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A Hybrid Solar Powered Wireless Charging System with IoT

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Abstract: ***ThisprojectpresentsaHybridSolarPoweredWirelessChargingSystemwithIoTMonitoring, aimedatpromoting sustainable and efficientenergyutilization.Solarenergyisharvestedusing a photovoltaic panel and stored in a lithium-ion battery bank through a regulated charging mechanism.Thestored energy is used to power two independent wireless charging platforms. Loadpresenceoneachwirelesschargingpadisdetectedusinginfraredsensors,allowingpower 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 16×2 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 parameterssuchastemperature, humidity, solarvoltage,andwirelesspadstatus.Byintegrating renewable energy harvesting, battery storage, wired power conditioning, and wireless power transferwithinanIoT-enabledframework,theproposedsystemdemonstratesapracticalhybrid charging solution suitable for educational and low-power charging applications.

IndexTerms: Solarenergy,ESP32microcontroller,wirelesscharging,IoTbased 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.

Solarenergy,when combined withbatterystorage, providesareliable and eco-friendlypower solution. Wireless charging further enhances user convenience by enabling contactless power transferandreducing physicalconnections. The integrationofembeddedsystemsandInternet ofThings (IoT)technology allows real-timemonitoring and intelligentcontrol ofsuch energy systems.

ThisprojectpresentsaHybridSolarPoweredWirelessChargingSystemwithIoTMonitoring, 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 compensationtopologies forhigh-power wireless charging.Liu *etal.* (2013) furtheradvanced

the field by integrating a photovoltaic system with a wireless charger, highlighting effective energymanagement between thesolarsourceandtheloadand demonstrating thefeasibilityof renewable-poweredwirelesspowertransfer. Morerecently, Biabaniand Vilathgamuwa(2019) focusedon IoT-based smartenergymonitoring, enablingreal-timedata acquisition, intelligent energy management, and remote system supervision. Together, these works provide the technicalfoundation fordevelopingahybridsolarpoweredwireless chargingsystemwithIoT monitoring.

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III. SYSTEM OVERVIEW

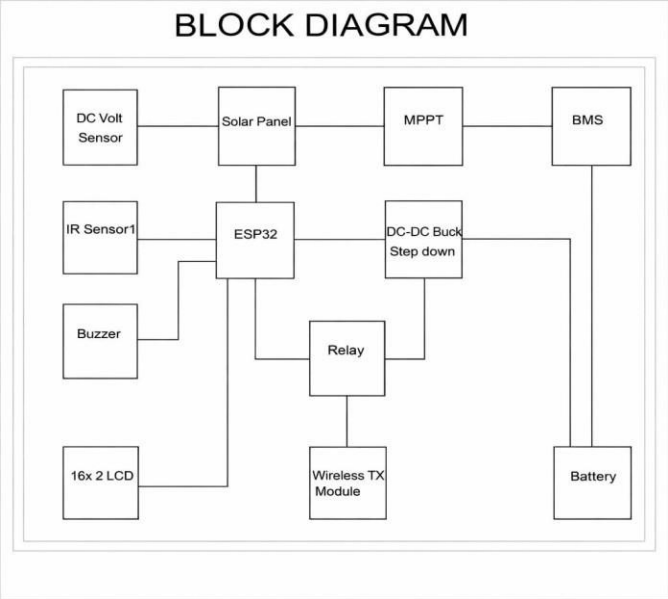


Fig1:Block diagram

Theblockdiagram of theHybrid SolarPowered Wireless Charging System consistsofasolar energyharvestingunit, powermanagement andstoragesection,controlunit,wirelesschargingunits,andmonitoringinterfaces.Thesolarpanelconvertssunlightintoelectricalenergy,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 16×2 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

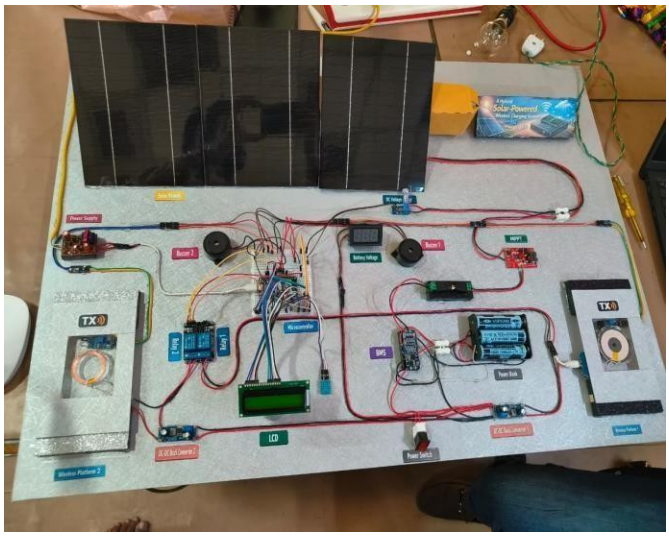


Fig.2.Systemphoto

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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) MPPTSolarChargeController

A 12 V MPPT charge controller regulates voltage and current from the solar panels to safely chargethelithium-ionbatterybank.Itpreventsoverchargingandreversecurrentflow,ensuring efficient and safe energy management.

