SMART MINI HYBRID AUTOMATION SYSTEM

(SIHAS)

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I declare that this report entitle “Smart Mini Hybrid Automation System” is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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ABSTRACT

Hybrid is a combination of the two supplies in this project by using Photovoltaic and Generator charge to Battery Bank. Components in the home need energy to operate 24 hours each time to meet human needs. The battery is used as an alternative energy during the night and the replenishment of batteries should occur during the daytime. All loads in the home will continue to function as voltage batteries will not come down to the minimum and to prolong the lifespan of batteries. This project aims to produce energy for home appliances distributor. Circuit of the solar charger adapters available in the market will be carried out and the controller is able to distribute energy to all applications in the home. Research and analysis on the charger, solar and electric generator available in the market need for modification of the circuit and replace it with arduino. This project also includes research in solar charger, generator and the means of modification of the circuit. A standby generator is a back-up electrical system that operates automatically. Within seconds of a utility outage an automatic transfer switch senses the power loss, commands the generator to start and then transfers the electrical load to the generator. The standby generator begins supplying power to the circuits. After utility power returns, the automatic transfer switch transfers the electrical load back to the utility and signals the standby generator to shut off. It then returns to standby mode where it awaits the next outage. Most units run on diesel. Battery charger device used to put energy into the cells, secondary or rechargeable battery by forcing electric current through it. In smart hybrid automation system, it have additional operation to the system that can be monitor through web server by develop the interface.

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ABSTRAK

Hibrid adalah gabungan dua bekalan dalam projek ini dengan menggunakan Photovoltaic dan caj Generator kepada Bank Bateri.. Komponen dalam rumah memerlukan tenaga untuk beroperasi 24 jam setiap masa bagi memenuhi kehendak manusia. Bateri digunakan sebagai tenaga alternatif semasa waktu malam dan proses pengisian semula batteri harus berlaku semasa waktu siang. Semua beban dalam rumah akan terus berfungsi kerana voltan batteri tidak akan turun ke nilai minimum dan ini untuk memanjangkan jangka hayat batteri. Projek ini bertujuan untuk menghasilkan tenaga pengedar untuk aplikasi rumah. Pengubahsuai litar daripada pengecas solar yang terdapat di pasaran akan dijalankan dan pengawal ini dapat mengagihkan tenaga kepada semua aplikasi dalam rumah. Kajian dan analisis ke atas pengecas solar dan penjana elektrik (generator) yang ada di pasaran diperlukan untuk pengubahsuaian litar dan menggantikannya dengan arduino. Projek ini juga merangkumi kajian pada pengecas solar, pejanaan elektrik (generator) dan cara-cara pengubahsuaian litar. Pada masa yang akan datang, pembaikan litar boleh fokus pada tempat pengecas supaya mencapai kecekapan yang tinggi dalam simpanan tenaga. Keadaan penjana yang siap sedia adalah sistem siap sedia elektrik yang beroperasi secara automatik. Dalam masa beberapa saat gangguan utiliti deria pemindahan kehilangan kuasa suis automatik, mendapat penjana untuk memulakan dan kemudian memindahkan beban elektrik penjana. Penjana siap sedia bermula membekalkan kuasa kepada litar. Selepas pulangan kuasa utiliti, suis pemindahan automatik memindahkan beban elektrik kembali ke utiliti dan isyarat penjana siap sedia untuk menutup. Ia kemudian kembali ke mod siap sedia di mana ia menunggu gangguan seterusnya. Kebanyakan unit menjalankan terhadap diesel. Pengecas bateri peranti yang digunakan untuk meletakkan tenaga ke dalam sel menengah atau bateri yang boleh dicas semula dengan memaksa arus elektrik melaluinya. Dalam sistem automasi pintar hibrid, ia mempunyai operasi tambahan kepada sistem yang boleh memantau melalui pelayan web dengan membangunkan antara muka.

