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DYNAMIC WIRELESS CHARGING FOR ELECTRIC VEHICLES

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ABSTRACT:
A dynamic charging solution for electric vehicles (EVs) integrates advanced algorithms and hardware to enable continuous charging while driving, improving range and reducing charging stops. Modeled using Python, the system optimizes energy transfer with real-time data on vehicle speed, battery level, and road conditions. It uses inductive charging technology to wirelessly transmit power to the vehicle's battery, with performance evaluated under various conditions. A feedback mechanism adjusts power transfer based on vehicle data and road conditions, ensuring optimal efficiency. The solution aims to reduce range anxiety, enhance EV adoption, and has future integration potential for smart cities and infrastructure.

INTRODUCTION

A dynamic wireless charging solution for electric vehicles (EVs) optimizes charging by adapting to real-time data like battery status, energy availability, and grid capacity. It enables communication between vehicles and stations, adjusting power delivery based on factors such as charge level and grid load. By incorporating renewable energy, it reduces grid reliance and enhances sustainability. The system prioritizes charging needs, integrates with smart grids, and minimizes wait times. Scalable and adaptable, it meets growing demand, supports various EV types, and accommodates future advancements in energy and technology.
A dynamic wireless charging solution for electric vehicles (EVs) optimizes the charging process by adapting to real-time data, such as battery status, energy availability, and grid capacity. The system enables communication between charging stations and vehicles, allowing real-time adjustments in power delivery based on factors like state of charge, time-of-day, and grid load, ensuring efficient energy distribution.
It incorporates renewable energy sources, reducing reliance on the traditional grid and enhancing sustainability integrating with smart grids and adopting advanced communication protocols, the system reduces wait times and helps balance energy demand. Scalable and reconfigurable, it adapts to growing EV numbers, different vehicle types, and evolving energy needs, supporting future technological advancements of EV charging.

OBJECTIVES

1. To implement wireless charging infrastructure
2. Safety of Induction coil during charging
3. Battery Charging of Car

PROBLEM STATEMENT

The growing adoption of electric vehicles (EVs) faces a significant challenge in addressing range anxiety and the need for frequent charging stops, which limit the practicality and convenience of EV usage. Traditional charging infrastructure requires stationary charging, leading to inefficiencies and extended travel times. There is a need for a dynamic charging solution that allows EVs to charge continuously while in motion, optimizing energy transfer based on real-time factors such as vehicle speed, battery level, and road conditions. This solution must be efficient, scalable, and compatible with existing infrastructure, while also reducing power loss, improving driving range, and enhancing the overall user experience.

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PROPOSED FRAMEWORK

A. Hardware components used

1. 1.ESP32 Microcontroller
2. Transmitter Coils
3. High-Frequency Inverter Circuit
4. 18650 Battery
5. OLED Display
6. Power Supply Unit
7. Voltage Sensors
8. Inductive Coupling Modules
9. Connectors and Wire

B. Software tools used

1. ESP_IDF
2. Blynk IoT Platform
3. Arduino IDE
4.

C. System Architecture

The ESP32 manages real-time communication and control, processing data from sensors to adjust power delivery based on vehicle speed, battery level, and road conditions. Transmitter coils embedded in the road generate an alternating magnetic field to wirelessly charge the vehicle's battery, while a high-frequency inverter circuit converts DC power to high-frequency AC for efficient power transfer. A rectifier and voltage regulation circuit stabilize the output for battery charging. The system's performance and charging parameters are monitored and displayed via an LCD, and data is sent to the cloud for remote access and analysis. Automated control mechanisms adjust power transfer and charging processes, ensuring optimal energy usage and reducing reliance on the traditional grid.

