UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF AN IOT-BASED INTEGRATED PHOTOVOLTAIC WITH SMART BACKUP POWER SOURCE

MUHAMMAD SYAHIR BIN MOHAMED SALLEHULLDIN

Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

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DEVELOPMENT OF AN IOT-BASED INTEGRATED PHOTOVOLTAIC WITH SMART BACKUP POWER SOURCE

MUHAMMAD SYAHIR BIN MOHAMED SALLEHULLDIN

A project report submitted
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Disahkan oleh:

Ahmad Idil

MUHD SYAHIR BIN SALLEHULLDIN

(COP DAN TANDATANGAN)

Alamat Tetap:
No 34, Jalan 3/9,
Taman Pinggiran Batu Caves,
68100, Selangor Darul Ehsan

AHMAD IDIL BIN ABDUL RAHMAN
Pensyarah Kanan
Jabatan Teknologi Kejuruteraan Elektrik
Fakulti Teknologi Kejuruteraan Elektrik Dan Elektronik
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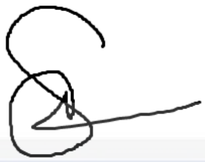
Signature : 

Student Name : MUHAMMAD SYAHIR BIN MOHAMED SALLEHULLDIN

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I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology (Industrial Power) with Honours.

Signature : Ahmad Idil

Supervisor Name : TS. AHMAD IDIL BIN ABDUL RAHMAN

Date : 10/1/2022

Signature : Johar Akbar

Co-Supervisor Name (if any) : TS. JOHAR AKBAR BIN MOHAMAT GANI

Date : 11/1/2022

DEDICATION

This work dedicated especially to my both parents, Mohamed Sallehulldin Bin Abbas and Mazlah Binti Abd Rahman that always give full support to me. Not to forget my supervisor, Ts Ahmad Idil Bin Abdul Rahman and co-supervisor, Ts Johar Akbar Bin Mohamat Gani that gives idea for this project. Also, not to forget my friends who are standing by me and give fully support during making this project.

ABSTRACT

Nowadays engineers are widely inventing modern technology in which new technologies will be introduced around the world every day that will make human life efficient. The Internet of Things (IoT) is one of the most ground-breaking inventions ever devised by engineers all over the world. The wireless automation system is one of the IoT applications that allows for real-time control and monitoring of home appliances through the Internet. This project is developed to help the users to achieve full time electrical supplies for houses, hospitals, server room's etc. The main appliances such as refrigerator, aquarium oxygen tank, medical supply equipment and aircond are such examples of electrical appliances. In this project, the ESP32 microcontroller is used and programmed to the Arduino IDE. The ESP32 microcontroller will be used to detect and read the input from the current and voltage sensor. At the same time, the ESP32 will process the input signal and inform to the relay to perform the solar output. The users can monitor the voltage, current, power, Kwh and battery backup indicator value from the blynk application. Besides, the users will be informed once the power supply is changed to solar battery backup from the blynk app notification. The blynk application is integrated with the ESP32 Wi-Fi module. The backup supply is from the battery unit. It have been charged from two types of solar panel. Those two types of solar panel is Monocrystalline and Polycrystalline. This two solar panel are used in order to analyze and compare the efficiency of those solar panels different themselves. The analysis of this project is carried out by recording the timing for charging and discharging the solar panels with the battery backup. The benefits from this project will enable the user to monitor the power consumption and to achive full time power supply more efficiency.

