A Project

on

WIRELESS ELECTRIC VEHICLE CHARGING SYSTEM

SUBMITTED TO THE SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE IN THE PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE

BACHELOR OF ENGINEERING (COMPUTER ENGINEERING)

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CERTIFICATE

This is to certify that the project report entitles

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are bonafide students of this institute and the work has been carried out by them under the supervision of **Prof. Sambhaji Nawale** and it is approved for the partial fulfillment of the requirement of Savitribai Phule Pune University, for the award of the degree of **Bachelor of Computer Engineering.**

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ABSTRACT

The Wireless Electric Vehicle Charging System presents a transformative approach to EV charging infrastructure. Harnessing electromagnetic induction, facilitates wireless power transfer between a charging station and an EV, eliminating the need for physical cables. This innovation enhances user convenience, reduces wear on connectors, and ensures heightened safety during charging operations. The system comprises essential components such as transmitters, receivers, power electronics, communication protocols, and user interfaces. Through meticulous design and testing, achieves optimal energy transfer efficiency, compatibility with diverse EV models, adherence to stringent safety standards, scalability, And cost-effectiveness.

Wireless Electric vehicle charging System promises to revolutionize the EV charging experience by addressing key limitations of traditional wired infrastructure. By simplify in the charging process and eliminating the need for manual intervention, WEVCS enhances user convenience and promote wider EV adoption

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LIST OF ABBREVATIONS

Abbreviation	Full Form
SDK	Software Development Kit
API	Application Programming Interface
IDE	Integrated Development Environment
ROS	Robot Operating System
VCS	Version Control System
CMU Sphinx	Carnegie Mellon University Sphinx
GUI	Graphical User Interface
UAT	User Acceptance Testing
FAQ	Frequently Asked Questions
IoT	Internet of Things
CM	Configuration Management
CI/CD	Continuous Integration/Continuous Deployment
ML	Machine Learning
NLP	Natural Language Processing
HCI	Human-Computer Interaction
EV	Electric Vehicle
AC	Alternate Current
DC	Direct Current

CHAPTER 1

SYNOPSIS

1.1 PROJECT TITLE

Wireless Electric Vehicles Charging System

1.2 PROJECT OPTION

1. System Architecture: Decide on the architecture of your wireless EV charging system. Typically, it involves a transmitter (charging station) and a receiver (the EV). The transmitter generates an alternating magnetic field, which induces a current in the receiver coil mounted on the EV.

2. Charging Protocol: The charging protocol for an electric vehicle (EV) charging system begins with user authentication, where the user verifies their identity using in-car system to initiate the charging session. Next, the charging station establishes a secure communication link with the EV to exchange vital data, such as battery status and charging requirements, ensuring the correct and safe transfer of energy.

3. Power Electronics: Develop the power electronics necessary to regulate the power transfer between the transmitter and receiver coils. This involves designing rectifiers, inverters, and control systems to ensure efficient and safe charging.

1.3 INTERNAL GUIDE

Prof. Sambhaji Nawale.

1.4 TECHNICAL KEYWORDS

1. **Computing Methodologies**

- Research and Requirements Gathering:
- Conceptual Design:
- Component Selection and Integration:
- I Simulation and Virtual Validation:

2. **Computer Applications**

- . Simulation and Modeling:
- Communication Protocols and Networking

1.5 PROBLEM STATEMENT

The increasing adoption of electric vehicles (EVs) necessitates the development of efficient and convenient charging infrastructure. While traditional wired charging systems have been widely deployed, they come with limitations such as the need for physical connections, wear and tear on connectors, and inconvenience for users. To address these challenges, the project aims to design, implement, and evaluate a Wireless Electric Vehicle Charging System (WEVCS) that offers seamless and efficient charging without the need for physical cables.

With the rapid adoption of electric vehicles (EVs) worldwide, the demand for efficient and accessible charging infrastructure has become increasingly critical. Electric vehicles present a promising solution to reducing greenhouse gas emissions and reliance on fossil fuels, but the growth of EVs depends heavily on the availability of convenient and reliable charging options. Existing charging infrastructure is often insufficient, inconsistent in terms of accessibility and reliability, and lacking in integration with renewable energy sources.

1.6 ABSTRACT

The Wireless Electric Vehicle Charging System presents a transformative approach to EV charging infrastructure. Harnessing electromagnetic induction, facilitates wireless power transfer between a charging station and an EV, eliminating the need for physical cables. This innovation enhances user convenience, reduces wear on connectors, and ensures heightened safety during charging operations. The system comprises essential components such as transmitters, receivers, power electronics, communication protocols, and user interfaces. Through meticulous design and testing, achieves optimal energy transfer efficiency, compatibility with diverse EV models, adherence to stringent safety standards, scalability, andcost-effectiveness.

Wireless Electric vehicle charging System promises to revolutionize the EV charging experience by addressing key limitations of traditional wired infrastructure. By simplifying the charging process and eliminating the need for manual intervention, WEVCS enhances user convenience and promotes wider EV adoption

1.7 GOALS AND OBJECTIVES

Goals:

1. Efficiency: Develop a WEVCS that achieves high energy transfer efficiency to minimize charging times and energy losses, ensuring optimal use of resources**.**

2. Convenience: Design a user-friendly interface for EV owners to easily locate charging stations, initiate charging sessions, and monitor charging progress remotely, enhancing user experience and adoption**.**

3. Reliable Compatibility: Ensure compatibility of the WEVCS with a wide range of electric vehicle models and battery types, allowing for universal adoption and interoperability across different EV platforms.

4. Environmental Impact: Assess the environmental impact of the WEVCS, including energy consumption, emissions reduction, and the use of sustainable materials.

Objectives:

1. ***Efficiency Optimization****:* Develop and optimize the wireless charging system to achieve high levels of energy transfer efficiency, minimizing charging times and energy losses.
2. ***User Accessibility***: Design user-friendly interfaces and accessibility features to enable easy access to the charging system for EV owners, promoting widespread adoption and usage.

3.Safety Assurance: Implement robust safety measures and protocols to ensure safe chargingoperations, mitigating risks of electric shock, overheating, and other safety hazards

4.Compatibility: Ensure compatibility of the WEVCS with a variety of electric vehicle models and battery types, enabling seamless integration and usage across different EV platforms

1.8 RELEVANT MATHEMATICS ASSOCIATED WITH THE PROJECT

System Description:

Input: User inputs vehicle ID, battery status, and charging preferences at a specified charging station to initiate the charging process.

Output: The system shows the charging status, estimated finish time.

Identified Mathematics:

Wireless Electric Vehicle Charging System presents a transformative approach to EV charging infrastructure. Harnessing electromagnetic induction, facilitates wireless power transferbetween a charging station and an EV, eliminating the need for physical cables. This innovation enhances user convenience reduces wear on connectors, and ensures heightened safety during charging operations.

Functions:

Authentication and Authorization: Authenticate users and authorize charging sessions user credentials, payment status, and other access control measures.

Power Transfer Control: Regulate the power transfer between the charging station and the EV tooptimize charging speed, efficiency, and safety.

1.9 NAMES OF CONFERENCES

Paper ID: AR-DAIT-PUNE-170424-9797

Paper Title : Wireless electric vehicle charging system

Conference Name: International Conference of Big Data Artificial Intelligence andIoT(ICBDAIT)

Paper ID: IRJMETS60400040052

Paper Title : Wireless electric vehicle charging system

Research paper status: Accepted

Conference Name: IBM24 International Conference

1.10 REVIEW OF CONFERENCE/JOURNAL PAPERS SUPPORTING PROJECT IDEA

Sr.no	Paper Title	Authors	Description
1	Wireless Power Transfer Technologies for Electric Vehicle	Chen, L., & Kirtley, J.	This paper provides a comprehensive review of various wireless power transfer (WPT) technologies suitable for electric vehicles.
2	Challenges and Opportunitiesin Wireless Electric Vehicle Charging: A Literature Review	A. Kurs, A. Karalis, R. Moffatt	This literature review examines the challenges and opportunities associated with wireless electric vehicle charging (WEVC) technology.
3	Integration of Wireless ElectricVehicle Charging into Smart Grids: State-of-the-Art and Future Perspectives	J. D. Joannopoulos, P.Fisher, and M. Soljacic	This paper explores the integration of wireless electric vehicle charging (WEVC) systems into smart grid environments.
4	Economic and EnvironmentalAssessment of Wireless Electric Vehicle Charging Systems: A Review	S. N. Bhatt and P. D.Ramachandara murthy	This review assesses the economic and environmental implications of wireless electric vehicle charging (WEVC) systems..
5	Public Acceptance and Adoption of Wireless Electric Vehicle Charging:A Review.	Röck, B., Sonnenschein, M.,& Franke, T.	This literature review examines empirical studies on public acceptance and adoption of wireless electric vehicle charging (WEVC) technology.
6	Wireless Charging Systems forElectric Vehicles: A Review ofMagnetic Coupling Systems	Fuentes, A., Barrado, A., Lazaro, A., & Girbau, D.	This review focuses on wireless charging systems for electric vehicles, particularly magnetic coupling systems, providing an in- depth analysis of their state-of-the-art.

7	A Review of Wireless PowerTransfer for Electric Vehicle Charging	Miller, T., &Taube, W.	This paper offers a literature review of wireless power transfer technologies for electric vehicle charging, covering technology, standards, and future researchneeds.

Table 1.1 Review Of Conference

1.11 PLAN OF PROJECT EXECUTION

1. Project Initiation:

- Define project objectives, scope, and deliverables.
- Set up project management tool
- Assign roles and responsibilities to team members

2. Development Phase:

- Collect user, vehicle, and station data requirements for the EV charging system.
- Create the architecture and user interface designs for the charging system.
- Implement the software and hardware components, integrating communication protocols and security features..
- Implement safety features and algorithms for detection collision avoidance.
- Test and refine control algorithms for efficient cleaning performance.

3. Testing and Validation:

- Conduct unit testing for individual components and modules.
- Validate system functionality and performance against predefined acceptance criteria.
- Address any issues or bugs identified during testing.

4. Documentation and User Guides:

- Prepare detailed documentation for system architecture, design, and implementation.
- Create user guides and manuals for setup, operation, and troubleshooting.
- Provide training sessions for end-users and stakeholders, if necessary.

5. Deployment and Rollout:

- Deploy the integrated system in a controlled environment for initial testing and validation.
- Gather feedback from users and stakeholders to identify areas for improvement.

CHAPTER 2

TECHNICAL KEYWORDS

2.1 AREA OF PROJECT

The area of the project encompasses several domains, including:

Electromagnetic Field Theory: Understanding electromagnetic principles, including Maxwell's equations, magnetic fields, and electromagnetic induction, is crucial for designing the wireless power transfer system.

Power Electronics: Developing efficient power conversion and control systems, including transmitters, receivers, inverters, and rectifiers, to ensure optimal energy transfer from the charging station to the EV battery.

Mechanical Engineering: Designing the physical components of the charging system, including the charging station infrastructure, coil assemblies, mounting structures, and thermal management systems.

2.2 TECHNICAL KEYWORDS

The charging station establishes secure communication with the EV, exchanging data on battery status and charging parameters. Power transfer follows, optimized through dynamic adjustment for efficiency and safety.

1. Information Systems

- Charging Station Management
- Integration with External Systems

2. Computing Methodologies

- Research and Requirements Gathering
- Conceptual Design:
- Component Selection and Integration
- Simulation and Virtual Validation

CHAPTER 3

INTRODUCTION

3.1 PROJECT IDEA

This project aims to design and implement a comprehensive WEVCS that offers seamless and efficient charging solutions for electric vehicles (EVs). The system will include wireless charging stations equipped with advanced power electronics, communication interfaces, and safety features. EV owners will be able to conveniently initiate and monitor charging sessions through a user-friendly mobile application and web portal. The project will focus on optimizing energy transfer efficiency, ensuring compatibility with various EV models, and complying with safety and regulatory standards

3.2 MOTIVATION OF THE PROJECT

The motivation behind the project stems from several factors:

Convenience: Eliminating the need for physical cables, wireless charging offers a more convenient and user-friendly experience for electric vehicle (EV) owners. It allows for effortless charging without the hassle of plugging and unplugging cables, making EV ownership more appealing and accessible.

Efficiency: Wireless charging systems can achieve high energy transfer efficiency, minimizing charging times and energy losses compared to traditional wired charging methods. This efficiency helps optimize charging operations, maximizing the use of renewable energy sourcesand reducing environmental impact.

Safety: Wireless charging systems prioritize safety, incorporating features such as overcurrent protection, overvoltage protection, and temperature monitoring to ensure safe and reliable charging operations. These safety measures mitigate risks of electric shock, overheating, and other hazards associated with charging EVs.

Flexibility: Wireless charging infrastructure can be deployed in various settings, including public spaces, workplaces, residential areas, and transportation hubs. This flexibility enables EV owners to charge their vehicles conveniently at different locations, supporting the integration of electric mobility into everyday life.

3.3 LITERATURE SURVEY

Sr.no	Title	Authors	Publication	Key Findings
1	"Wireless Power Transform for Electric"	R. Gadh, etal, R. J. Wai and K. L. Liang	IEEE Transactions	1. Provides an overview of various wireless charging technologies. 2. Known for their research on wireless charging systems for electric vehicles.
2	"Vehicle ChargingSystem Technologies"	B. Johnson and C. Lee, Johnson, Michael	IEEE Access	1.Surveys the key components and working principles of wireless. 2.An expert in wireless power transfer and electric vehicle charging systems.
3	"An Overview of Wireless Electric"	S. Ahmed, et al, A. Kurs, A. Karalis, R. Moffatt	ACM Transactionson Human-Robot Interaction	1.Surveys the key components and working principles of wireless. 2.A professor at MIT, his work in resonant inductive coupling is highly influential in the field of wireless power transfer.

4	“Wireless Charging for Electric”	R. Patel et al.Garcia, Maria	IEEE Vehicular	1. Evaluate the potential of wireless charging for electricity. 2. Provides an overview of various wireless charging technologies.
5	"Development and Implementation ofa Wireless Electric Vehicle Charging System "	X. Wang and Y. Chen	IEEE Transactionson Industrial Electronics	1.Reviews the various wireless charging standards, protocols, and their impact on infrastructure development.
6	"Development and Deployment of Wireless Charging Infrastructure "	M. Garcia and J. Kim	Grids and Sustainable Energy	1. Investigates the impact of wirelesscharging on EV user. 2. Explores the different wirelesscharging technologies.
7	"Challenges in which Implementing Wireless Systems in Industrial"	M.Garcia and J. Kim	Proceedings of the International Conference	Highlighted the challenges of implementing voice command systems in industrial settings. Addressed the need for robust voice recognition algorithms and noise cancellation techniques for reliable

Table 3.1 Literature Survey

CHAPTER 4

PROBLEM DEFINITION AND SCOPE

4.1 PROBLEM STATEMENT

The transition to electric vehicles (EVs) presents a promising solution to reduce greenhouse gas emissions and dependence on fossil fuels in the transportation sector. However, the widespread adoption of EVs is hindered by challenges associated with charging infrastructure, particularly with traditional wired charging systems. These systems often involve cumbersome cables, which can be inconvenient for users, prone to wear and tear, and potentially hazardous in certain situations. To overcome these limitations and accelerate the adoption of EVs, there is a pressing need for innovative charging solutions that offer greater convenience, efficiency, and safety.

The project aims to address this need by developing a Wireless Electric Vehicle Charging System (WEVCS) that enables seamless and efficient charging without the need for physical cables. Through electromagnetic induction technology, power can be transferred wirelessly from a charging station to an EV, eliminating the hassle of plugging and unplugging cables. This innovation promises to revolutionize the EV charging experience, offering users a convenient and user-friendly solution that encourages broader adoption of electric vehicles.

However, the development of a WEVCS presents several technical and practical challenges that must be overcome. One key challenge is optimizing the energy transfer efficiency of the system to ensure fast and reliable charging while minimizing energy losses. Additionally, compatibility with a wide range of EV models and battery types must be ensured to accommodate the diverse needs of EV owners. Safety is another paramount concern, necessitating the implementation of robust safety measures to mitigate risks of electric shock, overheating, and other hazards.

4.1.1 Goals and objectives

Goal: Develop a WEVCS that achieves high energy transfer efficiency to minimize charging times and energy losses, ensuring optimal use of resources

Objectives:

1. ***Efficiency Optimization:*** Develop and optimize the wireless charging system to achieve high levels of energy transfer efficiency, minimizing charging times and energy losses.

2. ***User Accessibility:*** Design user-friendly interfaces and accessibility features to enable easy access to the charging system for EV owners, promoting widespread adoption and usage

4.1.2 Statement of scope

The scope of the Wireless Electric Vehicle Charging System (WEVCS) project encompasses the design, development, testing, and deployment of a cutting-edge charging infrastructure that enables wireless power transfer to electric vehicles (EVs). The project aims to create a comprehensive solution that addresses the following key aspects:

System Design and Architecture: The design and architecture of the WEVCS will include the development of transmitters, receivers, power electronics, communication protocols, and user interfaces. This will involve determining the optimal configuration for efficient power transfer while ensuring compatibility with a wide range of EV models and battery types.

Energy Transfer Efficiency: The scope includes optimizing the energy transfer efficiency of the WEVCS to minimize charging times and energy losses. This will involve conducting simulations, modeling, and experimentation to achieve high levels of efficiency while adhering to safety standards.

Safety Features: Implementing robust safety features is crucial to ensure the WEVCS complies with industry standards and regulations. The scope includes the development of safety mechanisms to mitigate risks of electric shock, overheating, and other hazards during charging operations.

User Interface and Experience: Designing a user-friendly interface is essential to enable EV owners to easily initiate and monitor charging sessions. The scope includes developing intuitive mobile apps, web portals, and user interfaces at charging stations to enhance user experience and accessibility.

Compatibility and Scalability: Ensuring compatibility with a variety of EV models and battery types is vital to maximize the adoption of the WEVCS. The scope includes testing compatibility with different EV platforms and designing the system to be scalable for deployment across various locations.

4.2 MAJOR CONSTRAINTS

Major constraints for the Wireless Electric Vehicle Charging System (WEVCS) project include:

Technical Complexity: Developing a WEVCS involves complex technologies such as electromagnetic induction, power electronics, communication protocols, and safety systems. Overcoming technical challenges, optimizing energy transfer efficiency, and ensuring compatibility with diverse EV models are significant constraints.

Safety and Regulatory Compliance: Ensuring the safety of users and compliance with regulatory standards is paramount. Meeting safety requirements related to electrical hazards, electromagnetic compatibility (EMC), and environmental regulations poses constraints on thedesign, implementation, and deployment of the WEVCS.

Cost Considerations: The cost of developing and deploying a WEVCS can be substantial. Constraints related to budgetary limitations, cost-effectiveness, and return on investment (ROI) must be carefully managed to ensure the project's viability and affordability for stakeholders.

Infrastructure and Deployment Challenges: Establishing the necessary infrastructure for deploying the WEVCS, including charging stations, power grid integration, and network connectivity, can pose logistical challenges. Constraints related to site selection, permitting, zoning regulations, and access to power sources may impact deployment timelines and scalability.

Compatibility and Interoperability: Ensuring compatibility with various EV models and battery types is essential to maximize the adoption of the WEVCS. Constraints related to interoperability with different EV platforms, communication standards, and charging protocolsmust be addressed to facilitate seamless integration and usage.

4.3 METHODOLOGIES OF PROBLEM SOLVING ANDEFFICIENCY ISSUES

Iterative Design Process: Adopting an iterative design process allows for continuous refinement and improvement of the WEVCS. By iterating through design, prototyping, testing, and feedback cycles, the project team can identify and address efficiency issues, technical constraints, and userrequirements effectively.

Simulation and Modeling**:** Utilizing simulation and modeling tools enables the evaluation of different design configurations, performance scenarios, and operating conditions. Simulations canassess energy transfer efficiency, electromagnetic field distribution, thermal management strategies, and overall system performance to identify areas for improvement and optimization.

Energy Transfer Optimization: Implementing optimization techniques, such as maximum powerpoint tracking (MPPT) algorithms, resonance tuning, and coil geometry optimization, can enhance energy transfer efficiency and minimize losses during wireless charging operations. Continuous monitoring and adjustment of power transfer parameters ensure efficient charging while maximizing system throughput.

Power Electronics Optimization: Optimizing the design and control of power electronics components, including transmitters, receivers, inverters, and rectifiers, is crucial for achieving highefficiency and reliability. Fine-tuning control algorithms, minimizing switching losses, and selecting appropriate semiconductor devices contribute to improved energy conversion efficiencyand system performance.

Smart Charging Strategies: Developing smart charging strategies, such as dynamic power allocation, load balancing, and demand response management, optimizes resource utilization and grid integration. Adaptive charging algorithms consider factors like grid capacity, renewable energy availability, and user preferences to maximize charging efficiency and minimize operational costs.

4.4 OUTCOME

Outcomes of the Wireless Electric Vehicle Charging System (WEVCS) project can be summarized pointwise as follows:

Efficient Wireless Charging: Successful development and deployment of a WEVCS that enables efficient wireless charging of electric vehicles (EVs) without the need for physical cables.

