)	E (%)
150	0.5	0.5	0.24	0.5	0.45	0.23	93.75
200	1.0	0.6	0.6	1.0	0.55	0.55	91.67
255	1.5	0.75	1.13	1.5	0.70	1.05	93.33

Where as:

V_I =Voltage input ; C_I = Current input ; P_I = Power input;
V_O =Voltage output ; C_O =Current output; P_O = Power output;
E = Efficiency

The result from the simulation design (Table 1) and the result from the experimental (Table 2) shows resemblance output current produced based on the motor dc speed. That's mean there are no problem in the design of the support system circuit however the result that gain from the real hardware is slightly different from the both simulation. There are a lot of factor that maybe affect the reading that get from the real hardware. The main factor that is make the result are different is the device used to take a reading from the real hardware. The calibration issue is the reason why the reading that gets from real hardware by using a multimeter is slightly different from the simulation result. Besides that, the real hardware use a supply from the computer that act as a host in the support system. So that, a bit losses occur in the circuit of the system before the reading of the current produce are taken. There are a few factor that make a reading of the current produce from the real hardware is slightly different from the simulation result. In the process to build up the support system for small wind energy converter, all the process is done properly. In the calculation part above shows that the results gain for the support circuit's efficiency. When all the calculation are done by using the data from the actual

Appendix O

Paper of Smart Small Wind Energy Converter in PECS 2014

support system, the results shows that the support system has a high efficiency by using a low input power and produce high output power.

V. Conclusions

All the process to build up the support system was done properly unfortunately the small problem has occur at the python file that is the program that are used to make a host(pc) to communicate with the Arduino Uno board. Besides that, the simulation of the main circuit also has done properly without any problem and the result is showed in the part results and discussion above. By buildup the support system like in this project is very practical because in the real life and in the case there are no primary source (wind), the server that connected to the wind turbine will easy to handle the turbine by sent the speed input in the system and the input while directly control a wind turbine. In a real life, the wind detector will needed to be connected to the server and the wind turbine or the server need the device that will always update and checking the electrical supply at the load so that it can react faster if the electrical supply is shutdown. The second objective of this project that is to build up the additional Arduino Uno board in a support system in the case no main source (wind) is achieved.

Acknowledgement

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SMALL WIND ENERGY CONVERTER

by Che Wan M Ridhuan

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Wind power is generated by moving air. As the sun heats the land, the air above also warms and rises. Cold air then replaces the rising air. This creates the winds that we feel most days of the year. The diagram below shows how this 'system' works. Air tends to warm at a faster rate over land because the land retains its heat. Over the sea the air warms more slowly as heat by the sun is slowly cooled by the cold water. If you visit the seaside or coastal area you will probably find that the weather is more breezy or windy than inland. This is because the warm air rises over the land and cold air over the sea replaces it.

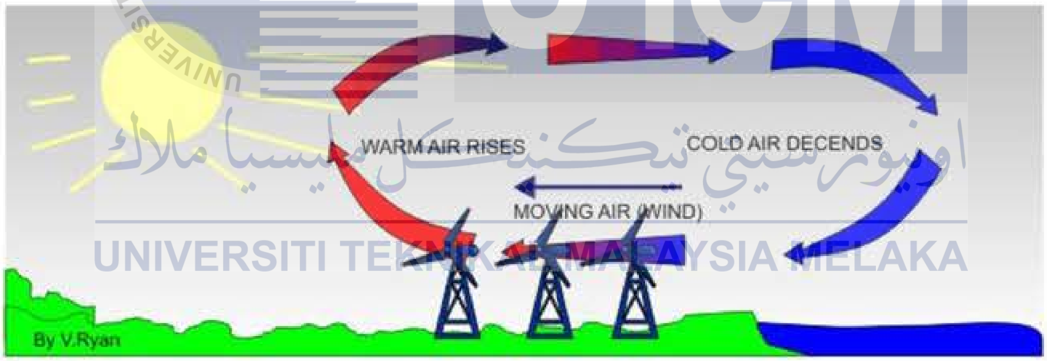

Figure 1 : Wind Turbine Concept

In east coasts of Malaysia, there have been a big potential to build wind power station. Since that there have enough wind moving for wind turbine. The wind turbine can be build at sea because dont't have enough space on land. Nowadays, lots of researchers try to find any alternative energy which is safe, friendly, renewal and useful in our daily life. Wind is one of the solutions which if we use it wisely wind will be our alternative energy support for our life. Large wind turbine technology is already one of the larger future energy supplies and small wind turbines have a big potential. What is needed for a common use of wind are turbines that meet a specification that is flexible enough for general application and be possible to mount almost everywhere and plug-in to the grid. Wind turbines on the market are often larger, mounted on high towers and need plenty of space around them for safety and efficiency. The only way is therefore to specify flexible wind turbines which need a small space, cheap, low risk to install and high efficiency.

1.2 Problem Statement

Due to the wind is one of the renewable energy that have a high potiential to be to be developed as a source of electrical energy. In addition, wind energy can reduce greenhouse effect when its compared with other sources of electricity such as hydro, coal, gas plant or other renewable energy that can be use to generate an electrical energy. In this project is about the development a small wind energy converter consists of DC motor as a wind turbine, lcd display(to measure a voltage in the power storage) and the arduino uno board that located in a support curcuit.

1.3 Objective

The objective of this project is to build a small wind turbine which produce a rated power(1 Watt – 5 Watt) and to built a support systems using arduino controller for emergency situation (if there is zero wind).

1.4 Project Scopes

In this study, the development of a small scale wind turbine involved several scopes of work. The detail of the scopes was stated in the Table 1 .

Table 1 : Scopes of work

SPECIFICATION	RESULT
Power produce	Rated power(1 Watt – 5 Watt)
Voltage produce	Rated voltage
Support system efficiency	>91%
Total Grid currentTHD	<5%
Type of current produce	Direct current (DC)
Application	Small appliances
Support circuit component	Arduino uno board, breadboard computer(host).

1.5 Significant Of The Study

The overall study is about how to build the small wind energy converter with the support circuit that will make sure there are always has a supply from the turbine to the power storage. In this study the battery is use in the prototype small wind energy converter as a power storage. The support system was build using the arduino board and the computer as a host to control the input level to the turbine. In case there are no primary source to rotate the turbine, the input level speed for turbine will be control by the webserver that located in the computer and then the speed will be sent to the arduino board. Then , the arduino board will control the speed of turbine in order to generate electricity at the output terminal. Althought the support system use a small power to run the circuit system but the support system will provide a huge power to the turbine and it will produce a large power at the power storage. In other words, the support system high efficiency. The small wind energy converter has a high potiential in the renewable energy field. The small wind energy converter has many benefit compare to the the huge wind converter. It's more relative small, the cost to build it up is more cheaper than huge wind converter and no need a plenty space. The continued study in small wind energy converter is very important to make sure the electricity can be generated from the safe, friendly, renewal and useful in our daily life.

1.6 Thesis Of Line

There are five chapter in this report that consisting from introduction, literature review, methodology, results and discussion and lastly the conclusion. The first chapter is introduction. This chapter was explain in detail about the concept of the wind, the objective and the problem statement of the study, project scope and the significant of the study. The second chapter is literature review. The related pass research about the wind energy conversion was stated in this chapter. The related research are internetional research. That's mean the related research in this chapter are from in the country and overseas. The next chapter are completely explain about how to build the prototype of the small wind energy converter from the basic till the end.All the recorded results for this study are stated in the next chapter that is chapter 4. In this chapter, all the results for the small wind energy converter are showed. Lastly, the conclusion about this study has been conclude in the chapter 5.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Wind is one of the renewable energy that can be use to produce a electricity. The using of wind as a source to generate a electric energy become more significant nowadays. There are a lot of the benefit by using a wind as a main source to produce electric. This chapter will study the recent development on small wind energy converter , their social and environment benefit and interconnection issues of distributed resources including wind power with electric power systems.

