

Dynamic Wireless Charging of Electric Vehicles and IoT Implementation

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Abstract - Our project, "Dynamic Charging System for Electric Vehicles and IoT-Based Monitoring," aims to address key challenges faced by electric vehicles (EVs), such as prolonged charging times and limited battery capacity. The system introduces a dynamic wireless charging mechanism that enables EVs to receive power wirelessly while in motion, thereby extending their driving range and reducing downtime. The charging process operates on the principle of inductive coupling, where high-frequency alternating current (AC) is converted into a resonating magnetic field through transmitting coils embedded beneath the road surface. The receiving coils mounted on the vehicle capture this energy and convert it into direct current (DC) to charge the battery continuously while driving. Alongside the wireless charging unit, the project incorporates an IoT-based monitoring system for intelligent control and real-time supervision. This system continuously monitors parameters such as battery level, power transfer efficiency, temperature, and energy consumption. The IoT data is transmitted to a cloud platform and displayed on a web dashboard or mobile application for user convenience.

Key Words: Dynamic Charging, Electric Vehicles, IOT Monitoring, Smart Transportation, Energy Efficiency, Automated Charging System

1. INTRODUCTION

Electric Vehicles (EVs) are automobiles powered entirely or partially by electric energy stored in rechargeable batteries. Unlike conventional vehicles that rely on internal combustion engines and fossil fuels, EVs use electric motors that provide higher efficiency, lower noise, and zero tailpipe emissions. With increasing environmental concerns and the need for sustainable energy solutions, EVs have become a major focus in modern transportation systems. EVs are charged mainly by two methods conventional plug-in (conductive) charging and wireless (inductive) charging.

1.1 Types of EV Charging

- **Static Charging:** In this method vehicle must remain stationary and physically connected to a charger through a cable. This method is simple and widely

used; it results in long waiting times and limited travel distance due to fixed charging locations.

- **Wireless Charging:** This method uses Inductive Power Transfer (IPT), where energy is transmitted magnetically between a transmitter coil on the ground and a receiver coil on the vehicle. It offers convenience and safety but, when used statically, still requires the vehicle to stop for charging.

To overcome these limitations, Dynamic Wireless Charging (DWC) has been developed. In this system, transmitter coils are embedded along the roadway, enabling the EV to receive power continuously while moving. This reduces range anxiety, minimizes battery size requirements, and improves energy utilization.

Therefore, Dynamic Charging System represents a significant advancement over traditional charging methods, promoting sustainable, efficient, and intelligent electric mobility.

2. LITRETURE REVIEW

- The paper by Merin Shen (2024) compares static and dynamic wireless charging systems for electric vehicles, focusing on efficiency, cost, and practicality. Static charging uses inductive coupling between coils for parked vehicles, offering high efficiency and low maintenance. Dynamic charging enables power transfer while driving, reducing battery needs but requiring costly infrastructure. Case studies from Norway and South Korea show its potential but also highlight challenges like high installation costs and alignment issues. The study concludes that standardization, government support, and innovation are key for widespread adoption of wireless EV charging.
- The paper "Dynamic Charging of Electric Vehicles" (IRJET, 2022) presents a system that enables wireless charging of EVs while in motion using inductive power transfer. The study aims to overcome challenges like long charging times and limited infrastructure. A prototype using rectifiers, inverters, and coils was developed and simulated in

MATLAB, showing effective power transfer and reduced battery dependence. Though the setup requires high initial infrastructure costs, it promises continuous charging, smaller batteries, and improved efficiency. The paper concludes that dynamic charging is a promising future technology for large-scale EV adoption.

- The paper “Wireless Energy Transfer on Road for Electrical Vehicles using Multiple Transfer Units” (IJESI, 2025) presents a dynamic wireless charging system that powers EVs while moving through inductive coupling. Multiple transmitter coils embedded in roads are activated by IR sensors to enable continuous charging. A prototype using Arduino was developed to ensure efficient energy transfer and real-time monitoring. The system reduces battery size, charging time, and range anxiety while promoting sustainability. The study concludes that integrating this technology with IoT and renewable energy can make EV charging more efficient and practical for future smart transportation.
- The paper by Miranda Harijaz (2023) presents the IoT implemented in EV Charging infrastructure and developed an algorithm for smart Data exchange between utility and EV user. This study shows how the charging infrastructure can be improvised in future with improving Authentication, Remote operation, Smart cities etc.

3. OPERATION PRINCIPLE

The diagram illustrates the working principle of a Dynamic Wireless Charging System for Electric Vehicles (EVs), where the vehicle receives power wirelessly while moving over a segmented charging track. The track consists of multiple transmitter coils (Transmitter-1, Transmitter-2, Transmitter-3) embedded beneath the road surface. These coils are powered through a common inverter that converts DC supply into high-frequency AC, which is essential for creating a strong alternating magnetic field required for inductive power transfer.

