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A Hybrid Solar Powered Wireless Charging System with IoT

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Abstract: This project presents a Hybrid Solar Powered Wireless Charging System with IoT Monitoring, aimed at promoting sustainable and efficient energy utilization. Solar energy is harvested using a photovoltaic panel and stored in a lithium-ion battery bank through a regulated charging mechanism. The stored energy is used to power two independent wireless charging platforms.

Load presence on each wireless charging pad is detected using infrared sensors, allowing power to be supplied only when a device is placed on the transmitter, thereby reducing energy wastage. An ESP32 microcontroller controls the relays, sensors, and display system, while audible alerts indicate load detection and charging initiation. A 16x2 LCD provides real-time system status, including battery charging information based on solar availability.

The system also incorporates IoT functionality using the Blynk platform to remotely monitor parameters such as temperature, humidity, solar voltage, and wireless pad status. By integrating renewable energy harvesting, battery storage, wired power conditioning, and wireless power transfer within an IoT-enabled framework, the proposed system demonstrates a practical hybrid charging solution suitable for educational and low-power charging applications.

Index Terms: Solar energy, ESP32 microcontroller, wireless charging, IoT based monitoring.

I. INTRODUCTION

The increasing use of portable electronic devices has created a need for efficient, safe, and convenient charging solutions. Traditional wired charging systems often suffer from cable damage, connector wear, and limited flexibility. At the same time, rising energy consumption emphasizes the importance of utilizing renewable energy sources such as solar power.

Solar energy, when combined with battery storage, provides a reliable and eco-friendly power solution. Wireless charging further enhances user convenience by enabling contactless power transfer and reducing physical connections. The integration of embedded systems and Internet of Things (IoT) technology allows real-time monitoring and intelligent control of such energy systems.

This project presents a Hybrid Solar Powered Wireless Charging System with IoT Monitoring, which combines solar energy harvesting, battery storage, and wireless power transfer. The system uses an ESP32 microcontroller to manage load detection, power delivery, and status monitoring through a local display and a cloud-based IoT platform, demonstrating a practical approach to sustainable and smart charging applications.

II. LITERATURE SURVEY

Kurs *et al.* (2007) introduced the concept of resonant inductive coupling for wireless power transfer and demonstrated efficient mid-range energy transmission, which forms the fundamental theory behind modern wireless charging systems. Later, Li and Mi (2015) presented a comprehensive review of wireless power transfer technologies for electric vehicle applications, discussing important design considerations, efficiency improvements, and compensation topologies for high-power wireless charging. Liu *et al.* (2013) further advanced

the field by integrating a photovoltaic system with a wireless charger, highlighting effective energy management between the solar source and the load and demonstrating the feasibility of renewable-powered wireless power transfer. More recently, Biabani and Vilathgamuwa (2019) focused on IoT-based smart energy monitoring, enabling real-time data acquisition, intelligent energy management, and remote system supervision. Together, these works provide the technical foundation for developing a hybrid solar powered wireless charging system with IoT monitoring.

III. SYSTEM OVERVIEW

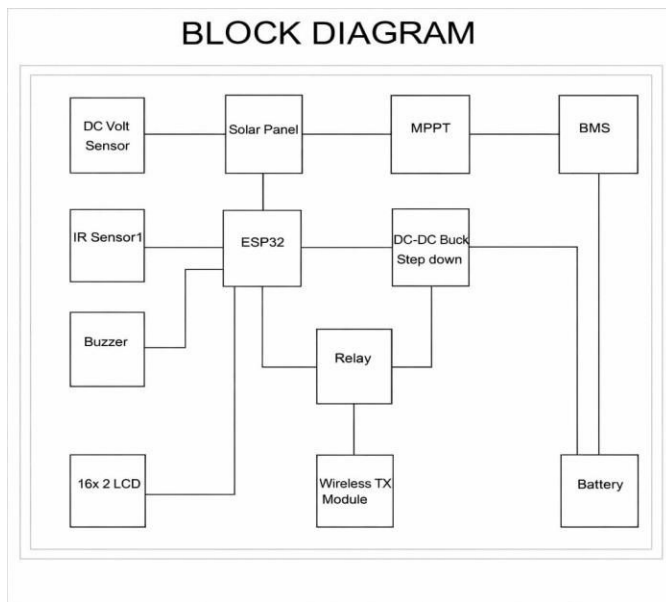


Fig1:Block diagram

The block diagram of the Hybrid Solar Powered Wireless Charging System consists of a solar energy harvesting unit, power management and storage section, control unit, wireless charging units, and monitoring interfaces. The solar panel converts sunlight into electrical energy, which is regulated and used to charge a lithium-ion battery bank through a charging controller and protection circuit.