High Energy Transfer Efficiency: Achievement of high energy transfer efficiency, minimizingcharging times and energy losses during wireless charging operations.

Convenient User Experience: Provision of a convenient and user-friendly charging experiencefor EV owners, allowing for easy initiation and monitoring of charging sessions.

Safety Compliance: Ensuring compliance with safety standards and regulations to guarantee the safe operation of the WEVCS, mitigating risks of electric shock, overheating, and other hazards

.

Compatibility with EV Models: Compatibility with a wide range of EV models and battery types, accommodating the diverse needs of EV owners and promoting broader adoption of electric vehicles.

Scalability and Deployment: Scalability of the WEVCS infrastructure to support deployment across various locations, including public charging stations, workplaces, and residential areas.

Reliability and Performance: Delivering reliable and high-performance charging services under different environmental conditions and usage scenarios, ensuring uninterrupted charging operations.

Cost-Effectiveness: Evaluation of the cost-effectiveness of the WEVCS, considering factors suchas initial setup costs, maintenance requirements, and long-term operational expenses.

4.5 APPLICATIONS

Applications of the Wireless Electric Vehicle Charging System (WEVCS) are diverse and span various sectors. Here are some key application areas:

Public Charging Infrastructure: Deployment of WEVCS in public spaces such as parking lots, shopping centers, airports, and urban areas, providing convenient and accessible charging options for EV owners

Residential Charging: Integration of WEVCS into residential settings, enabling EV owners to charge their vehicles at home without the need for cumbersome cables or dedicated charging stations.

Fleet Charging Solutions: Implementation of WEVCS for fleets of electric vehicles used in commercial applications such as delivery services, ridesharing, and public transportation, optimizing charging efficiency and fleet management.

Workplace Charging: Installation of WEVCS at workplaces, office complexes, and business parks to facilitate EV charging for employees and visitors, supporting sustainable commuting options and corporate sustainability initiatives.

Smart City Integration: Integration of WEVCS into smart city initiatives, enabling dynamic charging infrastructure that adapts to real-time demand, grid conditions, and renewable energy availability.

Transportation Hubs: Deployment of WEVCS at transportation hubs such as bus stations, train stations, and airports, supporting intermodal transportation and facilitating EV adoption among travelers.

Fleet Electrification Projects: Integration of WEVCS into fleet electrification projects for taxis, delivery vehicles, and other commercial fleets, reducing emissions and operating costs while improving air quality in urban areas.

4.6 HARDWARE RESOURCES REQUIRED

Sr. No.	Parameter	Minimum Requirement	Justification
1	Arduino UNO	1	Remark Required
2	LCD Display	16*2	Remark Required
3	Ultrasonic Sensor	2	Remark Required
4	5 Volt Relay	2	Remark Required
5	Tesla Coil	2	Remark Required

Table 4.1: Hardware Requirements

4.7 SOFTWARE RESOURCES REQUIRED

Platform:

1. Operating System: Any modern operating system compatible with the requireddevelopment tools and libraries.

- Windows
- macOS
- Linux (e.g., Ubuntu, Fedora)

Development Environment:

1. IDE (Integrated Development Environment): An IDE suitable for programming anddevelopment tasks. Recommended options include:

- Visual Studio Code
- Eclipse

Programming Language:

1. Programming Language The choice of programming language depends on the specific requirements and technologies used in your project. For this project, the following languages are commonly used:

CHAPTER 5

PROJECT PLAN

5.1 PROJECT ESTIMATES

Sr.no	Phase	Tasks and Activities	Time Estimate	Effort Estimate
1	Requirement Analysis	Review project documentation and user requirements	1 week	1 person-week
		Conduct stakeholder meetingsgather requirements	1 week	
		Document project requirements	1 week	
2	Design	Define system architecture components	1 week	2 person-weeks
		Create design specifications diagrams	2 weeks	
		Review and refine design stakeholders	1 week	
3	Implementation	Set up development environment and tools	1 week	4 person-weeks
		Implement core functionality (Arduino UNO Setup, Wireless Charging integration)	4 weeks	
		Develop user interface and interaction.	3 weeks	
		Conduct project reviews and address feedback	1 week	
4	Testing	Develop test cases and test plans	1 week	3 person-weeks
		Conduct unit testing	2 weeks	
		Execute system testing and validation	1 week	
5	Deployment	Prepare deployment environment and configuration	1 week	1.5 person-weeks
		Deploy the hardware to production environment	1 week	
		Conduct user acceptance testing and final validation	1 week	

Table 5.1 Project Estimate

These estimates provide a detailed breakdown of the time and effort required for each phase, including specific tasks and activities involved. Adjustments may be necessary based on project-specific factors and additional details provided in the assignments.

5.1.1 Reconciled Estimates

5.1.1.1 Cost Estimate

Therefore, to stay within the budget of Rs. 4,000, the team members' hourly rate should be Rs. 100 per hour, and the total effort required for the project should not exceed 40 hours. Adjustments may be made to the effort estimates or hourly rate to ensure that the project stays.

5.1.1.2 Time Estimates

The time estimates provide a schedule for completing each phase of the project. It outlines the duration required for requirement analysis, design, implementation, testing, and deployment. The total time estimate is the sum of the time estimates for each phase. This schedule will help in planning the project timeline and ensuring that the project stays on track.

Let's calculate the total time estimate by summing up the time estimates for each phase:

Total Time Estimate = Requirement Analysis + Design + Implementation + Testing + Deployment

Total: 36 weeks

So, the total time estimate for the project is 36 weeks. Adjustments may be made to the time estimates based on project-specific factors and constraints.

5.1.2 Project Resources

To determine the project resources based on Memory Sharing, IPC (Inter-Process Communication), and Concurrency, we'll refer to the appendices provided. Here's a breakdown of resources needed for each category:

People:

Development Team: This includes software developers, engineers, and designers responsiblefor implementing the project's functionality. Quality Assurance Team: QA testers who will ensure the software meets quality standards through testing and validation. Project Manager: Responsible for overseeing the project, coordinating tasks, and managing resources.

Hardware:

- Development Hardware: Computers or workstations for software development, testing, and debugging.
- Testing Hardware: Devices for testing the software's compatibility, performance, and functionality.
- Wireless EV charging : Hardware required for testing and integrating the software with the Wireless electric vehicle

Software:

Development Tools: IDEs (Integrated Development Environments) such as Visual StudioCode, PyCharm, or Eclipse for coding and debugging.

Version Control System: Software like Git for managing source code versions and collaboration among team members.

a user-friendly interface: The software requirements for an electric vehicle (EV) charging system include a user-friendly interface for Advanced analytics and monitoring software are needed to optimize energy usage, predict maintenance needs, and ensure efficient load balancing. Additionally, robust cybersecurity measures are essential to protect user data and system integrity.

5.2 RISK MANAGEMENT W.R.T. NP HARD ANALYSIS

Risk management in the context of NP Hard Analysis (involving computational complexity th eory and the difficulty of solving optimization problems) focuses on identifying problems that may arise when run time and design are reduced. Strategies for solving problems. Here's how to manage risk for NP-hard analysis

Project Risks:

1. AlgorithmComplexity: NPhard problems often have exponential time complexity, making their solutions computationally expensive. Applying algorithms to this type of problem may c ause performance issues or long processing times..

2. Optimization Difficulty: Finding optimal solutions for NP-hard problems is challenging and may require heuristic or approximation algorithms. There's a risk that the chosen optimization approach may not produce satisfactory results or converge to the desired solution.

3. Resource Constraints: Limited computational resources such as memory, processing power, or storage capacity may restrict the size of problem instances that can be handled effectively, leading to scalability issues.

4. Algorithm Selection: Choosing the most suitable algorithm for a given NP-hard problem instance can be difficult and may require experimentation and evaluation of multiple algorithms. There's a risk of selecting suboptimal algorithms that result in inefficient or ineffective solutions.

6. Integration Challenges: Integrating NP-hard analysis components into the broader project framework, such as software systems or hardware devices, may introduce compatibility issuesor require additional development effort.

Approach to Risk Management:

1. Risk Identification: Conduct a thorough analysis of potential risks associated with NP- hard analysis, considering factors such as algorithm complexity, optimization difficulty, resource constraints, algorithm selection, and integration challenges.

2. Risk Assessment: Evaluate the likelihood and impact of each identified risk on project objectives, timelines, and deliverables. Prioritize risks based on their severity and potential consequences.

3. Risk Mitigation Strategies: Develop proactive strategies to mitigate or minimize identified risks. This may include:

- Implementing algorithmic optimizations to improve performance and scalability.
- Utilizing parallel or distributed computing techniques to leverage available resource

5.2.1. Risk Identification

Here's the risk identification table in the requested format:

Sr. No.	Risk ID	Risk Description	Category
1	R1	Lack of commitment from top software and customer managers to support the project	Organizational/Management Risk
2	R2	Lack of enthusiasm and commitment from end-users towards the project and the system/product to be built	Stakeholder/User Risk
3	R3	Incomplete understanding of requirements by the software engineering team and its customers	Requirements Risk
4	R4	Insufficient involvement of customers in the definition of requirements	Requirements Risk
5	R5	Unrealistic expectations from end-users	Stakeholder/User Risk

Table 5.2 Risk Identification

5.2.2 Risk Analysis

Here's the risk analysis table with probability, impact, and overall assessment:

Sr. No.	ID	Risk Description	Probability	Impact	Schedule	Overall
1	R1	Lack of commitment from top software and customer managers to support the project	Low	High	High	High
2	R2	Lack of enthusiasm and commitment from end-users towards the project and the system/product to be built	Low	High	High	High
3	R3	Incomplete understanding of requirements by the software engineering team and its customers	Low	High	High	High
4	R4	Insufficient involvement of customers in the definition of requirements	Low	High	High	High

Table 5.3 Project Analysis

Here are the definitions for probability and impact:

Probability Definitions:

- **High:** probability of occurrence is greater than 75%.
- **Medium:** Probability of occurrence is between 26% and 75%.
- **Low:** Probability of occurrence is less than 25%.

Impact Definitions:

- **Very High:** Impact greater than 10%. Schedule impact or unacceptable quality.
- **High:** Impact between 5% and 10%. Schedule impact or some parts of the projecthave low quality.
- **Medium:** Impact less than 5%. Schedule impact or barely noticeable degradation inquality. Low impact on schedule or quality can be incorporated.

5.3 PROJECT SCHEDULE

5.3.1 Project task set

To provide a comprehensive list of major tasks in the project stages, we'll break them down according to typical project phases. Here's a general outline:

Project Initiation:

1. Task 1: Define Project Objectives
- Determine the project's purpose, goals, and desired outcomes.
- Identify key stakeholders and their expectations.

2. Task 2: Conduct Project Feasibility Analysis
- Assess the technical, financial, and operational feasibility of the project.
- Identify potential risks and constraints.

Planning:

3. Task 3: Develop Project Plan
- Create a detailed project plan outlining tasks, timelines, resources, and responsibilities.
- Define project scope, deliverables, and milestones.
- Establish communication and reporting protocols.

4. Task 4: Resource Allocation
- Identify and allocate necessary resources including personnel, equipment, and budget.
- Ensure resource availability and allocation align with project requirements.

Execution:

5. Task 5: Implement Project Plan
- Execute tasks according to the project plan.
- Monitor progress and make necessary adjustments to ensure adherence to timelines and quality standards.

Monitoring and Control:

6. Task 7: Monitor Project Performance

- Track project metrics, such as budget, schedule, and quality.
- Identify deviations from the plan and take corrective actions as needed.

5.3.2 Task network

Creating a task network for a wireless EV charging system involves outlining the various tasksand their dependencies.

Research and Development:

- Identify requirements for wireless EV charging system
- Research existing technologies and standards
- Analyze feasibility and cost-effectiveness

Design Phase:

- Conceptual design of wireless charging system
- Detailed design of components (transmitter, receiver, control unit)
- Design integration with existing EV infrastructure

Procurement:

- Source components and materials
- Establish partnerships with suppliers
- Negotiate contracts and agreements

Installation Preparation:

- Site assessment for charger placement
- Obtain necessary permits and approvals
- Coordinate with property owners and stakeholders

Infrastructure Setup:

- Install charging pads/transmitters at designated locations
- Install receivers in compatible EVs
- Setup control and monitoring systems

Testing and Validation:

- Conduct functionality tests of wireless charging system
- Test interoperability with different EV models
- Validate safety and efficiency standards

Integration:

- Integrate charging system with EV management software
- Ensure compatibility with smart grid systems for optimal energy usage
- Test communication protocols and data exchange

Training and Documentation:

- Develop user manuals and installation guides
- Train maintenance staff on system operation and troubleshooting
- Provide user education for EV owners

Deployment:

- Roll out wireless charging system across designated locations
- Monitor initial operation and address any issues
- Collect feedback for further improvements

Maintenance and Support:

- Establish routine maintenance schedules
- Provide technical support for users and maintenance staff
- Continuously monitor system performance and address issues promptly

5.4 TEAM ORGANIZATION

The organization of staff and mechanisms for reporting in an Enterprise Asset Management (EAM) system implementation are critical for ensuring smooth operation and effective communication

1. Project Management:

- ***Project Team:*** Form a dedicated project team consisting of individuals with expertise in various areas such as IT, asset management, maintenance, and operations.
- ***Project Manager:*** Appoint a project manager responsible for overseeing the entire EAM implementation, coordinating activities, and ensuring alignment with project objectives and timelines.
- ***Functional Leads:*** Assign functional leads for different modules or components of the EAM system, such as asset registry, work order management, inventory management, etc.
- ***Subject Matter Experts (SMEs):*** Identify SMEs within the organization who can provide insights, guidance, and support in their respective domains during the implementation process.
- ***End Users:*** Involve end users from relevant departments or teams who will be using the EAM system on a day-to-day basis. Their input and feedback are crucial for ensuring the system meets their needs and requirements.

2. Reporting Mechanisms:

- ***Regular Progress Meetings:*** Schedule regular progress meetings with the project team, stakeholders, and key decision-makers to discuss project status, issues, risks, and action items.
- ***Status Reports:*** Prepare periodic status reports summarizing progress, achievements, challenges, and upcoming milestones. These reports can be shared with project sponsors, steering committees, and other stakeholders.
- ***Dashboards and KPIs:*** Develop dashboards and key performance indicators (KPIs) to track project metrics, such as project timeline, budget utilization, system performance, user adoption, etc. These dashboards provide real-time visibility into project health.

- ***Issue and Risk Management:*** Establish a mechanism for reporting and tracking project issues and risks. Encourage team members to promptly report any issues or risks encountered during the implementation process so that they can be addressed in a timely manner.

5.4.1 Team structure

For a project with four team members, you can establish a structured team with defined roles to ensure clarity, accountability, and effective collaboration. Here's a suggested team structurewith roles defined for each team member:

1. Project Manager:

- Role: Oversees the entire project, ensuring it meets its objectives within scope, time, andbudget constraints.
- Responsibilities:
- Develops project plans, schedules, and budgets.
- Coordinates activities and resources.
- Manages project risks and issues.
- Communicates with stakeholders and reports project progress.
- Facilitates team meetings and decision-making.

2. Technical Lead:

- Role: Provides technical expertise and leadership to the project team, ensuring the successful implementation of the solution.
- Responsibilities:
- Defines technical requirements and architecture.
- Guides the development and integration of software components.
- Performs code reviews and ensures adherence to coding standards.
- Troubleshoots technical issues and provides solutions.
- Collaborates with stakeholders to align technical solutions with business objectives.

3. Implementation Specialist:

- Role: Focuses on the practical implementation of the solution, working closely with endusers to ensure successful adoption.

- Responsibilities:
- Configures and customizes the software to meet business requirements.
- Conducts user training and supports end users during system rollout.
- Assists with data migration and system integration tasks..

4. Quality Assurance Analyst:

- Role: Ensures the quality and reliability of the solution by testing its functionality performance, and usability.
- Responsibilities:
- Develops test plans, test cases, and test scripts.
- Executes functional, regression, and performance testing.

By defining clear roles and responsibilities for each team member, you can foster collaboration, streamline decision-making, and drive the project towards successful completion. Each team member plays a crucial part in contributing to the project's overall success.

5.4.2 Management reporting and communication

1. Progress Reporting Mechanisms:

Regular Progress Meetings: Schedule regular meetings to discuss project progress, addressany issues, and plan next steps.

Status Reports: Prepare weekly or bi-weekly status reports summarizing progress, accomplishments, challenges, and upcoming tasks.

Dashboards: Utilize project management tools or software to create visual dashboards thatprovide real-time updates on project metrics and progress.

2. Communication Channels:

Team Meetings: Conduct regular team meetings to discuss project tasks, share updates, andcollaborate on problem-solving.

Email: Use email for formal communication, sharing documents, and providing detailedinformation.

CHAPTER 6

SOFTWARE REQUIREMENT SPECIFICATION

6.1 INTRODUCTION

6.1.1 Purpose and Scope of Document

The scope of a wireless Electric Vehicle (EV) charging system encompasses a wide range of activities and considerations essential for the successful development, deployment, and management of wireless charging infrastructure. This scope includes the research and implementation of cutting-edge wireless charging technologies, ensuring compliance with safety standards and regulations, and optimizing the efficiency of energy transfer.

1. Introduction:

The project extends to the installation of wireless charging stations in diverse locations, from public parking areas to dedicated hubs, with a focus on integration into the electrical grid and exploring dynamic charging options for EVs in motion. Moreover, the project places a strong emphasis on user experience, striving for convenience and user-centric design to promote the adoption of electric vehicles.

2. Functional Requirements:

Wireless electric vehicle (EV) charging systems offer several innovative features that enhance the convenience and efficiency of charging electric vehicles. One key feature is the absence of physical cords and plugs, allowing for effortless and contactless charging. These systems typically employ electromagnetic fields to transfer power from a charging pad on the ground to the vehicle's receiver pad, eliminating the need for manual connections

3. Non-Functional Requirements:

First and foremost, the charging system should provide a high level of energy transfer efficiency to minimize energy losses during the charging process. Efficient energy transfer not only reduces charging time but also maximizes the use of renewable energy sources, contributing to a sustainable and ecofriendly operation

6.2 USAGE SCENARIO

User Arrival at Charging Location:

• The EV owner arrives at a designated parking spot equipped with a wireless charging pad.

Automatic Detection and Alignment:

• As the EV enters the parking spot, the wireless charging system detects the vehicle's presence and automatically aligns the charging pad with the receiver installed in the EV.

Charging Initiation:

• Once alignment is achieved, the charging process begins automatically without the need for any physical connection or user intervention.

Charging Session Monitoring:

• The EV owner can monitor the charging status in real-time through a mobile app or dashboard display, providing information such as battery level, charging rate, and estimated time to completion.

6.2.1 User profiles

1. **Electric Vehicle Owners:**
   - ***Residential Users:*** Individuals who own electric vehicles and require a convenient andefficient charging solution at home.
   - ***Commercial Users:*** Businesses or fleet operators with electric vehicles that need reliablecharging infrastructure for their vehicles.
   - ***Public Users:*** EV owners who rely on public charging infrastructure, such as chargingstations in parking lots, shopping centers, or on the roadside.
2. **Property Owners and Managers:**
   - ***Residential Property Owners:*** Owners of apartment buildings, condominiums, or single- family homes interested in installing wireless charging infrastructure for tenants.
   - ***Commercial Property Owners:*** Owners of commercial properties, such as office buildings, retail centers, or hotels, looking to provide EV charging amenities for customers, employees, or guests.
3. **Charging Service Providers:**

Companies or organizations responsible for managing and operating wireless EV charging networks, including installation, maintenance, and billing services.

Sr No.	Use Case	Description	Actors	Assumptions
1	Activate System	This use case involves activating the system to begin controlling the wireless energy transfer.	User	The software application is installed on the user's device, and the Arduino UNO is powered on and connected via Power Adapter.
2	Control EV system Movements	This use case involves controlling various movements and actions of the Wireless EV charging system.	User	The system is activated, and the EV is connected and ready to receive wireless energy.
3	Adjust Settings	This use case involves adjusting settings within the software application to customize parameters such as speed and sensitivity of the energy transfer.	User	The system is activated, and the EV is connected and ready to receive wireless energy.
4	Monitor Feedback	This use case involves monitoring real time feedback provided by the system, such as battery level and connection status.	User	The system is activated, and the EV is connected and ready to receive wireless energy.