2.2 Wind Speed Prediction

A.Kusiak, et.al [1] argue that one of the important aspect in handling the wind turbine energy converter is wind speed prediction. Wind speed is an important thing that must be to consider because to the power produced by the wind converter is totally depend on the wind speed. Determining the power generated by wind turbine at future times is important for unit commitment planning and maintenance scheduling. Wind speed must be predicted to estimate wind power generation capacity. Prediction (forecasting) of wind speed at three time scale, short, medium and long term is discussed. Short-term prediction aims at estimating wind speed at the time intervals such as 10 seconds or 10 minutes. Medium-term wind speed prediction studies usually focus on hourly predictions and long-term wind speed prediction involves days. Short-term wind speed prediction is important to control of wind turbines. Medium-term wind speed prediction support units commitment planning. Long-term wind speed prediction is used in determining generation mix and scheduled maintenance of power systems. Various approaches to wind speed prediction at different time scales have been developed in the past two decades.

2.3 Power Curve Of A Single Wind Turbine

Wind speed is the most influential factor on the power generated by a wind turbine. The theoritical power [2] that can be extracted from the wind is expresses by equation (1) :

$$P=0.5\pi R^2 Cp(\lambda,\beta)V^3 \quad (1)$$

Where P is the theoritical power captured by the rotor of a wind turbine, p is the air density, R is the radius of the rotor (blade's length) determining its sweeping area, $Cp(\lambda,\beta)$ is the power coefficient and V is the wind speed. The air density p at the turbine's hub height remains usually constant over a long-time horizon. Thus the most important operation parameters impacting the generated power area $Cp(\lambda,\beta)$ and V. The power coefficient indicates the efficiency of a turbine capturing the wind energy and its is optimized by the control system[3].

To analyze the perfomance of wind turbines, the SCADA data collected at a wind farm has been used. Table 2 shows data set 1 with the beginning time stamp "1/1/07 12:00AM" and ending time stamp "1/31/07 11:50 PM". Data set 1was divided into two data subsets, data set 2 and data set 3. Data set 2 contains 3476 data points and was used to develop a data-driven model estimating the power curve. Data set 3 inlcudes 871 data points and was used to test perfomance of the model learned from data 2[3].

Table 2 : Description of the data set

Data Set	Start Time Stamp	End Time Stamp	Description
1	1/1/07 12:00 AM	1/31/07 11:50 PM	Total Data Set : 4347 Observation.
2	1/1/07 12:00 AM	1/25/07 6:20 PM	Training Data Set : 3476 Observation.
3	1/25/07 6.30 PM	1/31/06 11:50 PM	Test Data Set : 871 Observation.

A wind turbine is expected to produce a certain amount of energy given the wind speed. In fact, all regions outsides of the logistic curve represent either power loss or power gain.

The data points in region away from the logitic-curve region usually represent an anomaly leading to, for example, decrease perfomance[3].

2.4 Social And Economic Benefit Of Wind Energy Technology

Wind benefits brought by (Resources, Energy and Tourism) RET have been extensively evaluated, as well as economic costs and its contribution to energy security. However, a thorough discussion of the socio-economic impacts of these technologies is still limited. This discussion becomes even more important in periods of low economic growth [4,5]. One of the the social and economic benefits are technological innovation and industrial development distributed generation and universal access to energy regional and local development, especially in rural areas and job creation. According to Laitner et al. [6], assessments on the performance of climate and energy policies usually do not take into account the dynamics of technological innovation, and often associate reductions in energy consumption and GHG emissions with economic losses.

Frankhauser et al. [4] argue that technological innovation and the creation of new opportunities for investments and economic growth are both consequences of climate policies. Technological change and innovation, in the long term, increase the demand for labour and skills. The writer also emphasize the role of good policies aimed at motivating technological innovation. In this context, the pioneers in the development of clean technologies have the potential for regional leadership. The author also use the case of Germany, which today stands out as a leader in the export of clean technologies. RET are capital intensive, and most of the investment is concentrated in the initial phase of the project – the cost of wind turbines and other equipment can account for about 75% of the total investment of a wind farm [7]. Thus, implementation of renewable energy projects tends to offer an opportunity for developing equipment industries for domestic consumption and even for export [4,8,9].

Usually in the country developments, energy consumption per capital is usually much lower than in developed ones, since the former are undergoing development . The inclusion of renewable energy and energy efficient technologies early in the development process accelerates the efficient use of resources, called leapfrogging, enabling development processes with lower environmental impacts [10]. The adoption of renewable energy development projects can meet the development goals without going through the intensity of fossil fuel consumption that marked the growth in developed countries [11]. The convergence between the fields of energy planning and economic development is present in various energy policies. Such convergence is known as energy-based economic development, whose main goals are to increase self-sufficiency and energy diversification, contributing to economic and industrial growth and development; to increase entrepreneurship and encourage technological innovation; and to increase the level of employment and training [12]. The presence of renewable energy projects in rural areas, especially those characterized by low economic development, can bring benefits to the community. High unemployment rates, lack of alternative economic development, and high rates of migration of economically active population, offer a worthwhile environment for investment in RET. Compared to traditional power plants, renewable energy units are often smaller, modular and decentralized and, therefore, they are often located in rural areas with low population density. Due to this feature, the construction of these plants demands high amounts of labour, and creates the potential for training and employment of rural populations in several locations [13].

Besides generating temporary jobs in construction, there are fewer but long lasting job opportunities in the operation and maintenance (O&M) of power plants. The deployment of renewable energy projects offers an alternative or complement to agricultural activities, and contributes to rural development [7]. Even though the number of jobs created in one location is not significant for the country, it might be regionally meaningful [14]. A study by Bergmann et al. [8] in Scotland showed that the rural population awareness regarding RET social benefits has increased, and is significantly higher than that from urban population. Another important aspect is land leasing by wind farms. Because wind turbines occupy only a small fraction of the area, the revenue from land renting can be invested in other productive activities in the property [7,15]. Futhermore the landowners and the workers in construction and O&M, other stakeholders benefit from renewable energy projects. During the construction stage there is an increase in demand of goods andservices, such as lodging and meals, due to the crew involved in the work. Suppliers ofgoods and services within communities can benefit from the project's installation, whichincreases total income of the community and creates temporary job opportunities.Depending on the project, other compensations such as school reforms and publicinfrastructure improvements also take place [7]. A summary of regional and local development benefits brought by investment inrenewable energy sources is illustrated in Figure 1.

Despite the potential to bring numerous benefits to the local and regional development, the incentive to renewable energy should not be considered as a development policy, but if applied in conjunction with other social policies, it can contribute to the local development of these communities [14]. Job creation is a key issue for the evaluation of economic development in a region. A concept that has been gaining ground in discussions of social and economic benefits in a low carbon economy is that of green jobs. According to UNEP [3], green jobs are those that contribute to preserving or restoring environmental quality. These jobs are located in diverse industries and include jobs in energy efficiency, clean technologies, efficient use of natural resources, and activities in low-GHG emissions. A discussion of job creation in RET, which gained momentum in the early year 2000, began due to uncertainties about the effectiveness of public policies for renewable energy and its effects on the economy, especially those based on heavy governmental subsidies. In addition to quantifying jobs and socio-economic impacts either locally or nation-wide, training and technological bottlenecks faced by the renewable energy sector also deserve attention. Studies with companies in the wind sector in the European Union have identified a lack of qualified professionals, especially for positions that require ahigher training level [16,17].