D. Implementation

Objective 1 To implement wireless charging infrastructure. The fig 1 shows the Fundamental architecture of the dynamic wireless EV charging system. The system design and planning for the dynamic wireless charging system for electric vehicles (EVs) focuses on creating a robust architecture that ensures efficient, safe, and reliable power transfer while the vehicle is in motion. The design process begins with defining system requirements, including selecting the operating frequency, input/output voltage, and coil specifications for optimal energy transfer. Key components such as the ESP32 microcontroller, Arduino, high-frequency inverter, IR sensors, and voltage regulators are carefully chosen and integrated to support dynamic charging scenarios.

This design ensures compatibility with various EV models, adheres to industry safety standards, and includes the development of effective control algorithms for seamless interaction between the charging infrastructure and moving vehicles. Simulation and testing are then conducted to verify the system's performance and optimize efficiency before hardware implementation.

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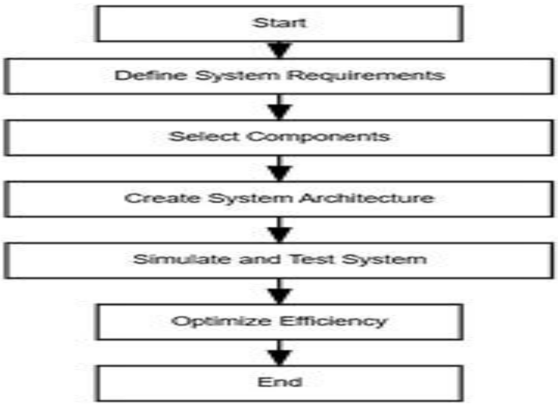

Fig 1: Flow chart of dynamic wireless EV charging system

Objective 2 Transmitter System Design

The fig 2 shows the flow chart of Transmitter System Design The transmitter system is a critical component of the Dynamic Wireless EV Charging System using Inductive Power Transfer. It consists of transmitter coils embedded in the road that generate an alternating magnetic field to transfer power to the vehicle's receiver coil. The system includes high-frequency inverter circuits, ultrasonic sensors for vehicle detection, and an ESP32 microcontroller for control.

The transmitter coils are strategically placed at regular intervals, with optimized spacing for continuous power transfer. The coils use Litz wire and operate at a frequency of 100 kHz. The high-frequency inverter circuit converts DC power into AC for inductive transmission. Ultrasonic sensors detect approaching vehicles and signal the ESP32, which activates the nearest coil to start the charging process. The ESP32 also controls the MOSFET switching and communicates with the receiver system for real-time monitoring, ensuring efficient power transfer.

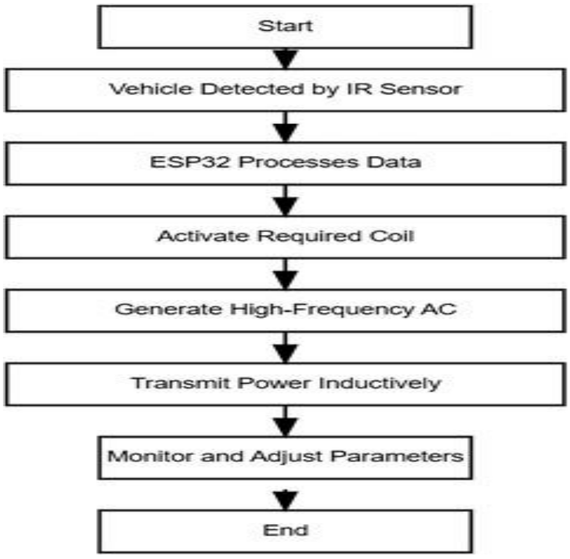

Fig 2: Flow chart of Transmitter System Design

Objective 3 Receiver System Design.

The fig 3 shows flow chart of Receiver System Design the Receiver System captures inductively transferred power from the road's embedded transmitter coils and converts it into DC voltage for charging the EV's battery. It consists of a receiver coil, rectifier, voltage regulation circuit, battery management system (BMS), ESP32 for monitoring, and an OLED display for real-time status updates.