3) Lithium-IonBatteryBank(3SConfiguration)

Thebatterybank consists ofthree3.7V,2600 mAhlithium-ioncellsconnectedinseries (11.1 Vnominal,12.6 Vfully charged). It stores solar energyand provides astablepowersupply to the wireless charging modules and control circuits.

4) BatteryManagementSystem(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–DCBuckConverter(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) *WirelessChargingModule(QiTransmitter)*

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

7) DCVoltageSensor

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) 16×2LCDDisplay

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

V. RESULT

Thesystemsuccessfullydemonstrated:

- Effectivesolar-basedbatterycharging
- Reliablewirelesspowertransferforlow-powerdevices
- Accurateloaddetectionandautomaticpower control
- Real-timelocal andremotemonitoringthroughIoT

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 monitoringintoasinglecompact system. Theproject demonstrates apractical and sustainable solution for low-power wireless charging applications while promoting energy efficiency and smart monitoring.Themodulardesign and scalability ofthesystem makeit suitableforfuture enhancements and real-world deployment.

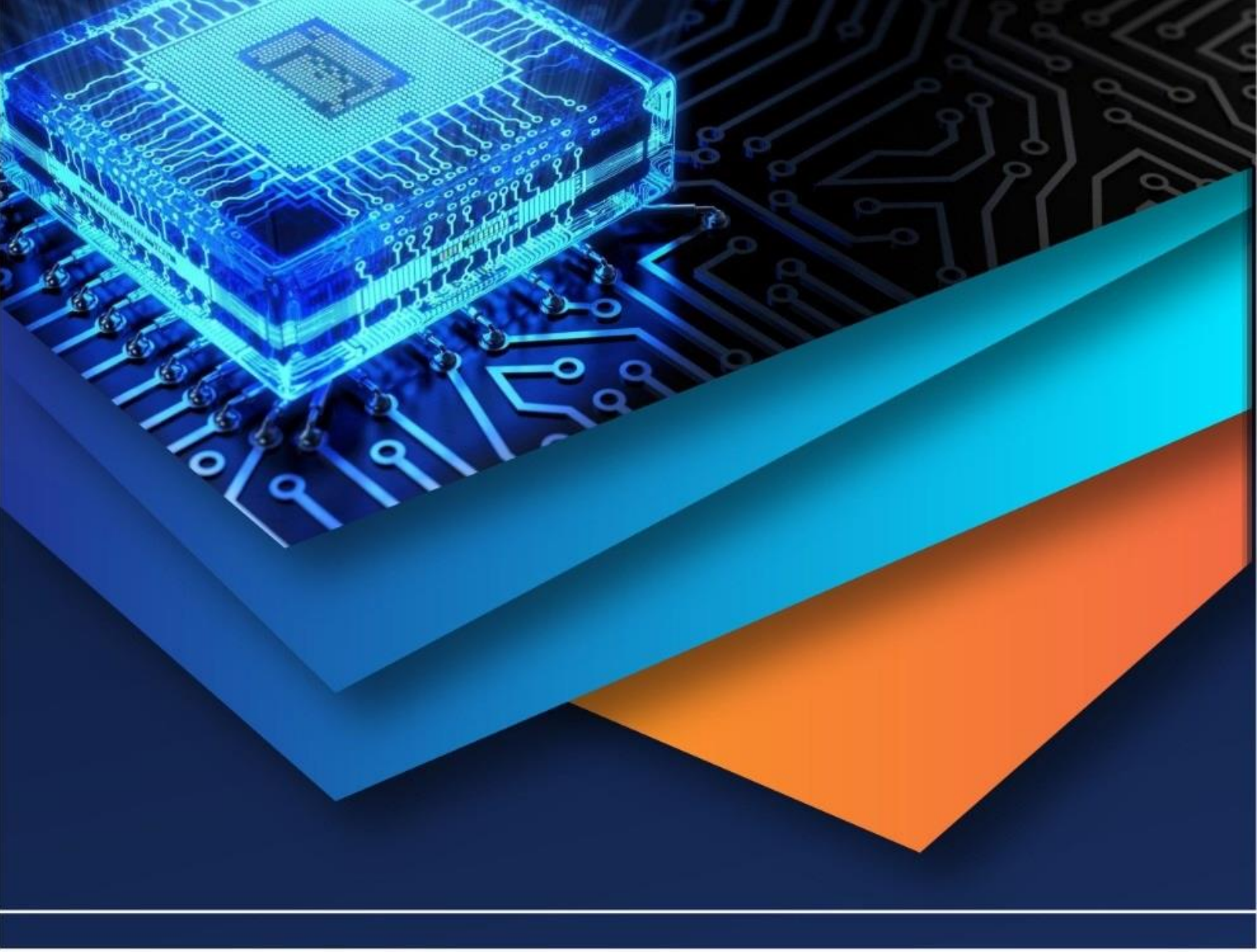
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