WIRELESS CHARGING STATION FOE ELECTRIC VEHICLE BASED ON IoT

Submitted

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DECLARATION

We declare that the project work contained in this report is original and it has been done by me under the guidance of my project guide.

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CERTIFICATE

This is to certify that Nischitha J, Shaik Mahammad Shafi, Basava Raj G Naganagouder bearing (Regd. No.:BU21EECE0200036, BU21EECE0200044, BU21EECE0200060) has satisfactorily completed Mini Project Entitled in partial fulfillment of the requirements as prescribed by University for VIIIth semester, Bachelor of Technology in "Electrical, Electronics and Communication Engineering" and submitted this report during the academic year 2024-2025.

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CHAPTER 1

INTRODUCTION

As electric vehicle (EV) adoption rises, the need for efficient and user-friendly charging infrastructure becomes crucial. Traditional plug-in systems are often inconvenient and inefficient, hindering the growth of EVs. Wireless charging offers a more seamless experience by eliminating the need for physical connectors. When integrated with Internet of Things (IoT) technology, wireless charging can be enhanced with real-time monitoring, energy optimization, and remote management. This IoT-based solution aims to make EV charging more accessible, efficient, and scalable, addressing key challenges in the current infrastructure.

1.1 Overview Of The Problem Statement

With the growing adoption of electric vehicles (EVs), there is an increasing demand for efficient, convenient, and accessible charging infrastructure. Traditional plug-in charging stations pose limitations in terms of convenience, accessibility, and usability. A promising solution is wireless charging technology, which allows EVs to be charged without physical connectors. Integrating this technology with the Internet of Things (IoT) can further enhance its functionality, offering smart features like real-time monitoring, remote management, and data-driven optimizations.

1.2 Objectives

>To develop a wireless power transmission system to charge the battery.
> To optimize coil power consumption when no vehicle is there.

> To reduce the size of the battery used in the vehicle.
> To develop a Robotic car to show continuous power delivery to the battery.

1.3 Goals

> To Reduce battery size and cost
> To improve EV uptake
> To improve operational efficiency
> To Extend driving range

The primary goal of this project is to develop an efficient wireless power transmission system for charging electric vehicle (EV) batteries. This includes optimizing power consumption by reducing coil energy usage when no vehicle is present, ensuring the system only activates when necessary. Another important aim is to reduce the size of EV batteries by enabling more frequent and accessible wireless charging, which would make vehicles lighter, more cost-effective, and environmentally friendly. Additionally, a robotic car prototype will be developed to demonstrate continuous power delivery, showcasing the potential of dynamic charging while vehicles are in motion. These combined efforts aim to make EV charging more efficient, sustainable, and practical for widespread adoption.

CHAPTER 2

LITERATURE REVIEW

The literature review for our project on wireless charging for electric vehicles (EVs), here are further details that contextualize the research and highlight the significance of using IoT in this technology:

1. **An IoT-Based Wireless Charging Service for the Public**:
   - This research addresses the deployment of IoT-enabled wireless charging stations in public areas, emphasizing **user accessibility** and **convenience**. The IoT layer is critical for remote monitoring and real-time data collection, which optimizes charging station management and enhances user experience. By integrating IoT, the system can automatically detect EVs nearby and initiate the charging process, allowing for seamless operation without manual intervention.
   - The paper may also discuss **security measures**, as IoT networks must safeguard user data and prevent unauthorized access to the charging infrastructure.
2. **A Review on IoT-Based Electric Vehicle Charging and Parking Systems**:
   - This review compiles advancements in using IoT to enhance the EV charging and parking experience. It likely explores IoT's role in energy management and predictive analytics, which help in managing electricity demand and scheduling charging times efficiently. This can reduce peak loads on the grid and minimize the overall energy cost associated with EV charging.
   - Furthermore, IoT-enabled systems can assist drivers in finding available parking spots with charging capabilities and provide real-time data on station occupancy and estimated wait times, improving the utilization of charging resources.