Figure 2. Regional and local aspects of RET. Own elaboration from [7,12,15,18]

Jobs generated by wind power and other RET can be grouped into three part according to their location, temporal nature, and level of expertise. The first part refers to jobs generated in technological development, and includes R&D and equipment manufacturing. The second part refers to jobs in installation and decommissioning of plants, and comprises planning, project management, transportation and power plant construction and decommissioning. The third part is operation and maintenance (O&M), and includes, besides the actual O&M of the plant, energy distribution and commercialization. The characteristics are summarized in Table 3.

Table 3 : Classification and characteristics of employment in RET [18]

Category	Volume Of Job Creation	Location	Temporal nature	Specialization level demanded
Technological devolepment	Medium	From non-local to local	Stable	Very high
Installation	High	From local to non-local	Temporary	High
Operation and maintenance	Low	Local	Stable	Medium

Employees' training is a key issue for renewable energy development [18]. At the same time, most of the local jobs generated by wind power is temporary for example during the installation of the project, policies aiming to maintain the stream of new projects each year should be considered.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter, a brief discussion on methodology approach performed in the study. It will be divided into several sections to give a detail explanation about the methodology of the development of small wind energy converter.

3.2 Flow Of Project

The flow of this prototype is showed in Figure 3 below. At first, after the selection of the final year project topic has researching done, the researcher about the small wind converter energy topic and literature review was done first in order to understand more details about the overall keypoint of this study. This research is more focus about the wind speed prediction, power produce by using a wind converter energy and benefits of the wind energy converter to social and economics and all the research is done with refer to the latest research.The Figure 3 below showed in detail about the flow of the project in the Final Year Project.

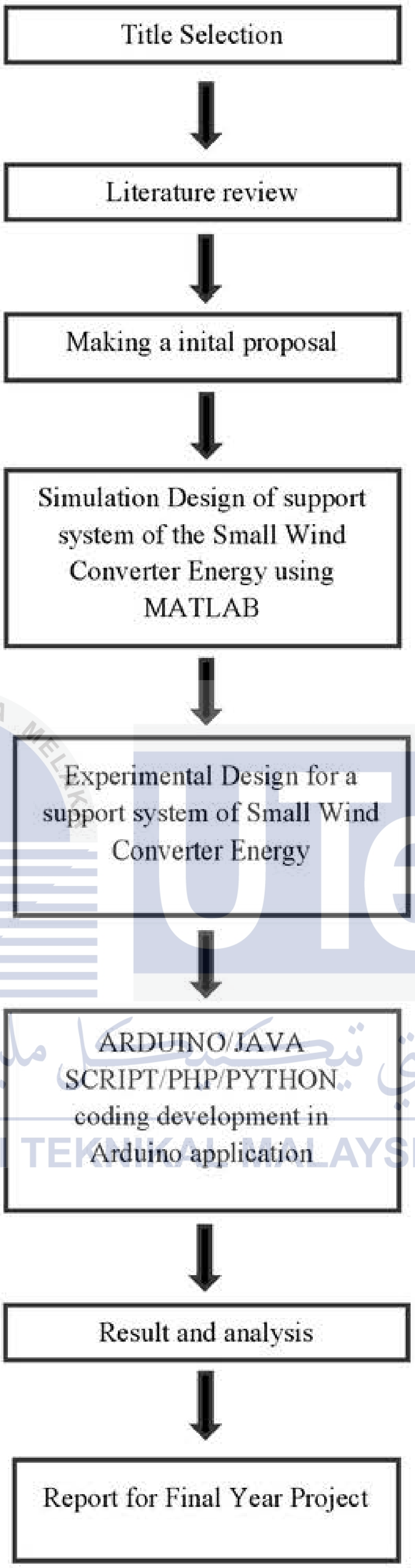

Figure 3 : Methodology flowchart

3.3 Simulation Design Circuit Of Support System Of The Small Wind Energy Converter

The simulation design of the support system is perfectly done in the proteus 7 professional. The proteus 7 professional is a microprocessor simulation software, printed circuit board(PCB) design and schematic capture. In the simulation case, the coding to install in the arduino uno board need to convert to the hex file before it can be installed in the board in the software. The simulation design in the proteus 7 professional is showed in the Figure 4 below and all the measurement of the voltage and current are recorded are showed in detail in chapter 4.

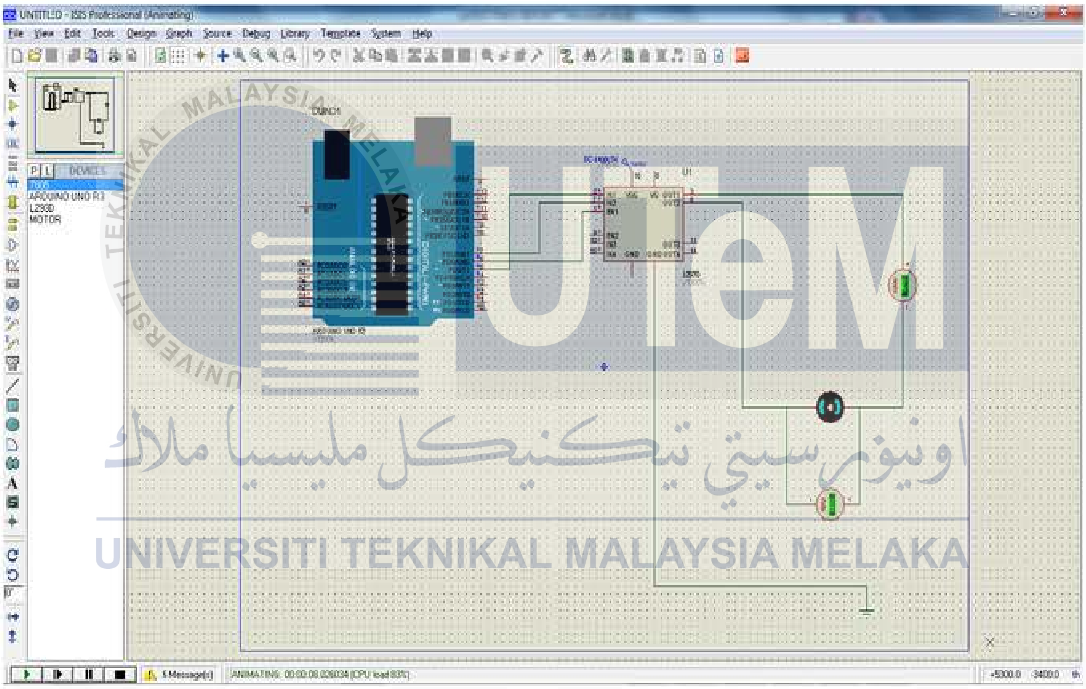

Figure 4 : Simulation design of support system of the Small Wind Energy Converter

3.4 Simulation Design Circuit To Determine The Output Current Based On The DC Motor Speed

The simulation design for the determine the current output based on the dc motor speed also done prefectly in the proteus 7 professional. The main purpose of this simulation circuit is to make sure the current output that produce from the support system is accurate with the value of the dc motor output in the real hardware configuration. The Figure 5 below shows that the design circuit to determine the output current based on variable dc motor speed. In this simulation, the experimental value for dc motor speed used is 30 rpm, 90 rpm, 100 rpm, 200 rpm and 255 rpm.