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LIST OF ABBREVIATIONS

AC - Alternating Current

ADC - Analogue Digital Converter

Ah - Ampere per Hour

Cm - Centimetre

DC - Direct Current

APD - Analogue Panel Display

FKE - Fakulti Kejuruteraan Elektrik

I - Current

L - Length

LED - Light-Emitting Diode

LVD - Low Voltage Disconnect

MPPT - Maximum Power Point Tracker

PCB - Printed Circuit Board

PV - Photovoltaic

PWM - Pulse Width Modulation

SPDT - Single pole, double throw

V - Voltage

W - Watt

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CHAPTER 1

INTRODUCTION

1.1 Research Background

1.1.1 Research Background

First and foremost, hybrid is not a new idea and it has been existed few years before. Apart from that, solar hybrid generator offers great condition for all human especially for the countries that face four seasons. Moreover, we can reduce the use of coal and fuel to produce electricity. For example, we can generate power electric by using photovoltaic (PV), battery, and back-up generator.

Besides, the electric system has many factors that can be incorporated into the final product. We know that when the winter season is coming, only little diffusion of sunlight can reach to the Earth. On the other hand, our country Malaysia is located few degrees north of the equator and therefore the temperature is almost uniform throughout the years.

Moreover, some equipment in the house need energy generated from the heat or light from the sun which can be used to produce heat, electricity, and cooling. Apart from that, all the equipment in hybrid house requires energy to function. We need a controller that can convert the energy from the PV panel and supply to all the equipment in house. Moreover, the equipment will be lack of energy during night and a battery is an alternative solution for the equipment to operate without any interruption.

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The importance of the server is growing with the growth of the Internet and the log data. The load on the server has rapidly grown with the increase in the number of Web server users. Thus, load monitoring has become an important technical aspect in the performance of the server for these reasons. The web-based is used to monitor the system of voltage and power in hybrid. The details of hardware and software platform are design. The concept of symbol table based on the analysis of the characteristics of energy monitoring data is introduced as an asynchronous interactive manner of the control software and Web interface to implement data collection. It also offers powerful means for helping and supporting the special needs of people with disabilities and in particular, the elderly. This application domain is very important and will steadily increase in the future.

1.2 Problem Statement

House usually involves different type of components for example fan, lamp and so on. These components require energy to operate efficiently. Moreover in hybrid situation, energy storage is needed for the components to operate. Besides, the component will be lack of energy during night or cloudy weather and battery bank is used for alternative supply during that period. Furthermore, the battery needs to be charged during day time to store the energy efficiently. Thus, the usage of smart hybrid system can reduce the energy use at home and provides savings in electricity consumption. In addition, it can reduce the use of coal and fuel to produce electricity. In addition, the smart hybrid systems that can be controlled and manages through the internet make it more convenient and user-friendly.

To provide twenty-four (24) hour electricity supply, the usage of smart hybrid can reduces the cost of electricity compared to the grid supply. Generator engine life also proved unsatisfactory. For isolated areas, fuel logistics and handling will increase operational costs. In the other hand, a solar electric system has many factors that should be incorporated into the final product. Hence, an engineered system design maximizes reliability and efficiency along with lowering maintenance requirements. The applications of renewable energy and alternative power supply should be established widely as a solution to replace the usage of grid supply.

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It would be easy for the consumer if they can monitor their hybrid system by using the internet. Hence, the implementation of automation system that uses Wi-Fi technology as a network infrastructure would help. The servers which present system core can locally (LAN) or remotely (internets) manages and control the hybrid system.

1.3 Objective

There are three objectives in this project:

I. To develop a controller for energy distribution in the house.
II. To develop the system for automatically charged and discharged the battery by using unused energy (solar), and generator.
III. To develop web-server for monitoring the system by using internet.

1.4 Scope of Research

This project focuses on the power supply from the PV panel and the energy distributed to battery storage and loads used. Other than that, this project was involved in circuit development for the existing solar charger controller in the market. Beside, this project also involved in circuit development of automatic generator controller method to back-up the low battery. This was the fundamental charging battery. Beside, all the system runs in DC and all equipment in the house are using DC 12 Volts to operate but in the reality, inverter was needed to convert DC to AC. These projects were used one piece of PV panel and one unit of 12 volts battery due to the limitation of cost. Furthermore, MySQL database is used to collect every single data and send to real-time web-server internets to monitor the energy when charging and discharging processes.