3.IoT Grid Alignment Assistant System for Dynamic Wireless Charging of Electric Vehicles:

- This study delves into the alignment issues in dynamic wireless charging systems, where misalignment between the transmitting and receiving coils can lead to **inefficiency and energy loss**. IoT sensors and grid alignment systems provide constant feedback to adjust vehicle positions and ensure optimal alignment during charging.
- The system can dynamically adjust charging parameters based on the **battery status** and **distance between coils**, thereby enhancing energy transfer efficiency. IoT enables automated adjustments, which are especially valuable in dynamic or in-motion wireless charging setups, such as roads embedded with wireless chargers.

CHAPTER 3

STRATEGIC ANALYSIS AND PROBLEM DEFINITION

3.1 SWOT Analysis

The SWOT analysis of our project, "Wireless Charging Station for Electric Vehicles Based on IoT," highlights the strengths, weaknesses, opportunities, and threats of implementing IoT-enabled wireless charging systems for EVs.

1. Strengths

- **Convenience and Ease of Use**: Wireless charging eliminates the need for physical connectors, making the process simpler and more convenient for EV owners, especially in public and high-traffic areas.
- **Operational Efficiency**: IoT integration allows real-time monitoring and remote management of the charging stations, optimizing their usage and maintenance schedules.
- **Scalability**: Wireless charging stations can be installed in various locations, such as parking lots, garages, and public spaces, making them flexible for different urban infrastructure requirements.
- **Reduced Wear and Tear**: Since there is no physical contact, wireless charging systems may experience less mechanical wear, potentially increasing their lifespan compared to traditional plug-in chargers.

2. Weaknesses

- **High Energy Loss**: Wireless charging often experiences more energy loss compared to wired systems, making efficiency a key concern. Misalignment between coils can further reduce efficiency.
- **High Initial Costs**: The installation and infrastructure costs of wireless charging stations are high, especially with IoT capabilities, which may limit widespread adoption.

- **Dependence on IoT Infrastructure**: Reliance on IoT means the system is vulnerable to connectivity issues, cyber threats, and technical failures, which could impact reliability.
- **Limited Charging Speed**: Wireless charging generally offers slower charging rates than direct plug-in solutions, which may be a limitation for users needing a quick recharge.