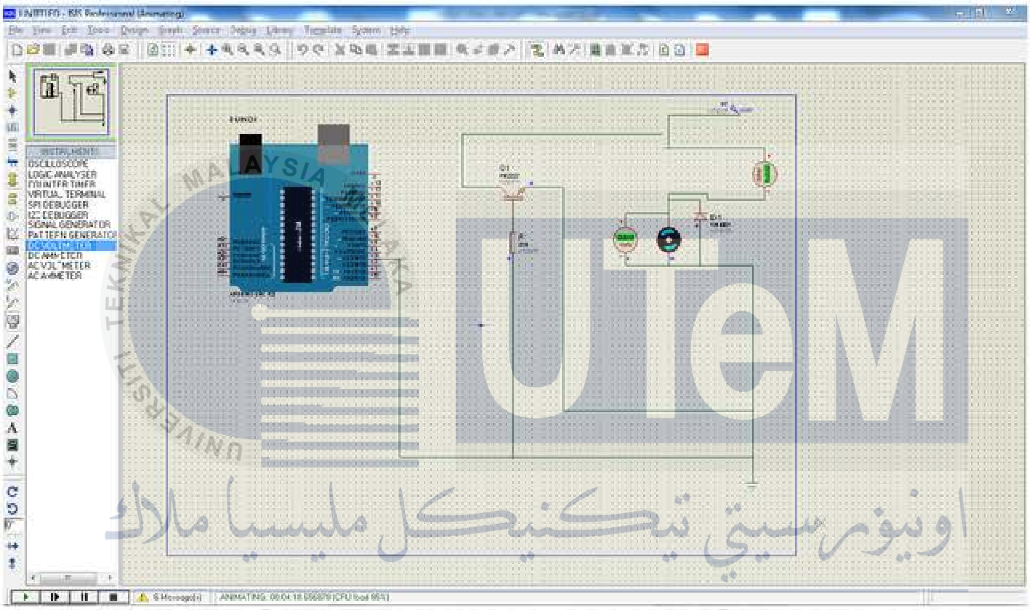

Figure 5 : Simulation output current based on the dc motor speed

The coding use to stimulate the circuit above is showed in the Figure 6. Before the coding can be install into the simulation arduino uno board, it has been convert to the hex file. The figure below shows that the coding that have been verify in the arduino.exe terminal beore it convert to the hex file.

Figure 6 : Coding for the simulation in figure 5

All the recorded value for the current output based on the experimental value of dc motor' speed are showed in the chapter 4.

3.5 Server System Development(Coding Development)

The local host development are using a hypertext preprocessor coding (php coding) to build up the webserver that are use to put the input speed of the dc motor to drive to motor . The coding are devolep in the Pspad editor software. Pspad editor software is a freeware of text editor and editor intended for use by a programmers. This software is designed as a universal GUI and can use to handle variable type of coding such as a python, html,php, perl and java. In the process to design a webserver(local host), the basic of the html and php coding is use. There are almost three days taken to completely all the html and php coding to design a webserver. The screen shot of coding to design a webserver are showed in the Figure 7 below.

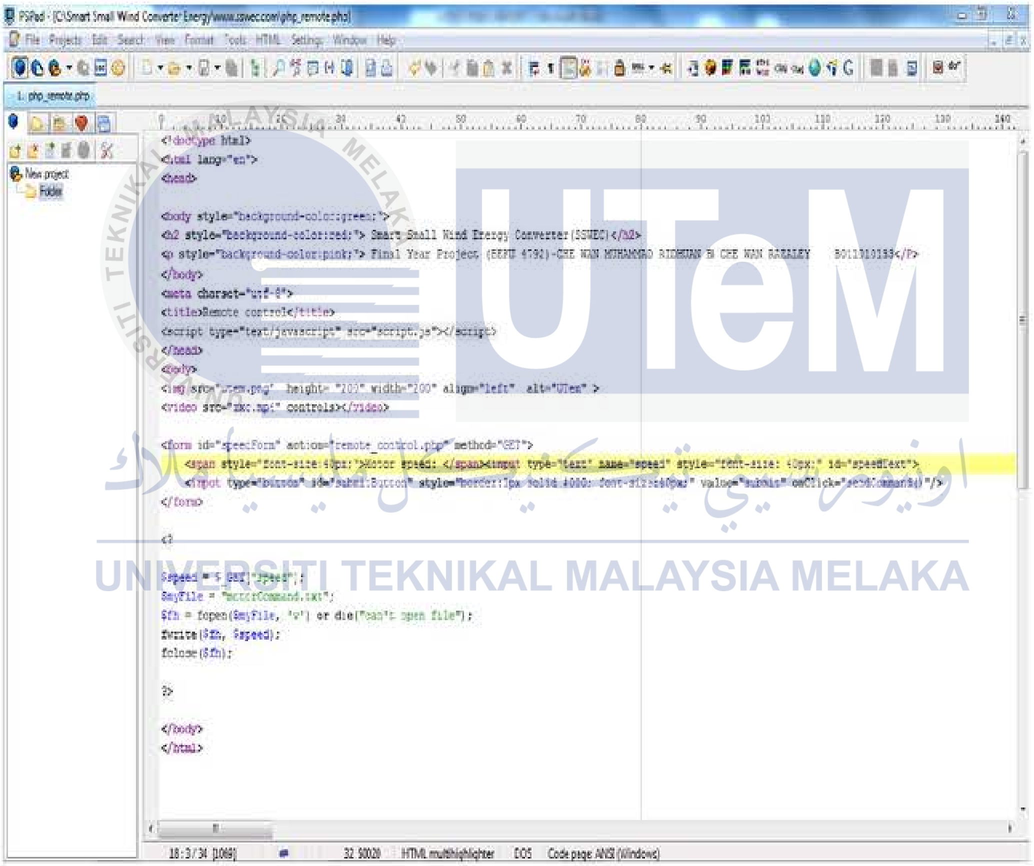

Figure 7: Coding to build up the webserver page

The Figure 7 above shows that the basic html and php basics coding to build up the webserver. All the coding above are use a Pspad editor to complete the compile process to check the error and to run the coding. When the coding is done properly, the software

EasyPHP Dev Server 13.1 VC11 is use to run the coding. All the detail about the EasyPHP is stated in the section 3.8 that is EasyPHP setup part . The domain name of the webserver(local host) is http://127.0.0.1/www.cwmr.com/php_remote.php. The complete webserver is showed in the Figure 8 below.

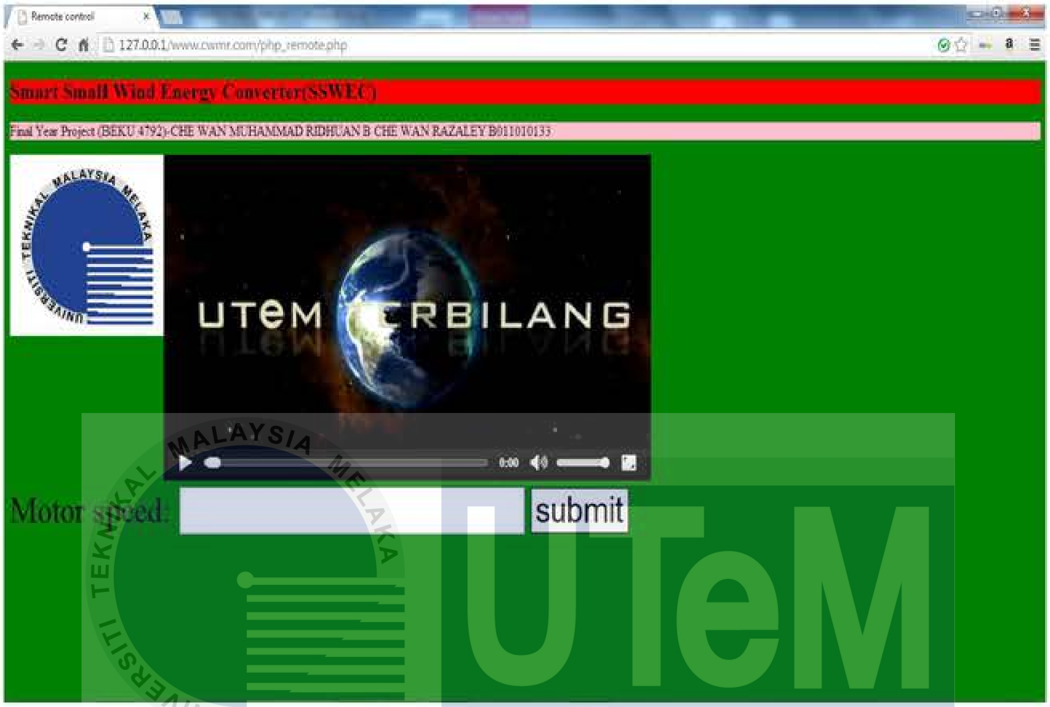

Figure 8 : Webserver(local host)

The Figure 8 above shows that the complete webserver that are need to control the speed of the dc motor. The input of the dc motor speed will put at the motor speed text and the speed will be send to the next stage after the the submit button pressed.