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1.5 Motivation

The function of hybrid system is to replace the grid supply. It is not easy to control the system operate automatically when there is lack of energy during cloudy weather because there is no renewable energy to process. To avoid this, the smart hybrid automation system is use to operate the system automatically by charging and discharging it and also can be monitor through the web server anywhere.

The use of smart hybrid automation technique is designed and implements a remotely controlled, energy-efficient, safe cost, and an alternative power. As a central controller, an Arduino microcontroller is use to communicates with the web server, the user interface. The house network brings together both Arduino and Wi-Fi router, thus making it a cost-efficient hybrid system. Events can be programmed to be triggered under specific conditions, and this can have a great role in reducing the total energy consumed by some appliances.

1.6 Contribution of Research

The development of controller will be able to monitor the energy distribution in the house and the development of system that will be able to monitor the usage of unused energy (solar) and generator to charge and discharge the battery automatically. The development of system that can monitor energy distribution in the house as well as automatically charged and discharged the battery through web server using internet.

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1.7 Report Outlines

This report includes of five chapters which Chapter 1 for Introduction, Chapter 2 for Literature Review, Chapter 3 for Methodology, Chapter 4 for Result and lastly Chapter 5 for discussion on whole research.

1. CHAPTER 1

Chapter 1 is related for Introduction, discussed more about project background, objectives on the research, problem statement, scope of the project and also summary of methodology.

2. CHAPTER 2

For Chapter 2, this chapter is included more about Literature review which is include review the previous work and also all material principle and mathematical theory use in this research.

3. CHAPTER 3

Then, Chapter 3 is more about methodology where flow of the process of research, software and hardware use in this project. Gantt chart and flow chart also included in Chapter 3 to show the flow of the research going.

4. CHAPTER 4

For chapter 4 which is the final result gain from this project. The result of the best analysis to charging and discharging process is by monitor on web-server. The prototype the smart hybrid with coding for between Adruino and Router (PHP language, Python Scripting, MySQL, and Tera term) also inserted in this chapter.

5. CHAPTER 5

Lastly, Chapter 5 included a conclusion for a whole project referred on database that collect from web interface and explain the achievement from the objective.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discusses on literature review of previous research on smart hybrid automation and web-server. Beforehand, there a few functional component parts that are used to combine and develop the smart hybrid system. There were Photovaltaic system, rechargeable battery, solar charge controller, generator controller, Adruino, Router and web-server (PHP language, Python Scripting, MySQL, OpenWRT, and Tera Term). This method has been actualized much of the time in many cases in engineering and software engineering study. Most of the paper specified that the Adruino is very efficient and prove to be superior for almost all the test problems and also in many applications depends on different application and terms.

2.2 Theory and Basic Principles

2.2.1 Photovoltaic

Generally, PV comes from the Greek word where ―photo is for the meaning of light whereas ―volt defined from the electricity pioneer Alessandro Volta. Solar cell is the

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other name for photovoltaic and it can convert light into energy. Besides, the photoelectric effect describes the absorption photons from light and the release of electron [1].

Photovoltaic cells are made from high-grade silicon (semiconductor) which can be electrically conductive when supplied with light or heat and operate as insulators at low temperature. A typical PV cells is build-up of an ultra-thin layer of phosphorus-doped (N-type) silicon and thicker layer of boron-doped (P-type) silicon. Moreover, P-type silicon contains fewer electrons whereas N-type silicon contains excess of electrons. P-N (positive-negative) junction is created when the N-type and P-type silicon contact together [2].

Besides that, the PV cells will absorb photon when being exposed to sun light and the electrons will be knocked loose from the atoms in the semiconductor material. The electrons will start traveling from the PV cells to the load. Apart from that, it will form an electric circuit when connecting a load on the positive and negative site on the PV cells. Furthermore, this electricity can be used to power up a load for such as a lighting system.

