SOLAR-POWERED RENTAL STATION FOR DETACHABLE POWER SOURCES

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BACHELOR OF SCIENCE IN COMPUTER ENGINEERING

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ABSTRACT

This study explores the advancements and applications of telemetry systems, which are pivotal in remote data monitoring and analysis across various industries. Telemetry technology, encompassing data acquisition, transmission, and analysis, plays a crucial role in fields such as aerospace, healthcare, and environmental monitoring. The research highlights the effectiveness of telemetry systems in providing accurate and reliable real-time data, enhancing operational efficiency, and enabling predictive maintenance. Key findings include significant improvements in data transmission speeds and reliability due to advancements in wireless communication and the integration of the Internet of Things (IoT). The study also identifies challenges such as data security and transmission interruptions in remote areas. Recommendations for future research include addressing these challenges and exploring new applications in emerging fields. This work underscores the transformative impact of telemetry on modern technology and its potential for continued innovation.

Keywords: *Telemetry, GPS Location*

This piece of work is wholeheartedly dedicated

to my parents

Papang

and

Nanay

ACKNOWLEDGMENT

I would like to express my gratitude to the following people and institutions which, in one way or another, greatly contributed towards the completion of this study.

To my adviser ***Engr. Jodie Rey D. Fernandez*** for painstakingly checking every detail of this paper. I am extremely thankful and indebted to you Sir for sharing your expertise and valuable guidance. Had not of your encouragement and moral support, this endeavor would surely fall to a complete obscurity.

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Jodie

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Convenience, connectivity, and overall quality of life are being enhanced by the Internet of Things (IoT), which is rapidly becoming an essential part of everyday life. According to Villamil, Hernández, and Tarazona (2020), "The internet of things is an emerging technology that is currently present in most processes and devices, allowing to improve the quality of life of people."

Similarly, as IoT continues to revolutionize daily living, solar energy, powered by innovations such as photovoltaic (PV) panels, plays a crucial role in shaping the future of global energy. Photovoltaic solar energy is rapidly becoming a key player in the global energy transition. This surge in demand and innovation paves the way for a more sustainable future, making solar energy a central focus in the race for renewable solutions. As highlighted by Sampaio and González (2017), "The capture of solar energy through photovoltaic (PV) panels to generate electricity has emerged as one of the most promising markets in renewable energy. With its rapid growth and significant investment potential, the photovoltaic market is now increasingly competitive, especially

in regions like Europe, China, and the United States."

In response to this, many systems utilize off-grid renewable energy . Systems such as solar power systems are designed to provide electricity. This aligns with the study of Ramly, Jamal, Abd Ghafar, and Babu (2019), who highlighted that the "Emergency Portable Solar Power Supply is a product that uses renewable energy source (sunlight) as the main source of electricity."

Today's solar power systems offer many benefits. The technologies mentioned above can contribute to addressing key issues in the Philippines. They aim to reduce the impact of frequent power interruptions in Camiguin and selected parts of Misamis Oriental, while promoting scalable renewable energy innovations for affected communities. Additionally, it contributes to sustainable energy systems by addressing the unique reliability challenges of off-grid and disaster-prone areas in the region.

According to an article by Albay (2025), In the Philippines, the average Filipino household experiences 28 electricity supply interruptions in a year, due to frequent outages caused by plant breakdowns based on a report. The sudden or frequent power interruptions force households and businesses alike to rely on costly diesel generators as a backup power source. In August 2025, the National Grid Corporation of the Philippines (NGCP) reported an unscheduled power interruption affecting Camiguin and Misamis Orien-

tal. The outage left thousands of households and businesses without power, mostly relying on diesel generators, and various power sources. Addressing this gap in reliable energy access is crucial to providing communities with an affordable, sustainable power alternative and reducing the impacts of sudden interruptions.

Recent efforts to adapt solar-powered power supply systems show potential but face limitations. For instance, Gozano et al. (2023) designed a solar-based portable power supply with a modular battery pack. However, the portable power supply was shown capable of only supplying a lower energy load, such as charging mobile phones, mobile lighting and small auxiliary loads such as a small AM/FM radio. There were also shortcomings, such as the short lifespan of AC power whenever the battery pack reaches a certain voltage drop.

