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IMPLEMENTATION OF ENERGY MONITORING FOR SOLAR SYSTEM

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“I hereby declare that I have read through this report entitle “ Implementation of Energy Monitoring for Solar System ” and found out that it has comply the partial fulfilment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation and Automation)(Hons.)”

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IMPLEMENTATION OF ENERGY MONITORING FOR SOLAR SYSTEM

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A report submitted in partial fulfilment of the requirements for the degree of

Bachelor of Electrical Engineering (Control, Instrumentation and Automation) (Hons.)

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2017

I declare that this report entitle entitle “Implementation of Energy Monitoring for Solar 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.

Signature :……

Name : Muhammad Al Akeef bin Alamin

Date :……

Dedicated to my beloved family, father and mother Alamin bin Hawadan Shah & Siti Zauyah binti Abd Rahman@Ali.

The late Puan Hamidah binti Abu Mansor. Al-Fatihah.

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ABSTRACT

This project discusses about the energy monitoring for solar system. Nowadays the need of green energy becomes one of a development campaign all around the world. Despite other source of energy, solar energy is used widely for standard voltage and current especially house or any simple appliances. Solar panels that absorb the sun's power to generate electricity provide clean power for homes, communities and businesses, and help cut the carbon emissions. Solar photovoltaic (PV) modules generate electricity from sunlight, which can be fed into the mains electricity supply of a building or sold to the public electricity grid. Reducing the need for fossil fuel generation, the growing grid-connected solar PV sector across the globe is helping create jobs, enabling families and businesses to save money, and cut greenhouse emissions. This project aims to develop a solar energy monitoring system hardware by using Internet of things (IoT). The control protocol for energy monitoring system is designed in order to measure the real-time state-of-charge (SOC) of the battery through IoT facility. Through this facility, the effect of solar irradiance towards state-of-charge of the battery can be observed and analyzed. In the methodology, the use of IoT technology with help of Arduino microcontroller and android apps is needed so that the combination of the new technology can be replaced by GSM system..

ABSTRAK

Projek ini membincangkan tentang pemantauan tenaga untuk sistem solar. Pada masa kini keperluan tenaga hijau menjadi salah satu kempen pembangunan di seluruh dunia. Walaupun sumber tenaga yang lain, tenaga solar digunakan secara meluas untuk voltan standard dan terkini terutama rumah atau apa-apa peralatan yang mudah. panel solar yang menyerap kuasa matahari untuk menjana tenaga elektrik menyediakan tenaga bersih untuk rumah, masyarakat dan perniagaan, dan membantu mengurangkan pelepasan karbon. solar photovoltaic (PV) modul menjana elektrik daripada cahaya matahari, yang boleh diberi makan ke dalam bekalan kuasa elektrik bangunan atau dijual kepada grid elektrik awam. Mengurangkan keperluan untuk penjanaan bahan api fosil, sektor PV solar grid yang berkaitan yang semakin meningkat di seluruh dunia membantu mewujudkan peluang pekerjaan, membolehkan keluarga dan perniagaan untuk menjimatkan wang, dan mengurangkan pelepasan rumah hijau. Projek ini bertujuan untuk membangunkan perkakasan sistem pemantauan tenaga solar dengan menggunakan Internet perkara (IoT). Protokol kawalan untuk sistem pemantauan tenaga dirancang untuk mengukur masa nyata state-of-caj (SOC) bateri melalui kemudahan IoT. Melalui kemudahan ini, kesan sinaran solar ke arah negeri-of-caj bateri boleh diperhatikan dan dianalisis. Dalam metodologi, penggunaan teknologi IoT dengan bantuan Arduino mikropengawal dan android aplikasi diperlukan supaya gabungan teknologi baru boleh digantikan dengan sistem GSM.