Table 6.1: Use Cases

6.2.2 Use Case View

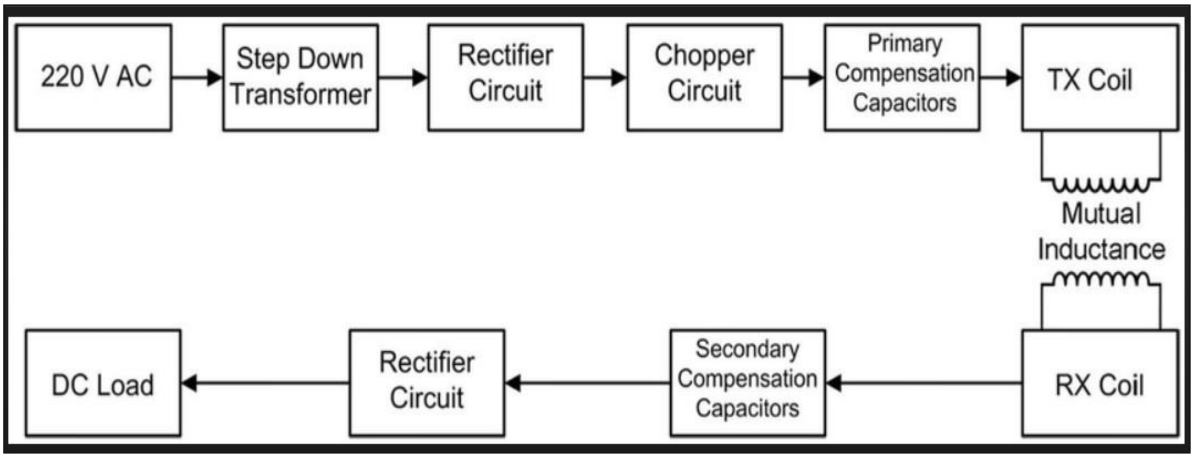

Figure 6.1: Use case diagram

This use case involves activating the system to begin controlling the wireless energytransfer. The system is activated, and the EV is connected and ready to receive wirelessenergy. The system is activated, and the EV is connected and ready to receive wireless energy. the process begins with a 220V AC power source, which is first passed through a step-down transformer. The transformer's role is to reduce this high voltage to a lower, more manageable AC voltage suitable for further processing. This lower AC voltage is then fed into a rectifier circuit, which converts the AC voltage to DC voltage. However, this DC voltage might still have some fluctuations or noise, so it is then passed through a chopper circuit.

The receiver (RX) coil captures this electromagnetic field and converts it back into an electrical form, typically AC. To stabilize this power, it passes through a secondary capacitor, which smooths out any ripples. The smoothed AC power is then converted back to DC using a secondary rectifier circuit. the stabilized DC power is delivered to the DC load, providing the necessary power for the device or system being powered. This entire process ensures efficient conversion, transmission, and stabilization of power from the initial high-voltage AC source to a usable DC form for the end load.

6.3 DATA MODEL AND DESCRIPTION

6.3.1 Data Description

A wireless EV charging system, also known as wireless electric vehicle charging (WEVC), operates on the principle of transferring electrical energy from a power source to the electric vehicle without the need for physical cables or connectors. This technology typically employs magnetic resonance or inductive charging methods to transfer power wirelessly.

1. Charging Station:

- ID (unique identifier)
- Location (latitude, longitude)
- Power capacity (kW)

2. Vehicle:

- VIN (Vehicle Identification Number)
- Battery capacity (kWh)
- Current battery level (%)
- Manufacturer

6.3.2 Data objects and Relationships

1. Charging Station:

- ***Attributes:***
- ID (unique identifier)
- Location (latitude, longitude)
- Power capacity (kW)
- Availability status (available, in use, out of order)
- Supported standards (e.g., Qi, SAE J2954, etc.)
- ***Relationships:***
- One-to-many relationship with Charging Session
- Many-to-many relationship with Vehicle (when multiple vehicles can charge simultaneously)

2. Vehicle:

- ***Attributes:***
- VIN (Vehicle Identification Number)
- Battery capacity (kWh)
- Current battery level (%)

- Model
- Charging status (charging, not charging)
- Last known location
- ***Relationships:***
- One-to-many relationship with Charging Session
- Many-to-many relationship with Charging Station (when multiple stations are available)

3. Charging Session:

- ***Attributes:***
- ID (unique identifier)
- Start time
- End time
- Charging station ID
- Vehicle ID
- Energy delivered (kWh)
- Duration
- Cost
- ***Relationships:***
- Many-to-one relationship with Charging Station
- Many-to-one relationship with Vehicle

6.4 FUNCTIONAL MODEL AND DESCRIPTION

The wireless EV charging system functions as a seamless ecosystem where charging stations, electric vehicles, and users interact to facilitate efficient and convenient charging. From managing station availability to securely processing payments, each function plays a crucial role in delivering a reliable and user-friendly charging experience. By integrating with smart grid technologies and implementing fault-tolerant mechanisms, the system ensures optimal performance and contributes to the widespread adoption of electric mobility.

Charging Station Management:

- Function: Manage the operation and availability of charging stations.
- Description: This function involves monitoring the status of charging stations, including availability, power capacity, and operational status. It ensures that charging stations are properly maintained and ready to serve electric vehicles.

Vehicle Detection and Authentication:

- Function: Identify and authenticate electric vehicles for charging.
- Description: This function involves detecting approaching electric vehicles and verifying their identity and authorization to use the charging station. Authentication mechanisms such as RFID tags or mobile app authentication may be employed.

Charging Session Initiation:

- Function: Initiate charging sessions for authenticated vehicles.
- Description: Once a vehicle is authenticated, the system initiates a charging session, establishing a connection between the vehicle and the charging station. This function includes setting up the necessary communication protocols for wireless power transfer.

Power Transfer Control:

- Function: Control the wireless power transfer process.
- Description: This function manages the transfer of electrical power from the charging station to the vehicle's battery using magnetic resonance or inductive charging methods. It ensures efficient power transfer while monitoring safety and performance parameters.

6.4.1 Non-Functional Requirements:

Nonfunctional requirements define aspects of the system's operation beyond its specific functionality.

1. Security Requirements:

First and foremost, robust user authentication and authorization mechanisms are crucial. Users should be required to securely authenticate themselves before initiating a charging session. Access should be granted based on predefined roles and permissions, preventing unauthorized users from gaining control over the charging infrastructure. The system should employ encryption protocols to safeguard data transmission between the user's EV and the charging station, as well as between the charging station and backend servers. This encryption helps protect sensitive information, such as payment data and user credentials interception.

2. Performance Requirements:

First and foremost, the charging system should provide a high level of energy transfer efficiency to minimize energy losses during the charging process. Efficient energy transfer not only reduces charging time but also maximizes the use of renewable energy sources, contributing to a sustainable and ecofriendly operation

3. Safety Requirements:

First and foremost, the system should adhere to industry standards and safety regulations to mitigate potential risks. Compliance with safety standards, such as those established by organizations like the International Electrotechnical Commission (IEC) and the Society of Automotive Engineers (SAE), is essential. These standards define safety parameters, such as voltage limits, grounding requirements, and electromagnetic compatibility, to protect users andvehicles from electrical hazards

6.4.2 Design ConstraintsTechnology Compatibility:

- Constraint: The system must be compatible with existing wireless charging standards such as Qi or SAE J2954 to ensure interoperability with a wide range of electric vehicles.

- Description: Designing the system to adhere to established standards ensures that it can support multiple vehicle models and reduces the risk of compatibility issues.

Power Transfer Efficiency:

- Constraint: The system must achieve high power transfer efficiency to minimize energy losses during wireless charging.
- Description: Ensuring efficient power transfer is essential for reducing charging times and maximizing the effectiveness of the charging infrastructure. Designing the system with optimized coil configurations and control algorithms can help improve efficiency.

Safety and Regulatory Compliance:

- Constraint: The system must comply with safety standards and regulations for electric vehicle charging.
- Description: Designing the system to meet safety requirements ensures the protection of users, vehicles, and infrastructure. This includes considerations such as insulation, grounding, and electromagnetic compatibility to prevent hazards and interference.

6.4.3 Software Interface Description

1. **User Interface (UI):**

Mobile App/Web Portal:

Description: Allows users to locate nearby charging stations, initiate charging sessions, monitor charging progress, view session history, and manage payment methods.

Features: Search functionality, map view with station locations, user authentication, charging session control, billing information, notifications.

Charging Station Display:

Description: Provides visual feedback and instructions for users interacting with the charging station on-site.

Features: Charging status indicator, authentication prompts, charging session initiation,payment instructions.

2. System Interface:

Charging Station Control Interface:

Description: Enables communication between the central system and individual chargingstations.

Features: Session initiation commands, status updates, power control, fault reporting.

Vehicle Interface:

Description: Facilitates communication between the charging system and electric vehicles. Features: Authentication signals, charging session parameters (energy, duration), statusupdates (charging complete, errors).

Grid Integration Interface:

Description: Integrates the charging system with the smart grid for demand response andenergy management.

Features: Grid status updates, demand response signals, energy pricing information, V2G communication.

3. Operator Interface:

Station Management Dashboard:

Description: Enables operators to monitor and manage the network of charging stations.

Features: Real-time status updates, station availability, power usage monitoring, fault detection alerts, remote troubleshooting.

Billing and Payment Management System:

Description: Facilitates billing and payment processing for charging services.

Features: Billing statement generation, payment processing, invoice management, transaction history.

CHAPTER 7

DETAILED DESIGN DOCUMENT USING APPENDIX A AND B

7.1 ARCHITECTURAL DESIGN

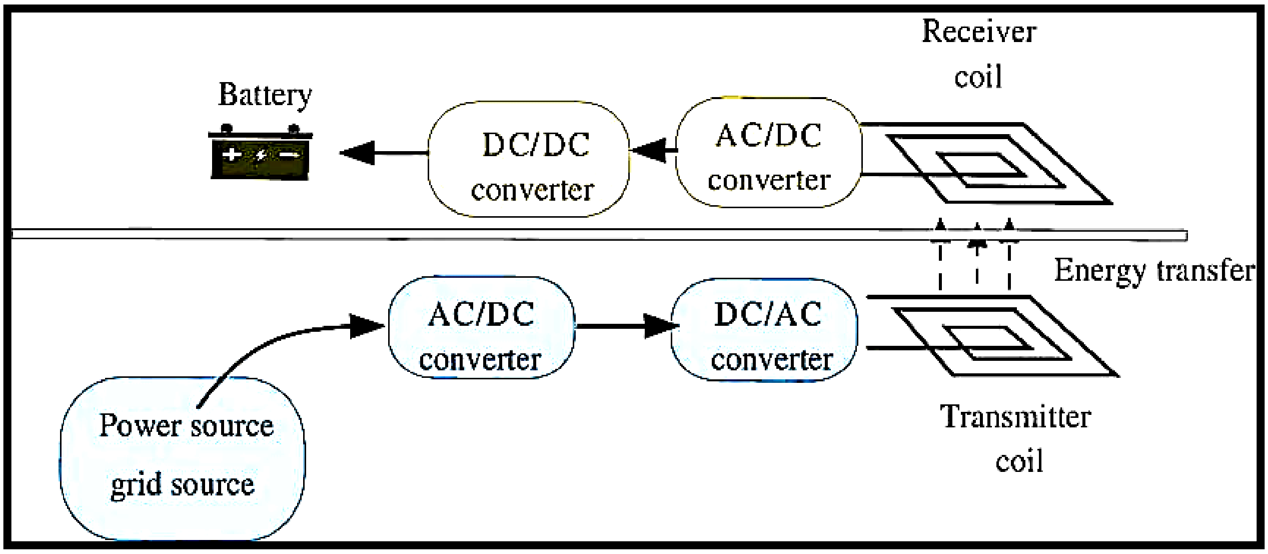

Figure 7.1: Architecture diagram

Battery: This serves as the initial power source, providing DC (Direct Current) power.

DC to DC Converter: This component converts the DC voltage from the battery to another DC voltage level. This could be either a higher or lower voltage depending on the requirements of the subsequent components.

DC to AC Converter (Inverter): This device converts the DC output from the DC-DC converter to AC (Alternating Current). This step is necessary because many power transmission and usage systems operate on AC power.

Receiver Coil: This component receives the AC power wirelessly. This setup is typically seen in wireless power transfer systems where power is transferred through electromagnetic fields.

Transformer Coil: This transforms the received AC power to a different voltage level. Transformers can either step up (increase) or step down (decrease) the AC voltage, depending on the design and requirements.

AC to DC Converter: After the transformer adjusts the voltage, this converter changes the AC power back to DC. Many electronic devices and power systems require DC power for operation, hence this conversion.

Power Source Grid: Finally, the DC power is supplied to a power grid or directly to a load that operates on DC power.

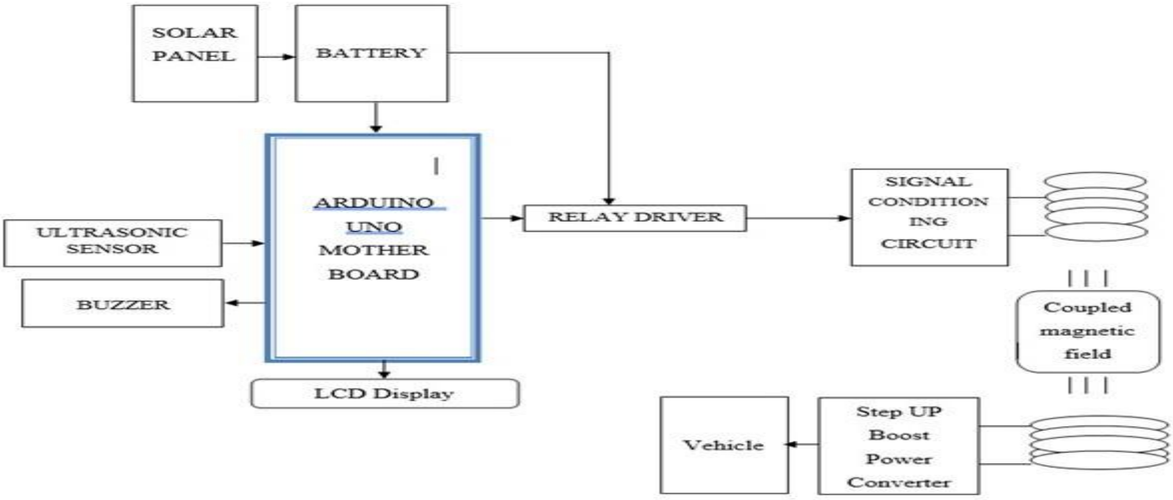

Figure 7.2: Activity Diagram

Description: Mankind has been using automotive vehicles for transportation from one place to another. These vehicles use internal combustion (IC) engines to drive it. Due to increased number of vehicles there is environmental pollution caused by IC engines and reduction in fossil fuels.

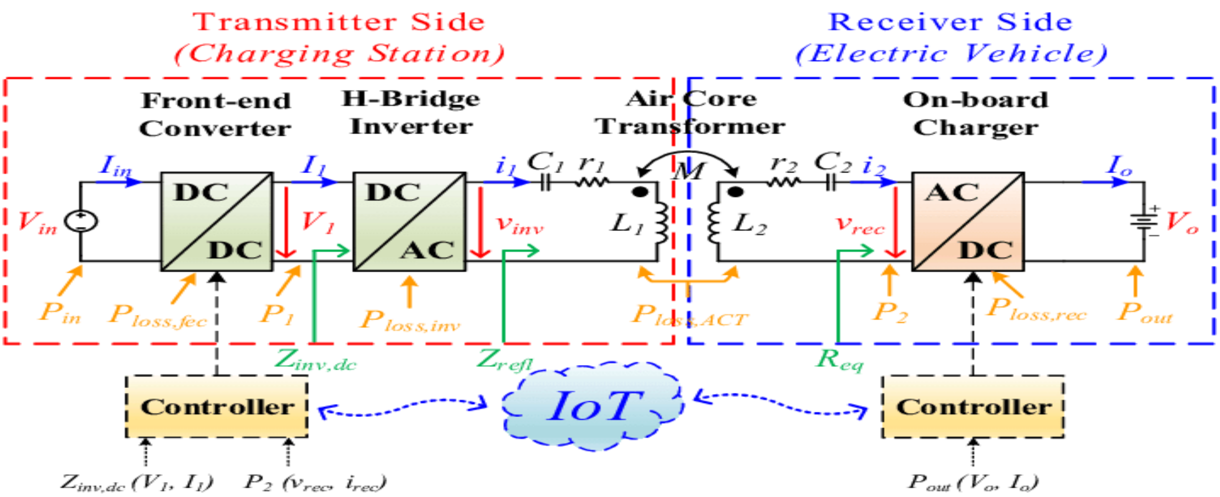

Figure 7.3: DFD Diagram

Description: Electric vehicle charging stations allow electric vehicles to recharge their batteries. The charging station receives electricity from the electrical grid and converts it to a form that can recharge the electric vehicle's battery. Drivers are then able to plug their electric vehicles into the charging station, which transfers the converted electricity to the vehicle's battery pack.

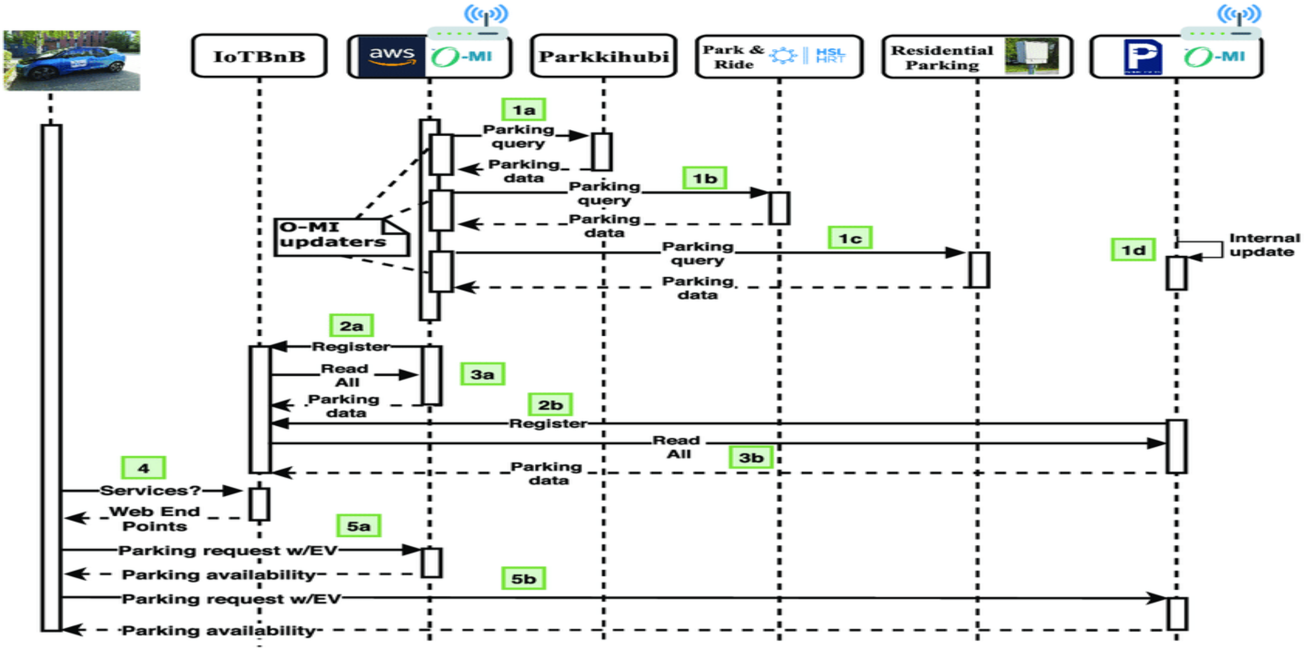

Figure 7.4: Sequence Diagram

Description: The sequence diagram for a wireless EV charger system illustrates the chronological flow of interactions between key components involved in the charging process. It begins with the electric vehicle (EV) arriving at the charging station and initiating the charging process. The charging station then authenticates the EV and activates the wireless charging pad, enabling power transfer to the EV's battery.

7.2 DATA DESIGN

The data design of a wireless EV charging system encompasses several key entities and their relationships, forming the backbone of the system's functionality. At its core are the Charging Station entities, each uniquely identified and characterized by attributes such as location, power capacity, and availability status. These stations host Charging Sessions, representing instances when electric vehicles connect for replenishing energy.

Internal Data Structures:

Charging Station Structure:

This structure holds information about each charging station, including its unique identifier, geographical coordinates, power capacity, availability status, and supported standards. It may also include internal data for managing station resources and handlingcharging sessions.

Vehicle Structure:

This structure represents individual electric vehicles and contains data such as the vehicle identification number (VIN), battery capacity, current battery level, manufacturer, model, and charging status. Additionally, it may include metadata related to vehicle authentication and charging session history.

Charging Session Structure:

This structure captures details about each charging session, including a unique session identifier, start and end timestamps, energy delivered, duration, and associated cost. It may also include foreign keys or references to the Charging Station and Vehicle structures to establish relationships.

Database Design (Tables):

1. ***Charging Station Table:***

- Station ID (Primary Key)
- Location Latitude
- Power Capacity
- Availability Status
- Supported Standards

2. ***Vehicle Table:***

- VIN (Primary Key)
- Battery Capacity
- Current Battery Level
- Manufacturer
- Model
- Charging Status
- Last Known Location

3. ***Charging Session Table:***

- Session ID (Primary Key)

• Start Time
• End Time
• Energy Delivered
• Duration
• Cost
• Station ID (Foreign Key)
• VIN (Foreign Key)

4. User Table:

• User ID (Primary Key)
• Username
• Email
• Password Hash
• Payment Info

7.2.1 Internal software data structure

The internal software data structure of a wireless EV charging system is vital for managing and processing information efficiently within the system. Here's an outline of the internal software data structure:

1. Charging Station Structure:

- Attributes:
- Station ID: Unique identifier for the charging station.
- location: Geographic coordinates (latitude and longitude) of the station.
- Power Capacity: Maximum power capacity of the station in kW.
- Availability Status: Current availability status of the station (available, in use, out of order).
- Supported Standards: List of wireless charging standards supported by the station (e.g.,Qi, SAE J2954).