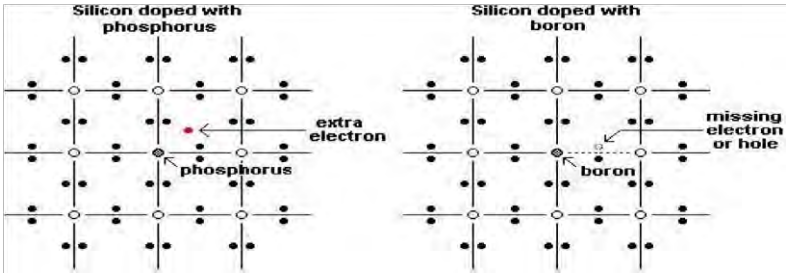

Figure 2.1: N-type silicon (phosphorous) and P-type Silicon (Boron)

A typical PV cells produces about 0.5-0.6 volt DC under open-circuit or no-load condition. Meanwhile, the current of the PV cells depends on its efficiency and the surface of the PV cells. The intensity of the sunlight striking the surface also affect the current (or power) from the PV cells, for example, the power will be higher under peak sunlight condition.

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2.2.2 The Photovoltaic Effect

Photovoltaic effect is the process where the PV cells convert the sunlight into electricity. This process discovered by French physicist Edmund Becquerel in 1839 while studying an electrolytic cell with two metal electrodes. The sunlight will emit photon and this photon will cause the electron to move from the valence band to the conduction band. Electron in the n region will migrate back to the hole in the p region and this will cause a potential difference (current passed by) when connecting a load on the two region [3].

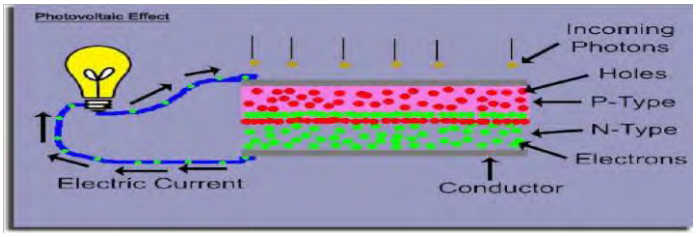

Figure 2.2: The Photovoltaic Effect

2.2.3 Rechargeable Battery

Battery is required for the stand-alone systems and the power generated by the solar panel is normally used to charge a lead-acid battery. Besides, nickel-cadmium batteries can be other option rather than lead-acid battery. However, the nickel-cadmium batteries are more expensive compared to the lead-acid type. A battery is made by individual cells and each cell can produce a voltage about 2 Volts DC. Therefore, a 12 Volt battery needs six cells. The capacity of a battery is measured in Ampere-hours or Amp-hours (Ah) and this mean that larger capacity of battery will have larger Ah.

Apart from that, the cycle life refers to the rate of a battery that can be discharged and this is important when using with solar cells. Solar application requires a battery that is capable to be discharged hundred or even thousands of times. This high rate of discharged battery is known as a deep-cycle battery [4]. For instance, car batteries are one of the most

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common types of lead-acid battery, yet this battery can merely survive in 5 or 10 cycles and therefore this battery is not suitable for solar system.

Figure 2.3: GP 12V 7.2Ah Battery

2.2.4 Solar Charger Controller

Figure 2.4: Solar Charge Controller

A solar charger controller is a vital part of all power system that is used to charge batteries. This charger controller can protect batteries in solar system from being overcharged or being over-discharged and this can increase the battery life span. Moreover,

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the basic function of a controller is quite simple which is to block reverse current and prevent battery from overcharging [5]. Apart from that, some controllers have the function to protect from electrical overload, display battery status, and prevent battery over discharge and the flow of power.

2.2.5 Generator Charger Controller

A generator charger controller is a second part of all power system that is used to charge batteries when battery is low. It uses to back up a power system. This charger controller also operates automatically from being overcharged or being over-discharged and this can increase the battery life span [6]. Moreover, the basic function of a controller is quite simple which is to block reverse current and prevent battery from overcharging. Apart from that, some controllers have the function to protect from electrical overload, display battery status, and prevent battery over discharge and the flow of power.

2.2.6 Arduino

Figure 2.5: Arduino UNO Board

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