SOLAR WIRELESS ELECTRIC VEHICLE CHARGING SYSTEM

An Undergraduate CAPSTONE Project
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Faculty of Engineering
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A CAPSTONE Project submitted to the Faculty of Engineering, American International University - Bangladesh (AIUB) in partial fulfillment of the requirements for the degree of Bachelor of Science in theirmentioned respective programs.

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DECLARATION

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APPROVAL

The CAPSTONE Project titled **SOLAR WIRELESS ELECTRIC VEHICLE CHARGING SYSTEM** has been submitted to the following respected members of the Board of Examiners of the Faculty of Engineering in partial fulfillment of the requirements for the degree of Bachelor of Science in the respective programs mentioned below on **January 2023** by the following students and has been accepted as satisfactory.

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ABSTRACT

This paper details the planning and design of a solar-powered charging for electric vehicles, a solution to the dual problems of expensive gasoline and harmful emissions. The number of countries with electric vehicles on the road is steadily rising. In addition to helping the environment, electric vehicles have proven useful in cutting down on transportation costs by substituting expensive fuel with much more affordable power. Here, we create a novel and effective answer to this problem by designing an electric vehicle charging infrastructure. There is no need to stop for charging because the EV can do so while it is in motion; the system is powered by solar energy; and there is no need for an additional power source. For its construction, the system employs a solar panel, battery, transformer, regulator circuitry, copper coils, AC to DC converter, atmega controller, and LCD display. This technology follows the ideology that charging electric vehicles can be done without having to pull over to a charging station. So, the technology proves the viability of a road-integrated, solar-powered wireless charging system for EVs.

Chapter 1

INTRODUCTION

1.1. Overture

In the field of transportation, electric vehicles (EVs) represent a novel concept. Electric vehicles (EVs) are predicted to take over the automobile market in the near future. The charging procedure for electric vehicles (EVs) must be regulated in this context in order to preserve the quality of the power networks. In spite of this, with the growth of electric vehicles (EVs), there will be a significant quantity of energy stored in the batteries, which will allow for the opposite effect. EV interactivity will be important technology in future smart grids, contributing to the autonomy of the power grid. Due to decreasing carbon dioxide emissions and rising fossil fuels, the electric vehicle has become more competitive than the conventional internal combustion engine vehicle. In spite of these drawbacks, the EV was not generally adopted in the market because of its high vehicle cost. There is a dearth of fast-charging stations and a paucity of all-electric vehicles. There are two types of electric vehicles: those that are powered entirely by electric power and those that are partially powered by electric power. In addition to their low operating costs and little impact on the environment, electric vehicles utilize little or no fossil fuels at all. Electric vehicles will be the primary means of transportation in the future to enhance charging station efficiency [1]. When it comes to acquiring an electric vehicle, the absence of charging infrastructure is the most common argument given for not doing so. The portable EV charger was tested by lowering charging time with renewable energy. A hybrid power system is used in this study to provide a unique service to long-distance EV drivers. Between major highways, there aren't any places for these drivers to refuel their automobiles with electricity. The wireless EV charger is a great choice for people who want to use electricity to charge their electric vehicles [2]. Because of rising fossil fuel prices and declining CO2 emissions, electric vehicles are now more cost-competitive than traditional Considered as a continuous vehicles. Electric vehicles were not extensively adopted because of restrictions such as high car costs [2]. There is a dearth of fast-charging stations and a paucity of all-electric vehicles. It is possible for EVs to be powered entirely or in part by electricity. Due to their lack of moving parts and little impact on the environment, electric cars have lower operating expenses than gasoline-powered counterparts [3]. Our project system uses a solar panel, battery, transformer, regulator circuits, copper coils, AC to DC converter, atmega controller, and LCD display to build the system. There is no need to stop for recharging with this system because electric vehicles may be charged while travelling. A charge controller connects the battery to the solar panel. dc electricity is being stored in the battery. Now, in order to send the DC power, it must be converted to AC power. A transformer is used here to accomplish this task.

1.2. Engineering Problem Statement

One or more electric motors, or traction motors, are used to propel an electric vehicle (EV). It is possible for an electric vehicle to be self-contained using a battery, solar panels, fuel cells, or an electric generator that converts gasoline to energy to be fueled by an off-vehicle collector system. There are many different types of electric vehicles, such as hybrid and all-electric cars, trucks, trains, ships, planes, and spacecraft. Electricity was a popular mode of vehicle propulsion during this historical period, which provided a level of comfort and operational convenience not possible in gasoline-powered vehicles at that time. Although modern internal combustion engines have dominated vehicle propulsion for more than a century, electric power is still widely used in trains and other small vehicles.

1.3. Related Research Works

To date, electric vehicle (EV) charging technology has been needed since the mid-19th century. Disposable batteries were used in the initial electric vehicles, and "charging" technology eventually replaced the "dead" batteries. Because none of these early EV vehicles were massproduced, there was no market for them. Recharging points as a major issue, many homes were built before the early 20th century. Charging the vehicle at the residence was impossible because there was no electricity. In order to make electric vehicles more available to the general public, homes had to be electrified [4]. This would have the desired effect of would lead to an increase in the number of people purchasing and using electric vehicles. In the early years of the twentieth century, 38 percent of the vehicles in the United States were powered by electricity [5]. These automobiles might be charged in two ways: either with the vehicle's batteries in it, or if the battery was taken from the vehicle and charged elsewhere installed on the vehicle in the first place

1.3.1. Earlier Research

Using this timeline, one may learn about the scientific discoveries that led to the development of solar energy, and how it has evolved through time into electrical vehicle charging source. Solar panels are a fantastic source of power, but it's interesting that it has been reluctant to realize their full potential. During the 1973 oil embargo, solar seemed like a "better option than fossil fuels" because of gas shortage [7]. Demand for energy independence increased, which led to the first wave of solar incentive programs in many states.