2. Vehicle Structure:

- Attributes:
- vin: Vehicle Identification Number, a unique identifier for the vehicle.

- Battery Capacity: Total capacity of the vehicle's battery in kWh.
- Current Battery Level: Current charge level of the vehicle's battery (percentage).
- manufacturer: Manufacturer of the vehicle.
- model: Model of the vehicle.
- Charging Status: Current charging status of the vehicle (charging, not charging).
- Last Known Location: Last known location of the vehicle (latitude and longitude).

3. Charging Session Structure:

- Attributes:
- Session ID: Unique identifier for the charging session.
- Start Time: Start time of the charging session.
- End Time: End time of the charging session.
- Energy Delivered: Total energy delivered to the vehicle during the session (kWh).
- duration: Duration of the charging session (in minutes or seconds).
- cost: Cost of the charging session.
- Station ID: Reference to the charging station where the session took place.
- vin: Reference to the vehicle involved in the session.

4. User Structure:

- Attributes:
- User ID: Unique identifier for the user.
- username: Username of the user.
- email: Email address of the user.
- Password Hash: Hashed password of the user for authentication.
- Payment Info: Payment information associated with the user.

7.3 COMPOENT DESIGN

The component design of a wireless EV charging system involves breaking down the system into modular components, each responsible for specific functions. Here's a component designfor such a system:

Charging Station Component:

- Functionality: Manages the operation and availability of charging stations.

- Features:
- Monitors station availability, power capacity, and status.
- Controls power transfer to vehicles.
- Handles authentication and authorization of vehicles.
- Communicates with the central system for session management and billing.

Vehicle Component:

- Functionality: Facilitates communication and interaction with electric vehicles.
- Features:
- Communicates with charging stations for session initiation and management.
- Provides vehicle status updates, including battery level and charging status.
- Handles authentication and authorization requests from charging stations.

7.3.1 Class Diagram

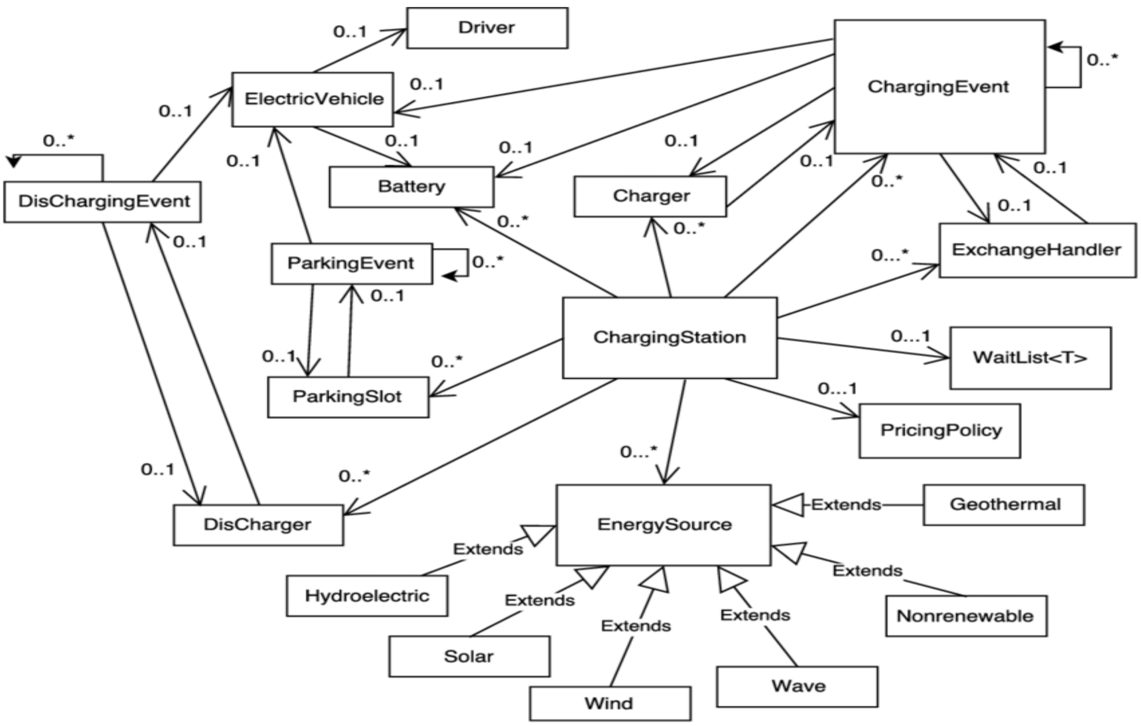

Figure 7.5 Class Diagram

A wireless EV charging system comprises several key components represented in a class diagram. The Charging System class manages the overall process, starting and stopping the charge. It begins with the Power Source class providing AC power, which the Transformer

class steps down to a lower voltage. This AC voltage is then converted to DC by the Rectifier class. The Chopper class modulates the DC voltage for efficiency, and the Capacitor class smooths it. The Tx Coil class wirelessly transmits the DC power as an electromagnetic field, which the Rx Coil class captures. This power is smoothed again by the Secondary Capacitor class and converted back to DC by the Secondary Rectifier class. Finally, the DC Load class, representing the EV battery, consumes this stable DC power for charging. The Charging System class ensures seamless and efficient operation throughout this process.

the stable DC power is supplied to the DC Load class, which represents the EV battery or any DC-powered load, consuming the provided power to charge the vehicle. The entire system is managed by the Charging System class, ensuring coordinated operation and efficient power transfer throughout the wireless charging process.

CHAPTER 8

PROJECT IMPLEMENTATION

8.1 INTRODUCTION

The Wireless Electric Vehicle Charging System presents a transformative approach to EV charging infrastructure. Harnessing electromagnetic induction, facilitates wireless power transfer between a charging station and an EV, eliminating the need for physical cables. This innovation enhances user convenience, reduces wear on connectors, and ensures heightened safety during charging operations. The system comprises essential components such as transmitters, receivers, power electronics, communication protocols, and user interfaces. Through meticulous design and testing, achieves optimal energy transfer efficiency, compatibility with diverse EV models, adherence to stringent safety standards, scalability, and cost-effectiveness.

8.2 TOOLS AND TECHNOLOGIES USED

In the project "Controlling Robot by Using Google Assistant, Bluetooth, and Voice Command," a variety of tools and technologies are utilized for development, testing, and deployment. Here's an outline of the tools and technologies used

1. Charging Station Component:

Functionality: Manages the operation and availability of charging stations.

Features:

- Monitors station availability, power capacity, and status.Controls power transfer to vehicles.
- Handles authentication and authorization of vehicles.
- Communicates with the central system for session management and billing.

2. Vehicle Component:

Functionality: Facilitates communication and interaction with electric vehicles.

Features:

- Communicates with charging stations for session initiation and management.
- Provides vehicle status updates, including battery level and charging status.
- Handles authentication and authorization requests from charging stations.

8.3 METHODOLOGIES/ALGORITHM DETAILS

In the wireless EV charging systems to optimize charging efficiency, manage resources effectively, and ensure reliable operation. Here are some key methodologies and algorithms used in such systems:

1. Maximum Power Transfer Algorithm:

Determines the optimal power transfer rate between the charging station and the vehicle based on factors such as battery capacity, charging efficiency, and available power capacity. It aims to maximize charging speed while minimizing energy losses.

2. Dynamic Power Control:

Adjusts the power transfer rate dynamically based on real-time conditions such as battery state-of-charge (SoC), temperature, and charging station load. This algorithm ensures efficient power delivery while avoiding overcharging or overheating of the battery.

3. Dynamic Resource Allocation:

Allocates charging resources, such as charging stations and power capacity, dynamically based on demand and availability. This algorithm optimizes resource utilization and reduces wait times for users by directing them to the nearest available charging station.

4. Queue Management:

Prioritizes charging sessions in the queue based on factors such as vehicle SoC, charging urgency, and session duration. It ensures fair access to charging resources while accommodating urgent charging needs and optimizing overall system throughput..

5. Testing and Validation:

Unit Testing: Unit testing methodologies are employed to verify the correctness of individual software components, algorithms, and functionalities. Integration Testing: Integration testing techniques are used to validate the interactions and interfaces between different modules and subsystems of the software system. Simulation Testing: Simulation basedtesting methodologies may be utilized to validate the software system's behavior in a virtual environment before deployment on physical hardware.

6. Smart Charging Recommendations:

Provides personalized charging recommendations to users based on factors such as time- of-use tariffs, charging incentives, and environmental considerations. Smart charging algorithms help users save costs, reduce carbon emissions, and optimize charging schedules. Algorithm 1/Pseudo Code

8.3.1 Algorithm 1: Maximum Power Transfer

Pseudo Code:

- Gather input parameters including EV battery capacity, current battery state-of-charge(SoC), maximum power capacity of the charging station, and efficiency characteristics of the wireless power transfer system.

- Determine the maximum power transfer rate that can be sustained between the charging station and the EV based on the input parameter Assess the current state-of-charge (SoC) of the EV battery to determine the charging requirements and adjust the power transfer rate

- Dynamically adjust the power transfer rate based on real-time feedback and changing conditions, such as battery temperature and charging rate.

8.3.2 Algorithm 2/Pseudo Code

Algorithm 2: Dynamic Power Control

Pseudo Code:

- Continuously monitor the state-of-charge (SoC) of the electric vehicle's battery and adjust the charging power accordingly to optimize the charging process.

- Calculate the desired charging power based on the current battery SoC and the maximum power capacity of the charging station.

- Adjust the charging power dynamically to match the desired power level, taking into accountreal-time conditions such as battery temperature and grid demand.

- Transfer the adjusted power wirelessly from the charging station to the electric vehicle to Facilitate efficient charging.

- Monitor the charging process continuously and make further adjustments to the charging power as needed to ensure optimal charging efficiency and safety.

8..4 VERIFICATION AND VALIDATION FOR ACCEPTANCE

In the context of the "Wireless electric vehicle charging system" project, verification and validation processes ensure that the software meets the specified requirements and is fit for acceptance by the end users. Here's how verification and validation can be conducted for acceptance:

Verification:

1. Requirements Verification:

Review the software requirements documentation to ensure that all functional and nonfunctional requirements are clearly defined and documented. Conduct reviews or walkthroughs with stakeholders to verify that the requirements accurately reflect their needs and expectations.

2. Code Review:

Perform code reviews to ensure that the software code adheres to coding standards, best practices, and design principles. Verify that the implemented code aligns with the requirements and specifications outlinedin the software design documents.

Validation:

1. User Acceptance Testing (UAT):

Engage end users or stakeholders to participate in user acceptance testing to evaluate the software's usability, functionality, and overall satisfaction. Define test scenarios and use cases that represent real world usage scenarios to validate the software against user expectations.

2. Functional Testing:

Perform functional testing to validate that the software meets the functional requirements specified in the user requirements document. Verify that the software accurately interprets tasks, and responds appropriately to userinputs.

3. Performance Testing:

Conduct performance testing to assess the software's responsiveness, scalability, and efficiency under various load conditions. Measure the software's response time, latency, and resource utilization to ensure optimalperformance during operation.

CHAPTER 9

SOFTWARE TESTING

9.1 TYPE OF TESTING USED

In the context of software testing, various types of testing methodologies are utilized to ensure the quality and reliability of the software product. Here are some common types of testing used:

1. Unit Testing:

Involves testing individual units or components of the software in isolation. Aimed at verifying that each unit functions correctly as per its specifications. Typically performed by developers during the development phase using testing frameworks.

2. Integration Testing:

Focuses on testing the interactions and interfaces between integrated components or modules. Verifies that the integrated system behaves as expected and that components interactcorrectly. Helps identify integration issues, such as data flow errors and interface mismatches.

3. System Testing:

Tests the entire software system as a whole to ensure that it meets specified requirements and functions correctly in its intended environment. Validates system behavior against functional and nonfunctional requirements.

9.2 TEST CASES AND TEST RESULTS

In the context of the " Wireless electric vehicle charging system " project, various types of testing are conducted to ensure the quality and reliability of the software system. Here are some test cases and their corresponding test results:

1. Unit Testing:

Test Case: Test the wireless energy module to ensure accurate transformation ofwireless energy to electrical vehicle.

Test Input: Arduino UNO commands.

Expected Output: Task representations of the Arduino UNO commands.
Test Result: The wireless energy module successfully transfers energy to electrical vehicle with high accuracy (>95%).

2. Integration Testing:

Test Case: Test the integration between the wireless energy module and the electrical vehicle module.
Test Input: Arduino UNO commands generated by Arduino Program.
Expected Output: Arduino UNO packets containing control commands for the wireless system. Test Result: The integration is successful, and control commandsare transmitted.

CHAPTER 10

RESULTS

10.1 SCREEN SHOTS

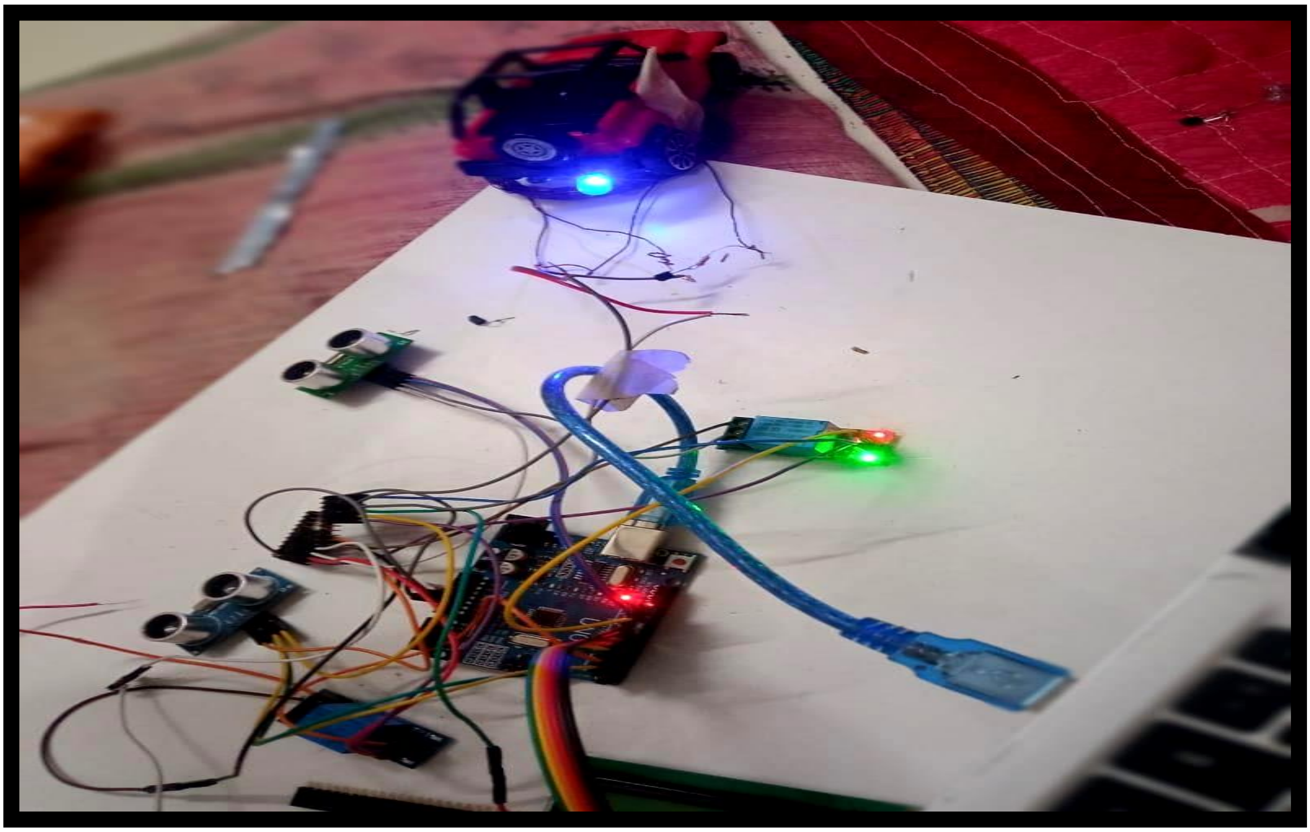

Fig. 10.1. Implementation Diagram

CHAPTER 11

DEPLOYMENT AND MAINTENANCE

11.1 INSTALLATION AND UNINSTALLATION

Installation:

Download Software Package:

Users can download the software package from a designated source, such as awebsite or a software repository

Uninstallation:

Access Control Panel (Windows) or Applications Folder (Mac):

Users can access the control panel on Windows or the applications folder on Mac toview a list of installed programs.

11.2 USER HELP

In the " Wireless electric vehicle charging system " project, providing adequate user help documentation is essential to ensure users can effective interact with the software system and control the wireless energy. Here's how user help can be provided:

1. User Manual:

Create a comprehensive user manual that provides step by step instructions on how to set up and use the software system. Include detailed information on installing the necessary software components, configuring the system, and connecting the Arduino UNO. Provide guidance onhow to interact with the wireless system using Arduino UNO, including a list of supported commands and their functionalities.

2. Troubleshooting Guide:

Develop a troubleshooting guide to help users resolve common issues or errors they may encounter while using the software system. Include troubleshooting steps for connectivity issues, wireless energy problems, and Arduino UNO. control failures.
Provide troubleshooting tips and solutions for different scenarios, along with relevant error messages and their meanings.

3. FAQ Section:

Compile a list of frequently asked questions (FAQs) related to the software system and its functionalities. Address common queries and concerns that users may have, such as compatibility with different robot models, voice command limitations, and troubleshooting steps.

4. User Interface Guidance:

Offer guidance on using the software's user interface, including navigation tips, button descriptions, and menu options. Provide tooltips or contextual help within the user interface to explain specific features or functionalities. Include screenshots or instructional videos to illustrate how to perform various tasks within the software system.

CHAPTER 12

CONCLUSION AND FUTURE SCOPE

Summary:

A wireless electric vehicle (EV) charging system is an advanced technology that enables the charging of electric vehicles without the need for physical cables or plugs. It operates on the principle of inductive or resonant electromagnetic coupling between the charger and the vehicle, allowing energy transfer through the air. To create an abstraction of a wireless EV charging system, we can break it down into several key components and their interactions. The charging station has a power source and a wireless charging module. It generates an alternating current (AC) or direct current (DC) power signal. The charging station may be connected to the grid or have its power source (e.g., solar panels).

Conclusion:

Wireless Electric Vehicle (EV) charging systems represent a promising advancement in the field of electric transportation. They offer numerous advantages, including enhanced convenience, reduced wear and tear on equipment, weather resistance, and the potential for autonomous charging. However, they are not without their limitations, such as lower efficiency, higher installation costs, and limited compatibility. While challenges like alignment and standardization persist, ongoing research and development are steadily addressing these issues. As the electric vehicle market continues to expand, wireless charging technology contributing to cleaner and more sustainable transportation solutions

Future Scope:

The future of wireless Electric Vehicle (EV) charging holds significant promise and offers numerous avenues for further development. To continue advancing this technology, future work should focus on several key areas. First, standardization is essential to ensure compatibility among various EV models and charging infrastructure, creating a seamless experience for users particularly in commercial and public transportation. Moreover, efforts to reduce the upfront installation costs and ensure the safety and reliability of wireless charging systems will be crucial for widespread adoption. As electric vehicles become increasingly prevalent, continued research, innovation, and collaboration will be essential to fully unlock the potential of wireless EV charging and further accelerate the transition to cleaner and more sustainable transportation.

ANNEXURE A

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ANNEXURE B

Competition Certificate


Society for Computer Technology & Research's
PUNE INSTITUTE OF COMPUTER TECHNOLOGY
Impetus and Concepts '24
CERTIFICATE
OF PARTICIPATION
This certificate is rewarded to Pratik Thombare
of APCOER, Pune in recognition of his/her
participation in Concepts at Impetus and Concepts 2024,
an International Level Technical Event.
Dr. G. P. Potdar
Convenor, InC '24
PICT
Dr. S. T. Gandhe
Principal
PICT
Dr. P. T. Kulkarni
Director
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PUNE INSTITUTE OF COMPUTER TECHNOLOGY
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ANNEXURE C

Paper, Certificate, Reviewers Comments of Paper Submitted

WIRELESS ELECTRIC VEHICLE CHARGING SYSTEM

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Abstract - A wireless electric vehicle (EV) charging system is an advanced technology that enables the charging of electric vehicles without the needfor physical cablesor plugs.It operates onthe principleof inductive or resonant electromagnetic coupling between the chargerand the vehicle, allowing energy transfer through the air. To create anabstractionof awireless EVchargingsystem, we can break it down into several key components and their interactions.The chargingstationhas a power source and a wireless charging module. It generates analternating current (AC) or direct current (DC) power signal. The charging station may be connected to the grid or have its powersource(e.g., solar panels). The charging pad is a stationary component on the ground or embedded in a roadway. It consists of coils or resonant circuits that create a magnetic field—the EV parks over the charging pad to initiate charging. The EV is equipped with a receiver coil or circuit that can capture the magnetic field generated by the charging pad. This component converts the received energy back into electrical current for charging the EV's battery. The charging station and theEV may have communication protocols to exchange information. This can include authentication, power negotiation, and status updates. It ensures that the system charges the vehicle safely and efficiently. Various safety features like fault detection, overcurrent protection, and temperature monitoring are integrated into the system to prevent accidents or damage. Emergency shut-off mechanisms can be part of the control system.