Innovations in solar-powered power supply systems offer a promising solution to these challenges. Bhatti et al. (2024) developed a portable solar station with integrated battery management and load monitoring system, having a power output of 200 W, and a 2x2 array of 50 W solar panels to provide electricity for basic necessities, in times of power interruptions due to natural disasters. Similarly, the study by Ramly et al (2019) designed a portable solar power supply for emergency situations, supplying electricity up to 100W

at one time, and utilizing Arduino Uno with Bluetooth module and voltage sensor to get the voltage readings integrated to a mobile application. The said system lasted for two days without the need for charging. Despite these innovations, current solar-powered power supply systems still face limitations, such as low energy capacity, short battery lifespan, and restricted support for higher power loads.

To bridge these gaps, this study proposes a solar-powered rental station for detachable power sources with a 2x2 solar panel array for energy harvesting, a LiFePO4 battery for reliable storage, and an inverter for AC power conversion. The system integrates an ESP32 microcontroller, integrating IoT mechanisms to manage operations, with GPS for location tracking and GSM for communication. A coin-slot mechanism with a solenoid lock ensures secure access, while a mobile app provides real-time monitoring of battery charge levels and system status. The compact and user-friendly design offers a sustainable solution for communities affected by frequent power interruptions.

1.2 Statement of the Problem

Air pollution is among the Philippines' most critical environmental issues, primarily caused by the use of fossil fuels. The Philippines' reliance on fossil fuels for electricity generation, particularly coal, contributes to elevated

levels of air pollution. In 2025, coal accounted for approximately 52.7% f the country's electricity generation, while natural gas contributed 20.1%. This dependence on fossil fuels leads to the emission of pollutants that adversely affect air quality and public health. (LowCarbonPower, 2025).

Electricity is a necessity for modern life. In Camiguin (served by CAMELCO) and certain parts of Misamis Oriental (served by MORESCO 2), the local community frequently experiences unscheduled power interruptions, occurring multiple times a week. This issue is consistent with research indicating that power interruptions are common in developing countries (Ibañez, 2024; Taniguchi, 2019), such as the Philippines, particularly in rural areas (Ibañez, 2024; Ali, 2016). These interruptions not only hinder productivity but also affect daily comfort in many households, making them very inconvenient and a source of frustration.

Despite the availability of off-grid setups, power banks, and small gasoline generators, these options are often limited by cost, power capacity, or environmental sustainability. Furthermore, the reliance on fossil-fueled alternatives poses safety risks and contributes to pollution. In response, the government encourages a shift away from fossil fuel energy sources (Koons, 2024) and promotes the use of renewables, as outlined in the policy framework provided for in Republic Act (RA) No. 9513 or the "Renewable Energy Act of 2008".

Hence, there is a growing need for technological systems, such as solar-powered systems, to align with sustainability mandates. Studies show that the transition to greater use of renewables has wide-ranging implications (Villanueva, 2021), underscoring the importance of integrating supportive technologies into local environmental strategies.

Solar-powered systems have been introduced either as portable power supplies or as charging stations, yet existing systems face multiple limitations. Many of these are only capable of supplying low-energy loads, such as charging mobile phones, providing mobile lighting, or powering small auxiliary devices like AM/FM radios (Gozana et al., 2023). Additionally, the average cost of an off-grid setup is high (Boodoo, 2024), making it unaffordable for many households. Research also shows that solar-powered systems are commonly implemented in academic settings (Catalan, 2019) but have not been widely deployed in public areas.

Given these limitations, there is a clear need for an innovative solar-powered rental system that is both affordable and scalable, while providing reliable energy access for households and public areas affected by frequent and unscheduled power interruptions. This study aims to design and develop a solar-powered rental station with detachable power sources, offering a sustainable and user-friendly alternative to conventional backup solutions.

1.3 Objectives of the Study

In view of the above stated problem, we have the following objectives:

1.3.1 General Objectives

- To design and develop a solar-powered rental station with detachable power sources that serves as a reliable, sustainable, and user-friendly solution for supplying electricity, specifically intended for communities experiencing frequent power interruptions.

1.3.2 Specific Objectives

- To design the system architecture that integrates photovoltaic panels, energy storage, and charging modules, ensuring sufficient capacity for powering small to medium-scale appliances.

- To develop a functional prototype of the rentable station with a detachable power source with a secure coin-operated or app-based access mechanism for rental use.

- To integrate GPS and GSM modules to support real-time location tracking, communication, and monitoring of rented units.

- To evaluate the system's performance in terms of efficiency, portability, security, and user satisfaction in a rental-based context

- To provide sustainable energy access through affordable and shared power sources powered by solar energy.