1.3.1.1. Dynamic Wireless Power Transfer in Electric Vehicles

In order to power the electric motor or charge the on-board Rechargeable Energy Storage System (RESS), a hybrid or fully electric vehicle can use a force move system. While stationary, the batteries can be charged through remote force move by use of charging pads. The vehicle must be parked in an appropriate area to charge the battery, although both options are suitable for use whether doing an evaluation at home or while on the road. We propose a wireless charging system for electric vehicles that is friendly to the environment and allows for the vehicle to be charged wirelessly while it is in motion on the roads. The proposed method is also utilized to charge vehicles at garages, parking lots, and malls. In addition, the solar PV systems and wind turbines set up alongside the roadways may be called upon to supply electrical energy for the proposed charging infrastructure shown in figure 1.0. Micro grids are formed when renewable energy sources like solar panels and wind turbines are linked to provide electricity to essential services like wireless charging [8]. The extra power can either be sent back to the main power system or used to power streetlights. An air-core transformer, with its main winding buried in the road and its secondary attached to the car, is also part of the system for wirelessly charging the battery. A rectifier and dc-dc converter stage take the secondary's alternating current and convert it to a voltage and current that may be used to charge the battery pack.

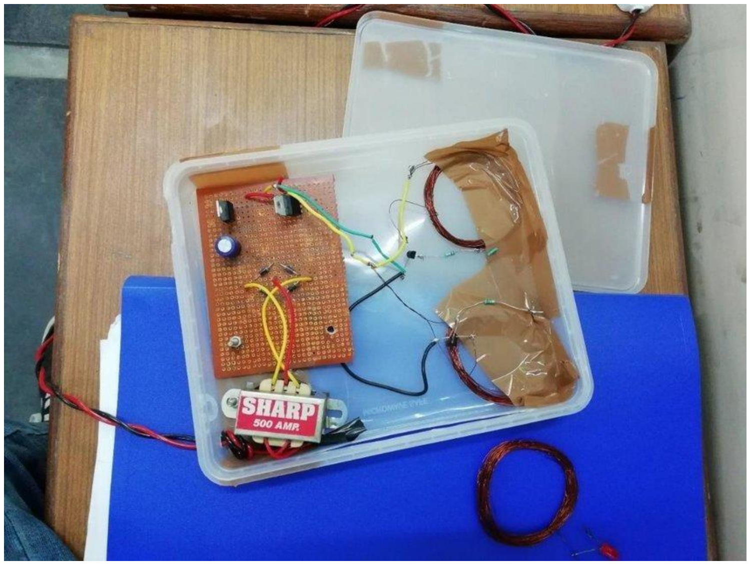

Figure 1.0: Prototype design of wireless transmission [8]

1.3.1.2. Effect of Coil Dimensions on Dynamic Wireless Power Transfer for Electric Vehicles

Employing state-of-the-art simulation tools, examine how changing the receiver coil's size and layout impacts power transfer efficiency and operational cost. This paper shows that the coupling coefficient depends non-monotonically on the size of the coil due to the spatial distribution of the magnetic field. As a result, the size of the coil, at which the coupling coefficient reaches its maximum, is a critical design parameter that impacts the overall performance of the system shown in figure 1.1 [9]. We also talk about how to implement our findings into a multi-objective optimization algorithm.

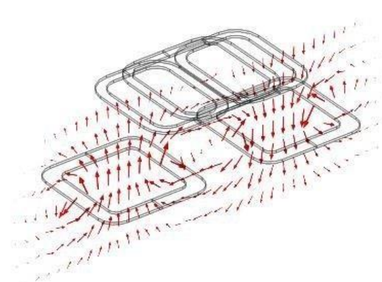

Figure 1.1: Flux lines generated in the bipolar transmitter coils [9]

1.3.1.3. Dynamic Wireless Power Transfer for Electric Vehicle

Gasoline is used in 56% of all vehicles, while the transportation sector uses 29% of all energy. Gasoline use results in the release of greenhouse gases that are bad for the environment. The electric vehicle offers a viable alternative to conventional fuels, relieving some of the strain on those resources. A key challenge in implementation is the restricted range of EV. A big battery capacity is a primary requirement for EVs in order to extend their driving range. Moving while charging, or "Dynamic Wireless Power Transfer," is one potential option. One can considerably cut down on the car's battery energy storage capacity if you charge it while you drive. The obstacles to implementing DWPT for EV are outlined in this thesis. Small, segmented coils laid on the road or long rails can both be used to execute DWPT. Lower efficiency, a more sophisticated power electronics system, and a lower coupling coefficient are all issues with long tracks. The coupling coefficient of segmented DWPT is higher than that of long track DWPT, and thus requires fewer sophisticated power electronics and is more efficient overall. To use a segmented coil construction in DWPT, however, we must first overcome a few obstacles. In this thesis, we compare and contrast many types of magnetic couplers by modeling their operation and adjusting the coupling coefficient and misalignment with and without a protective shield. Additionally, several vii reactive compensation circuits that are tolerant of misalignment, load independence, power factor, and efficiency are compared. Implementing dynamic wireless power transfer (DWPT) is difficult because of the need for automatic identification of EV to prevent efficiency loss and ease safety concerns. The authors of this paper suggest a new approach to coil detection for segmented DWPT. With the EV's approach anticipated, the transmitter embedded in the road is activated to provide a seamless, instantaneous power transfer shown in figure 1.2. The transmitter coil can be reliably powered at low speeds through communication. However, the communication lag time for detecting an EV is prohibitive when traveling at high speeds along roads. In order to detect EVs at high speeds with little expense and power consumption, this work presents a unique orthogonal coil arrangement. In conclusion, this dissertation provides a method for tracking the point of greatest efficiency during Wireless Power Transfer (WPT). Conventionally, the load is considered simply resistive in the literature. However, in most of the cases, the battery is the end load, and the equivalent circuit of battery consists of resistive and reactive parts [10]. That's why matching load and source impedances is crucial for optimal system performance. An algorithm is described in this paper that can be used to improve the overall performance of the system. The suggested technique modulates both frequency and phase shift of the inverter output voltage to decrease the input power, whereas output power is kept constant by the output side dcdc converter. The output dc-dc converter regulates the voltage and current of the battery.