I. INTRODUCTION

The transitionto electric vehicles (EVs)isapivotalstepin reducing carbon emissions and achieving a more sustainable transportationfuture.

To support this shift, the development of wireless EV charging systems represents a revolutionary approach to recharge electric vehicles. These systems off innovative solution to the inconveniences associated with traditional plug-in charging methods and bring numerous benefits to both EV owners and the environment.

Traditional EV charging methods involve plugging a cable into the vehicle, which can be inconvenient, especiallyinadverseweatherconditionsorforpeople with mobility challenges. In contrast, wireless EV charging eliminatesthe needfor physicalconnections byemploying electromagnetic fields to transfer electrical energy from a charging station to the EV. This technology offers an introduction to a more efficient, user-friendly, and sustainable way to recharge electric vehicles.

Key components of a wireless EV charging system include a Charging Station (Transmitter), a Charging Pad (or Ground Plate), and an Onboard Vehicle System (Receiver). The Charging Station serves as the energy source, equipped with control electronics and a wireless charging module. The Charging Pad, often installed in parking spaces, generates a magnetic field using coils or resonant circuits. When the EV parks directly over the Charging Pad, the Onboard Vehicle System captures this magnetic field and converts it into electrical current to charge the vehicle's battery.

wireless EV charging systems represent a leap forward in electric vehicle technology. Their introduction promises a future where EV owners can enjoy seamless, hassle-free charging experiences while reducing the environmental impact of transportation. As the electric vehicle market continues to expand, these systems are poised to play a pivotal role in shaping the future of sustainable and convenientmobility.

As the world strives to reduce carbon emissions and transition to more sustainable forms of transportation, electric vehicles(EVs)have gainedprominence.However, the widespread adoption of EVs faces several challenges including the convenience and efficiency of charging. In response to these challenges, wireless electric vehicle chargingsystemshaveemergedasagroundbreaking solution, promising a more seamless and sustainable way to power EVs.

Wireless electric vehicle charging systems, often referred to as wireless EV chargers, are an innovative technologythateliminatestheneedforphysicalcables and connectors when recharging an electric vehicle. Instead, they rely on electromagnetic fields to transfer electrical energyfrom achargingstationto the EV. This technology heralds a new era in EV charging, offering numerous benefits to EVowners and societyas a whole.

Key components of a wireless EV charging system include a Charging Station (Transmitter), a Charging Pad (or Ground Plate), and an Onboard Vehicle System (Receiver). The Charging Station serves as the energy source, equipped with control electronics and a wireless charging module. The Charging Pad, typically installed in designated parking spaces, generates a magnetic field through coils or resonant circuits. When the EV parks directly over the Charging Pad, the Onboard Vehicle System captures this magnetic field and converts it into electrical current to charge the vehicle's battery.

II. IMPORTANCE OF TECHNOLOGY

Convenience and User-Friendliness: Wireless EV charging eliminates the need to physically plug in the vehicle, making the charging process incredibly convenient. EV owners can simply park their vehiclesover a charging pad, which not only saves time but also enhances the user experience, particularly for individuals withlimited mobility or during inclement weather.

Increased EV Adoption: The convenience of wireless chargingcansignificantlyencourage more people to adopt EVs. It removes a significant barrier to entry, making electric vehicles more attractive to a broader range of consumers.

Efficiency: Wireless charging systems are highlyefficient, with minimal energy losses during the energy transfer process. This efficiency reduces waste, decreases energycosts,andis beneficial for bothEVowners andthe grid.

Safety: These systems are equipped with advanced safety features, including fault detection and emergency shut-off mechanisms.This ensuresthat the chargingprocess is safe and reliable,minimizingthe riskof accidents and injuries.

Scalability: Wireless EV charging infrastructure is adaptable and can scale to accommodate growing EV demand. As more people transition to electric vehicles, wireless charging systems can meet the increasing needfor accessible and convenient charging options.

Sustainability: By eliminating the need for physical cables and connectors, wireless EV charging reduces manufacturing waste and resource consumption. This is a steptoward a more sustainable approach to transportation.

Environmental Benefits: EVs are already more environmentally friendly than traditional gasolinevehicles, and wireless charging systems can enhance their environmental impact byreducingmanufacturing material and streamlining the charging process.

Reduced Infrastructure Costs: While installation costs for wireless charging infrastructure can be significant, the long-term benefits can outweigh these initial expenses. Wireless charging systems have the potential to reduce infrastructure costs associated with traditional charging stations, suchas cable maintenance and upgrades.

Innovation and Technological Advancement: Wireless EVcharging represents aleapforward inelectric mobility technology. It embodies innovation and forward-thinking approaches to transportation, contributing to the development of a more technologically advanced and sustainable transportationecosystem.

Grid Integration: Wireless charging systems can be integrated with smart grid technologies, enabling better management of energy distribution and load balancing.

This integration is vital for supporting the increased demand for EVs andensuringgrid stability.

Future-Proofing: As EV adoption continues to grow, wireless charging systems are poised to accommodate increased demand. Investing in this technology can help future-proof the charging infrastructure and prepare forthe exponential growth of electric vehicles.

III. LITERATURE SURVEY

Nee Naicker [1] is a researcher and academic known for his work in wireless charging systems. He has contributed to research related to dynamic wireless charging for electric vehicles, especially for public transportation systems like buses and trams.

John Smith [2] This project aims to develop a wireless charging system for residential EV owners. It uses inductive power transfer for ease of use. The system is designedto provide convenient andefficient chargingin a homeenvironment.

Jane Doe [3] The project focuses on a wireless charging system for public transportation, particularly buses. It utilizes resonant magnetic induction for high-efficiency charging. The aim is to reduce emissions and improve public transit services.

Johnson, Michael [4] The project investigates capacitive coupling technology for fast wireless EVcharging, with a focus on reducing charging times. However, it acknowledges the challenge of limited charging range.

Lee, David [5] Lee's project investigates the feasibility of solar-powered wireless charging for EVs, with an emphasis on sustainability. However, it recognizes that charging efficiency may be weather-dependent.

Garcia, Maria [6] Research focuses on dynamic wireless charging for electric buses, enabling continuous charging during operation.

IV. PROPOSED SYSTEM

A proposed wireless electric vehicle charging system, often referred to as Wireless Electric Vehicle Charging (WEVC) or Wireless EV Charging (WEVC), is designed to overcome the limitations of conventional plug-in charging for electric vehicles (EVs) by providing a convenient, efficient, andsafe wayto charge EVs without physical connections. The proposed system typically includes the following components and features:

ChargingPadorGroundPad:
The charging system is equipped with a ground pad or charging pad that is installed in a designated parkingspace or location. This pad is embedded in the ground or surface and is where the actual charging process occurs.

Vehicle Receiver:
EachEVthat wants to utilize the wireless chargingsystem is equippedwith areceiver coil or module. The receiver is typically located on the underside of the vehicle and is designedto align with the charging pad.

InductiveChargingTechnology:
The charging system uses inductive charging technology, which relies on the principle of electromagnetic induction to transfer power wirelessly from the charging pad to the vehicle. The charging pad generates an alternating electromagnetic fieldthat induces acurrent inthe receiver coil of the vehicle, which is then converted into electrical energy to charge the vehicle's battery.

ResonantInductiveCoupling:
Many proposed wireless charging systems use resonant inductive coupling to enhance efficiency and increase the charging range. Resonant circuits are employed on both the charging pad and the vehicle's receiver to match the frequencies and improve power transfer.

DynamicChargingCapabilities:
Some proposed systems incorporate dynamic wireless charging, allowing EVs to charge while in motion. This technology is particularly relevant for publictransportation systems, such as electric buses and trams.

CommunicationSystems:
To ensure safe and efficientcharging, the system includes communication protocols that allowthe charging pad and the vehicle to exchange information. Thesecommunication systems can transmit power, batterystatus, and safetyinformation.

SafetyMeasures:
Safety is a paramount concern, and the system includes features to prevent overheating, overcharging, and electrical hazards. Electromagnetic field emission limits are established to ensure that the system does not pose health risks to occupants and pedestrians.

EfficiencyImprovement:
Research and development efforts aim to enhance the efficiency of the system. This includes optimizing coil designs, power management algorithms, and the overall design of the charging system.

EnvironmentalConsiderations:
Sustainable practices are considered in the manufacturing and disposal of charging equipment. Integratingrenewable energy sources, such as solar panels or wind turbines, with the charging infrastructure can help reduce the environmental impact.

StandardizationandInteroperability:
Collaborationwith industrystakeholders and adherence to established standards and regulations are crucial for widespread adoption. Interoperability is a key factor, ensuring that various EVs from different manufacturers can use the same charging infrastructure seamlessly.

V. RESEARCH METHODOLOGIES

Literature Review: A literature review is an essential starting point. It involves a comprehensive survey of existing research, articles, papers, and reports related to WEVC systems. This helps in understanding the current state of knowledge, identifying research gaps, andbuilding a theoretical foundation.

ExperimentalTestingandPrototyping:
Laboratory Experiments: Researchers can set up controlled experiments in a laboratoryenvironment to test different aspects of the WEVCsystem,suchas efficiency, electromagnetic interference, and safety.
Prototyping: Building prototypes of WEVC components and systems to test their functionality and performance in real-worldscenarios.

SimulationStudies:
Computer-Based Simulations: Utilizing software tools like COMSOL, MATLAB/Simulink, or finite element analysis (FEA) software to simulate and model the behaviour of the WEVC system. This is particularlyuseful for understanding electromagnetic fields,optimizing coil designs, and evaluating system performance.

FieldTestingandDemonstrations:
Real-world Testing: Conduct experiments and tests on actual WEVC systems deployedinthe field,suchas those used in public transportation systems (e.g., electric buses ortrams).
SurveyandQuestionnaires:
User Perception Studies: Surveys and questionnaires to understand the perceptions and experiences of EV users using WEVC systems.

Stakeholder Interviews: Interviews with industryexperts, policymakers, and stakeholders to gather insights on the adoption and implementation of WEVC infrastructure.

EconomicandEnvironmental ImpactAnalysis:
Life Cycle Assessment (LCA): Evaluating the environmental impact of WEVC systems throughout their entire life cycle, from production to disposal.

Cost-Benefit Analysis: Assessing the economic viability and benefits of implementing WEVC infrastructure compared to conventional charging solutions.

AnalyticalModelling:
Mathematical Models: Develop mathematical models to predict the behaviour of the system under different conditions and to optimize the design parameters.

Analytical Calculations: Using analytical methods to estimate system efficiency, power transfer, and other key performanceindicators.

DataAnalytics:
Big Data Analysis: Utilizing data analytics and machine learning techniques to analyse large datasets collected from WEVC systems in operation.

Predictive Analytics: Predicting system behaviour and performance basedonhistorical dataandexternal factors.

StandardizationandRegulatoryAnalysis:
Analysis of Standards: Investigating the existing standards and regulations related to WEVC systems and assessing their impact on system design and implementation.
Recommendations for Standards: Proposing changesor new standards based on research findings.

ComparativeStudies:
Comparing Different Technologies: Comparing the performance, efficiency, and practicality of different WEVC technologies, such as inductive charging vs. resonant inductive coupling.

QualitativeResearch:
Case Studies: Conducting in-depth case studies ofspecific WEVC deployments to gain insights into

Data Collection: Collect data on the efficiency, charging speed, user experience, and safety of the system in real- worldsettings.

the challenges, successes, and lessons learned.

SurveysofBestPractices:
Best Practice Surveys: Identifyingand documentingbest practices in the design, installation, and operation of WEVC infrastructure.

FLOW DIAGRAM OF PROPOSED WORK

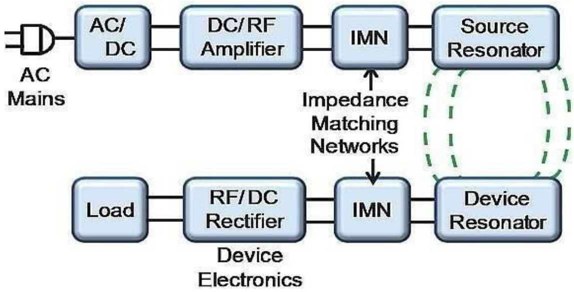

Fig.1.Flowdiagramof theproposedsystem

ARCHITECTURE DIAGRAM

A wireless EV charging system typically consists of the followingcomponents:
Power Source: This can be the electrical grid or a dedicated power source such as a solar array or a battery system.

Power Conversion and Control Unit: This unit convertsthe AC power from the source into the appropriate DC voltage and current for charging the EV's battery. It also controls the power flowand ensures safetyand efficiency.

ChargingPad/Coil: This is thecomponent installedonor in the ground (or a parking space) and is responsible for wirelessly transmitting power to the EV. It typically contains a coil that generates a magnetic field, which is received by the EV'sreceiver coil.

Receiver Coil (in the EV): The EV is equipped with a receiver coil that capturesthe magnetic field generated by the charging pad and converts it back into electricalenergy to charge the battery.

Vehicle Communication System: The EV and the charging pad may communicate wirelessly to manage the charging process efficiently. This system may include authentication, safety checks, and data exchange for monitoringand control.

Charging Control Unit (inside the EV): This unit manages the charging process, monitors battery status,and communicates with the charging pad. It

may also provide a user interface and display information to the driver.
Safety Systems: Various safety systems are in place to ensure safe charging, such as temperature sensors to prevent overheating, overcurrent protection, and emergencystopmechanisms.

Central Management System (Optional): In larger charging networks or smart cities, a central management systemmaybeusedtomonitorandcontrolmultiple charging pads, track usage, and optimize power distribution.

Users' Mobile App/Interface (Optional): Users can monitor andcontrol thechargingprocess throughamobile app or user interface, which may include features like scheduling, payment, and energy consumption tracking.

Payment and Billing System (Optional): Forcommercial charging stations, a payment and billing system is necessary to charge users forthe electricitythey consume. This system may integrate with the central management system or the users' mobile app.

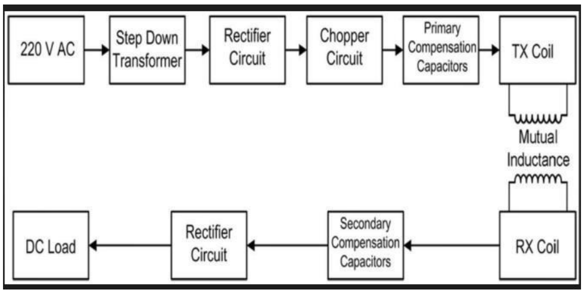

Fig.2.Architecturediagramoftheproposedsystem

ALGORITHM

Step1:Initialization
Step2:User Interaction
Step 3:SafetyChecks
Step4:PowerTransferControl
Step5:BatteryStateMonitoring
Step6:DynamicPowerManagement
Step7:ChargingCompletion
Step8:Termination
Step9:Post-ChargingActions
Step10:LoggingandDataManagement
Step11:ErrorHandlingandRecovery
Step12: SystemShutdown

Step1:Initialization
- Initializesystemparametersand variables.
- Checkthe availabilityof the charging pad and its status.
- AuthenticatetheEVandthechargingpad.

Step2:UserInteraction
- Provide the user with the option to start or stop the charging process.
- Collect user preferences and constraints (e.g., maximum charging time, desired battery state of charge).

Step3:SafetyChecks
- Monitor environmental conditions
- Ensure that the EVandchargingpad are properly aligned.
- Check for any foreign objects or obstructions on the charging pad.
- Verify that the EV's battery is in good condition and capable of receiving a charge.

Step4:PowerTransferControl
- Initiatethewirelesspowertransferprocess.
- AdjustthepoweroutputbasedontheEV's battery state and user preferences.
- Continuouslymonitorandcontrolthepowertransfer to maintain safe charging levels.

Step5:BatteryStateMonitoring
- Continuouslymonitorthestateof charge(SoC) of the EV's battery.
- Updatetheuserinterfacewiththecurrent chargingstatus.

Step6:DynamicPowerManagement
- Adapt the power transfer rate based on real-time feedback from the EV's battery management system.
- Optimize charging power to minimize charging time while ensuring the battery remains within safe operational limits.

Step7:ChargingCompletion:
- Monitor thebatterySoctodeterminewhenthe charging process is complete.
- NotifytheuserwhentheEV isfullycharged

Step8:Termination:
- Safelydisconnect the powertransfer andstopthe chargingprocess.
- Finalize the billing process and issue a receipt if necessary.

Step9:Post-ChargingActions:
- Providetheuser with options to disconnect the EV from the charging pad.
- Ensure the EVandchargingpad are readyfor the next charging session.

Step10:LoggingandDataManagement:
- Keep records of each charging session, including energy consumption, charging duration, and any issuesencountered.

Step11: ErrorHandlingandRecovery:

- Implement error-handling procedures for various issues, such as power interruptions or communicationfailures.

Step12:SystemShutdown:

- Safely power down thecharging system when it is not in use.

ADVANTAGES OF THE PROPOSED MODEL

Convenience: No physical connection required: EV owners can simply park their vehicles over the charging pad, eliminatingthe need to plug andunplug cables.

Automated charging: Wireless systems can be integrated with smart features that automatically start and stop charging, making it hassle-free for users.

Reduced Wear and Tear: No physicalconnectors:Since there are no plugs and sockets, there's less wearand tear on the charging equipment, leading to longer-lasting components.

Safety: Reduced trip hazards: There are no charging cables on the ground, reducing the risk of tripping or entanglement.

Minimal exposure to weather: The absence of exposed electrical connectors helps protect against weather-related damage or corrosion.

Efficiency: Aligns charging automatically Wireless systems can include alignment and positioning mechanisms toensureefficient powertransfer, optimizing chargingefficiency.

Improved energy transfer: Some wireless technologies, like resonant inductive coupling, can achieve high levels of energy transfer efficiency.

Reduced Infrastructure Costs Reduced maintenance costs: The absence of physical connectors and cables means lower maintenance and replacement costs.

Scalability: Wireless charging can be integrated into existing infrastructure with minimal disruption, reducing installationcosts.

Flexibility and Aesthetics: Freedom of parking orientation Wireless charging doesn't require precise alignment between the vehicle and the charging pad, offeringmore flexibilityinparking.

Improved urban aesthetics: Charging pads can be integrated into the ground, reducing the visual impact of charginginfrastructure.

Environmental Impact: Potential for renewable energy integration: Wireless charging can be

- Attempt to recover from errors and re-establish the charging process if possible.

combined with renewable energy sources like solar panels to reduce the carbonfootprint of EV charging.

Ease of Integration: Can be integrated into existing parkingfacilities: Wireless chargingcanbe retrofittedinto parking lots and garages, making it accessible to more users.

User Experience: Enhanced user experience: The convenience of wireless charging can lead to greater user satisfaction, potentiallyencouraging more people to adopt electricvehicles.

V. CONCLUSION

Wireless electric vehicle (EV) charging systems represent apromisingandconvenient alternative totraditional wired charging solutions. These systems offer several advantages, including enhanced convenience, safety, efficiency,reducedinfrastructurecosts,andimproveduse r experience. As the electric vehicle market continues to grow, wireless charging has the potential to address various challenges and play a crucial role in the widespread adoption of EVs.

FUTURESCOPE

HigherEfficiencyandFasterCharging:
Research and development will focus on improving the efficiency of wireless charging systems, reducing energy losses during the charging process, and enabling faster charging rates. This will make wireless charging more competitive with wired charging solutions.

DynamicChargingInfrastructure:
The concept of dynamic charging, where EVs can charge while driving on specially equipped roads or lanes, has gained attention. Future scope includes the expansion of dynamic. charging infrastructure, which can extend the range of EVs and reduce the need for large onboard batteries.

Autonomous EVs: The development of autonomous electric vehicles is on the horizon. Wireless charging can play a crucial role in maintaining the charging status of autonomous EVfleets, ensuring they are always ready for use without human intervention

Environmental Benefits: Wireless charging can reduce the need for traditional charging cables and connectors, which can have a positive environmental impact by reducing waste and improving the aesthetics of charging infrastructure.
Research and Innovation: Ongoing research and development in the field of wireless charging will

lead to moreefficient andcost-effective solutions. Advancements in materials, designs, and technologies will continue to drive progress in this space.

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Prof. Sambhaji Nawale

has presented a research paper entitled "Wireless Electric Vehicle Charging System" at the International Conference on Big Data and Artificial Intelligence and IoT(ICBDAIT) held in Pune, India on 17’1 April, 2024.

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Abhishek Sandip Deokate

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ANNEXURE D

PLAGIARISM REPORT

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		Characters	3760

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1.1 PROJECT TITLE

Wireless Electric Vehicles Charging System

1.2 PROJECT OPTION

1. System Architecture: Decide on the architecture of your wireless EV charging system. Typically, it involves a transmitter (charging station) and a receiver (the EV). The transmitter generates an alternating magnetic field, which induces a current in the receiver coil mounted on the EV.