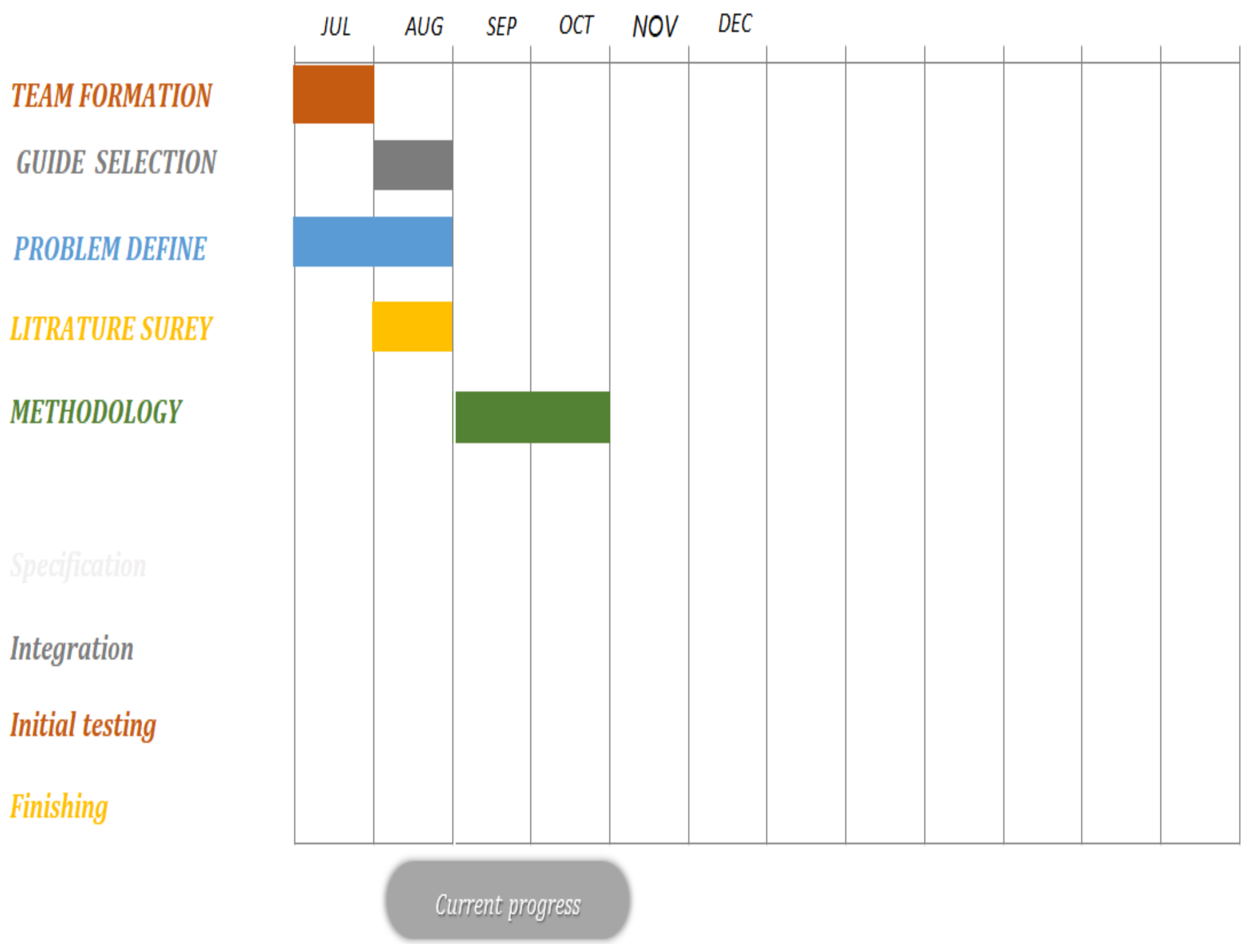
3. Opportunities

- **Growing EV Market**: With the global shift towards electric vehicles, there is a significant opportunity to expand wireless charging solutions as the demand for efficient EV infrastructure grows.
- **Smart City Integration**: The project aligns well with smart city initiatives, where wireless charging can be incorporated into urban planning, enabling charging infrastructure in public areas such as parking spaces, curbsides, and traffic signals.
- **Sustainability Goals**: Increased use of wireless charging in EVs can contribute to reduced greenhouse gas emissions and lower dependency on fossil fuels, supporting broader environmental and sustainability goals.
- **Innovation in IoT and Energy Management**: Advances in IoT and energy management can lead to more efficient, dynamic wireless charging solutions, reducing energy loss and improving performance.

4. Threats

- **Technical and Regulatory Challenges**: There may be technical challenges in maintaining efficiency, safety, and interoperability across different EV models, as well as regulatory hurdles regarding electromagnetic field (EMF) exposure and energy standards.
- **Infrastructure Requirements**: Integrating wireless charging into existing infrastructure may require significant modifications, which could limit adoption in certain urban areas or older buildings.
- **Economic Feasibility**: High costs may slow down adoption in less profitable or low-traffic areas, and the initial investment may not be justified until the technology matures and becomes more cost-effective.
- **Competitive Alternatives**: Traditional wired fast chargers are continually improving, potentially offering faster, cheaper, and more energy-efficient options, which could limit the demand for wireless charging stations.