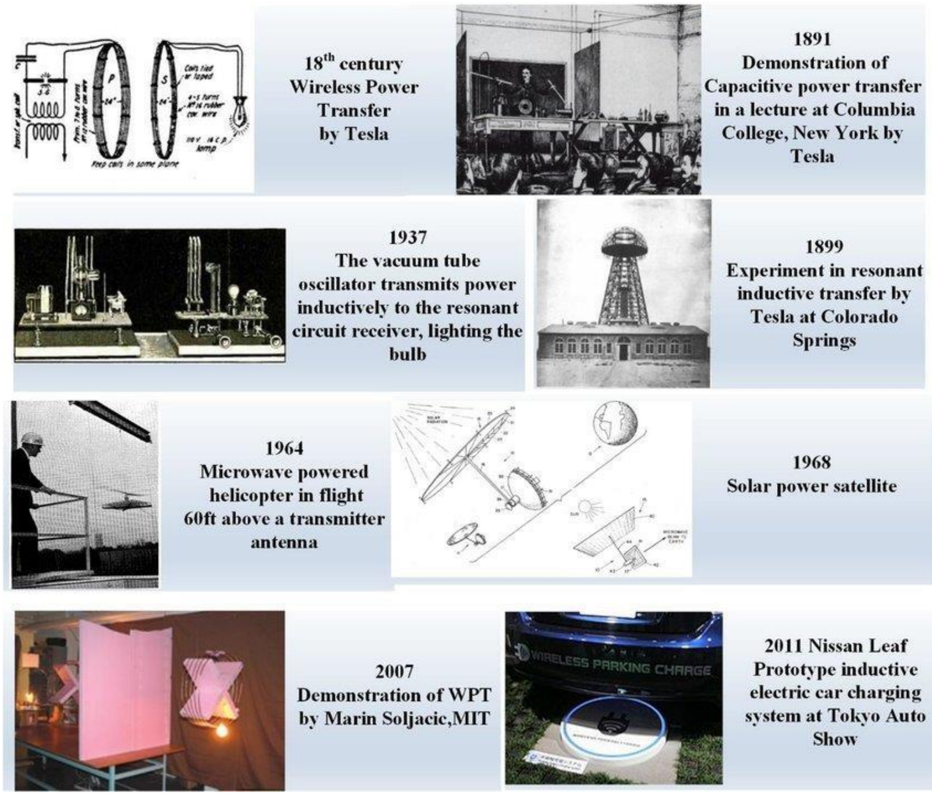

Figure 1.2: Timeline diagram of development of the Wireless Power Transfer [10]

1.3.1.4. Dynamic Wireless Power Transfer for Electric Vehicles: Technology and Infrastructure Integration Challenges

The ability to wirelessly charge a moving vehicle using resonant inductive power transfer is referred to as "dynamic wireless charging." To accomplish this, source coils are installed in the road and a pickup coil is installed in the car; the two coils are then connected to transfer as much energy as possible. Dynamic wireless charging systems theoretically solve the EV battery problem by providing unlimited range and allowing the use of smaller batteries, which reduces cost and weight; however, implementation will be limited by the availability of the charging infrastructure, which is limited by its cost [11].

In order to highlight the technology challenges associated with the transition from stationary to dynamic wireless charging and the implementation challenges in terms of infrastructure, this paper presents a literature review on the recent advancements of stationary and dynamic wireless power transfer used for EV charging that addresses power limitations, electromagnetic interference regulations, communication issues, and interoperability shown in figure 1.3.

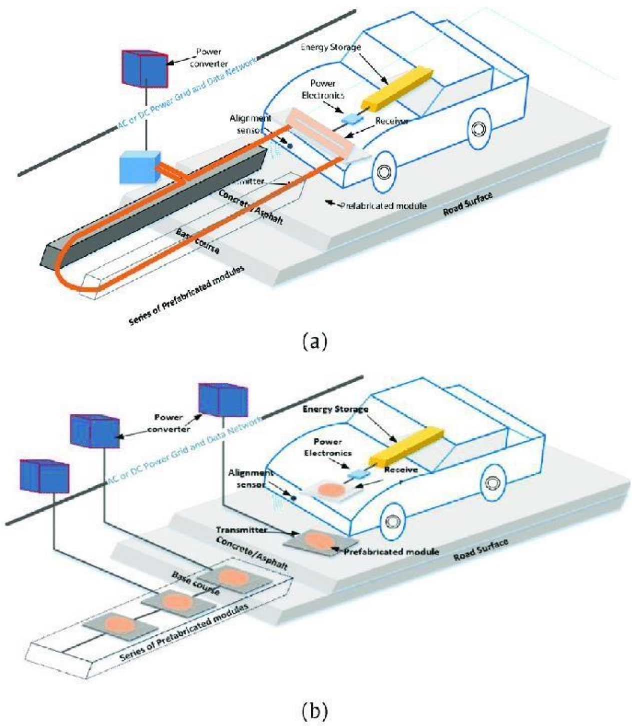

Figure 1.3: Basic diagram of dynamic wireless electric vehicle charging system [11]

1.3.1.5. Communication Requirements for Dynamic Wireless Power Transfer for Battery Electric Vehicles

Emerging technology known as dynamic wireless power transfer (WPT) allows for the wireless extension of an electric vehicle's power source while in motion, hence increasing the vehicle's range. Because of this, there must be wireless transmission between the RSC and the OBC. The network must allow mobility in addition to reserving resources for essential data streams through configuration, administration, and/or protocol action to ensure the deterministic behavior required for WPT real-time control loops [12]. Current networking technologies are inadequate to deal with these peculiarities. Therefore, a new approach to network architecture is needed. Highlighting the need for standardization of protocols for communication in real-time control loops, this paper presents the characteristics of the communication system that must be taken into account when designing WPT communication protocols and system architecture that supports real-time in-motion control applications.