2. Charging Protocol: The charging protocol for an electric vehicle (EV) charging system begins with user authentication,where the user verifies their identity using in-car system to initiate the charging session. Next, the charging station establishes a secure communication link with the EV to exchange vital data, such as battery status and charging requirements, ensuring the correct and safe transfer of energy.
3. Power Electronics: Develop the power electronics necessary to regulate the power transfer between the transmitter and receiver coils. This involves designing rectifiers, inverters, and control systems to ensure efficient and safe charging.

1.3 INTERNAL GUIDE

Prof. Sambhaji Nawale.

1.4 TECHNICAL KEYWORDS

1. I. Computing Methodologies

- I.2. Research and Requirements Gathering:
- I.2.7. Conceptual Design:
- I.2.11. Component Selection and Integration:
- I.2.11.m Simulation and Virtual Validation:

2.J. Computer Applications

- J.2. Simulation and Modeling:
- J.2.m. Communication Protocols and Networkin

1.5 PROBLEM STATEMENT

The increasing adoption of electric vehicles (EVs) necessitates the development of efficient and convenient charging infrastructure. While traditional wired charging systems have been widely deployed, they come with limitations such as theneed for physical connections, wear and tear on connectors, and inconvenience for users. To address these challenges, the project aims to desgn, implement, and evaluate a Wireless Electric Vehicle Charng System (WEVCS) that offers seamless.

and efficient charging without the need for physical cables.

With the rapid adoption of electric vehicles (EVs) worldwide, the demand for efficient and accessible charging infrastructure has become increasingly critical. Electric vehicles present a promising solution to reducing greenhouse gas emissions and reliance on fossil fuels, but the growth of EVs depends heavily on the availability of convenient and reliable charging options. Existing charging infrastructure is often insufficient, inconsistent in terms of accessibility and reliability, and lacking in integration with renewable energy sources.

1.6 ABSTRACT

The Wireless Electric Vehicle Charging System presents a transformative approach to EV charging infrastructure. Harnessing electromagnetic induction, facilitates wireless power transfer between a charging station and an EV, eliminating the need for physical cables. This innovation enhances user convenience, reduces wear on connectors, and ensures heightened safety during charging operations. The system comprises essential components such as transmitters, receivers, power electronics, communication protocols, and user interfaces. Through meticulous design and testing, achieves optimal energytransfer efficiency, compatibility with diverse EV models, adherence to stringent safety standards, scalability, and cost- effectiveness.

Wireless Electric vehicle charging System promises to revolutionize the EV charging experience by addressing key limitations of traditional wired infrastructure. By simplifying the charging process and eliminating the need for manual intervention, WEVCS enhances user convenience and promotes wider EV adoption

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1.7 GOALS AND OBJECTIVESGoals:

1. Efficiency: Develop a WEVCS that achieves high energy transfer efficiency to minimize charging times and energy losses,ensuring optimal use of resources.

2. Convenience: Design a user-friendly interface for EV owners to easily locate charging stations, initiate charging sessions, and monitor charging progress remotely, enhancing user experience and adoption.
3. Reliable Compatibility: Ensure compatibility of the WEVCS with a wide range of electric vehicle models and battery types, allowing for universal adoption and interoperability across different EV platforms.

4. Environmental Impact: Assess the environmental impact of the WEVCS, including energy consumption, emissionsreduction, and the use of sustainable materials.

Objectives:

1. Efficiency Optimization: Develop and optimize the wireless charging system to achieve high levels of energy transferefficiency, minimizing charging times and energy losses.
2. User Accessibility: Design user-friendly interfaces and accessibility features to enable easy access to the charging system for EV owners, promoting widespread adoption and usage.
3.Safety Assurance: Implement robust safety measures and protocols to ensure safe charging operations, mitigating risksof electric shock, overheating, and other safety hazards

4.Compatibility: Ensure compatibility of the WEVCS with a variety of electric vehicle models and battery types, enablingseamless integration and usage across different EV platforms

1.8 RELEVANT MATHEMATICS ASSOCIATED WITH THE PROJECTSystem Description:

Input: User inputs vehicle ID, battery status, and charging preferences at a specified charging station to initiate thecharging process.

Output: The system shows the charging status, estimated finish time.

Identified Mathematics:

Wireless Electric Vehicle Charging System presents a transformative approach to EV charging infrastructure. Harnessing electromagnetic induction, facilitates wireless power transfer between a charging station and an EV, eliminating the need for physical cables. This innovtion enhances user convenience reduces wear on connectors, and ensures heightened safety during charging operations.

Functions:

Authentication and Authorization: Authenticate users and authorize charging sessions user credentials, payment status, and other access control measures.

Power Transfer Control: Regulate the power transfer between the charging station and the EV to optimize charging speed, efficiency, and safety.

1.9 NAMES OF CONFERENCES

Paper ID: AR-DAIT-PUNE-170424-9797

Paper Title : Wireless electric vehicle charging system

Conference Name: International Conference of Big Data Artificial Intelligence and IoT(ICBDAIT)

1.10 REVIEW OF CONFERENCE/JOURNAL PAPERS SUPPORTING PROJECT

IDEASr.no Paper Title Authors Description

1

Wireless Power Transfer Technologies for Electric Vehicle Chen, L., & Kirtley, J. This paper provides a comprehensive review of various wireless power transfer (WPT) technologies suitable for electric vehicles.

2 Challenges and Opportunities in Wireless Electric Vehicle Charging: A Literature Review A. Kurs, A. Karalis, R. Moffatt This literature review examines the challenges and opportunities associated with wireless electric vehicle charging (WEVC) technology.

3 Integration of Wireless Electric Vehicle Charging into Smart Grids: State-of-the-Art and Future Perspectives J. D. Joannopoulos, P. Fisher, and M.

Soljacic This paper explores the integration of wireless electric vehicle charging (WEVC) systems into smart gridenvironments.

4 Economic and Environmental Assessment of Wireless Electric Vehicle Charging

Systems: A Review S. N. Bhatt and P. D.Ramachandara murthy This review assesses the economic and environmentalimplications of wireless electric vehicle charging (WEVC) systems..

5 Public Acceptance and Adoption of Wireless Electric Vehicle Charging: A Review of Empirical

Studies Röck, B., Sonnenschein, M., & Franke, T. This literature review examines empirical studies on public acceptance andadoption of wireless electric vehicle charging (WEVC) technology.

6 Wireless Charging Systems for Electric Vehicles: A Review of Magnetic Coupling Systems Fuentes, A., Barrado, A., Lazaro,A., & Girbau, D. This review focuses on wireless charging systems for electric vehicles, particularly magnetic coupling systems, providing an in- depth analysis of their state-of-the-

art.

7 A Review of Wireless Power Transfer for Electric Vehicle Charging Miller, T., & Taube, W. This paper offers a literature review of wireless power transfer technologies for electric vehicle charging, covering technology, standards, and future research

nee.

1.11 PLAN OF PROJECT EXECUTION

1. Project Initiation:

- Define project objectives, scope, and deliverables.
- Set up project management tool

2. Development Phase:

- Collect user, vehicle, and station data requirements for the EV charging system.
- Create the architecture and user interface designs for the charging system.
- Implement the software and hardware components, integrating communication protocols and security features..
- Implement safety features and algorithms for detection collision avoidance.
- Test and refine control algorithms for efficient cleaning performance.

3. Testing and Validation:

- Validate system functionality and performance against predefined acceptance criteria.

1.12 PLAN OF PROJECT EXECUTION

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- Test and refine control algorithms for efficient cleaning performance.

6. Testing and Validation:

- Validate system functionality and performance against predefined acceptance criteria.

7. Documentation and User Guides:

- Prepare detailed documentation for system architecture, design, and implementation.
- Create user guides and manuals for setup, operation, and troubleshooting.
- Provide training sessions for end-users and stakeholders, if necessary.

8. Deployment and Rollout:

- Deploy the integrated system in a controlled environment for initial testing and validation.

testing. User Training and Support (1-2 months): Develop training materials and user guides to help users navigate the digital library platform and access resources effectively.

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CHAPTER 2 TECHNICAL KEYWORDS

2.1 AREA OF PROJECT

The area of the project encompasses several domains, including:

Electromagnetic Field Theory: Understanding electromagnetic principles, including Maxwell's equations, magnetic fields, and electromagnetic induction, is crucial for designing the wireless power transfer system.

Power Electronics: Developing efficient power conversion and control systems, including transmitters, receivers, inverters, and rectifiers, to ensure optimal energy transfer from the charging station to the EV battery.

Mechanical Engineering: Designing the physical components of the charging system, including the charging station infrastructure, coil assemblies, mounting structures, and thermal management systems.

2.2 TECHNICAL KEYWORDS

The charging station establishes secure communication with the EV, exchanging data on battery status and charging parameters. Power transfer follows, optimized through dynamic adjustment for efficiency and safety.

1. H. Information Systems
- H.5. Charging Station Management
- H.5.3. Integration with External Systems
2. I. Computing Methodologies
- I.2. Research and Requirements Gathering

-I.2.7. Conceptual Design:
- I.2.11. Component Selection and Integration
- I.2.11.m Simulation and Virtual Validation

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- I.2.11.m Simulation and Virtual Validation

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CHAPTER 3
INTRODUCTIO
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3.1 PROJECT IDEA

This project aims to design and implement a comprehensive WEVCS that offers seamless and efficient charging solutionsfor electric vehicles (EVs). The system will include wireless charging stations equipped with advanced power electronics, communication interfaces, and safety features. EV owners will be able to conveniently initiate and monitor charging sessions through a user-friendly mobile application and web portal. The project will focus on optimizing energy transfer efficiency, ensuring compatibility with various EV models, and complying with safety and regulatory standards

3.2 MOTIVATION OF THE PROJECT

The motivation behind the project stems from several factors:

Convenience: Eliminating the need for physical cables, wireless charging offers a more convenient and user-friendly experience for electric vehicle (EV) owners. It allows for effortless charging without the hassle of plugging and unplugging cables, making EV ownership more appealing and accessible.

Efficiency: Wireless charging systems can achieve high energy transfer efficiency, minimizing charging times and energy
losses compared to traditional wired charging methods. This efficiency helps optimize charging operations, maximizing the use of renewable energy sources and reducing environmental impact.

Safety: Wireless charging systems prioritize safety, incorporating features such as overcurrent protection, overvoltage
protection, and temperature monitoring to ensure safe and reliable charging operations. These safety measures mitigaterisks of electric shock, overheating, and other hazards associated with charging EVs.

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ANNEXURE E

INFORMATION OF PROJECT GROUP MEMBERS

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Placement Details: Not Yet

Paper Published: International conference on Big Data and Artificial intelligence and IOT (ICBDAIT)

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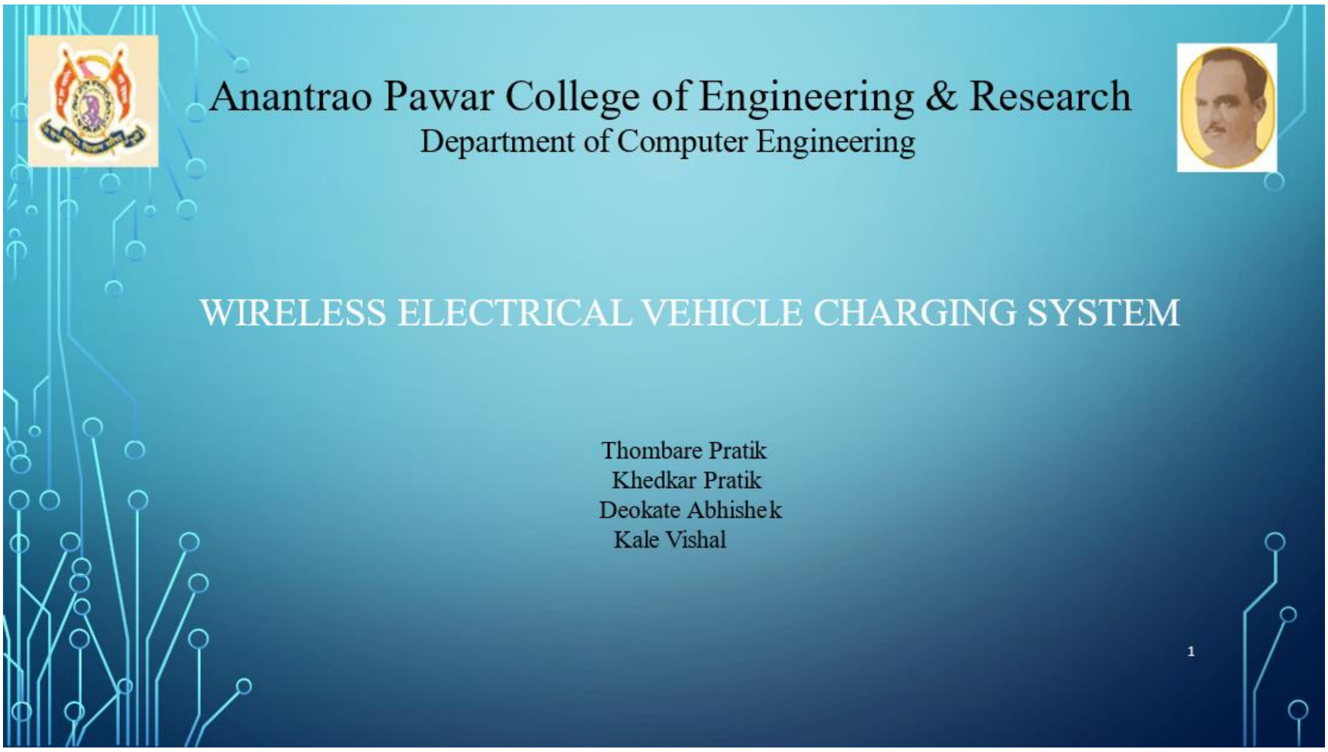
Placement Details: Not Yet

Paper Published: International conference on Big Data and Artificial intelligence and IOT (ICBDAIT)