3.6 Hardware Setup

The hardware use in the support system of small wind energy converter is arduino uno board, breadboard, arduino jumper, L293D motor driver and the dc motor.Arduino Uno board is a one of the device that can be use to interface between the host and the ouput. In this support system the output use is dc motor. The arduino uno board is use as a medium to sent a motor speed from the server to the dc motor that throught the arduino board and go to the breadboard and lastly to the dc motor. The arduino board hardware is show in the Figure 9 below.

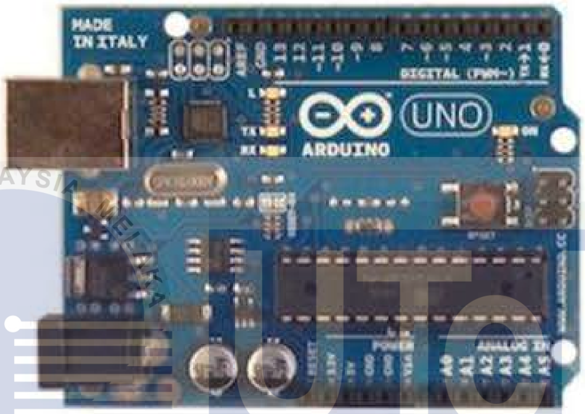

Figure 9 : Arduino Uno board

The Figure 9 above showed the arduino uno board structure in real life. Arduino uno board is a single board microcontroller. The hardware consists of an open-source hardware board designed around an 8-bit Atmel AVR microcontroller, or a 32-bit Atmel ARM. Besides that, this software consists standard programming language compiler and a boot loader that execute on the microcontroller. The arduino board needs a coding or a program to function. In this support system, the coding is upload to the arduino uno board using the the arduino.exe software. Arduino.exe is a terminal that a programmer use to upload a coding or the program to the arduino board. The coding that installed in the arduino uno board are verify in the arduino.exe terminal before it can upload to the arduino uno board. Figure 10 to Figure 12 shows the coding use, the coding verify process in the arduino.exe and the upload the coding to the arduino uno board process.

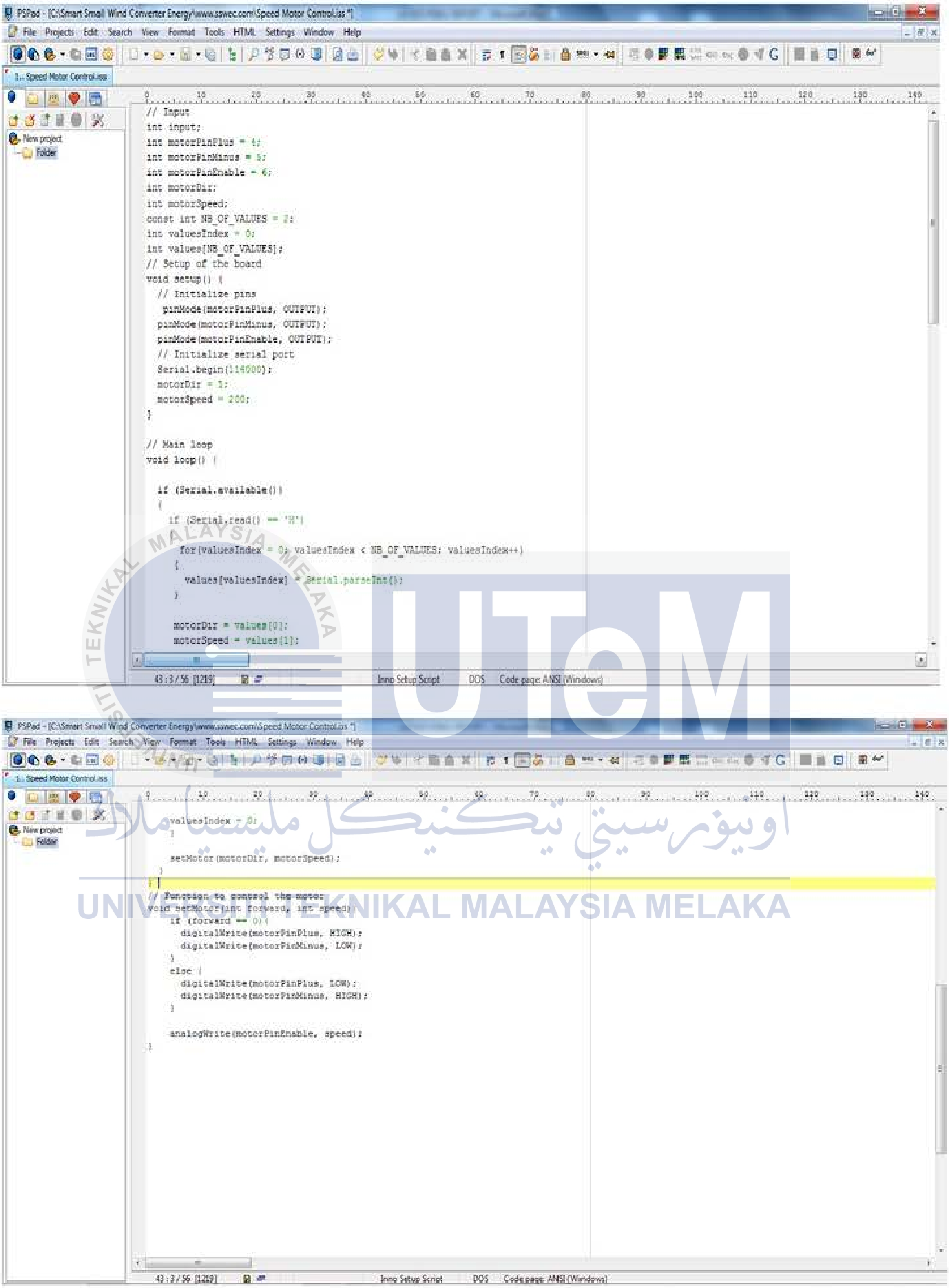

Figure 10: Motor speed coding that installed in arduino uno board

Figure 11 : Coding Verify Process

Figure 12 : Uploading the coding to the arduino uno board process

The Figure 10 shows that the coding use to program the arduino uno board. All the coding or program must go through the verify process in the arduino.exe before it can be upload to the arduino board.The Figure 10 shows the detail about the process. After the verify process are done and there are no mistake in the coding, the arduino.exe terminal will stated "Done Compiling" as showed in the Figure 11. Thats mean there are no error in the coding. After the compiling process are prefectly done, the coding need be upload to the arduino board by the same terminal thats is arduino.exe.If the uploading coding are successful, the terminal will stated that "Done Uploading" as showed in the Figure12.