3.2 Project Plan - GANTT Chart



CHAPTER 4

METHODOLOGY

4.1 Description of the approach

The approach of the "Wireless Charging Station for Electric Vehicles Based on IoT" project is centered on developing an efficient and user-friendly wireless charging system, leveraging IoT for improved monitoring and management. By replacing physical connectors with wireless power transfer through transmitting and receiving coils, the system is designed to eliminate the manual steps in EV charging, aiming for a seamless, automated experience. IoT sensors and controllers within the system allow for real-time data collection on power usage, vehicle detection, and battery status, optimizing the energy transfer process and reducing wastage. Key to the design is its adaptability to various urban environments, such as parking lots, garages, and other public infrastructure locations where vehicles could wirelessly charge while stationary. A robust coil alignment mechanism is also integral, ensuring energy efficiency by allowing minor misalignments without significant power loss. The project tests its use cases in diverse scenarios, including personal, fleet, and public charging needs, while verifying performance metrics like energy efficiency, alignment sensitivity, and durability. This system aligns with the vision of modernizing urban infrastructure, encouraging sustainable EV adoption, and supporting smart city initiatives through accessible, IoT-enabled wireless charging that integrates seamlessly into daily life.

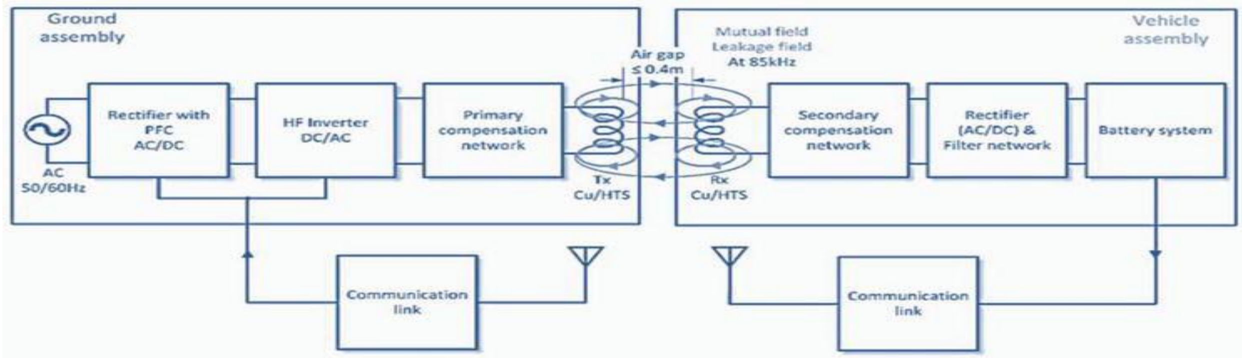
4.2 Tools and techniques utilized

The "Wireless Charging Station for Electric Vehicles Based on IoT" project incorporates a variety of tools and techniques to ensure efficient and effective wireless charging for EVs. The project relies heavily on IoT integration, using IoT sensors and controllers to monitor charging status, battery levels, and power consumption in real-time, thus optimizing the energy transfer process. Wireless power transfer technology is central, employing inductive coupling through transmitting and receiving coils to enable energy flow without physical connectors. The design of these coils includes alignment mechanisms to address common issues like misalignment, which can lead to energy loss; the system's alignment technique minimizes such losses to ensure consistent power delivery. For data and control management, the system leverages remote monitoring tools through IoT, allowing for automated, real-time adjustments in response to factors like battery status or coil positioning. Testing and analysis techniques, such as efficiency testing, alignment sensitivity testing, and durability assessments, are employed to evaluate the system's performance under real-world conditions. These tools and techniques collectively contribute to a streamlined, reliable, and user-friendly wireless charging system, supporting the integration of EV charging into public infrastructure and advancing the potential for smart city applications

4.3 Design Considerations

The design considerations for the "Wireless Charging Station for Electric Vehicles Based on IoT" project focus on ensuring efficient and reliable energy transfer between the ground and vehicle assemblies. In the ground assembly, an AC source is converted through a rectifier with Power Factor Correction (PFC) and a High-Frequency (HF) inverter. The inverter supplies the primary compensation network, which connects to the transmitting coil. The system is designed to maintain a minimal air gap ($\leq$ 0.4 m) between the transmitting and receiving coils, with a mutual field leakage field operating at approximately 85 kHz to ensure effective energy transfer.