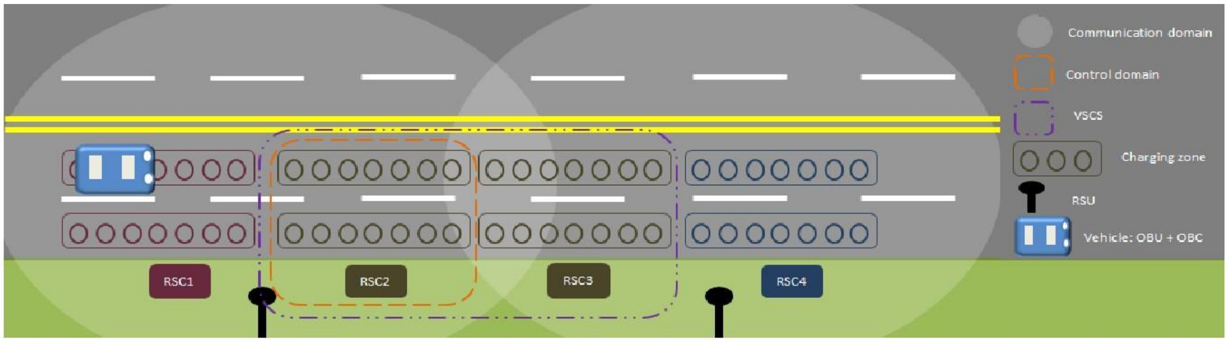

Figure 1.4: Dynamic Wireless Power Transfer for battery electric [12]

1.3.1.6. Overview of wireless power transfer for electric vehicle charging

The study provides a review of existing wireless power transfer (WPT) technologies with the goal of applying them to the wireless charging of electric vehicles (EVs). Each technology's rudimentary concepts are laid out [13]. After the technologies for charging electric vehicles have been categorized, their benefits and drawbacks will be explored. This article provides a comprehensive overview of promising technologies including coupled magnetic resonance and magnetic gear technology shown in figure 1.5. New discoveries, major technical problems, difficulties, and cutting-edge studies are presented. Trends in the field of study are also provided.

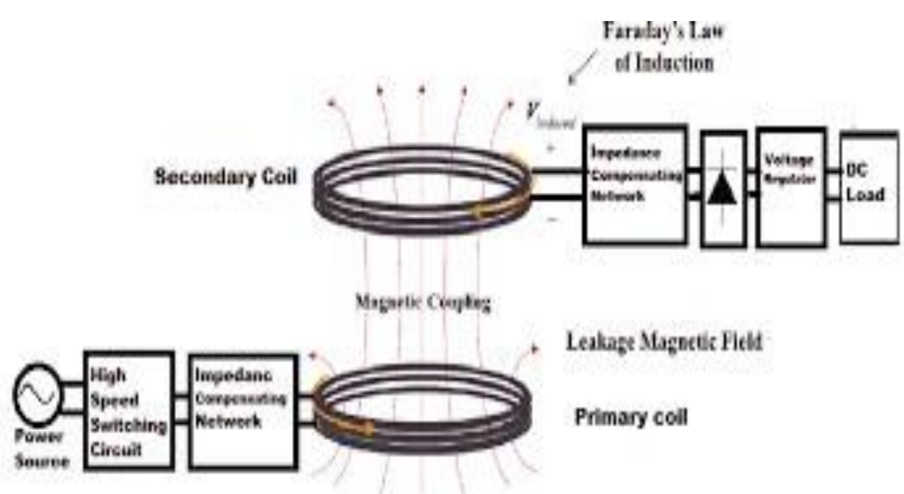

Figure 1.5: wireless power transfer (WPT) [13]

1.3.1.7. Advances in Wireless Power Transfer Systems for Roadway-Powered Electric Vehicles

Vehicles that can directly and effectively get power while travelling along a road, such as roadway-powered electric vehicles (RPEVs), are promising contenders for the future of transportation. In this work, we take a look back at the inductive power transfer systems (IPTSs) that have proven useful for wirelessly powering RPEVs [12]. Trace the IPTS's evolution from its inception in the 1890s, when the first RPEV was built, to the present day. There have been significant advancements in the IPTS's size, weight, efficiency, air gap, lateral tolerance, electromagnetic force, and cost over the past century, and as a result, RPEVs are seeing increased commercialization shown in figure 1.6. This paper provides an overview of the significant events that have occurred in the history of IPTS and RPEVs, with a special emphasis on the recent advances of on-line electric cars, the first of which went on sale in 2013.

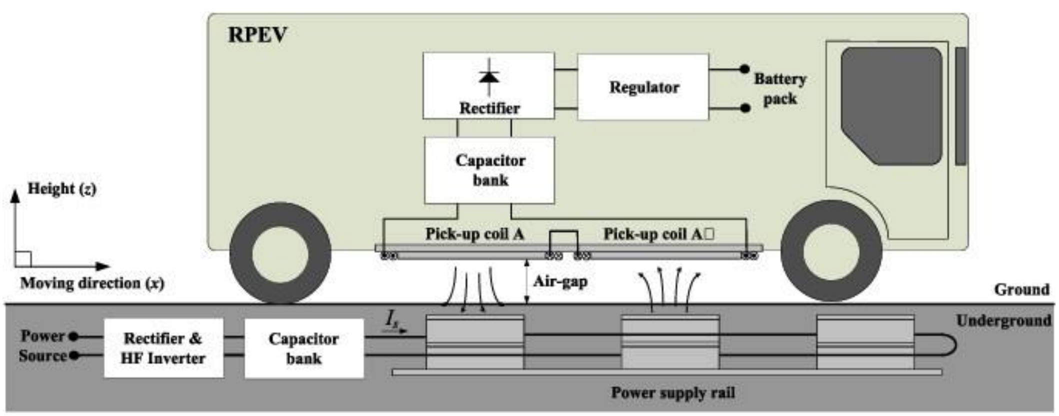

Figure 1.6: Modern Advances in Wireless Power Transfer Systems for Roadway Powered Electric Vehicles [14]

1.3.1.8. Development of dynamic wireless power transfer system for vehicle logistics robot. Electrical Engineering in Japan

In manufacturing, reducing the need for human labor is of paramount importance. A yard is a staging area in an automobile assembly line where finished vehicles are kept until they are ready to be shipped. It has been suggested that an autonomous vehicleloading robot be used to automate the yard alignment process in place of human drivers. This research proposes a system for dynamic wireless power transfer (DWPT) between vehicles and roadside infrastructure [15]. Using simulation and real-world measurements, we show that the transmitter coil can withstand the robot's weight without failing. It is also demonstrated that, even with stainless steel, there is a significant eddy current loss caused by the reinforcement bars of the road structure. Loss due to coil resistance is analogous to this. Utilizing a frequency control system and an automated coil detection system, this setup is able to attain a 1.8 kW DWPT in a manufacturing environment.

