Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF IOT-BASED POWER OUTAGE MONITORING SYSTEM WITH RENEWABLE ENERGY INTEGRATION FOR SMART AGRICULTURE

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Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

2023

DEVELOPMENT OF IOT-BASED POWER OUTAGE MONITORING SYSTEM WITH RENEWABLE ENERGY INTEGRATION FOR SMART AGRICULTURE

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A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : Development of IoT-Based Power Outage Monitoring System with Renewable Energy Integration for Smart Agriculture

Sesi Pengajian : 2023

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DEDICATION

This research is devoted in its whole to my dear parents who have continuously provided their moral, spiritual, emotional, and financial support, served as my sources of inspiration and strength when I felt like giving up.

To all of family members, friends, and classmates who offered their support and encouragement in order for me to complete my study. Finally, I would want to express my gratitude to the Almighty God for providing strength, mental power, protection, skills, and a long and healthy life to complete this project's thesis.

ABSTRACT

Nowadays, living without electricity seems unimaginable, our existence would be impossible without the electricity supply from residential areas to industrial activities. However, heavy consumption of electricity can result in power outages, hence making the operation of the smart agriculture system, for instance to be inefficient. Besides, power failure can cost a lot of damage to production. Furthermore, unexpected power outages can also cost a thousand dollars in lost revenue. Since most of the current power failure events cannot be reported in time, therefore, in this work, an IoT-based Power Outage Monitoring System with Renewable Energy Integration has been developed for Smart Agriculture System. In this work, a solar energy is used to power up microcontroller in ESP32 while a current sensor is used to detect the presence of the current flowing to power up the electronic devices. Blynk application is used where the monitored data, such as the current value obtained from the current sensor, will be uploaded and updated to the Blynk server from time to time for monitoring purposes.

ABSTRAK

Pada masa kini, hidup tanpa elektrik tidak dapat dibayangkan, kewujudan kita tidak mungkin tanpa bekalan elektrik dari kawasan perumahan kepada aktiviti perindustrian. Walau bagaimanapun, penggunaan elektrik yang banyak boleh mengakibatkan bekalan elektrik terputus, justeru menjadikan operasi sistem pertanian pintar, contohnya menjadi tidak cekap. Selain itu, kegagalan kuasa boleh menyebabkan banyak kerosakan kepada pengeluaran. Tambahan pula, gangguan bekalan elektrik yang tidak dijangka juga boleh menyebabkan kehilangan hasil beribu-ribu dolar. Memandangkan kebanyakan peristiwa kegagalan kuasa semasa tidak dapat dilaporkan tepat pada masanya, oleh itu, dalam kerja ini, Sistem Pemantauan Gangguan Kuasa berasaskan IoT dengan Integrasi Tenaga Boleh Diperbaharui telah dibangunkan untuk Sistem Pertanian Pintar. Dalam kerja ini, tenaga suria digunakan untuk menghidupkan pengawal mikro ESP32 manakala sensor arus digunakan untuk mengesan kehadiran arus yang mengalir untuk menghidupkan peranti elektronik. Aplikasi Blynk digunakan di mana data yang dipantau, seperti nilai semasa yang diperoleh daripada sensor semasa, akan dimuat naik dan dikemas kini ke pelayan Blynk dari semasa ke semasa untuk tujuan pemantauan.

ACKNOWLEDGEMENTS

First and foremost, All Praise be to Allah for all the good health and strength that He has showered upon me. With His countless blessings, I was able to accomplish and committed fully to this project.

To my supervisor, Ts. Dr. Ida Syafiza Binti Md Isa, thank you for your supervision, encouraging words, understanding, and patience in supervising me during the completion of this project. Also, thank you to my classmates who are under the same supervisor for all your reminders and kind sharing with me during this project.

Finally, I'd like to thank my family for their encouragement, support, and prayers for me during my studies. Not to mention my thankfulness to my close friends for constantly providing me with motivational thoughts.