The vehicle assembly includes a secondary compensation network that receives power from the transmitted field and converts it back to DC through a rectifier and filter network, which then charges the EV battery. Both assemblies have a communication link to synchronize operations, allowing real-time adjustments based on the charging requirements. The design also includes consideration for alignment between coils to reduce energy loss, and each assembly's power electronics ensure optimal conversion and efficient energy flow. This layout supports consistent and safe power transmission, addressing the challenges of misalignment, energy efficiency, and reliability.



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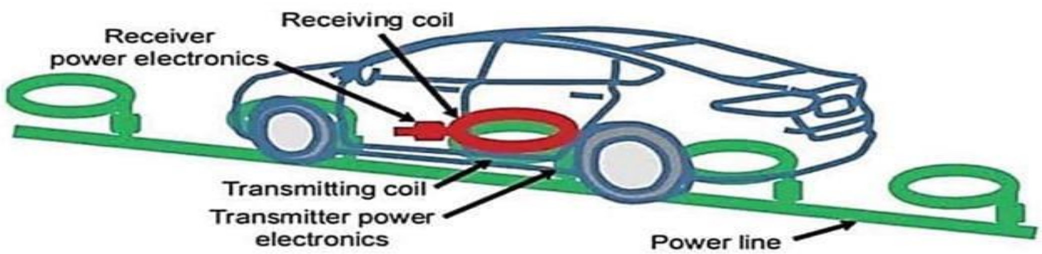

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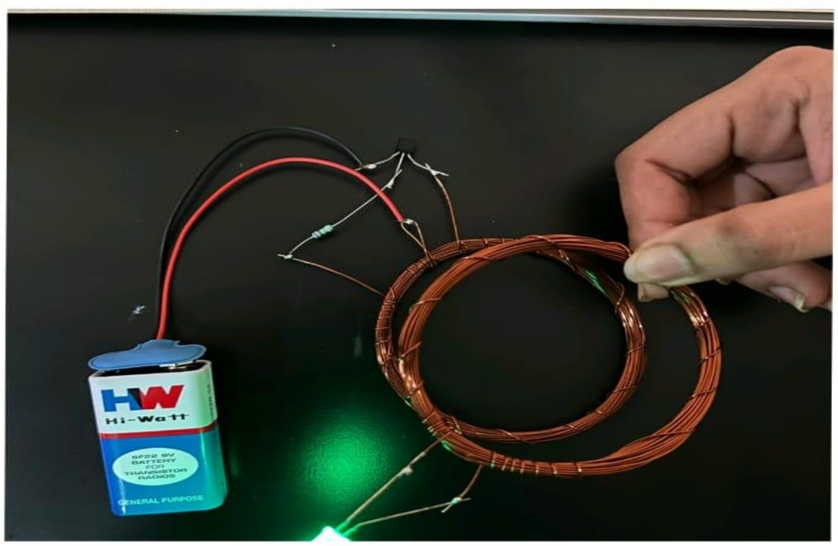
CHAPTER 5

IMPLEMENTATION

5.1 Description of how the project was executed



This setup demonstrates wireless power transfer using electromagnetic induction. Here's how it works based on the reference images:

1. **Components Used**:
   - A 9V battery
   - Two copper wire coils
   - An LED (green)
   - Connecting wires and possibly a transistor or resistor for current regulation

2. **Circuit Setup**:
   - In the first image, you see two separate coils. The left coil is connected to a 9V battery, creating a primary coil (the transmitter).
   - The other coil, on the right, is connected to the LED, serving as the secondary coil (the receiver)

   .

3. **Wireless Power Transfer**:
   - When current flows through the primary coil, it creates a magnetic field around it.
   - When the secondary coil is placed close to this magnetic field (as shown in the second image), it induces a current in the secondary coil.
   - This induced current is enough to light up the LED in the secondary circuit without direct contact with the battery.

4. **Demonstration**:
   - The second image shows the coils positioned close to each other, which allows the LED to light up due to the induced current from the electromagnetic field generated by the primary coil.