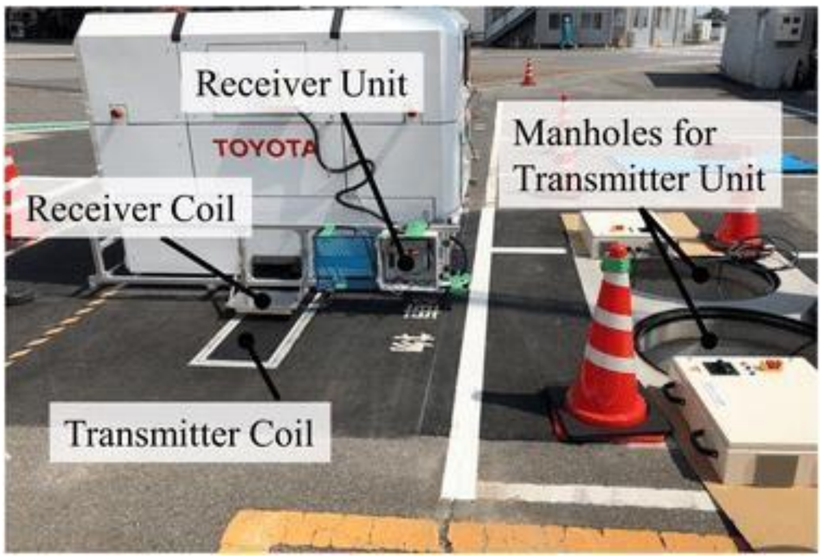

Figure 1.7: DWPT system of VLR [15]

1.3.2. Recent Research

Any related research which is generally not more than 5 years or 2 years old can be considered recent work. A clear indication should be there how the recent research complements the proposed project methodology.

1.3.2.1. Comprehensive Development of Dynamic Wireless Power Transfer System for Electric Vehicle

This article details the full process of creating a dynamic wireless power transfer (WPT) system for charging an electric vehicle's battery (EV). The development procedure begins with an analysis of the dynamic WPT system's electrical requirements, continues with the design of the system's power stages, and ends with a validation test. In the design phase, the electrical size of the power stage components is depicted along with the structure of the coupling set, the layout of the coils, the configuration of the conversion stages, and the topology of the compensation networks [16]. Within the verification phase, we discuss how a dynamic WPT system is set up and report the outcomes of experimental testing conducted with a roving pickup along the track.

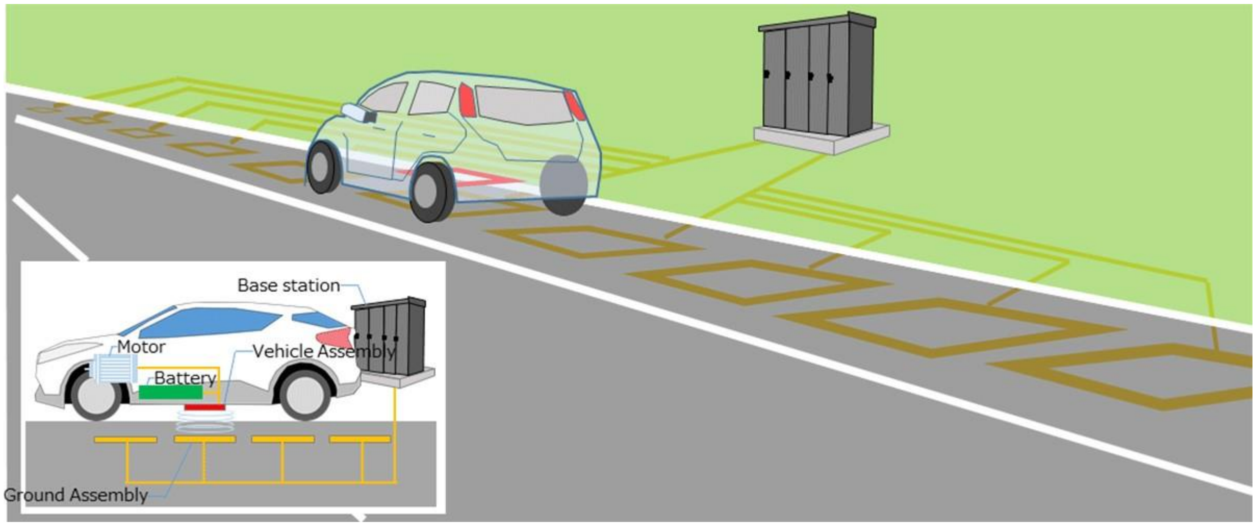

Figure 1.8: Base station along with ground station [16]

1.3.2.2. Dynamic Wireless Power Transfer in ElectricVehicles using Magnetic Resonance: A Case of Developing Countries

In the 19th century, the concept of power distribution for wireless lights before the idea of wireless power transfer for charging electric automobiles [17]. Using wireless power transfer (WPT) technology, we can now create power pads for wirelessly charging EVs. Power pad for EV charging issues, a major barrier for EV owners, are addressed by this technology. Wireless charging can be accomplished through magnetic induction or radio frequency, using a static or dynamic wireless power transfer system; in the former case, magnetic induction is used to power the charging pads, which convert electrical energy to magnetic energy and enable transmission over an air gap, typically short to mid-range. Parabolic dishes are used to direct radio waves, which have a very great range, onto their intended target in the atmosphere using radio frequency (or microwave) technology shown in figure 1.9. The driver of a vehicle powered by a stationary wireless power transfer (SWPT) technique can simply park and depart, while the driver of a vehicle powered by a dynamic SWPT method can charge an electric vehicle (EV) while driving and switch lanes once the EV is fully charged. Dynamic wireless power transfer describes this phenomenon (DWPT).

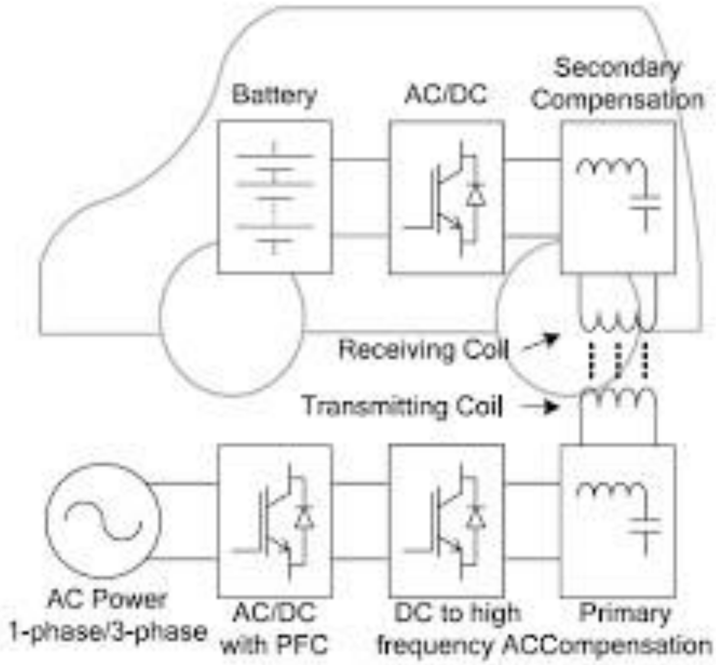

Figure 1.9: Block diagram of the wireless power transfer system [17].