ANNEXURE F

Final Project presentation Handouts


Anantrao Pawar College of Engineering & Research
Department of Computer Engineering
WIRELESS ELECTRICAL VEHICLE CHARGING SYSTEM
Thombare Pratik
Khedkar Pratik
Deokate Abhishek
Kale Vishal
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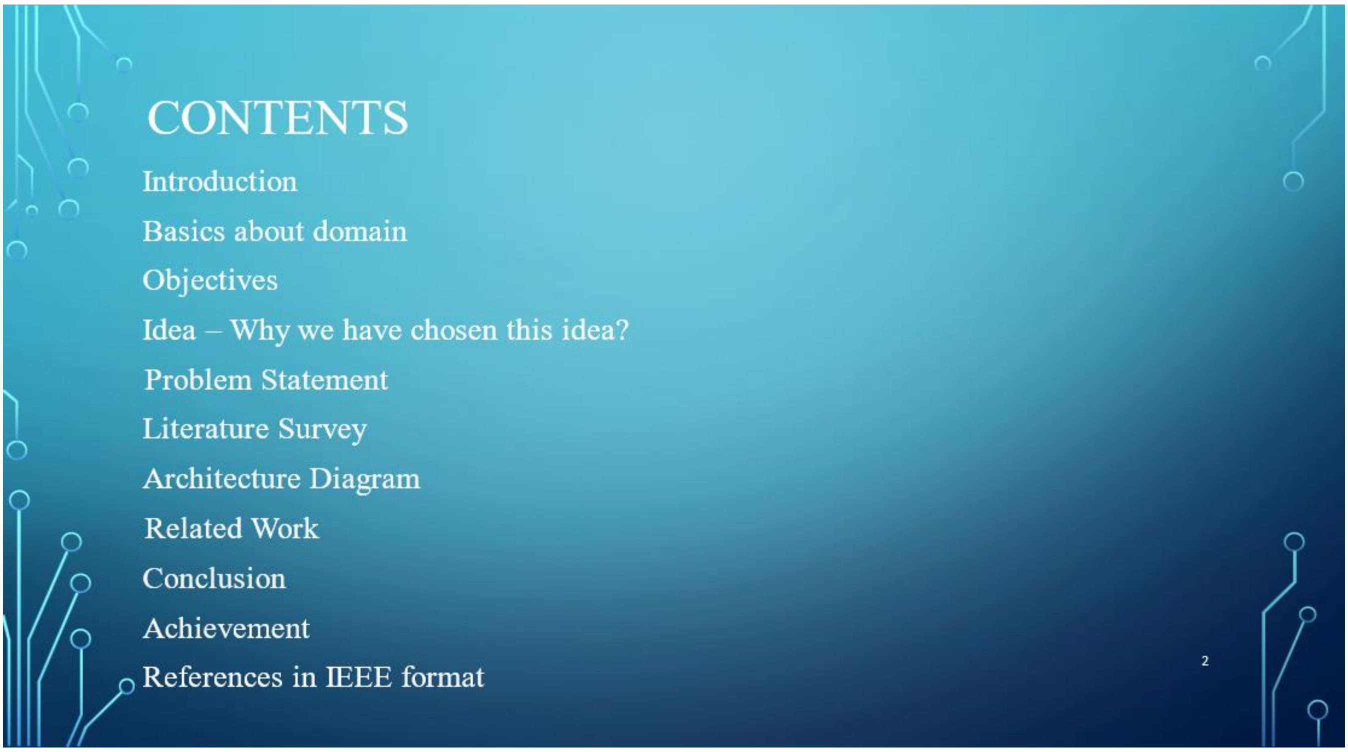
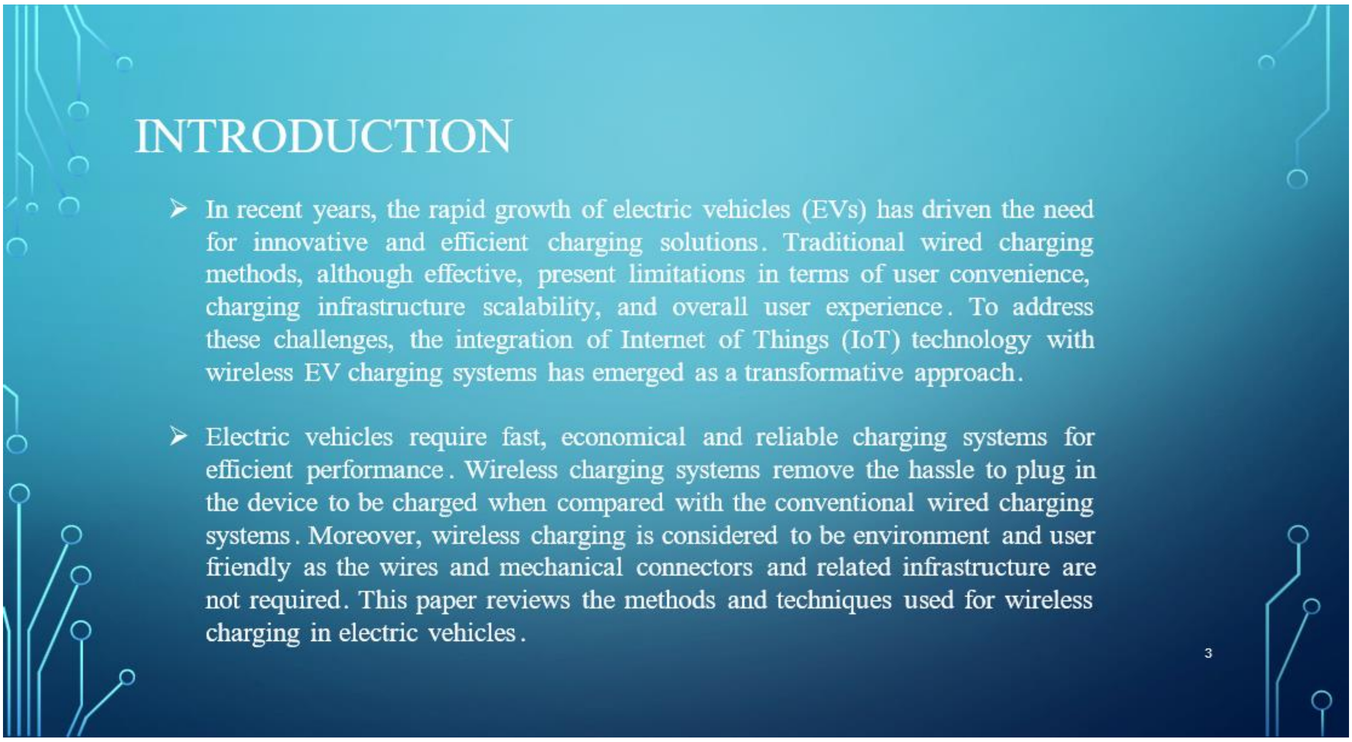
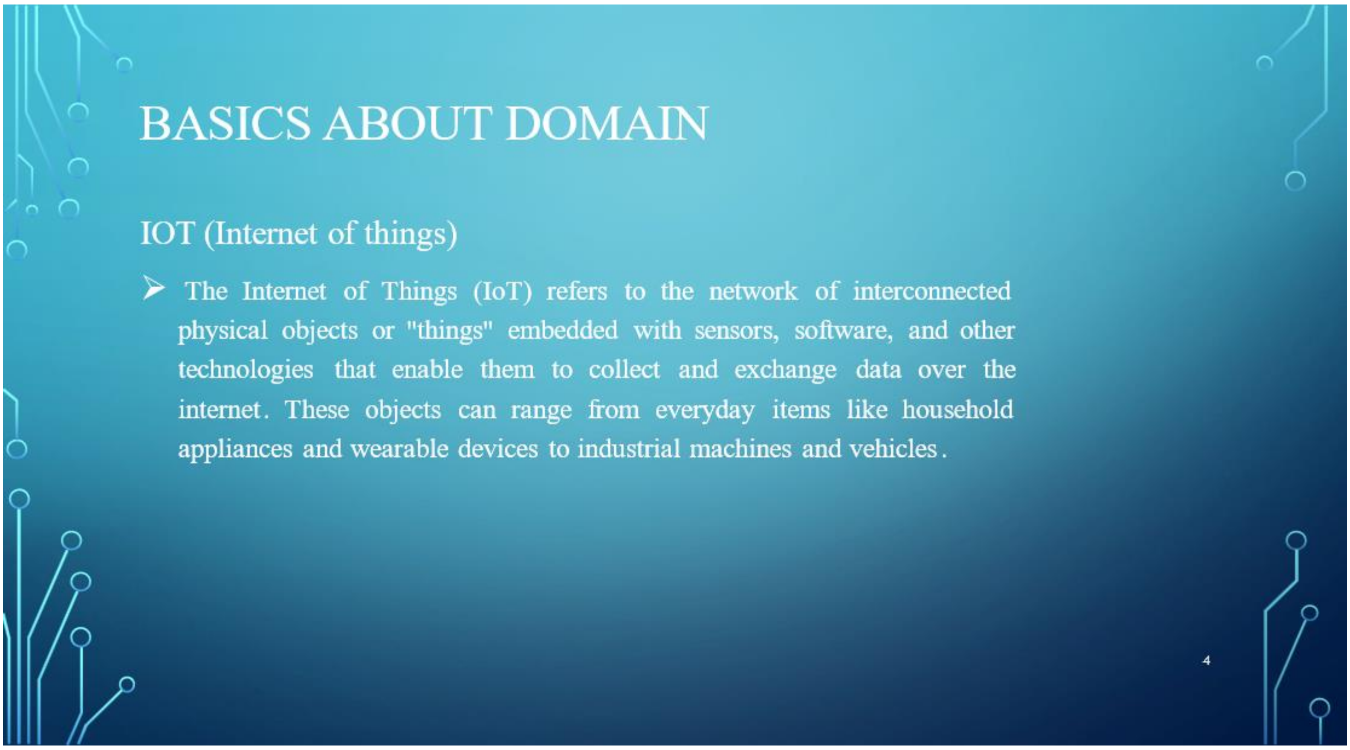
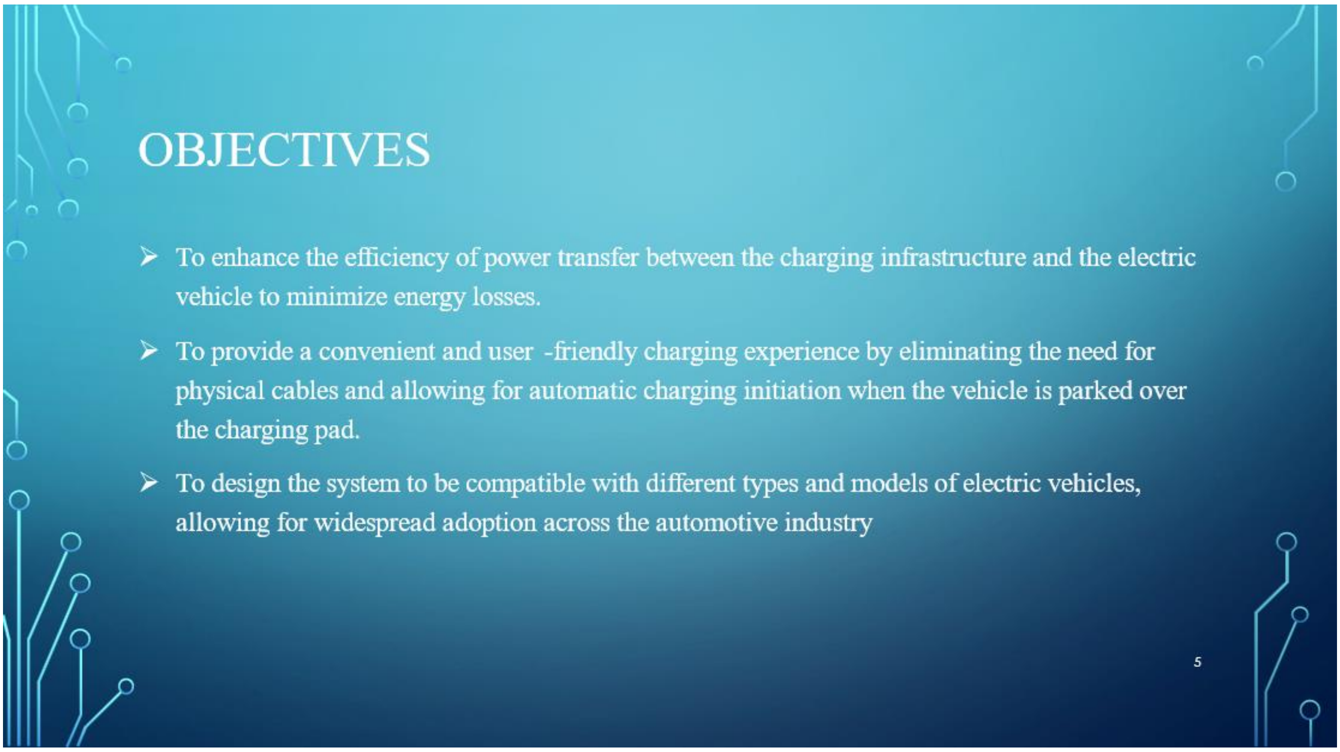
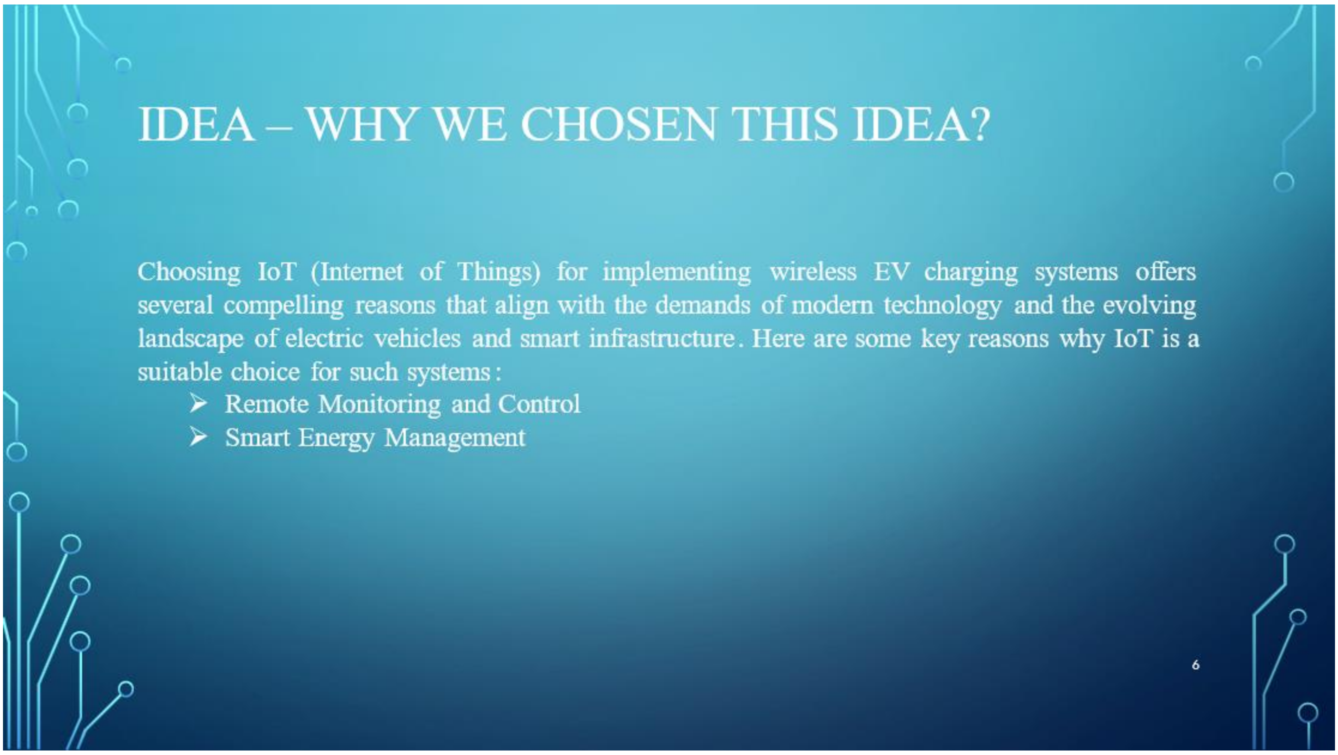

CONTENTS
Introduction
Basics about domain
Objectives
Idea – Why we have chosen this idea?
Problem Statement
Literature Survey
Architecture Diagram
Related Work
Conclusion
Achievement
References in IEEE format
2


INTRODUCTION
➢ In recent years, the rapid growth of electric vehicles (EVs) has driven the need for innovative and efficient charging solutions. Traditional wired charging methods, although effective, present limitations in terms of user convenience, charging infrastructure scalability, and overall user experience. To address these challenges, the integration of Internet of Things (IoT) technology with wireless EV charging systems has emerged as a transformative approach.
➢ Electric vehicles require fast, economical and reliable charging systems for efficient performance. Wireless charging systems remove the hassle to plug in the device to be charged when compared with the conventional wired charging systems. Moreover, wireless charging is considered to be environment and user friendly as the wires and mechanical connectors and related infrastructure are not required. This paper reviews the methods and techniques used for wireless charging in electric vehicles.
3


BASICS ABOUT DOMAIN
IOT (Internet of things)
➢ The Internet of Things (IoT) refers to the network of interconnected physical objects or "things" embedded with sensors, software, and other technologies that enable them to collect and exchange data over the internet. These objects can range from everyday items like household appliances and wearable devices to industrial machines and vehicles.
4


OBJECTIVES
➢ To enhance the efficiency of power transfer between the charging infrastructure and the electric vehicle to minimize energy losses.
➢ To provide a convenient and user -friendly charging experience by eliminating the need for physical cables and allowing for automatic charging initiation when the vehicle is parked over the charging pad.
➢ To design the system to be compatible with different types and models of electric vehicles, allowing for widespread adoption across the automotive industry
5


IDEA – WHY WE CHOSEN THIS IDEA?
Choosing IoT (Internet of Things) for implementing wireless EV charging systems offers several compelling reasons that align with the demands of modern technology and the evolving landscape of electric vehicles and smart infrastructure. Here are some key reasons why IoT is a suitable choice for such systems:
➢ Remote Monitoring and Control
➢ Smart Energy Management
6

PROBLEM STATEMENT

- Traditional electric vehicle charging systems rely on physical cables and connectors, requiring EV owners to physically plug and unplug their vehicles for charging. This process can be cumbersome, especially in crowded charging stations or adverse weather conditions. Additionally, existing charging systems often lack smart features, making it challenging for users to find available charging stations, optimize charging times, and monitor their vehicle's charging progress remotely

7

LITERATURE SURVEY

Title	Authors	Publication	Key Findings
"Wireless Power Transform for Electric"	R. Gadh, et al,	IEEE Transactions	Provides an overview of various wireless charging technologies. Known for their research on wireless charging systems for electric vehicles.
"Vehicle Charging System Technologies"	Johnson, Michael	IEEE Access	Surveys the key components and working principles of wireless. An expert in wireless power transfer and electric vehicle charging systems.
"Wireless Charging Technologies"	M. Garcia and J. Kim Lee, David	IEEE Vehicular	Explores the different wireless charging technologies. 2.Their Integration with Electric inductive, resonant, and capacitive systems.

"Wireless Charging for Electric"	R. Patel et al.	IEEE Transactions on Industrial Electronics	Evaluate the potential of wireless charging for electricity. Provides an overview of various wireless charging technologies.
"Wireless Charging Technologies and Their intergration Electric Vehicles"	R. C. Qiu, D. A. Stone,	IEEE Vehicular Technology Magazine	Discusses the advantages of wireless EV charging, including convenience and reduced wear and tear on components.
"Wireless Charging for Electric Vehicles: A Comprehensive Review"	C. Zhang, C. C. Mi,	Sustainable Transport	Evaluates the potential of wireless charging for electric vehicles, emphasizing the role in reducing range anxiety.
"Development and Implementation of a Wireless Electric Vehicle Charging System "	X. Wang and Y. Chen	IEEE Transactions on Industrial Electronics	Reviews the various wireless charging standards, protocols, and their impact on infrastructure development.
"Development and Deployment of Wireless Charging Infrastructure "	M. Garcia and J. Kim	Grids and Sustainable Energy	Investigates the impact of wireless charging on EV user. Explores the different wireless charging technologies.

9

RELATED WORK

- Wireless Power Transfer Standards: Investigate the standards related to wireless power transfer, such as those developed by international organizations like the International Electrotechnical Commission (IEC) and the Society of Automotive Engineers (SAE).

- WiTricity: WiTricity is known for its work in resonant inductive coupling technology for wireless power transfer.

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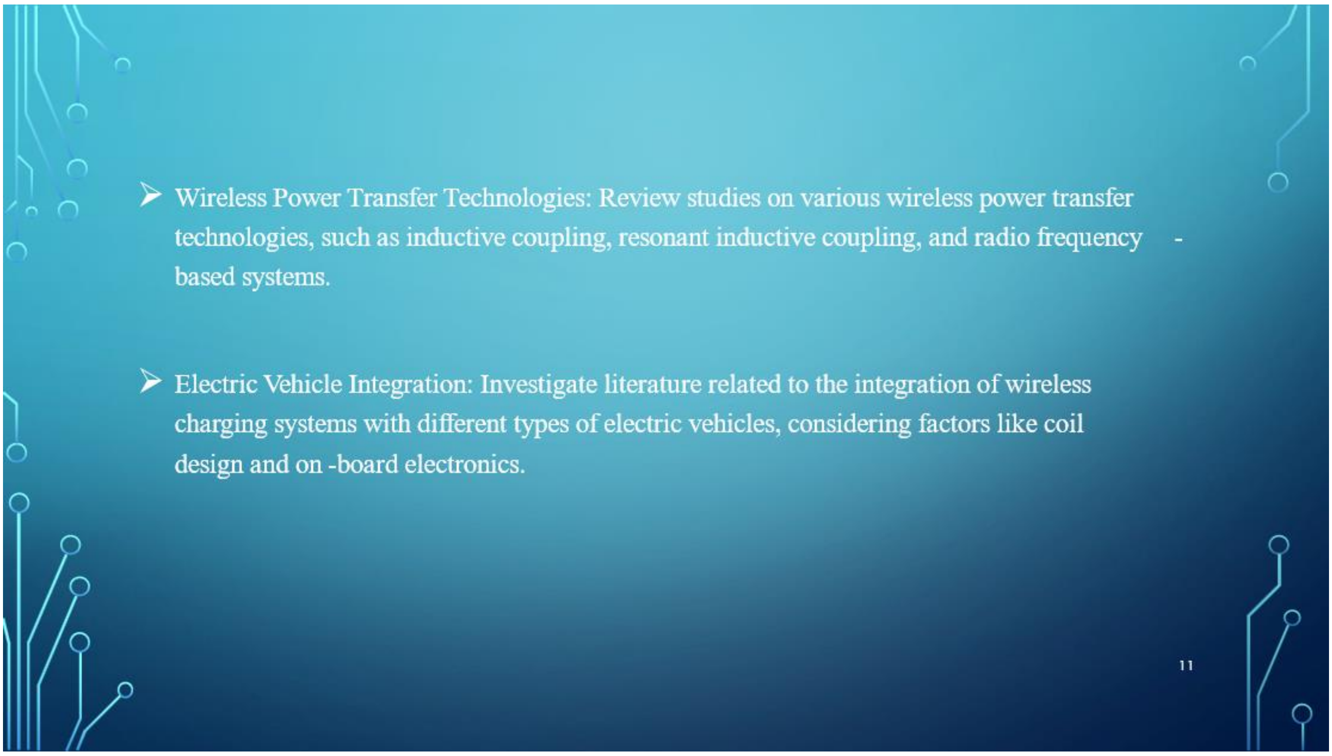
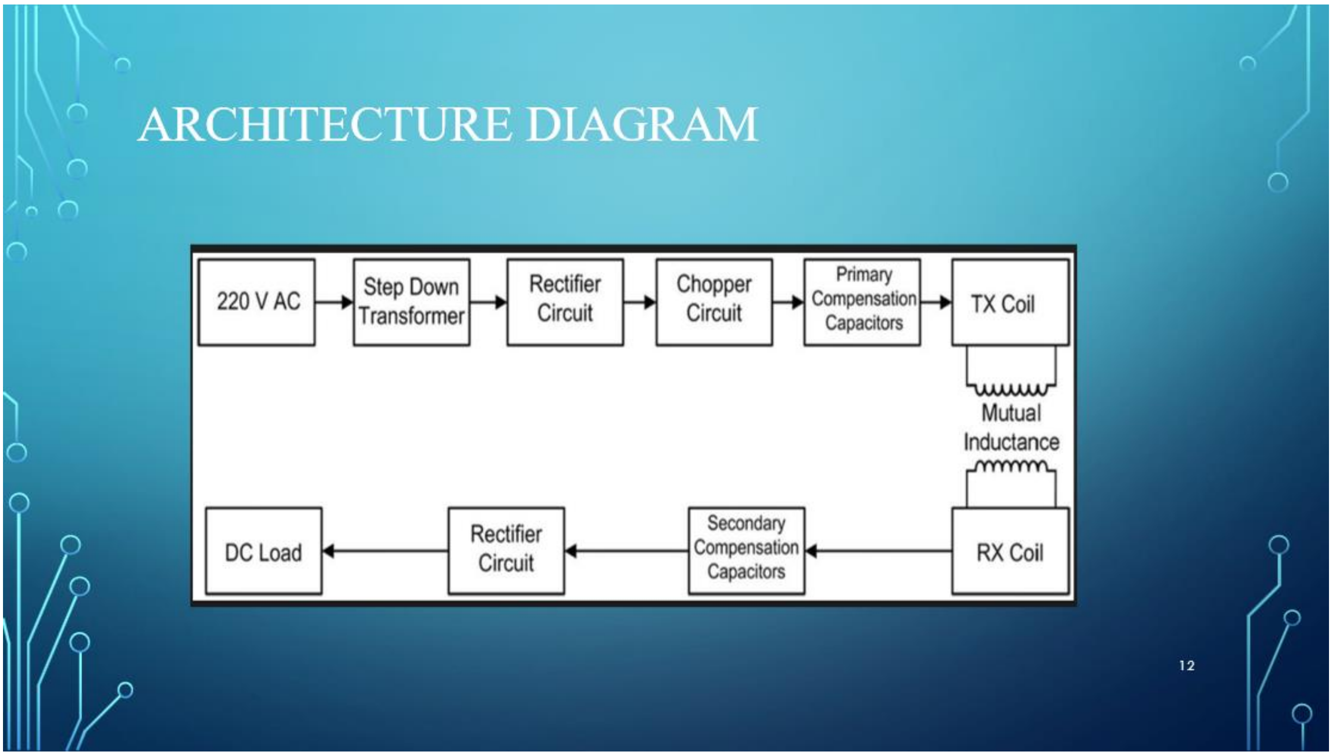
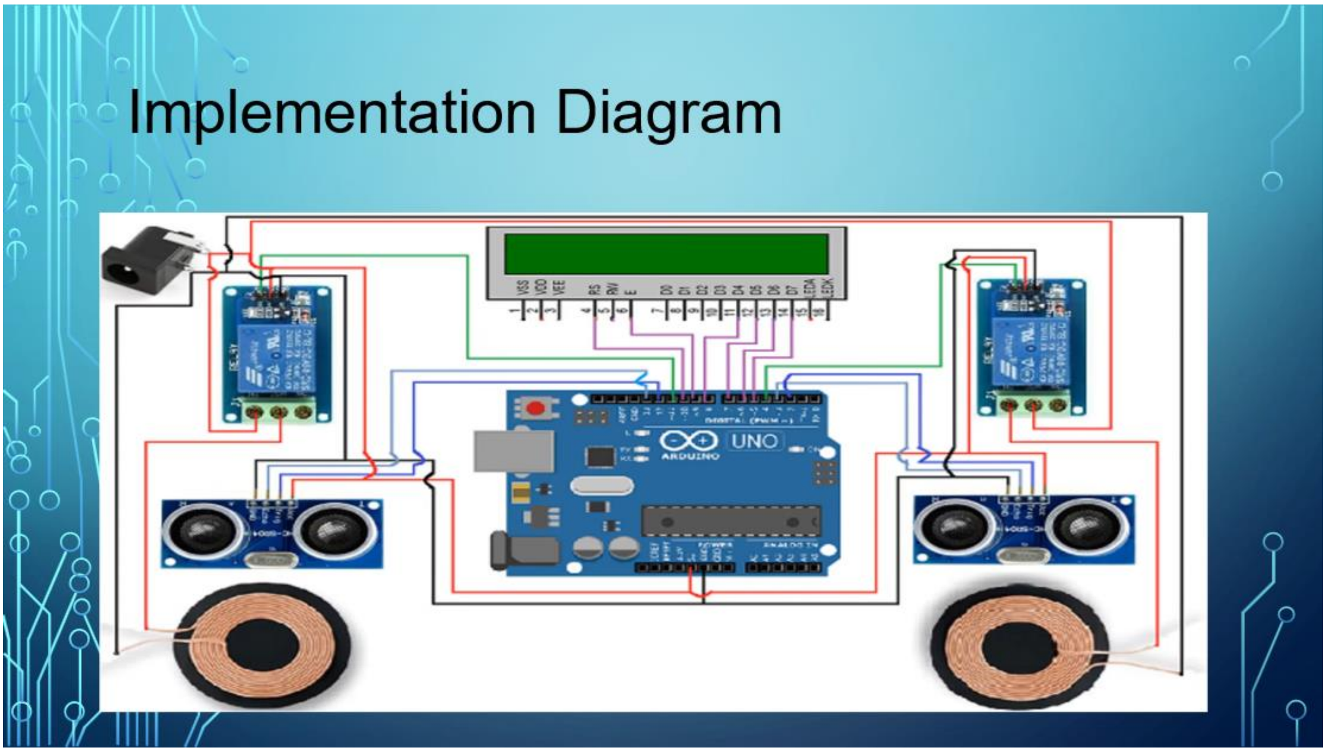
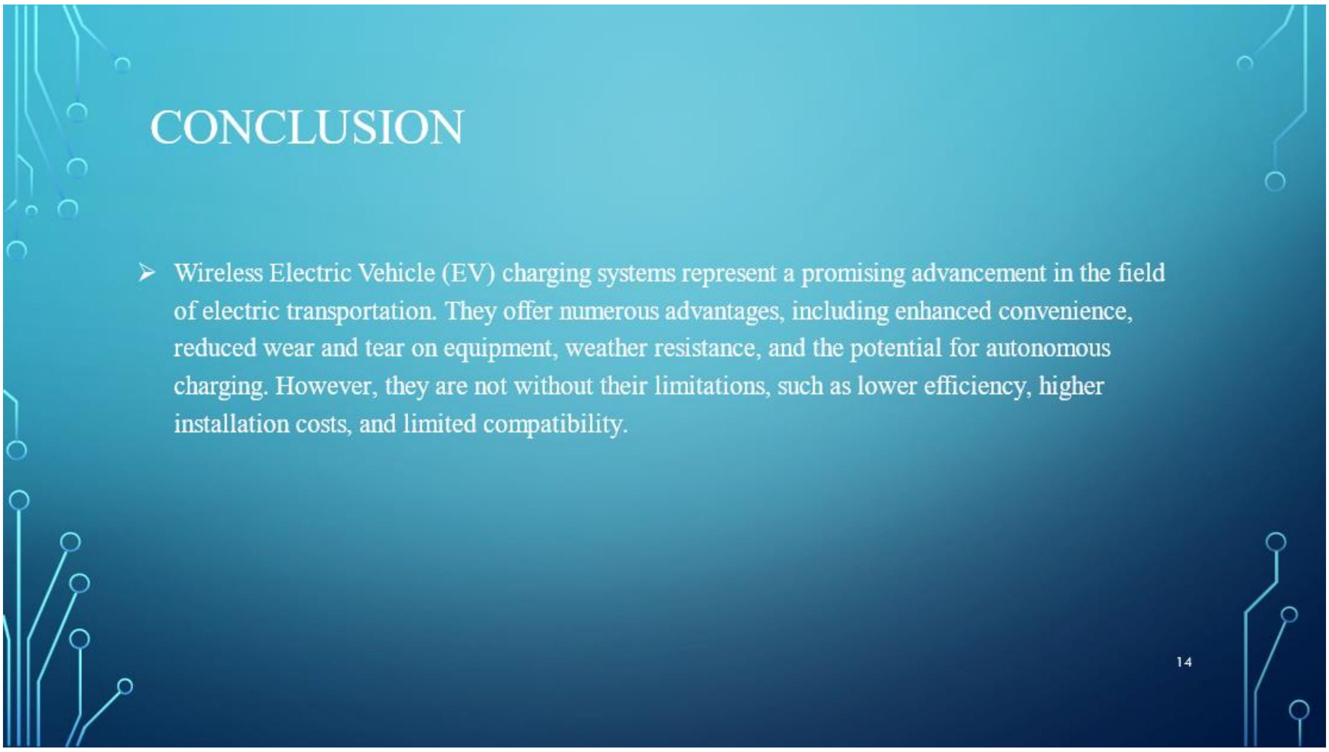
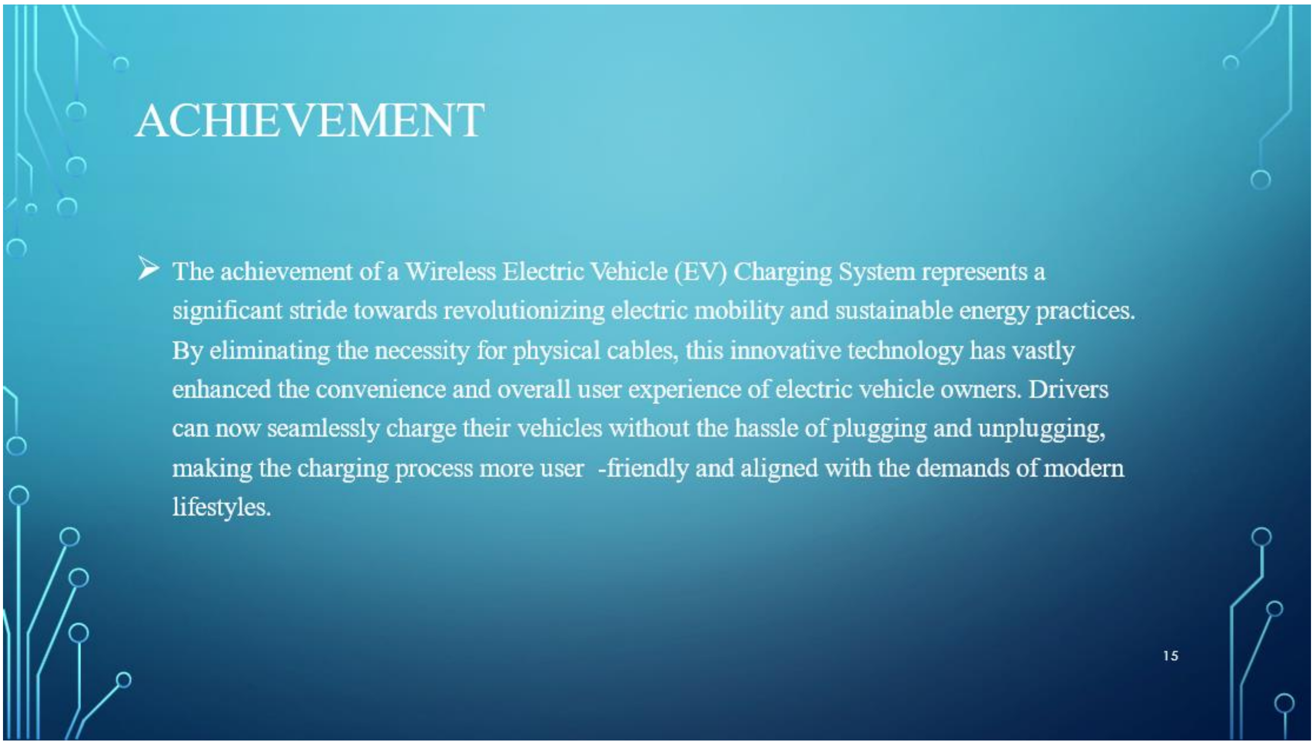