This is a basic demonstration of electromagnetic induction, showcasing how energy can be wirelessly transferred between coils when they are within close proximity.

5.2 Challenges faced and solutions implemented

Overheating of Components

- Challenge: The 9V battery and wires might heat up, especially if the coils have low resistance and draw a lot of current, potentially damaging components.
- Solution: Adding a resistor or transistor to regulate current flow can help prevent overheating. Ensure the wire gauge is appropriate for handling the current generated in the primary coil.

Weak LED Illumination

- Challenge: Even with the coils in close proximity, the LED might light up dimly if the induced current is insufficient.
- Solution: Use an LED with a lower voltage rating or a higher-efficiency LED. Alternatively, optimizing the number of coil turns and reducing resistance in the secondary circuit may help increase brightness.

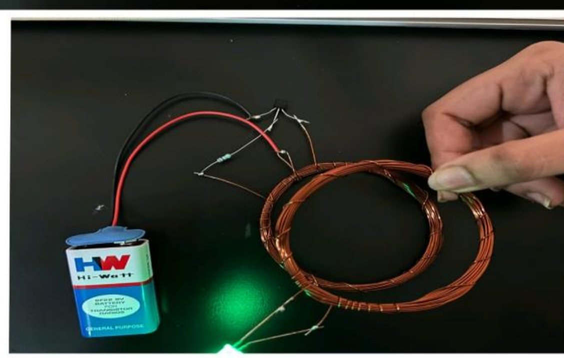
CHAPTER 6

RESULTS

6.1 OUTCOMES

The demonstration of wireless power transfer using inductive coupling includes two copper coils, one connected to a 9V battery with an LED, and the other coil is independent but positioned close to the first. When the coils are brought near each other, the LED lights up, indicating power transfer between the coils via electromagnetic induction.

The top part of the image shows the setup with both coils separated, while the bottom part shows the coils close to each other, allowing power transfer and lighting the LED. This is a simple and effective demonstration of the principles of wireless power transfer.



How It Works

- **Electromagnetic Induction**: When current flows through the primary coil, it creates a magnetic field around the coil. As the magnetic field fluctuates, it induces a voltage in the secondary coil when it is placed close to the primary coil.
- **Energy Transfer**: The induced voltage in the secondary coil powers the LED, lighting it up. The closer the coils, the stronger the inductive coupling, resulting in more power transferred and a brighter LED.

Key Factors for Efficient Power Transfer

- **Distance Between Coils**: The closer the coils, the stronger the magnetic coupling, and the more efficient the power transfer.
- **Number of Turns in the Coil**: More turns in the coil increase the magnetic flux and the amount of induced current, making power transfer more effective.
- **Core Material**: Using a ferromagnetic core (like iron) can concentrate the magnetic field and improve inductive coupling, though this setup seems to use just air, which still works but with less efficiency.

6.2 Interpretation Of Result

- **Wireless Power Transfer Mechanism**: This experiment is a simple but effective model of how wireless power transfer works. It illustrates how electrical energy can be transferred through magnetic fields without physical connections. In real-world applications, this principle is scaled up with advanced materials and components to improve efficiency and range.
- **Limitations and Efficiency**: This experiment also highlights the limitations of inductive coupling. Efficiency decreases with distance, and without a proper core material (like iron), energy loss is higher, which affects practical applications like charging devices over a distance.

CHAPTER 7

CONCLUSION

The experiment demonstrates the basic principle of wireless power transfer through inductive coupling. By placing two coils in close proximity, an alternating magnetic field from the primary coil induces a current in the secondary coil, which powers an LED. This confirms that energy can be transferred without direct physical contact, but the efficiency of this transfer diminishes as the distance between the coils increases. The results highlight that proximity is crucial for effective power transfer, as the strength of magnetic coupling decreases with distance, affecting the amount of induced current and the brightness of the LED. This setup provides a simple but clear representation of how wireless charging systems operate in real-world applications, such as in smartphones and electric vehicles, using the foundational principles of electromagnetic induction described by Faraday’s Law.

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