1.3.2.3. An Improved and Integrated Design of Segmented Dynamic Wireless Power Transfer for Electric Vehicles

This paper aims to present a stable charging method for high-power applications by detailing advancements in a segmented dynamic wireless power transfer (DWPT) system for electric vehicles (EVs). For high-power applications, an integrated design is shown that takes into account the improved switching sequence, the reduced size of segmented transmitters, and the parallel inverter technology. Depending on where the pickups are, power is distributed to one of three adjacent transmitters installed on the rail. A Q-shaped coil, a DD-shaped coil, and another Q-shaped coil follow one another in this trio of transmitters (QDDQ) [18]. One way to minimize the impact of output voltage fluctuations and maximize the efficiency of the energized transmitters is to employ QDDQ as the elementary energized group. FEA is used for the complete DWPT system's design, and several circuit topologies are analyzed. Over all, the performance of a dynamic charging experimental prototype is verified, and it is found to be in close agreement with the theoretical analysis shown in 1.10. There are five transmitters and one receiver in this prototype. All measurements are in units of 500 millimeters. From a 100 to 200 load, the suggested system has been verified to achieve a constant output voltage of 500 V at an estimated 85% dc-dc efficiency. At a load of 100, the maximum output power is 2.5 kW.

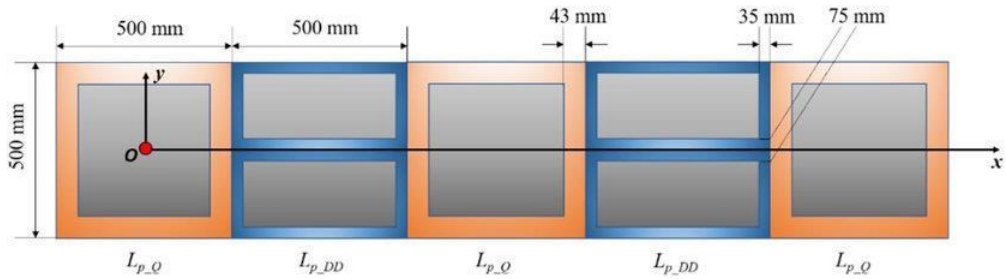

Figure 1.10: The detailed diagram of the transmitter array [18].

1.3.2.4. Dynamic Wireless Power Transfer: Potential Impact on Plug-in Electric Vehicle Adoption

This research aims to quantify the relationship between the widespread use of dynamic wireless power transfer (DWPT) and the increasing popularity of EV plug-in hybrids (PEV). Insights into the social value of DWPT and the justification of expenditures on its R&D, demo, and rollout can be facilitated by this connection. For four major cities, we estimate the spatial connections between charging possibility and DWPT availability [19].In order to include the consumer value of DWPT into a validated consumer choice model in which PEV sales are exogenous, we first define the consumer value of DWPT as a function of key DWPT deployment characteristics. The results show that the deployment of DWPT has a considerable effect on PEV sales, even at a modest 0.5% of road length by 2050. There is a large variance in effects. The effects appear to be more pronounced for BEVs than for PHEVs, for shorter-range BEVs than for longer-range ones, and for users who have charging difficulties, such as those who lack access to convenient charging infrastructure at home or at work or who log a lot of miles per day. When the DWPT availability is high enough (about 0.8%), DWPT becomes a viable option to home or workplace chargers for consumers with neither, and this can result in a sudden expansion of the PEV customer base.

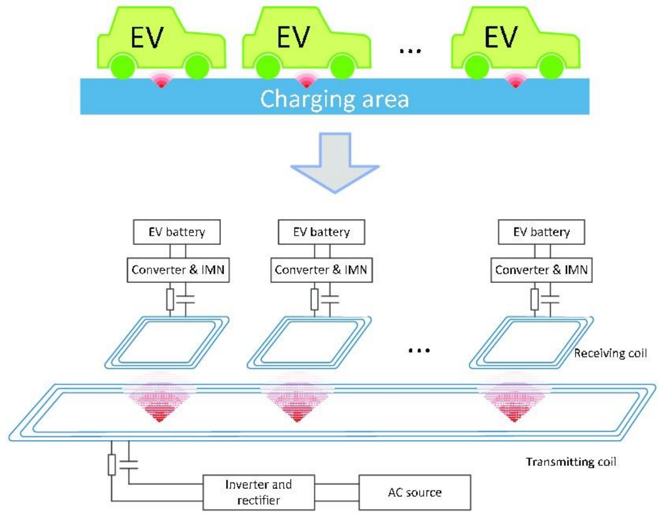

Figure 1.11: Schematic diagram of the long-track dynamic wireless power transmission [19]

1.3.2.5. Wireless Power Transfer for Electric Vehicle Applications

Magnetic resonance wireless power transfer (WPT) is the technology that could release us from the confines of cables once and for all. Specifically, the WPT uses the same fundamental concept—called inductive power transfer—that has been studied and refined for at least three decades. In recent years, WPT technology has seen significant advancements [20]. With a kilowatt's worth of power, the distance between the grid and the load grows from millimeters to hundreds of meters. As a result of these developments, the WPT is increasingly appealing for use in both static and dynamic EV charging applications. In this research, we surveyed the WPT field for technologies that could be used to charge EVs wirelessly. Challenges associated with recharging time, range, and cost can be readily overcome by implementing WPT in EVs. When it comes to selling EVs in large quantities, battery technology is now obsolete. Researchers should feel motivated by the state-of-the-art accomplishments to further WPT and EV.