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LIST OF ABBREVIATION

IoT	-	Internet of Things
SOC	-	State-of-Charge
PV	-	Photovoltaic
GUI	-	Graphical User Interface
DB	-	Distributed Board
WEF	-	World Economic Forum
MPPT	-	Maximum Power Point Tracking
UV	-	Ultra Violet
DC	-	Direct Current
AC	-	Alternating Current
TSC	-	Three Stage Charging
Volt	-	Voltage
Amp	-	Ampere
PSM	-	Projek Sarjana Muda
FYP	-	Final Year Project

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CHAPTER 1

INTRODUCTION

1.1 Project background

This project is focusing on design and analysis of solar energy monitoring system using IoT of an Espresso 2.0 devices that can be connected directly to android or apple operating system. The system is developed to monitor and read the harvested energy of photovoltaic (PV) panel that charge the battery that is efficient for the home usage.

The solar (PV) panel connected directly to the solar charger controller, then transfer the harvested energy to the battery. The battery connected to the solar charger controller so the state of charge (SOC) can be monitored through the system. Throughout the discharging of energy stored by the PV panel to the battery, connection of a switch, current sensor and voltage divider added in order to read all data thus could be controlled directly by using the IoT system.

This project prototype can be connect from the solar (PV) system directly to the Distributed Board (DB) in the house. It consumes the power from the charged battery automatically and provide information on how much energy of the electrical appliances are consumed.

Pointing down the reliability in SOC for the system, ammeter and voltmeter are connected directly in between the photovoltaic (PV) panel and battery. The reading will show the data of current (ampere) and voltage (volt) in term of charging while discharging of the battery will be indicated by using current sensor and voltage divider directly to Arduino microcontroller.

All data that been collected by the system to user give them advantage on calculation of how much energy from the solar system stored. This will make the overall system user friendly with controllable charge or discharge of the system.

Nowadays most people are demanding the simple and easy excess or control of any system that were capable in any distance or places. By implemented the IoT technology that connected directly to the system it can read, control and transfer the reading data via the apps, and email. But there were limitation of using the IoT which there were only 1 analog input and 4 digital input, so decision been made to use it for controlling on and off of the charging or discharging battery and data transfer for the energy stored by the battery in term of energy, current and voltage reading. The effect of solar irradiance based on sunlight radiation intensity towards state of charge of a battery been studied by using the energy data collection in this project.

Next, the user are capable to install the application directly to their smartphone as they just need to search it from the internet. This will satisfying the users because it is easier to control the system in distances, as long as they have the internet connection and the system is connected to Wi-Fi.

1.2 Problem Statement

The usage of alternative source of energy become more important nowadays. Solar energy is one of the most popular source of energy used by consumers because it's a simple platform that can be constructed anywhere with high durability of energy charge towards solar irradiance of sunlight intensity.

Throughout the potential and popularity of solar energy application, there is such incomplete interface (system) in term of monitoring and real time read and control of SOC (state of charge) or discharge energy and consumption of the stored energy.

User requested easier way for them to monitor or control any system when they were in other places far from the system. Nowadays users demanded the usage of internet in daily life

and the technology of Wi-Fi give users some advantage for them to connect and doing some work far from any constructed system.

This project also propose and provide awareness to mobility & control of the system. The system empowered by integrate IoT into the control system mechanism plus development of GUI (graphical user interface) for user. Users also demanding the interactives, portable monitoring and control system.

1.3 Motivation

From the newly technology approached, the convenient aspect for users considered as important mechanism towards any product invented. Thus, the needed of easily monitor and new technology combination are recommended to construct the prototype or product as simple and useful for users. The energy monitoring for the solar system will be used with same application of cloud computing using internet of thing. The internet of things application were highlighted by World Economic Forum (WEF) in 2016 conferences at Geneva Switzerland as the new technology required for the future industrial forward. So it could be consider the internet of things application for industrial, is simpler and easily controlled even by using smartphones with android OS or iOS platform.

Besides the important of internet of things application, Gordon Research Conference 2016 at Hong Kong University of Science and Technology had mention about the important of solar energy, the direct conversion and utilization of solar energy is increasingly important as global demand for energy grows, and regulatory constraints on pollution as well as world concession about climate change become more pressing. Over the past few decades, great efforts have been devoted to the development and study of materials, physics and devices for advanced solar energy conversion.

1.4 Objective

This project embarks into following objectives:

1. To develop a solar energy monitoring system hardware prototype by using Internet-of-things (IoT) technology that can measure voltage, current and power of the charged battery.
2. To analyses the effect of solar irradiance of sunlight intensity towards state-of-charge of the battery.