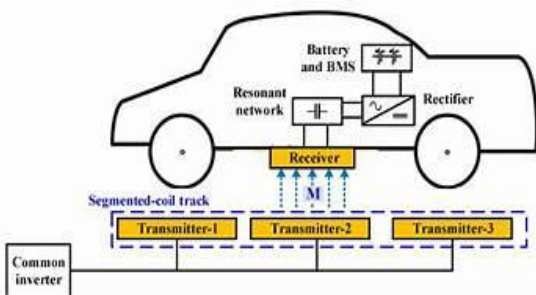


Fig. 1 Power Flow diagram of Dynamic Charging

As the vehicle moves along the road, a receiver coil mounted underneath the car aligns with each transmitter coil. When alignment occurs, magnetic coupling takes place, allowing power to transfer wirelessly from the ground coil to the vehicle coil. The received AC power is then passed through a resonant network, which improves power transfer efficiency by tuning the system to the desired resonant frequency.

After resonance compensation, the power enters a rectifier, which converts the high-frequency AC into DC. This DC output is supplied to the battery and Battery Management System (BMS). The BMS monitors battery health, controls charging rate, and ensures safe operation. As the vehicle continues to move forward, each transmitter coil activates sequentially, enabling continuous power transfer along the track without requiring the vehicle to stop.

4. METHODOLOGY

The methodology consists of developing hardware prototype. The key components used in Hardware are:

- **Microcontrollers:** In this project Arduino and ESP32 are used. Arduino UNO is used for managing the Relay module as shown in figure meanwhile ESP controller is used to Monitor Vehicle parameters and for IoT Interfacing.
- **Relay Module:** In this model two 4-Channel relay modules are used for energizing the transmitter coil when vehicle is above the coil.
- **Sensors:** In this model different types of sensors are used i.e. IR sensor is used for detecting position of vehicle, Temperature and Humidity sensors are used for checking the temperature and humidity near the battery, Voltage and Current sensors are used for measuring Voltage and current values and calculating SOC (State of Charge).
- **Transmitter Circuit:** Transmitter circuit consists of High frequency switching circuit which is powered by Timer IC. The high frequency DC supply is used to transmit power wirelessly.
- **Copper Wire:** here we have used gauge 7 of enameled copper wire for transmitter and receiver coil. We selected the turn ratio of 1:6 for transmitter and receiver coil respectively.

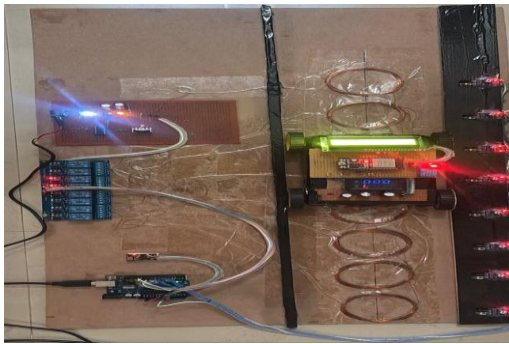


Fig. 2 Model Prototype

5. WORKING PRINCIPLE

The working principle can be explained using block diagram which can be given by:

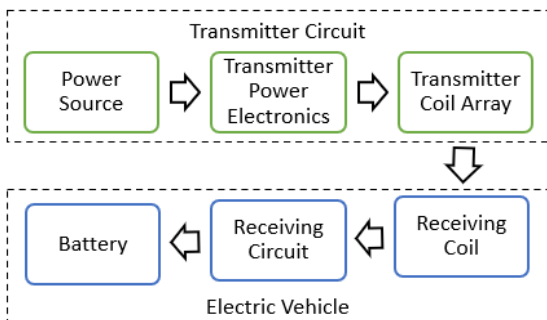


Fig. 3 Working Block diagram

The batteries supply constant DC supply to the Arduino and transmitter circuit which have timer circuit and MOSFET driver. By setting the appropriate value of resistors, the switching frequency is set. The high frequency pulses are given to the gate terminal of the MOSFET which gives high Frequency switching DC Voltage to the transmitter coil.

The IR sensors are used for detection of vehicle on the road. When the vehicle is detected by the sensor, the corresponding Coil is energized by relay and hence power is transmitted from road to the vehicle.

The vehicle circuit consists of receiving coil, rectifier, filter and regulator, sensors, BMS system. The rectifier circuit converts the received signal into pulsating DC which is converted into pure DC voltage by filter and regulator.

The BMS system consists of multiple sensor and battery pack. The sensors constantly measure the parameters such as voltage, current, SOC, temperature, humidity etc.

These measured values are displayed on the LCD display mounted on the vehicle meanwhile other display shows the value of receiving voltage and current when car is above the

coil. These measured values are again transferred to a web server or on Cloud system using ESP32's inbuilt WIFI and Bluetooth and SPI system. The Cloud data can be easily reached using the IP address by user as well as utility.