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LIST OF SYMBOLS

Ω	-	ohm
µ	-	micro

LIST OF ABBREVIATIONS

V - Voltage

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CHAPTER 1

INTRODUCTION

1.1 Background

Electricity is the most amazing and life-changing in human invention and it has contributed to the reduction of darkness and the development of human activity. Electricity is frequently used in factories, schools, and hospital hence benefit everyone. Nowadays, living without electricity seems unimaginable, our existence would be impossible without the electricity from home to industrial activities. However, heavy consumption of electricity can result in power outages and make things more difficult to operate.

A power outage is a temporary or permanent loss of electric power in a specific area or segment of a power grid. Depending on the extent of the damage caused by the outage, it could affect a single house, a single building, or a whole city. A power outage is also known as a power loss, or blackout. In other words, it is the interruption of an end user's electrical power network supply [1].

There are many factors that need to be examined to determine the system's constraints and to identify the most efficient strategies for resolving problems [2]. Therefore, this prevention strategy can also improve the system stability, reliability, and security of the system. In this work, an IoT-based Power Outage Monitoring System with Renewable Energy Integration has been developed for Smart Agriculture System. Moreover, a solar energy is used to power up the system with microcontroller in ESP32 while a current sensor is used to detect the presence of the current flowing to power up the electronic devices. Blynk application is used where the monitored data, such as the current value obtained from the current sensor, will be uploaded, and updated to the Blynk server from time to time for monitoring purposes.

1.2 Problem Statement

Inappropriate load voltage, voltage collapse, voltage instability in transmission networks, dynamic or static stability loss, multiple tripping of overloaded lines, and other factors are among the causes of power system blackouts. Unexpected power outages and blackouts have a huge impact on businesses in the affected areas. When an unexpected power outage happens, it will affect and cause high cost and financial burden on the industries due to delays in productions. Besides, the backup generators require continuous maintenance and testing to ensure they will work in the event of a power outage [3].

Moreover, in a smart agricultural system, a power outage may affect the growth of the plants, hence reducing the quality of the plants. This is because, in a smart agricultural system, the power supply is important. If the power failure is not solved in time, it will affect or even generate serious economic losses to Smart agriculture system [4]. However, due to power outages, report cannot be on time and there is no back up due to this power loss situations. Therefore, in this work an IoT-based power outage monitoring system with renewable energy integration for a smart agriculture system has been proposed. A current sensor is used to detect the presence of the current flowing to power up the electronic devices. The system is also integrated with the cloud servers where the current values flow to the electrical devices will be updated and stored in the cloud using BLYNK applications for monitoring purposes.

1.3 Project Objective

The objectives of this work are as follows:

a) To develop an IoT-based Power Outage Monitoring System with Renewable Energy Integration to monitor the power outage event for Smart Agriculture system.

b) To develop a data logging system using Blynk application to update and store the status of the monitored devices.

c) To evaluate the performance of the developed system in terms of its reliability.

1.4 Scope of Project

The scope of this project are as follows:

a) Development of IoT-Based Power Outage Monitoring System with Renewable Energy Integration will be proposed for Smart Agriculture system.

b) A current sensor will be used to detect the power outage of the system.

c) The status of the power system will be updated in the cloud server via Blynk application every seconds for monitoring purposes.

d) ESP32 will be used as a controller to control the overall system.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In the past few years, there have been a lot of large-scale power outages all over the world. Most of the time, these accidents are caused by one or more faults that lead to a chain of other faults. Cascading failures in the power system happen when one part of the system breaks down, which then causes other parts to break down [1].

Power systems should be able to offer consumers with uninterrupted electricity supply under all conditions. However, because the networks cover such a broad geographical area, they are susceptible to a variety of defects. Moreover, extreme transmission failures resulting in blackout are caused by tripping of transmission lines due to short-circuit faults and protection device failures in lines. Additionally, generation failures are caused by generator overloading, which leads in a loss of power, as well as substation failures, voltage, and frequency instabilities, which result in power outages [5].

Since most of the current power failure event cannot be reported in time, therefore this project using Renewable Energy to generate power from a solar to powered up microcontroller in ESP32 and update the current values flowing from the electronic devices into cloud monitoring system to prevent further losses and troubleshooting. Therefore, this chapter provides an elaboration on the related previous past work causes of power outages and a few studies focused on the development of IoT-Based Power Outage Monitoring

System. The previous past research on the Renewable Energy for Smart Agriculture is also elaborated on this chapter.