1.5 Scope

This project focuses on the development of monitoring and control the system constructed based on charging and the usage of energy from the charged battery that connected to solar panel via IoT application. Besides, this project is significant to Malaysia that nowadays is soaring forward towards renewable energy implementation. The development of the hardware part consists of system configuration and wiring. The simulation of the performance of the system is conducted by using ARDUINO IDE, PROTEUS and FRITZING software. The results are evaluated in real-time basis where the energy stored is monitored by smartphone and the data also can be transmit directly to users via email. From the data study, investigation of the state-of-charge toward solar irradiance in term of sunlight intensity could be made.

1.6 Project Outline

This report consists of 5 chapters. Chapter 1 discusses about the project background which is explain about the project. Then, the problem statement of this project and the scope of the research also will be discussed. Chapter 2 elaborates literature review, reviews of the previous researches project that are related with this project will be discussed. The information will become additional source for the project in to be able more successful. To have a brief understanding of the researches related to the project, a few literature reviews had been done. This chapter will describe the related to the literature reviews. Chapter 3 discusses the explanations about the flow chart of the project from the beginning to the end of the project. For this chapter, it will explain the principle of the methods and techniques that are using by the previous researcher. The selected techniques must be chosen to approach the objective of this project. The data will record from the experimental setup. The Gantt chart also discuss in this chapter. Chapter 4 presents result of the project will be discussed. This will include the data collection, simple analytical analysis and so on. The complete work for the project also been discussed which will describe clearly on what and how the result fully achieve based on the project objectives. Chapter 5 concludes the findings until to-date and discuses about the overall conclusion of the project.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

In this chapter, the review that had been done will be discussed. Review and reference been done by various source such as journal, book, website and others. The reviews are the most important parts to complete this project.

The main reviews for this entire project are:

- Solar energy
- Photovoltaic (PV) panel and Efficiency of solar
- Solar charge controller
- State of charge (SOC)
- Internet of Thing (IoT) in term of monitoring

2.1 Solar Energy

One of widely use renewable energy is the solar energy that receive from the solar radiation of the sun then being absorb by photovoltaic (PV) panel. The sun provided the radiation that is known as isolation energy when it reach to the earth, which make the production

of solar electricity possible. The electromagnetic wave from the sun also produce heat and other radiation such UV. The implement of solar energy consumption could be used by the whole community in Malaysia as an alternative to electricity produced by coal, hydroelectric or fossil fuel. [1]

2.2 Photovoltaic (PV) panel and efficiency of solar

The solar system provide an unlimited source of energy and feature in many application, for the endless of the usage of a photovoltaic (PV) panel it is easy and clean to use energy from it. There are some factors lead the effectiveness of absorbing energy by photovoltaic (PV) panel such light intensity, temperature and load. This will lead to the amount of charging whereas to make it as maximum as much to store energy in the battery, the method of efficiency calculates known as Maximum Power Point Tracking (MPPT) to extract the maximum value of power known as Maximum Power Point (MPP). [2]

Due to limited time of energy from PV panels that depend on the sunlight and weather or any environment condition the system could be lack of reliability, efficiency or effectiveness thus it does not receive it maximum power from PV. The system will be reliable as the battery being added, however the system need to be more than one huge battery to maintain it efficiency of charging and make it consistence due to charging and saving time compare to single huge battery that need longer time of charging.[5][7] From the step before could lead to quickly charge of the battery and can prevent the overcharging or undercharging that could decrease the lifetime of battery. To make all the statements below as reality the MPPT will control and the charging control processes combined in the same system. [1]