After the coding are prefectly installed in the arduino uno board, the next stage is to setup the connection between the arduino uno board to the breadboard and the dc motor. The Figure 13 below show the breadboard hardware, the Figure 14 below shows the arduino jumper, the Figure 15 shows that L293D motor driver and the Figure 16 below shows that the output of this system thats is the DC motor with the nominal voltage 5V.

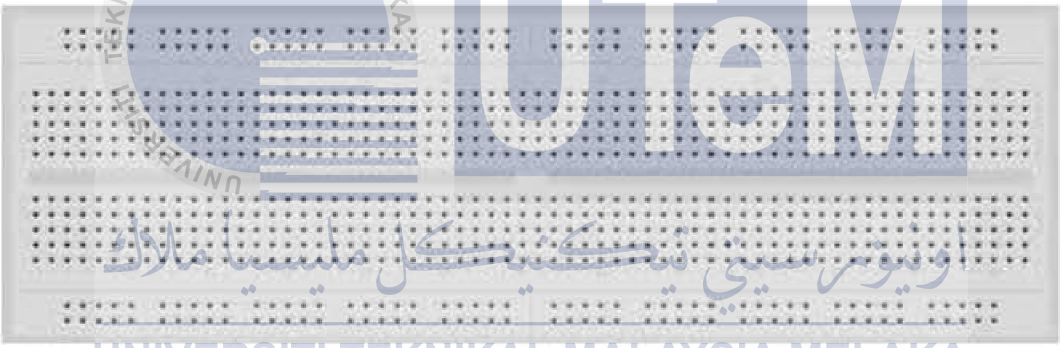

Figure 13 : Breadboard hardware

Figure 14 : Arduino jumper

Figure 15 : Motor driver

Figure 16 : DC motor

Finally, to complete the hardware setup, a connection between all the component was created. In general, the simplify of the connection between all the component in the support system are showed in the block diagram in the Figure 17 below.

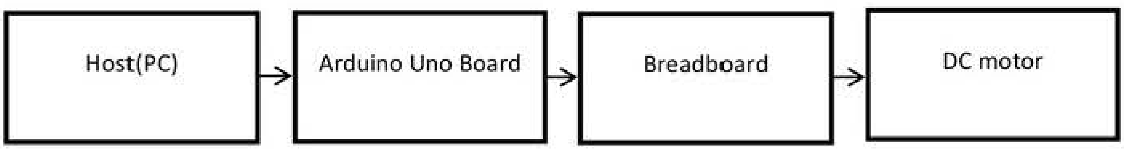

Figure 17 : Block diagram of the connection between hardware component

The Figure 17 shows the flow of connection between the hardware connection between the component in the support system of the Small Wind Energy Converter. The connection is start from the computer as a server and the computer will connected to the Arduino Uno board that are already installed with the coding or program ro run the motor. After that, the arduino uno board connected to the breadboard and lastly the breadboard is connected to the our final output thats is dc motor with nominal voltage 5V. The Figure 18 shows that the real connection of the support system circuit.

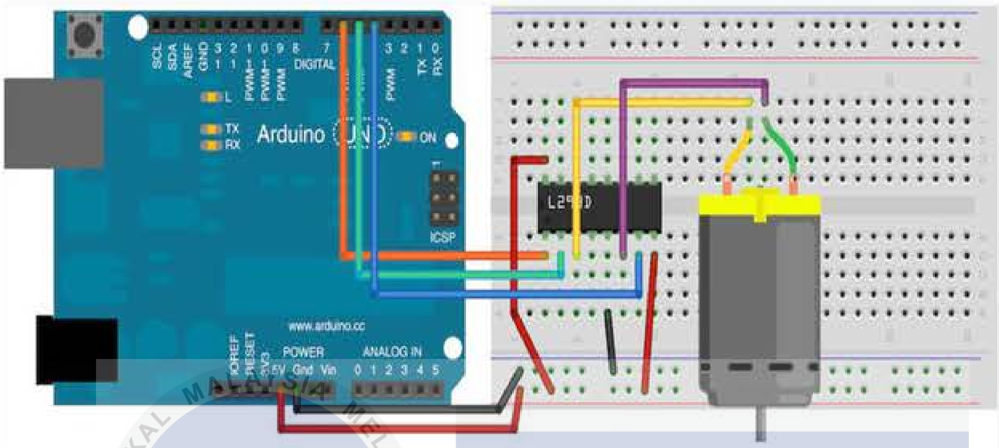

Figure 18 : Final connection between all the component in the support system

The connection above are design using the fritzing software from the the fritzing.org. Fritzing is a open source hardware. The complete connected hardware will conneted to the computer(host) through the A to B cable. The figure 19 shows that the cable use to connect between the hardware to the pc(host).

Figure 19 : A to B cable

3.7 Python Coding Setup

The python coding or the python file is use to establish the communication between the pc with the arduino uno board. This coding is use a same editor to build it that is a Pspad editor. The python program will send the content of the file to the arduino with the right protocol. The file will be generated by the webserver interface that already setup in the server system development. The Figure 20 below shows that the python coding that are verify in the Pspad editor.