1.4 Significance of the Study

This project benefits a diverse range of stakeholders including:

Community Residents. Community residents will benefit from continuous access to electricity through the solar-powered portable power source. This system ensures the community residents can use essential household appliances and stay connected during power outages, improving daily lives and overall comfort.

Environment. This study contributes to environmental sustainability by promoting the use of solar energy, a renewable resource, instead of relying on fossil-fueled generators. The system reduces carbon emissions and pollution, aligning with global sustainability goals.

Future Researchers. Future researchers will find this study helpful because it gives important information on how to create solar-powered portable charging systems with features like GPS tracking, coin/app payment, and real-time monitoring.

Affordable and Clean Energy. This system provides support on giving people access to energy that is affordable, reliable, and environmentally friendly by offering a solar-powered rental station that provides communities,

especially those often experiencing blackouts with a clean and low-cost source of electricity.

Industry, Innovation, and Infrastructure. This helps achieve the goal of improving systems, creating new technologies, and building stronger infrastructure by using modern technologies as well as solar energy that helps in creating innovative solutions that gives communities a reliable energy option during power interruptions.

1.5 Scope and Limitations

This research focuses on designing a solar-powered rental station with detachable power sources to provide reliable and sustainable electricity for communities in Camiguin and Misamis Oriental, which face frequent power interruptions. The system integrates photovoltaic panels, energy storage, and charging modules to power small to medium-scale appliances. The design will include a coin-operated or app-based access mechanism for renting the power sources.

The study will incorporate GPS and GSM modules for real-time location tracking and communication, ensuring efficient monitoring of rented units. The system will be evaluated for efficiency, portability, security, and user satisfaction, focusing on its performance in a rental context. By offering

a solar-powered alternative, this targeted solution addresses a critical gap in providing reliable energy access for communities affected by frequent power outages.

1.6 Definition of Terms

Internet of Things (IoT) A network of physical devices, such as sensors, appliances, and power sources, connected to the internet, enabling them to collect, send, and receive data for remote monitoring, control, and management.

Solar Energy Energy that is harnessed from sunlight using technologies such as photovoltaic (PV) panels, which convert sunlight into electricity, which is used to power the portable power sources.

Fossil Fuel Natural energy sources such as coal, oil, and natural gas, derived from the remains of ancient plants and animals, that are burned to produce energy but contribute to environmental pollution and climate change due to the emission of greenhouse gases.

Photovoltaic (PV) Panels Solar panels that convert sunlight into electricity, serving as the primary source of power generation for solar-powered systems.

Portable Power Station Compact, mobile units that provide electrical power for charging devices or operating appliances, often powered by renewable sources like solar energy and designed to be easily transported or moved.

Renewable Energy Energy derived from natural resources that are replenished on a human timescale, such as sunlight, wind, and geothermal heat, which are harnessed to produce electricity in an environmentally sustainable manner.

Off-grid power system A power system that operates independently from the main electricity grid, using renewable energy sources like solar or wind to provide electricity in areas without access to centralized power.

Solar harvesting The process of capturing sunlight using solar panels or other solar technologies and converting it into usable electrical energy, typically for storage in batteries or direct use.

Power Interruption TA temporary loss or disruption of electrical power, often due to faults, maintenance, or other technical issues in the power grid, affecting the availability of electricity to households or businesses.

CHAPTER 2

REVIEW OF RELATED LITERATURE

This chapter presents some preliminary concepts and known results that are needed in this study.

2.1 Preliminary Concepts and Results

This section contains some basic definitions and results.

CHAPTER 3

METHODOLOGY

In this chapter, we detail the methodology employed to conduct the study, providing a comprehensive overview of the research design, data collection, and analytical procedures.

3.1 Research Design

Your research design.

3.2 Formula

3.3 Tables

Table 1: A sample long table.