The ESP32 microcontroller acts as the central control block, interfacing with infrared sensors placed on each wireless charging pad to detect load presence. Based on sensor inputs, the controller activates relays that supply power to the wireless transmitter modules. Buzzers provide audible indications for load detection and charging initiation.

System parameters such as solar voltage, temperature, and humidity are monitored using appropriate sensors and displayed on a 16x2 LCD. Additionally, the ESP32 communicates with the Blynk IoT platform over WiFi, enabling real-time remote monitoring of charging status and system conditions. The integration of these blocks forms a hybrid system that combines renewable energy, battery storage, wireless power transfer, and IoT-based monitoring.

IV. METHODOLOGY

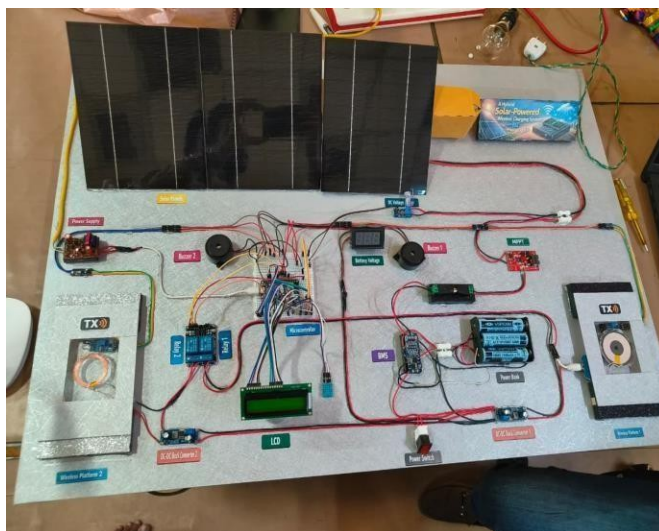


Fig.2.System photo

1) *Solar Panel*

Three 12 V, 5 W solar panels are connected in parallel to produce a 12 V output. The panels convert sunlight into electrical energy and supply power to the MPPT charge controller for charging the battery bank, enabling renewable energy harvesting.

2) *MPPT Solar Charge Controller*

A 12 V MPPT charge controller regulates voltage and current from the solar panels to safely charge the lithium-ion battery bank. It prevents overcharging and reverse current flow, ensuring efficient and safe energy management.

3) *Lithium-Ion Battery Bank (3S Configuration)*

The battery bank consists of three 3.7 V, 2600 mAh lithium-ion cells connected in series (11.1 V nominal, 12.6 V fully charged). It stores solar energy and provides a stable power supply to the wireless charging modules and control circuits.

4) *Battery Management System (BMS)*

A 3S, 12.6 V, 10 A BMS protects the battery from overcharging, over-discharging, and short circuits, improving safety and battery lifespan.

5) *DC-DC Buck Converter (XL4015)*

This converter steps down the battery voltage to required levels (typically 5 V) to power the wireless charging transmitters and other low-voltage components efficiently.

6) *Wireless Charging Module (Qi Transmitter)*

The Qi-based transmitter operates on 5 V DC input and transfers power wirelessly using electromagnetic induction, enabling contactless charging of devices.

7) *DC Voltage Sensor*

A 0–25 V voltage sensor monitors the solar panel voltage and helps track battery charging conditions.

8) *DHT11 Sensor*

The DHT11 measures ambient temperature and humidity, providing environmental data for monitoring and IoT display.

9) *16×2 LCD Display*

The LCD operates at 5 V and displays system status, battery level, charging indication, and wireless pad activity for user interaction.

V. RESULT

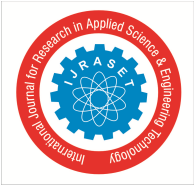
The systems successfully demonstrated:

- Effective solar-based battery charging
- Reliable wireless power transfer for low-power devices
- Accurate load detection and automatic power control
- Real-time local and remote monitoring through IoT

Testing confirmed stable operation, reduced power wastage, and user-friendly interaction through visual and audible indicators.

VI. CONCLUSION

The Hybrid Solar Powered Wireless Charging System successfully integrates renewable energy generation, battery storage, intelligent control, wireless power transfer, and IoT monitoring into a single compact system. The project demonstrates a practical and sustainable solution for low-power wireless charging applications while promoting energy efficiency and smart monitoring. The modular design and scalability of the system make it suitable for future enhancements and real-world deployment.



VII. ACKNOWLEDGMENT

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