ABSTRAK

Jurutera pada masa kini banyak mencipta teknologi moden, dimana teknologi baru sentiasa bertambah di seluruh dunia setiap hari yang akan menjadikan kehidupan manusia lebih efisien. Internet of Things (IoT) adalah salah satu penemuan paling hebat yang diperkenalkan oleh jurutera seantero dunia. Sistem automasi tanpa wayar adalah salah satu aplikasi IoT yang membolehkan kawalan dan pemantauan masa nyata bagi peralatan rumah melalui Internet. Projek ini dibangunkan untuk membantu pengguna mendapatkan bekalan elektrik sepenuh masa untuk rumah, hospital, bilik server dan lain-lain. Peralatan utama seperti peti sejuk, akuarium oksigen, peralatan bekalan perubatan dan pendingin udara adalah contoh perkakasan elektrik yang digunakan oleh kebanyakan pengguna. Mikrokontroler dalam projek ini digunakan oleh ESP32 dan diprogramkan ke Arduino IDE. Mikropengawal ESP32 akan digunakan di dalam projek ini, di mana ia akan diprogramkan ke Arduino IDE. ESP32 akan digunakan untuk mengesan dan membaca input dari sensor arus dan voltan. Pada masa yang sama, ESP32 akan diproses dari isyarat input yang akan memberitahu genganti untuk melakukan keluaran solar. Pengguna dapat memantau nilai voltan, arus, kuasa, kwh dan penunjuk sandaran batery dari aplikasi blynk. Di samping itu, pengguna akan diberitahu setelah bekalan kuasa diubah menjadi bateri bantuan solar melalui pemberitahuan aplikasi blynk. Aplikasi blynk digunakan dengan bantuan modul Wi-Fi ESP32. Bekalan bantuan adalah dari unit bateri. Ia telah dikendalikan dari dua jenis panel solar. Dua jenis panel solar tersebut ialah dari jenis solar Monocrystalline dan Polycrystalline. Dua panel solar ini digunakan untuk menganalisis dan membuat perbandingan dari segi kecekapan kedua-dua solar panel tersebut. Analisis projek ini dijalankan dengan mencatat masa untuk mengecas dan mengeluarkan cas dari panel solar ke unit bateri. Kelebihan dari projek ini membolehkan pengguna memantau penggunaan tenaga dan mendapatkan bekalan kuasa sepenuh masa dengan lebih efisien.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

δ	-	Voltage angle

LIST OF ABBREVIATIONS

V	-	Voltage
W	-	Watts
Kwh	-	Kilo Watts Hour
IoT	-	Internet of Thing

CHAPTER 1

INTRODUCTION

1.1 Background

In recent years, engineers have applied advanced technology, where numerous devices have been developed. When the smart power backup is connected to the internet via a phone application, it is classified as an Internet of Things (IoT) system. This technology was created to achieve a full-time operated home power supply which includes an easy process for persons in need. The smart power backup is made up of several electrical components that will come together to form a single technological system. This system primarily uses photovoltaic solar panels, sensors, a phone device, and a microprocessor to process tasks automatically without the need for human intervention. The system may perform any action based on the settings that have already been programmed to operate with the home appliances. Photovoltaics, or PV for short, is a direct procedure for producing electricity from sunlight that works all the time while the sun is shining. However, the amount of energy generated is dependent on the intensity and hits of sunlight rays that directly reach the PV modules (means that the ray of sunlight is perpendicular to the PV modules). It will produce power without causing any noise or pollution, and it will provide users with a quiet, quick, and stable electrical supply. Due to the decrease of fossil fuel energy consumption and the concern of environmental effect out of it, this accessible of energy resources is expanding and becoming well-known across the world. As people grow more conscious of the importance of the environment, more eco-friendly energy resources are being developed to prevent issues from becoming more serious. Global warming and climate change are two examples of environmental causes or challenges that have led to the increased usage of renewable energy in recent years.

1.2 Problem Statement

In general, the smart power backup source is the most significant element in order to achieve full time power supply. By using the photovoltaic module, it will provide the power source to the battery that has been charged during daylight. The problem can occured to hospitals or big companies that have server rooms that need to maintain temperature rooms. On top of that, when there is no power supply to hospitals, it will automaticly switch off the medical supply or equipment thus it will risk to the patient.

Furthermore, it can impact the user when there is no people present at home for a long time when blackouts happen. Thus, it will turn off the main home appliance such as the fridge or aquarium oxygen. Moreover, it can impact the temperature in server room. When the temperature around and within the server and networking equipment becomes too high the server will shut down and there will be a loss of data.

1.3 Project Objective

In order for this project to be successful, the following objectives need to be achieved as follows:

a) To develop an IoT-based integrated photovoltaic with smart backup power source.

b) To design and build an IoT-based circuit and hardware for a BIPV-powered home automation system.

c) To analyze and compare the efficiency between the monocrystalline solar panel and the polycrystalline solar panel.

1.4 Scope of Project

The project is divided into two sections, one for software design and the other for hardware design. The circuit development for the IoT-based integrated photovoltaic with smart backup power source is designed using software implementation, in which written program in the ESP32 microcontrooler will be able to monitor all of the hardware components. At the same time, the microcontroller for this project is programmed using the Arduino IDE. The Wi-Fi Module is also used as a modem in this project to transmit notifications to the user. This project proposes the best design and implementation for the immersive development of an IOT-based integrated photovoltaic system with a smart backup power source.