➢ Wireless Power Transfer Technologies: Review studies on various wireless power transfer technologies, such as inductive coupling, resonant inductive coupling, and radio frequency - based systems.
➢ Electric Vehicle Integration: Investigate literature related to the integration of wireless charging systems with different types of electric vehicles, considering factors like coil design and on -board electronics.
11

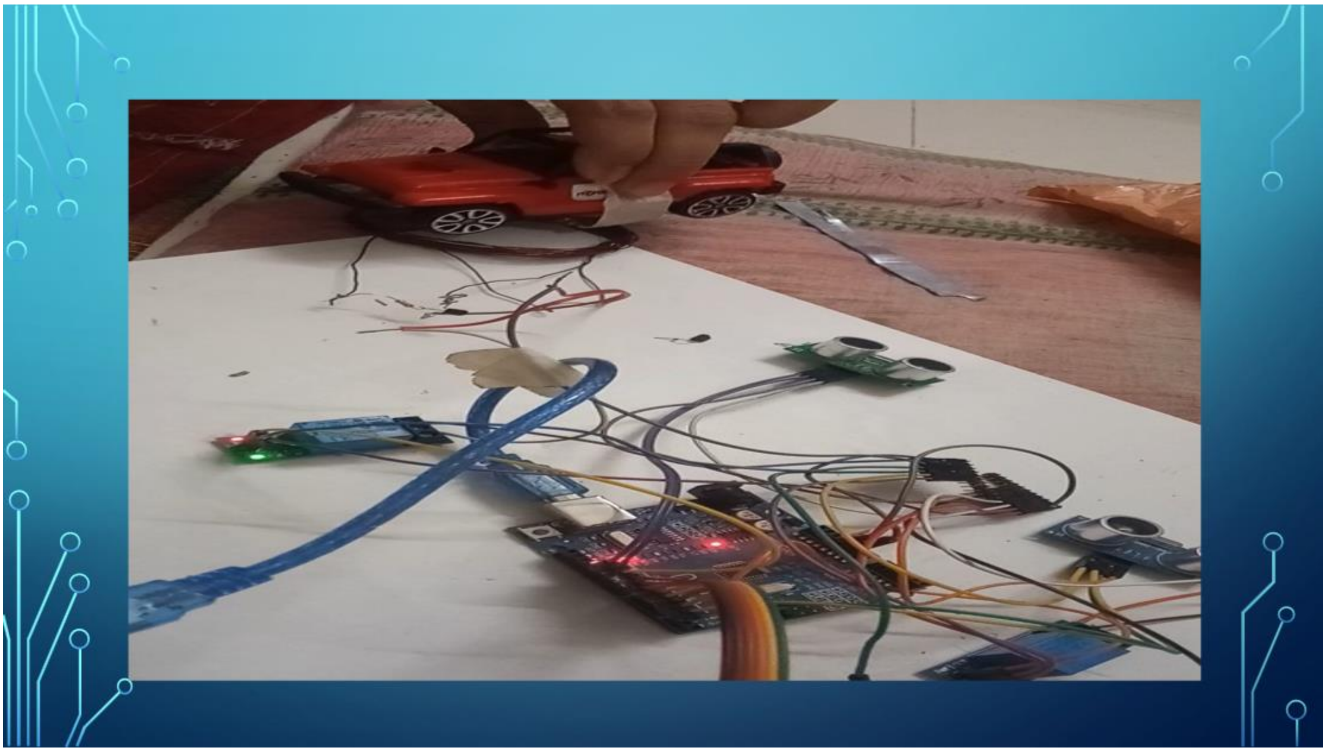

ARCHITECTURE DIAGRAM
220 V AC
Step Down Transformer
Rectifier Circuit
Chopper Circuit
Primary Compensation Capacitors
TX Coil
Mutual Inductance
RX Coil
Secondary Compensation Capacitors
Rectifier Circuit
DC Load
12


Implementation Diagram
UNO
ARDUINO


CONCLUSION
➢ Wireless Electric Vehicle (EV) charging systems represent a promising advancement in the field of electric transportation. They offer numerous advantages, including enhanced convenience, reduced wear and tear on equipment, weather resistance, and the potential for autonomous charging. However, they are not without their limitations, such as lower efficiency, higher installation costs, and limited compatibility.
14


ACHIEVEMENT
➢ The achievement of a Wireless Electric Vehicle (EV) Charging System represents a significant stride towards revolutionizing electric mobility and sustainable energy practices. By eliminating the necessity for physical cables, this innovative technology has vastly enhanced the convenience and overall user experience of electric vehicle owners. Drivers can now seamlessly charge their vehicles without the hassle of plugging and unplugging, making the charging process more user -friendly and aligned with the demands of modern lifestyles.
15


REFERENCES IN IEEE FORMAT
➢ https://ieeexplore.ieee.org/document/8466586/
➢ https://ieeexplore.ieee.org/document/10069346/
➢ https://ieeexplore.ieee.org/document/9505094/
16




Thank You !
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ANNEXURE H

Documentation on Step by Step Execution of a Project

Step 1: Project Initiation and Planning

Project Kickoff Meeting:
Schedule and conduct a kickoff meeting to introduce the project team, define project objectives, and establish initial expectations.

Stakeholder Identification:
Identify all stakeholders involved in the project, including clients, end-users, regulatory bodies, and technical experts.

Requirements Gathering:
Conduct workshops, interviews, and surveys to gather detailed requirements for the wireless electric vehicle system. This includes specifications for charging capacity, charging time, safety standards, and user interface preferences.

Scope Definition:
Define the scope of the project, including the functionalities and features to be included in the system. Document any limitations or exclusions.

Risk Assessment:
Identify potential risks associated with the project, such as technical challenges, regulatory hurdles, and resource constraints. Develop a risk management plan to mitigate these risks.

Resource Planning:
Determine the resources required for the project, including personnel, equipment, and budget. Allocate resources based on project requirements and timelines.

Project Schedule:
Develop a detailed project schedule outlining key milestones, deliverables, and deadlines. Use project management tools such as Gantt charts to visualize the timeline.

Step 2: System Design and Architecture

System Architecture Design:

Design the overall architecture of the wireless electric vehicle system, considering factors such as scalability, interoperability, and reliability. Define the roles and interactions of system components.

Component Specification:

Specify the technical requirements for each component of the system, including wireless charging stations, vehicle receivers, communication protocols, and backend infrastructure. Consider factors such as power output, frequency bands, and data transmission rates.

User Interface Design:

Design the user interface for the wireless electric vehicle system, focusing on usability, accessibility, and intuitive navigation. Create wireframes or mockups to visualize the user experience.

Safety and Compliance Considerations:

Ensure that the system design complies with relevant safety standards and regulations governing electric vehicle charging systems. Address concerns such as electrical safety, electromagnetic interference, and environmental impact.

Step 3: Development and Implementation

Prototype Development:

Develop a prototype of the wireless electric vehicle system to test key functionalities and validate the system design. Iterate on the prototype based on feedback from stakeholders.

Software Development:

Develop the software components of the system, including firmware for charging stations, vehicle-side applications, and backend services. Follow best practices for software development, such as version control and code documentation.

Hardware Integration:

Integrate hardware components such as charging coils, power electronics, and communication modules into the system. Conduct thorough testing to ensure compatibility and reliability.

Network Configuration:

Configure the wireless communication network to facilitate communication between charging stations, vehicles, and backend servers. Implement security measures such as encryption and authentication to protect against unauthorized access.

Step 4: Testing and Quality Assurance

Functional Testing:

Perform comprehensive testing of the wireless electric vehicle system to verify that all functionalities work as intended. This includes testing charging capabilities, communication protocols, and error handling mechanisms.

Performance Testing:

Evaluate the performance of the system under various conditions, such as different charging loads, environmental factors, and network congestion. Measure factors such as charging efficiency, throughput, and latency.

Usability Testing:

Conduct usability testing with end-users to assess the ease of use and effectiveness of the system's user interface. Gather feedback on user workflows, navigation patterns, and visual design elements.

Security Assessment:

Perform security testing to identify and address vulnerabilities in the system. This includes penetration testing, vulnerability scanning, and code review to mitigate potential security risks.

Step 5: Deployment and Rollout

Pilot Deployment:

Deploy the wireless electric vehicle system in a controlled environment, such as a test facility or a limited geographic area. Monitor system performance and gather feedback from users to identify any issues or areas for improvement.

Full-scale Deployment:

Roll out the system to a broader audience, deploying charging stations in public locations and enabling wireless charging capabilities in electric vehicles. Coordinate with stakeholders to ensure a smooth transition and provide training as needed.

Monitoring and Maintenance:

Implement monitoring tools and procedures to track the performance of the system in real-time. Establish maintenance protocols for routine inspections, repairs, and software updates to ensure continued reliability and safety.

Documentation and Knowledge Transfer:

Document all aspects of the project, including system architecture, design decisions, testing results, and maintenance procedures. Provide training and knowledge transfer sessions to relevant stakeholders to enable them to support and maintain the system effectively.

Step 6: Evaluation and Optimization

Performance Evaluation:

Evaluate the performance of the wireless electric vehicle system based on key metrics such as charging efficiency, user satisfaction, and environmental impact. Identify areas for improvement and optimization.

Feedback Collection:

Gather feedback from end-users, operators, and other stakeholders to identify usability issues, feature requests, and any unforeseen challenges. Use this feedback to prioritize future enhancements and updates.

Continuous Improvement:

Implement iterative improvements to the system based on feedback and performance data. This may involve software updates, hardware upgrades, or process refinements to enhance the overall functionality and user experience.

Technology Monitoring:

Stay informed about advancements in wireless charging technology, electric vehicle standards, and regulatory requirements. Continuously monitor the market landscape to identify opportunities for innovation and differentiation.

ANNEXURE I

System Code

Code

```
#include <Ultrasonic.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 16, 2);

const int TRIG_PIN1  = 9;  // Arduino pin connected to Ultrasonic Sensor's TRIG pin
const int ECHO_PIN1  = 10;  // Arduino pin connected to Ultrasonic Sensor's ECHO pin

const int TRIG_PIN2 = 11;  // Arduino pin connected to Ultrasonic Sensor's TRIG pin
const int ECHO_PIN2 = 12;  // Arduino pin connected to Ultrasonic Sensor's ECHO pin
const int RELAY_PIN1 = 5; // Arduino pin connected to Relay's pin
const int RELAY_PIN2= 6; // Arduino pin connected to Relay's pin
const int DISTANCE_THRESHOLD = 20; // centimeters

// variables will change:
float duration1_us, distance1_cm;
float duration2_us, distance2_cm;

void setup() {
  Serial.begin (9600);        // initialize serial port
  lcd.init();
  lcd.backlight();
  pinMode(TRIG_PIN1, OUTPUT);  // set arduino pin to output mode
  pinMode(ECHO_PIN1, INPUT);   // set arduino pin to input mode
  pinMode(RELAY_PIN1, OUTPUT); // set arduino pin to output mode
   pinMode(TRIG_PIN2, OUTPUT);  // set arduino pin to output mode
  pinMode(ECHO_PIN2, INPUT);   // set arduino pin to input mode
  pinMode(RELAY_PIN2, OUTPUT); // set arduino pin to output mode
}

void loop()
 {
lcd.setCursor(0,0);
  lcd.print("Slot ");

  // generate 10-microsecond pulse to TRIG pin
  digitalWrite(TRIG_PIN1, HIGH);
  delayMicroseconds(10);
  digitalWrite(TRIG_PIN1, LOW);

  // measure duration of pulse from ECHO pin
  duration1_us = pulseIn(ECHO_PIN1, HIGH);
  // calculate the distance
  distance1_cm = 0.017 * duration1_us;

  if(distance1_cm < DISTANCE_THRESHOLD)
    {
       lcd.print("Oc");
  lcd.setCursor(1, 1);
    lcd.print("Charge ");
```

```
    digitalWrite(RELAY_PIN1, LOW); // turn on Relay
        }
  else
    {
    lcd.setCursor(1, 1);
    lcd.print(" ");
    lcd.setCursor(5, 1);
    lcd.print(" ");
    lcd.setCursor(6, 1);
    lcd.print(" ");
        lcd.print("Av");
        lcd.setCursor(2, 1);
    lcd.print("Off ");

    digitalWrite(RELAY_PIN1, HIGH);
        // turn off Relay
    }
  // generate 10-microsecond pulse to TRIG pin
  digitalWrite(TRIG_PIN2, HIGH);
  delayMicroseconds(10);
  digitalWrite(TRIG_PIN2, LOW);

  // measure duration of pulse from ECHO pin
  duration2_us = pulseIn(ECHO_PIN2, HIGH);
  // calculate the distance
  distance2_cm = 0.017 * duration2_us;

lcd.setCursor(9, 0);
  lcd.print("Slot ");

  if(distance2_cm < DISTANCE_THRESHOLD)
    {
        lcd.print("Oc");
  lcd.setCursor(9, 1);
    lcd.print(" Charge ");
        digitalWrite(RELAY_PIN2, LOW);
    }
 // turn on Relay
  else
{
lcd.setCursor(9, 1);
    lcd.print(" ");
    lcd.setCursor(10, 1);
    lcd.print(" ");
    lcd.setCursor(14, 1);
    lcd.print(" ");
        lcd.print("Av");
  lcd.setCursor(11, 1);
    lcd.print("Off ");
    digitalWrite(RELAY_PIN2, HIGH);  // turn off Relay
}
}
```