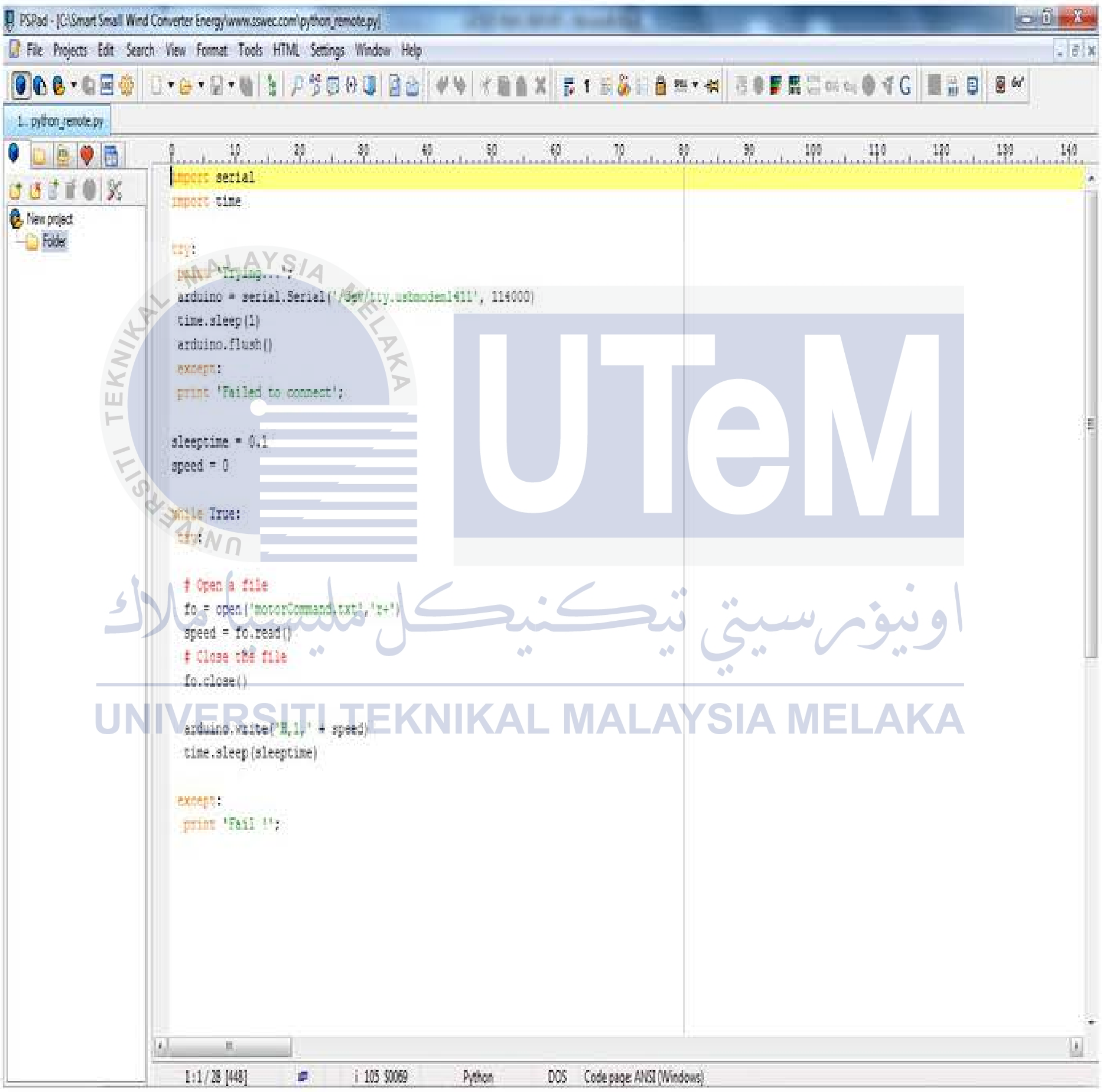

Figure 20 : Python cofiguration

3.8 EasyPHP DevServer Setup

EasyPHP is a software that are use in this system support system to compile all the coding file in the one directory of the webserver. The EasyPHP DevServer 13.1 V11 are used in this project. The Figure 21 below shows all the coding file that already setup to the one directory in the webserver.

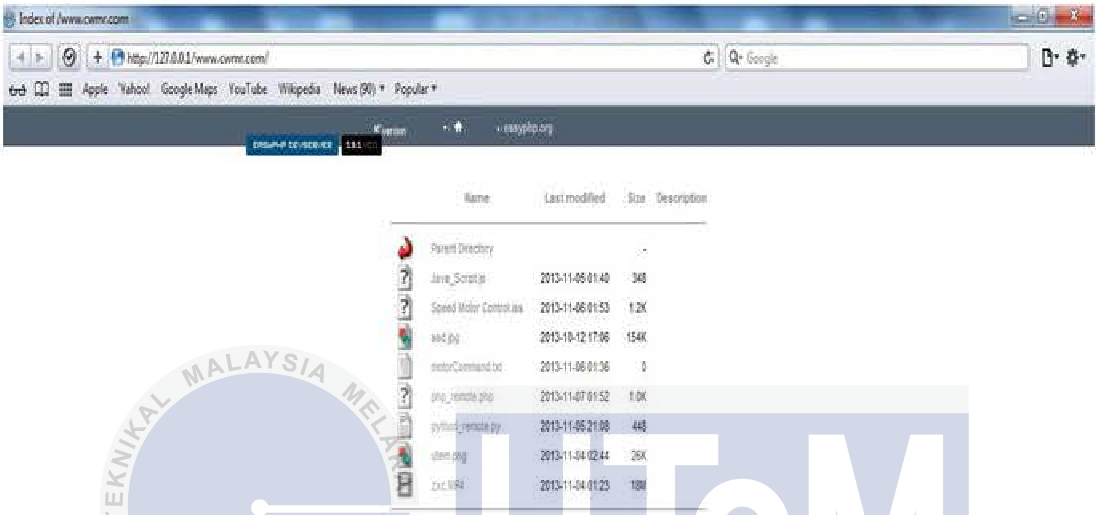

Figure 21 : Coding file setup in the webserver directory

The main page of directory for all the coding file is http://127.0.0.1/www.cwmr.com/. The php_remote.php is a file that will connect direct to the webserver main page as show in the Figure 21.

3.9 Experimental Design For Support System Of A Small Wind Energy Converter

This part of experimental design will go through in detail about the support system that will make sure the direct current(dc)'s motor will continuosly rotate in case there are no primary source for the small wind converter energy. The Figure 22 below shows the block diagram for the support system of small wind converter energy.

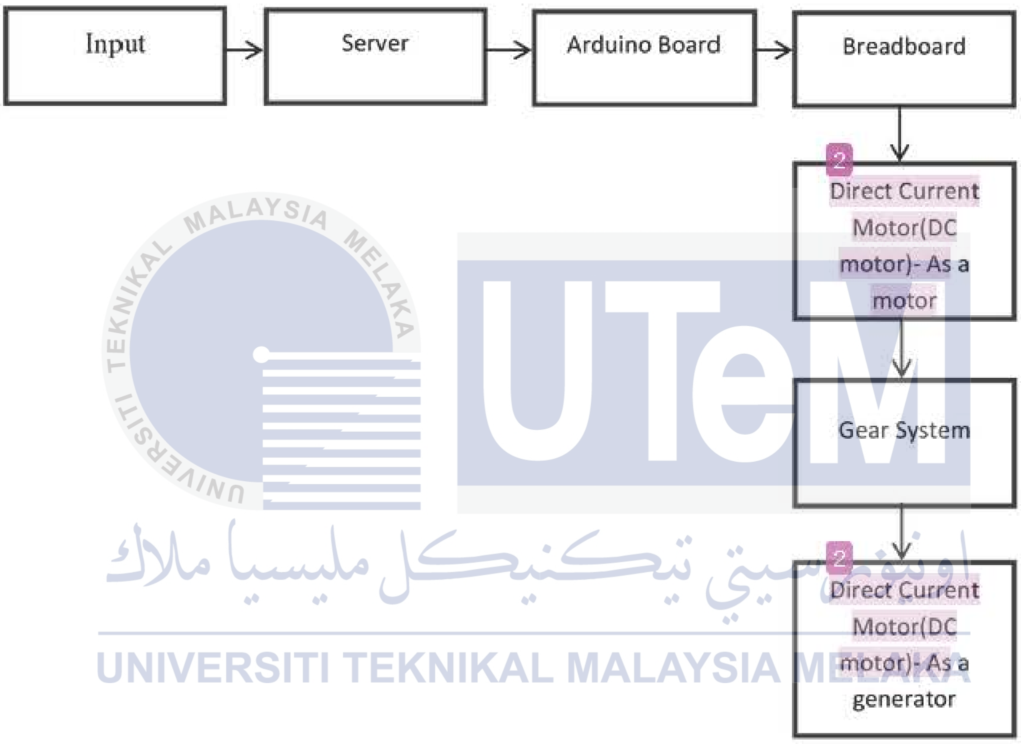

Figure 22: Block diagram for a support system

The block diagram above shows how the support system for the small wind converter energy works. The input will be added in the server that are build up using the php coding. All the detail about the process to design a server are stated in the next section. The motor speed are put in the server website and the server will communicate with the python coding or python program that running in the host pc. When the actual input speed are completely sent from the webserver to the python program, the python program will sent the data input to the arduino uno board and then the arduino board will communicate with the breadboard that are connected to the direct current motor(DC motor). The motor will rotate depends on the input value that are put in the server. The range of dc motor's speed is between 0 to 255. The range are already setup while in the process to build up the server system. The Figure 23 below shows the experimental design for the whole system for the small wind energy converter energy.

Figure 23 : Experimental Design For The Support Systems

3.10 Experimental Design For The Whole System Of A Small Wind Energy Converter

This part of experimental design will go through in detail about the whole system of the Small Eind Energy Converter. In the normal situation, the small wind turbine will be function by using a natural wind energy and in case there are no main source to rotate the wind turbine, the support system circuit will handle the rotation of the wind turbine. The main putpose of this support system is to make sure there are always have a power supply to the power storage. The Figure 24 below shows that the experimental design for the small wind energy converter project.