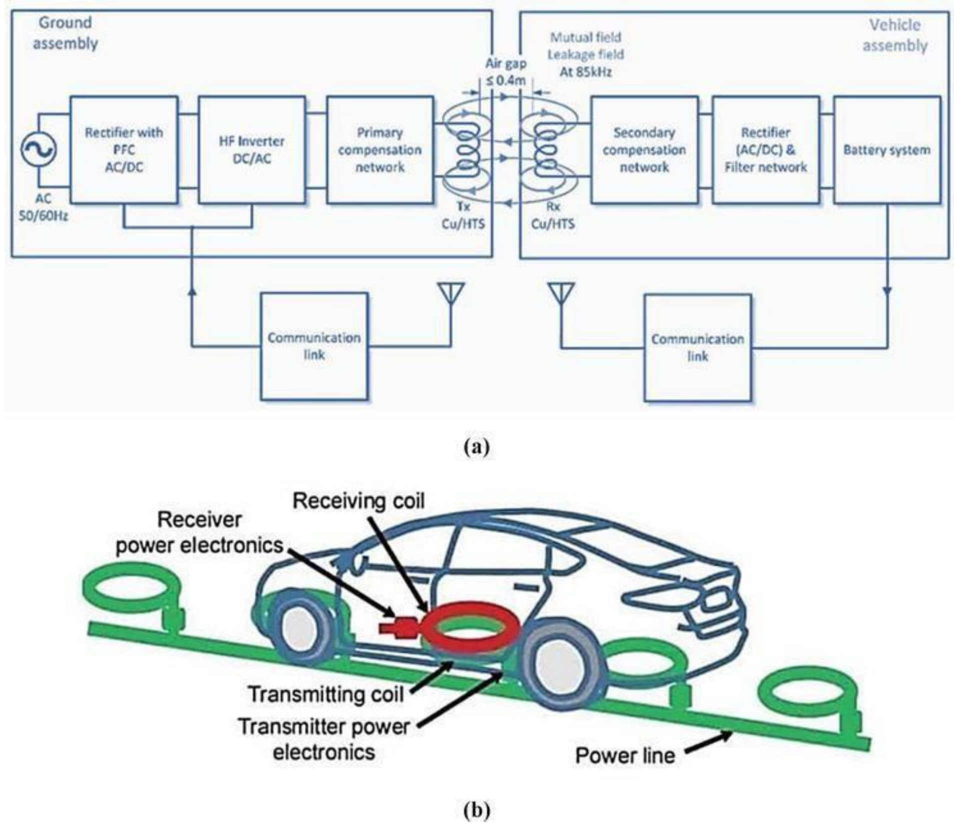

Figure 1.12: Wireless Power Charging in Electrical Vehicles [20]

1.3.2.6. Segmental Track Analysis in Dynamic Wireless Power Transfer

Due to the severe oil crisis and environmental challenges, electric vehicles have attracted increasing attention. However, the electric vehicle's drawbacks are slowing its market growth and expansion. These include the vehicle's limited range, expensive batteries, and difficult charging. Realizing on-road wireless power transfer technology can efficiently address issues of limited driving range, prevent the battery from being entirely depleted to increase the battery's service life, and decrease the need for an onboard battery. In this research, the first examine the compensation topology and charging mode of wireless power transfer technology, and then we construct an analogous circuit model of a segmental wireless power transfer system [21]. To predict the experimentally observed coupling coefficient, we simulated a magnetic field while varying the track's shape and length.

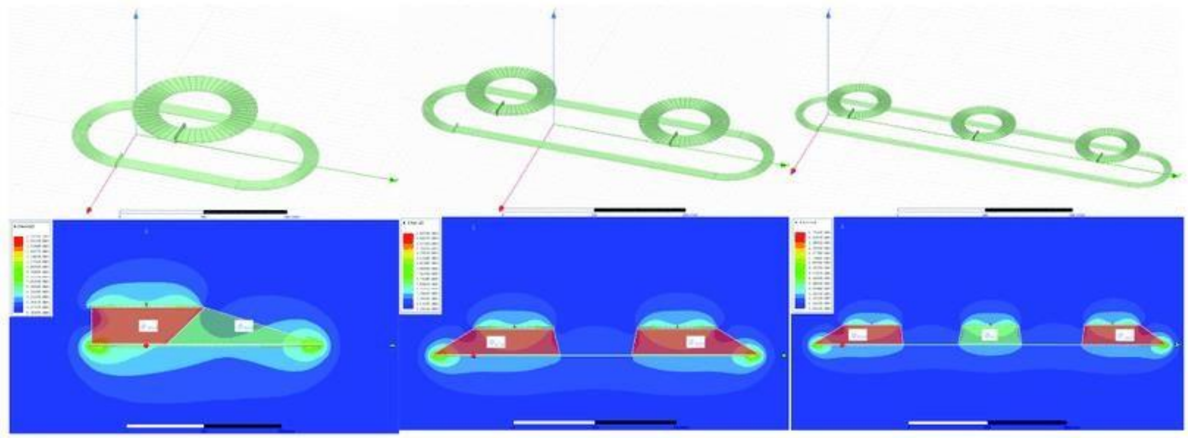

Figure 1.13: Models and magnetic field distribution of 2d, 4d, and 6d racetracks [21]

1.3.2.7. Dynamic Electric Vehicle Routing Problem

New services involving the charging of electric vehicles and their efficient use while driving are needed to encourage their widespread adoption [22]. For instance, there's the conundrum of picking a charging station while on the go (the "dynamic EV routing dilemma"). In this paper, we discuss some of the major difficulties that arise from providing this service. After surveying current research, we analyzed the topic at hand and suggested a multi-criteria dynamic programming approach.