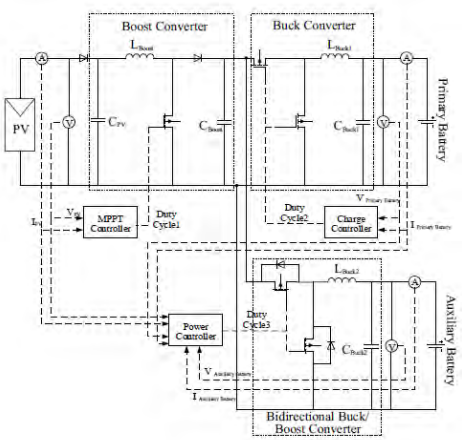

Figure 2.1: circuit of solar harvesting system

For the applications of small-scale harvesting, there were condition where internal consumption of circuitry are often to eat up the energy harvested. [8] The alternative of operation at more or less constant of voltage need to be done by coupling directly the solar cells to a fixed voltage, thus the rechargeable battery is used. For application with high solar irradiations areas, fragments from the harvested energy can be use by the MPPT, or the voltage can be operate with a constant value could be more efficient to lower solar input appliances. [6][9]

2.3 Solar charge controller MPPT

2.3.1 MPPT Technique

The standard method used to control the harvested solar energy is by using a solar controller or known as MPPT (Maximum Power Point Tracking) devices. The MPPT is an electronic device that are DC to DC converter can optimizes the match between PV panel, battery, and load. The function of MPPT also can simply convert a higher voltage DC output from PV panels then step down to lower voltage that needed to charge batteries. [1]

The solar cells are a neat things. Unfortunately the cells are not a smart, neither are batteries. Most PV panels are built to put out a nominal 12 volts. The catch is "nominal". In actual fact, almost all "12 volt" solar panels are designed to put out from 16 to 18 volts. The problem is that a nominal 12 volt battery is pretty close to an actual 12 volts - 10.5 to 12.7 volts,

depending on state of charge. Under charge, most batteries want from around 13.2 to 14.4 volts to fully charge - quite a bit different than what most panels are designed to put out.

Other reason of using MPPT is to increase the efficiency of the power from PV panel.

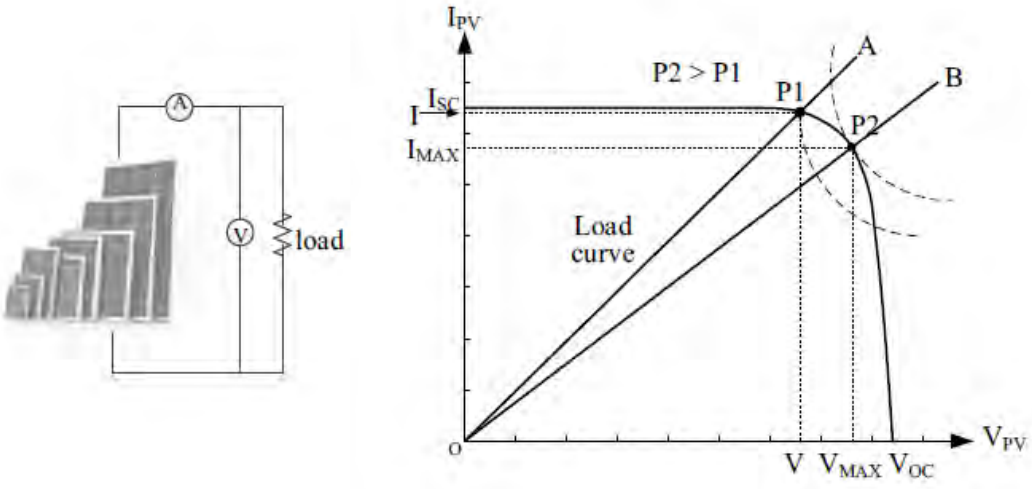

Figure. 2.2: The operation of the MPPT.

In the MPPT process, it work continuously to make sure the system operate at or round the MPP (Maximum Power Point). There are many ways to track the MPP, and the common method to track the maximum power is Perturb and Observe method (P&O method).

The basic principle of the P&O method been done by adjusting the duty cycle of the converter, that is indirect disturbance to the output power of the PV. Comparison being made and compares the new and old power for adjustment. It is define as

$$dP = P(k) - P(k-1) \qquad (1)$$

- If the value $P(k)>P(k-1)$ positive, the system will adjust the voltage by adjusting the duty cycle of the converter in the same direction.

- If the value $P(k)<P(k-1)$ negative, the system will adjust the voltage by adjusting the duty cycle of the converter in the opposite direction.