Figure 24 : Experimental Design For The Whole Systems

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

In the chapter 4, the result that gain from simulation and experimental result are stated in detail. This chapter have been divided into five section that is simulation result for main circuit of the small wind energy converter, experimental result for support system of small wind energy converter, simulation result for design circuit to determine the currrent output based on the motor speed, result for efficiency of the support system and discussion part.

4.2 Simulation Result Of Main Circuit Of The Small Wind Energy Converter

The simulation result is obtain from the simulation that has properly done in the MATLAB software. The design use in simulation is showed in the figure under section 3.3. All the recorded data that gain from the simulation are stated in the Table 4 below.

Table 4 : Simulation result for support system of Small Wind Energy Converter

Direct-Current motor speed(rpm)	Current produce(A)
30	0.02
90	0.10
100	0.23
200	0.39
255	0.42

4.3 Experimental Result For The Support System Of The Small Wind Energy Converter

In the experimental result, the hardware as showed in the figure 23 is used to obtain the current produced and current produce based on the speed rotation of the dc motor in the support system of the small wind energy converter. The measurement are taken using a multimeter. The Figure 24 below shows that the multimeter device that are used take the measurement from the support system of a small wind energy converter.

Figure 25 : Multimeter

All the measurement that are obtain from support system are recorded and all the data are showed in the Table 5 .

Table 5 : Measurement from the support system

Direct-Current motor speed(rpm)	Current produce(A)
30	0.01
90	0.09
100	0.22
200	0.36
255	0.40

4.4 Simulation Result For Design Circuit To Determine The Currrent Output Based On The Motor Speed

The main pupose of this simulation is to make sure the current produce from the dc motor speed is same with the actual hardware and the result from the simulation of the support system od the small wind energy convereter. All the experiment result and the simulation reults are based on the experimental value of the dc motor speed. The experimental value used is 30 rpm ,90 rpm,100 rpm,200 rpm and 255 rpm. All the reading that get from this simulation are show in the Table 6 below.

Table 6 : Result for current produce based on the dc motor speed

Direct-Current motor speed(rpm)	Current produce(A)
30	0.03
90	0.10
100	0.23
200	0.39
255	0.42

4.5 Result For Efficiency Of The Support System

The point of this part is to make sure that the support systems has a higher efficiency. By using the formula of efficiency ((power out/power in) x 100), the efficiency of the support system are recorded in the Table 7 below. The experimental value of the speed DC motor used is 150rpm, 200rpm and 255rpm.

Table 7 : Efficiency Of The Support System

DC motorSpeed (rpm)	V_I(v)	C_I(A)	P_I(w)	V_O(v)	I_O(A)	P_O(w)	E(%)
150	0.5	0.5	0.24	0.5	0.45	0.23	93.75
200	1.0	0.6	0.6	1.0	0.55	0.55	91.67
255	1.5	0.75	1.13	1.5	0.70	1.05	93.33

There are 7 parameters that's involved in this part. There are V_I, C_I, P_I, V_O,C_O,P_O and E. The explenation for all the paramater are stated below.

Where as:

V_I =Voltage input ; C_I = Current input ; P_I = Power input; V_O =Voltage output ;
C_O=Current output; P_O = Power output; E = Efficiency

From the resuts that recorded in the Table 7 above, it's shows that the support systems has a hugh efficiency that between 91 percent to 94 percent. All the detail about the results has been discussed in the discussion part below.

4.6 Discussion

The result from the table simulation design and the result from the simulation current produce based on the motor dc speed is perfectly same. Thats mean there are no problem in the design of the support system circuit. However the result that gain from the real hardware is slightly different from the both simulation. There are a lot of factor that maybe affect the reading that get from the real hardaware. The main factor that are make the result are different is the device used to take a reading from the real hardware. The calibration issue is the reason why the reading that get from real hardware by using a multimeter as show in the figure 24 above is slightly different from the simulation result. Besides that, the real hardware use a supply from the computer that act as a host in the support system. So that, a bit losses may occur in the circuit of the system before the reading of the current produce are taken. That's are a few factor that make a reading of the current produce from the real hardware is slightly different from the simulation relsult.

In the process to build up the support system fo small wind energy converter, all the process are done properly except the small problem have occur in the python.py file. The coding in that file has a few problem. The actually function of the python.py file is to get the actually speed of the dc motor from the motorCommand.txt that are generated by the web interface. The input installed in the webserver and then the webserver will sent the value of the speed to the motorCommand.txt as showed in the figure 21. Then, the python.py file will take the value and sent to the arduino uno board during the communicate process between the computer(host) and the arduino uno board but in this case the pyhton.py file was not working properly in the first implementation stage. The file or the program cannot take the value from the webserver and sent it to the arduino board to proceed to the next stage. To overcome the problem, it was been refered to the internet and the coding has been examined by the expert. This is to verify where the problem that make the coding cannot run and do it function properly. All the process to to overcome this problem has done prefectly in one weeek only. For others stage in process to build up the small wind energy converter are running smoothly.

CHAPTER 5

CONCLUSION , RECOMMENDATION AND AWARDS

5.1 Introduction

This section is briefly explain about the conclusion of this small wind energy converter project as well as the award which was obtained under this small wind energy converter project.

5.2 Conclusion

All the process to build up the support system was done properly unfortunately the small problem has occur at the pyhton file that is the program that are use to make a host(pc) to communicate with the arduino uno board. For the coding use to complete the whole support system for a Small Wind Energy Converter are attached together in the appendices part. All the ways to overcome has been discussed in the discussion part. Besides that, the simulation of the main circuit also have done properly without any problem and the results as showed in the part 4.2.

By build up the support system like use in this project is very practical because in the real life and in the case there are no primary source(wind), the server that connected to the wind turbine will easy to handle the turbine by sent the speed input in the system and the input while directly control a wind turbine. The support systems has a higher efficiency. For this prototype, the efficiency of the support system is between 91 percent to 94 percent. In a real life, the wind detecter will needed to be connected to the server and the wind turbine or the server need the device that will always update and cheking the electrical supply at the load so that it can react faster if the electrical supply is shutdown. The success in the process to build up the support system of the small wind energy converter as showed in the figure 21 is show that the second objective of this project that are to build up the an additional arduino uno board in a support system in the case no main source(wind) is achieved. Generally, both objecive that is to build up the small scale wind turbine that will produce rated power and to build the support system for the small wind turbine are achieved.

5.3 Recommendation

This project has a high potential to be applied in the real life. In the real life , this protytpe of the small wind energy converter need a sensor that's detect the power storage level in the system. This sensor is to make sure there are always have a voltage in the power storage and in case the storage level is achieve at the minimum level it's will send a signal to the support system and the support systems will take over to control the wind turbine in order to supply a voltage to the power storage. This project has a lot of benefit and it's convenient to applied in the real life.

5.4 Awards

Basically, this project has joined the three competition that's is a UTeMEX 2013, INTERNATIONAL ENGINEERING INVENTATION AND INNOVATION EXHIBITION(i-ENVEX 2014) and POWER AND ENERGY CONVERSION SYMPOSIUM (PECS) 2014. The first competition has been held at UTeM on 12 December 2013.For this competition, this project has win a bronze medal. The next competition that's is i- ENVEX 2014 has been held at UNIMAP on 11 April to 13 April. This project also obtained a bronze medal for this competition and the last competition is POWER AND ENERGY CONVERSION SYMPOSIUM (PECS) 2014. For the PECS, the technical paper under this project has been accepted 14 April 2014 and the symposium date for this competiton is 12 May 2014. That's all the detail about the competition and the medal obtained under the small wind energy conveter project and all the certificate and the medal for for UteMEX 2013, i-ENVEX 2014 and PECS 2014 are attached together in the appendices part from appendix g until appendix o.

SMALL WIND ENERGY CONVERTER

ORIGINALITY REPORT

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