The receiver coil, placed under the vehicle, is designed with flat spiral air-core coils made of Litz wire for optimal

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efficiency. The power received is high-frequency AC, which is then converted to stable DC using a full bridge rectifier, filter capacitors, and a buck converter. The battery charging circuit, including a BMS and TP4056 charging module, ensures safe storage of energy in the 18650 lithium-ion battery. The ESP32 monitors and controls the system, providing real-time data to ensure efficient and safe charging.

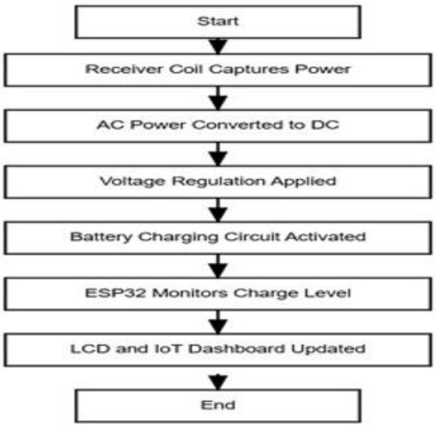

Fig 3: Flow chart of Receiver System Desig

RESULTS

The Fig 4 shows the Interfacing Esp-32 with Ultrasonic sensor and OLED. The ultrasonic sensor measures the distance between the sensor and an object. The ESP32 processes the signal, calculates the distance, and sends the data to the OLED display. If the distance falls below a certain threshold, a specific action can be triggered. This system enables real-time monitoring, making it ideal for applications like object detection or distance-based automation. Objective 2 Interfacing Raspberry pi to DC Water Pump, Fan and LED.

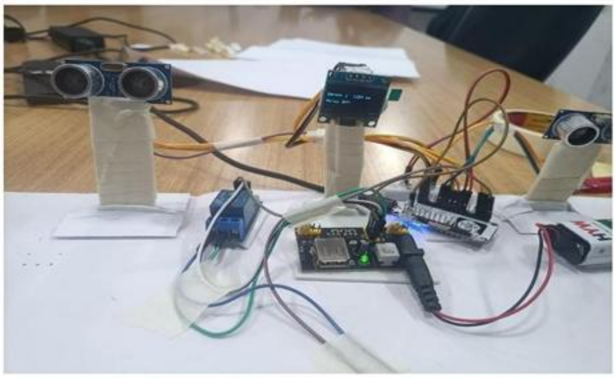

Fig 4: Interfacing Esp-32 with Ultrasonic sensor and OLED

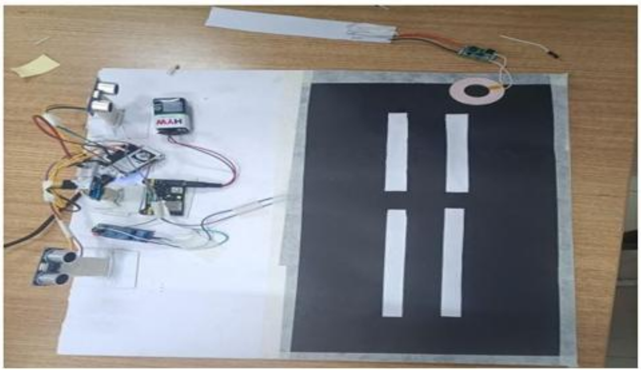

Fig 5: Interfacing of Esp-32 with induction coil

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CONCLUSION

The developed dynamic wireless charging system presents a transformative approach to electric vehicle (EV) charging, ensuring continuous power transfer while vehicles are in motion. By integrating inductive power transfer (IPT) technology with optimized coil designs and control algorithms, the system achieves high energy efficiency and stable power delivery. This innovation reduces dependence on conventional charging stations, extending the operational range of EVs and supporting widespread electric mobility adoption. Despite the need for infrastructure modifications, the technology demonstrates robust performance across varying road conditions and vehicle speeds, making it a viable solution for the future of sustainable transportation.

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