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3.4 Images

Table 2: Sample Data Table

Item	Quantity	Price ($)
Apples	10	0.50
Bananas	5	0.30
Cherries	20	1.20
Dates	50	2.50

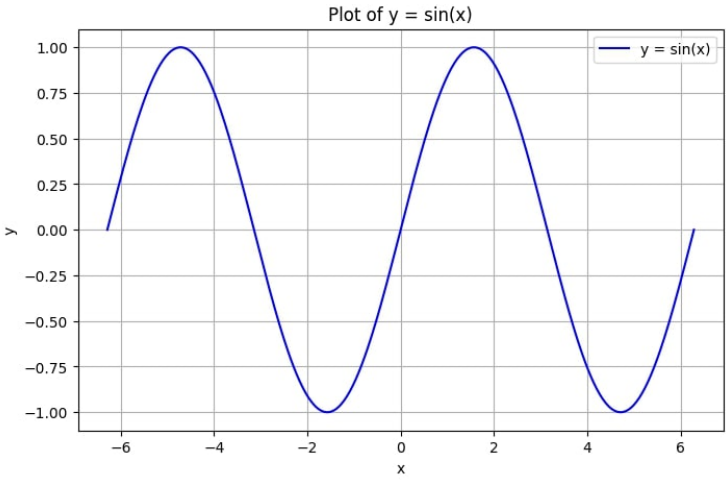

Figure 1

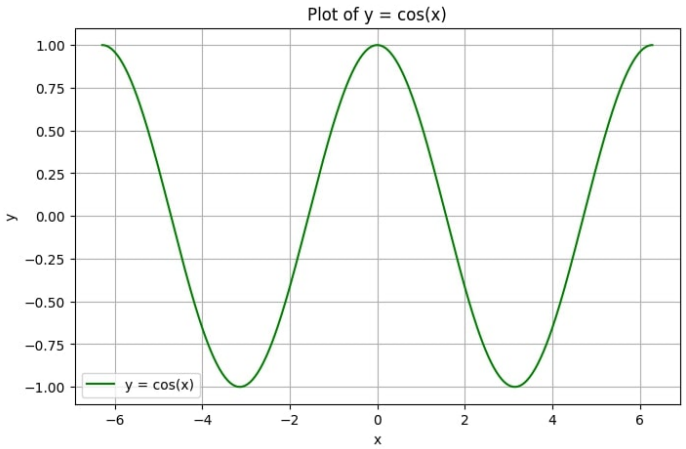

Figure 2: Cosine Graph

CHAPTER 4

RESULTS AND DISCUSSION

This chapter presents the findings from the research conducted and provides a thorough analysis and interpretation of these results.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

This chapter provides the summary of the results obtained in this study and gives some recommendations for further investigation.

5.1 Summary of Findings

The study's findings address the initial research questions by confirming the effectiveness, reliability, and diverse applications of telemetry systems. The "Summary of Findings" section provides a concise overview of the key results from your research. This section should be factual and focus on presenting the data without interpretation. It should include:

Key Results:

Briefly summarize the most significant findings. Use bullet points or numbered lists for clarity if appropriate. Present the data as it was found, highlighting major patterns, relationships, or trends. Data Presentation:

Include tables, graphs, or charts that succinctly summarize the data. Make sure each visual aid is clearly labeled and includes a brief description. Coverage of Research Questions:

Address each of the research questions or hypotheses posed at the be-

ginning of the study. Summarize the results relevant to each question.

5.2 Conclusion

The "Conclusions" section interprets the findings and discusses their implications. This section should:

Interpret Findings:

Provide an interpretation of the data summarized in the previous section. Discuss what the results mean in the context of the research questions or hypotheses. Implications:

Explain the significance of the findings. Discuss how the results contribute to the field of study or practical applications. Limitations:

Acknowledge any limitations in the study that may affect the results or their interpretation.

5.3 Recommendations

The "Recommendations" section provides actionable suggestions based on the study's findings and conclusions. This section should:

Practical Applications:

Offer specific recommendations for practitioners, policymakers, or other stakeholders based on the findings. Future Research:

Suggest areas for further investigation that could address the study's limitations or build on its findings. Implementation:

Provide guidance on how the recommendations can be implemented effectively.

APPENDICES

Type your appendix here.

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CERTIFICATE OF AUTHENTIC AUTHORSHIP

I hereby declare that this submission is my own work and, to the best of my knowledge, it contains no materials previously published or written by another person, nor material which, to a substantial extent, has been accepted for the award of any other degree or diploma at USTP or any other educational institution, except where due acknowledgement is made in the manuscript. Any contribution made to the research by others, with whom I have worked at USTP or elsewhere, is explicitly acknowledged in the manuscript.

I also declare that the intellectual content of this manuscript is the product of my own work, except to the extent that assistance from others in the project design and conception or in style, presentation and linguistic expression is acknowledged.

JODIE REY D. FERNANDEZ

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JODIE REY D. FERNANDEZ

Date: "insert date signed