1.5 Summary

This report consists of five chapters in general and in this segment a brief description is given for each chapter respectively. Chapter 1 explains briefly the project background, problem statement, objective, scope and the significance of the project in order to create and develop of an-IoT based integrated photovoltaic with smart power source. In addition, this chapter also clearly explains and addresses how the project is being carried out and states the objective scope and of project accordingly.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter explains the context and basic concept of an IoT-based integrated pv system using the ESP32 to control the relay output and energy monitoring. On top of that, this chapter covers the ELCB design, components inside the ELCB, Microcontroller, Wi-Fi module and the BIPV solar system which acts as a backup supply. Furthermore, the previous project's worth will also be discussed in this chapter. This chapter has been covered in all the research related to the project. This will provide more clarity about the project and a better understanding particular towards the project design and system implementation.

2.2 Internet of Things (IoT) Technology

The Internet of Things (IoT) would be a necessary component of this project's progress. The ESP32Wi-Fi module will be enabled by following the device instructions, which will then be connected to the Internet, allowing the user to track and manage the ELCB even though they are not at home. The Arduino UNO microcontroller can be able to receive signal data from the Wi-Fi module while the user uses the software on their mobile device, where the electrical equipment can be operated by adding or disconnecting the power supply to the relay module. The proposed project prototype was easy to use and the user could manage and track it from everywhere and anywhere as long as the internet connectivity exists.

The Internet of Things (IoT) refers to a network made up of small devices that can collect and share electronic information. Via the Internet, Bluetooth, or other methods, these devices can be attached to each other and to a device or software that can operate them. In general, the Internet of Things (IoT) applies to several contexts in which network access and computing capability are extended to objects, sensors, and ordinary products that are not usually called computers, thus allowing these devices to produce, share, and consume data with little or no human interference. This technology also has a broad range of features, including knowledge about the manufacturing process, data transmission, and the ability to monitor human data from sensors (Chaudhari et al., 2018).

Embedded technologies, such as processors, sensors, and communication hardware, are used in IoT technology, which includes smart devices that can capture and transfer data from their surroundings. IoT computers would be able to share data gathered in the past to the cloud to be analyzed or manually analyzed by linking them to the internet gateway. This technology has the potential to benefit a large number of individuals, whether in their personal lives or at work, and it is critical for businesses to have a smart system to simplify their business activities. IoT devices will be able to simplify the user's daily routine, and the technologies will undoubtedly become more widely used and common across current and IoT future industries.

2.3 Earth Leakage Circuit Breaker (ELCB)

In the electrical system, an ELCB is a protective unit with a high earth impedance. This device is used to identify currents that are leaking to the ground and cut the power supply. It is used to track minor stray voltages around the metal enclosures in electrical installations. For single phase, it consists of a two-pole switch, and for three phase, it consists of a four-pole switch with those poles linking the supply and load ends. A solenoid trip coil is deeply attached to this two-pole switch. The trip coil was also attached to the earth's electrical installation's.

Figure 2.1: Single phase with two-pole ELCB

Figure 2.2: Three phase with four-pole ELCB

ELCBs were invented about 60 years ago and were once commonly used in electrical installations. Since the voltage-operated ELCB and the current-operated ELCB were known as ELCB to avoid confusion between the two separate systems, The ELCB is now commonly referred to as Residual Current Device (RCD). If the incorrect type of equipment is used on an electrical system, the protection provided can be inadequate.

Today, the ELCB is one of the safety equipment that helps to protect the residential electrical grid. When the circuit breaker trips, the reset button reacts by closing the circuit breaker off. The fault normally occurs while no one is at home, and it is potentially caused by an overcurrent, short circuit, or leakage current on the live conductor, which may cause the ELCB to trip “Down” and switch off the entire residential power supply.

As a result of this situation, some important household appliances can be rendered inoperable. When the user is not at home, most ELCB must be manually reclosed during tripping, which can be a major concern. The ELCB was used extensively in the TT earthing system. The consumer's protective earth link is created by a local connection to the earth in a TT earthing system, irrespective of any earth connection at the generator unit.

2.4 Voltage Earth Leakage Circuit Breaker (vELCB)

This technology has been widely used since then, however it is no longer installed in new buildings. Voltage controlled ELCBs are devices that run depending on the amount of voltage flowing in the circuit. It detects a voltage increase in the covered enclosures as well as a distant isolated earth reference electrode. If the voltage reaches 50 volts, the main breaker will trip and the supply will be cut off. From the earth terminal to the vELCB, there are two links. One terminal was attached to the earth cable, while the other was connected to the earth rod. As compared to current-operated ELCBs, this ELCB has many drawbacks, including the need for an extra wire from the load to the ELCB and the inability to ground individual units. The ELCB's goal is to detect voltage and current leakage. The vELCB's level of shock protection was however restricted, as these devices would not have shock