2.2 Impacts and Causes of Power Outages

A temporary outage of the power supply will cause absolute chaos and disruption to many sectors. The lack of power supply and power interruptions cause industrial to experience rising economic damage. The economic loss of power outages must be analyzed in many circumstances, including power system design, economic and reliable operation of power systems.

As a result, one of the most essential phases to resolving the power loss problem is to ensure that the electrical system has blackout protection [6]. The major goal of a modern and developed electric power system is to supply clients with more economical, sustainable, and secure electricity. In this era of advanced technology, consumers believes that reliability mean consistent and high-quality electric power. When improving electric power reliability, more customers can receive the benefits.

To overcome this power outage issue there are several things that need to be done to limit disruption, including investigations, corrective actions, increased monitoring, diagnostics, and improved control center performance [7].

Another reason of this power shortage is when big loads are suddenly disconnected, and transmission lines are tripped due to system faults. The unstable power needed to be detected quickly, or else electrical equipment could be damaged and distance relay operations could be affected [8].

Next, because the modern society's operation is dependent on energy, longer blackouts cause widespread delays that lead to instability, including traffic disruptions, medical system failures, water supply and sewer system service interruptions, payment difficulties, and security system risk. As a result, the energy grid's resilience should be constantly maintained to increase its reliability [9].

In the case of a disturbance, power systems must maintain stability and assure continuous power delivery. As the power system spans broad regions, faults and breakdowns are common then unpredictable flaws and cascades occurrences can cause blackouts that disrupt modern living. In power systems, the most critical quantities to control are frequency, voltage, and rotor angle of synchronous generating units. Demand and generation imbalances impact frequency stability, while reactive power imbalances affect voltage [10]

In [11], reliability of power supply reflects the power grid system's continuous delivery capacity and is a quality measure. Power supply reliability can be determined by average user power outage times. The paper [12], [13] examines the shortcomings of the prior setting scheme for under-frequency load-shedding and automatic switching devices, particularly when large power shortages occur in an unstable network. The suggested technique intends to prioritise maintaining the unit's safety, improve the protection coordination scheme to achieve optimal unit safety, and assure the power supply's operation with zero loss.

The shortage of electricity supply and power interruptions cause rising economic loss for users. The economic loss of power outages must be evaluated in several situations, including power system planning, the economic and reliable operation of power systems, and the planning of power systems [14].

The failure rate of these power supply modules has increased. The expense of replacing failed power supply modules with new power supply modules will be considerable. To cut costs, efforts have been made to spend manpower in failure analysis and maintenance of failure modules, as well as collect a large amount of data in continuous repairing and preventative maintenance work [15].

In [16], transmission and generation outage data may be utilised to evaluate previous system performance or anticipate future system performance. A typical power flow case, load data, corrective measures accessible in the system, operational strategies, and component reliability indices computed from outage data are used to evaluate the predictive reliability of an electric power system in conceptual terms.

Lastly, companies operating in the impacted areas suffer a large loss of revenue due to power disruptions. Companies that using manual or automatic power backup may lose production hours when switching to it, resulting in production and revenue losses due to missed deadlines, unproduced and unsold products [17].

2.3 Power System Blackouts

Several power systems blackouts have occurred all around the world which affected millions of people during the shortage of energy. In 2012, there was a 15-hour power outage that affected about 620 million residents of the north and east of India [8] The blackout was caused by the overloading of one of the 400 kV Gwali–Binar transmission lines, while the other transmission line was unavailable for maintenance. The system failed again the next day due to an imbalance between demand and generation, and about 32 GW of energy was disrupted affecting around 700 million people. This power outage affects the largest number of people ever recorded [5].

Next, in 2014, the Bangladesh Power System (BPS) went down completely for about 24 hours when the High Voltage Direct Current (HVDC) station went down without being planned. The situation got worse because the spinning reserve did not work, and some generators did not get enough maintenance. After all the under-frequency load shedding