6. IOT IMPLEMENTATION

For IoT implementation in this project ESP32 is used for because it supports Data transmission using WIFI, Bluetooth and SPI. For programming of microcontroller, Arduino IDE software is used where as for Blynk platform is used for IoT monitoring. The block diagram for IoT interfacing can be shown as below

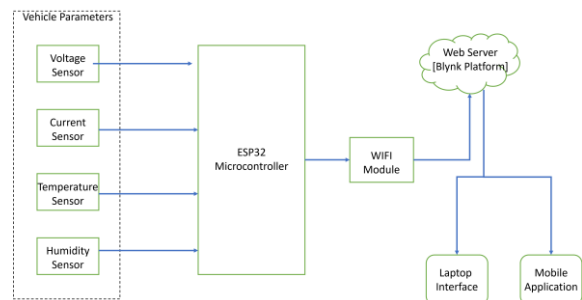


Fig.4 Block diagram for IoT Interfacing

Here different sensors are feeding the data to the ESP microcontroller. The data is then transmitted to the Blynk webserver which offers different tools such as real-time graph monitoring, Numeric values and so on without higher time delay.

7. RESULTS

The model demonstration for this project can be given below in which the first fig. the vehicle prototype is given in which ESP microcontroller is used for the battery monitoring and IoT data exchanging, The vehicle is charging successfully and the voltage and current can be seen on the digital display on the vehicle.

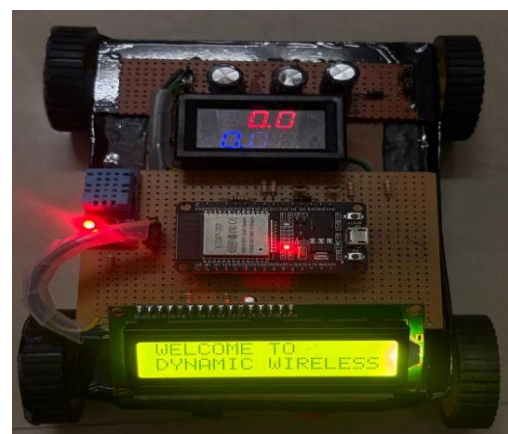


Fig. 5 Vehicle Prototype

In IoT Dashboard, the current charging status, Battery Voltage, Temperature, SOC, and Humidity can be observed. The real time data can be monitored and stored on the sever.

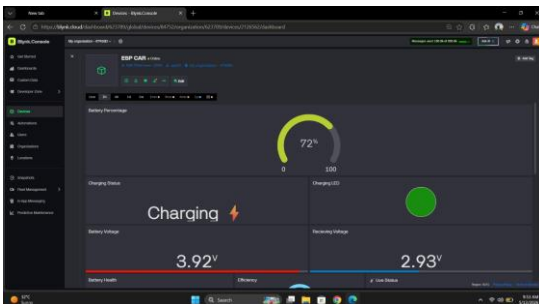


Fig. 6 Battery Parameter Monitoring

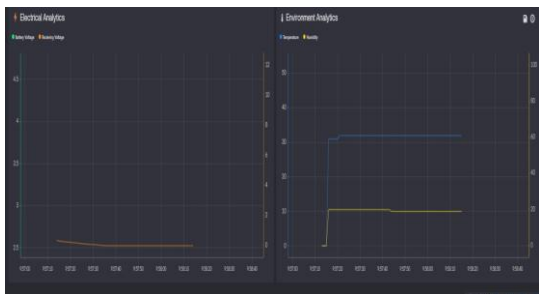


Fig. 7 Real time Monitoring

8. CONCLUSION

This work presents the advance feature for the Electric vehicle charging infrastructure. By increasing in the EV application, the problem of waiting time in charging station arises. This project demonstrates Dynamic Wireless charging system alongside of IoT implementation. The proposed system effectively charges vehicle compared with conventional EV charging method with problems such as Prolong charging period, limited driving range, Downtime at charging stations etc. The model demonstrates the working of Dynamic Wireless charging method for EV's which ensures reliable charging while moving and reducing range anxiety. Additionally, integration of IoT system ensures real-time data monitoring of vehicle parameters such as SOC, SOH, Voltage, Current, Temperature, Humidity etc.

This project highlights the potential of dynamic charging technology that can be usable in future for transportation systems to make them more efficient, sustainable and intelligent.

9. FUTURE SCOPE

The integration of dynamic charging method may have great future expansions such as using advanced controlling techniques and algorithms, implementing Artificial Intelligence [AI] and Machine Learning [ML] which can

greatly enhance the efficiency of charging system and can also improve the Data analysis on the Cloud server. The implementation of renewable energy sources such as wind, solar is a possible option to make system eco-friendlier and more sustainable.

Further improvements can be improvised designing of coils on the road and improvement in high frequency switching devices which can reduce losses making system more efficient and reliable. IoT platform can be advanced by using advance cybersecurity systems, Cloud analysis system and developing a user-friendly Mobile application for better Data management.

10. LIMITATIONS

Although the project works finely, the efficiency is low due to improper designing of transmitter circuit and coils design. By selecting appropriate power transfer methods (such as resonance inductive power transfer) and designing the coils with proper size and shape the circuit would be more efficient.

Cost is one important limiting factor during the project. The cost of the Blynk subscription costs around 2,800 INR for basic premium membership. Also, while designing the model the total costing for the model goes up to 6000 INR. Hence while being a non-sponsored project cost had become an issue during the project.

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