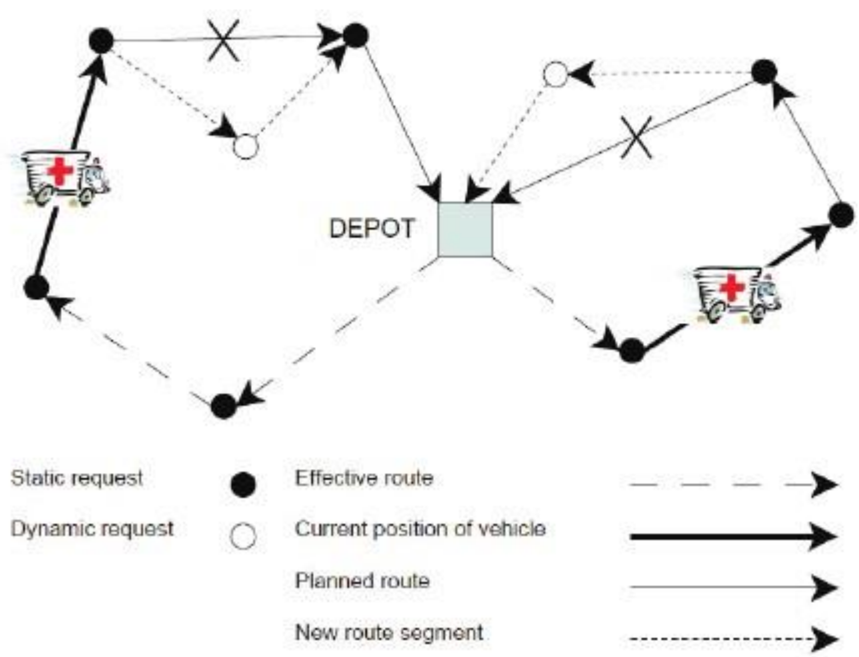

Figure 1.14: Example of dynamic vehicle routing problem with 7 static requests [22]

1.3.2.8. Dynamic Electric Vehicle Routing: Heuristics and Dual Bounds

The electric vehicle routing problem with public-private recharging strategy, in which vehicles may recharge en route at public charging infrastructure and at a privatelyowned depot. To protect against the unpredictability of demand at public charging stations, we develop routing policies that anticipate station queue dynamics. Using decomposition, we locate desirable routing policies, such as the best static policy and rollout approaches based on fixed routes that dynamically react to observed queues [23]. The decomposition also lets us set dual boundaries, which gives us a metric for how well our routing policies perform. Through computational studies, we demonstrate that our policies' value is, on average, within 4.7% of the value of an ideal policy. Moreover, we show that our policies significantly outperform the usual routing scheme in which vehicles are often recharged at a central depot. More generally, we demonstrate how operations research techniques typically used for static and deterministic routing can be modified for use with dynamic and stochastic routing problems.

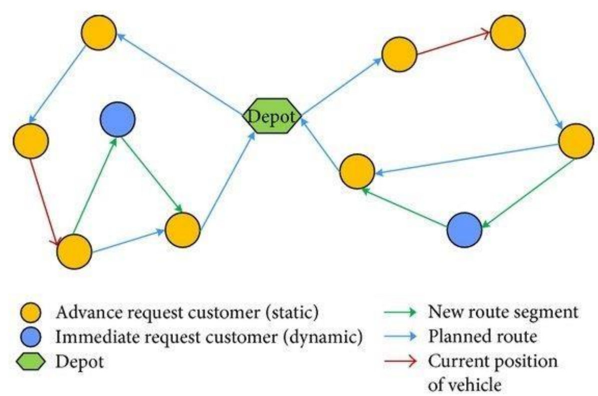

Figure 1.15: An example for dynamic vehicle routing problem [23]

1.4. Critical Engineering Specialist Knowledge

For this reason, there is also dynamic charging. Electric vehicles in motion can be charged wirelessly utilizing the same principles that govern wireless charging for your Smartphone. Using the theory of magnetic induction, dynamic charging allows electricity to be transmitted wirelessly from cables beneath the road to a receiver within the vehicle. One key distinction between static charging and dynamic charging is that the latter requires the vehicle to be in motion while the former does not. Static charging, already in use with modified automobiles, entails parking the car directly on top of a charging pad in a public or private setting. When it comes to recharging electric vehicles (EVs), range, on-board energy storage size, and network dispersion are all concerns that can be mitigated through the use of DWPT, or dynamic wireless power transfer. With the right infrastructure in place, technology that allows drivers to top off their batteries while on the go might significantly boost the electric vehicle industry. Current traction battery technologies, conductive and inductive charging methods, influential characteristics related to the dynamic charging state, and notable work within the field of WPT charging systems are all discussed. As a means of recognizing the importance of the work that has to be done in this area, we summarize the system requirements for DWPT that are unique to the interaction environment between drivers, vehicles, and infrastructure. In other words, the gap is not a result of a lack of technology, but rather a problem with how that technology is being put into practice. When appropriate standardization is lacking, system architectures cannot be designed and implemented without causing interoperability concerns. Success in deployment requires maximizing the technology's impact while using as little underlying infrastructure and resources as possible; we analyze deployment scenarios and places that have the best chance of making this a reality.

1.5. Stakeholders

The importance of charging infrastructure for electric vehicles (EVs) is growing as their popularity grows. When compared to the number of automobiles, the quantity of charging stations is inadequate. If battery prices keep dropping at their current rate, the market for electric vehicles is expected to expand exponentially. There is a fundamental stumbling block to the widespread use of electric vehicles, and it is the slow pace at which charging stations are being installed. A lack of public chargers is blamed on the chicken-and-egg problem that arises from the unfavorable economics of installing. The argument focuses less on other possible causes. It has been hypothesized that the rate of adoption could be slowed by the wide variety of opinions held by those involved in planning the charging infrastructure's rollout. Not only do stakeholders have divergent views on the current roll-out plan, but they also have diverse expectations about how new technologies and policies will affect the future charging infrastructure. However, there has been no empirical investigation on this question. Decisions about how to deploy charging infrastructure must be made by policymakers over the medium to long term. Cost-benefit analyses for investments in new technology infrastructure tend to take a while. Numerous charge methods, both new and ancient, vie for the attention of policymakers. the resurgence of battery swapping as an alternative to charging. As these technologies advance rapidly, it becomes more difficult to settle on a single path for the future. Due of the enormous quantity and diversity of potential participants,

The addition serves to further complicate things. The charging infrastructure is a joint effort of utilities, grid operators, automakers, new entrants, governments, and oil companies. These groups hold contrasting views on how the market should be structured and whether or not it should be governed at all. Legislators are trying to find out from experts in the sector which issues are most pressing for them to tackle. Although the goals of the charging infrastructure industry's players have been outlined before, a comprehensive analysis of how these goals translate into thoughts on the future of electric vehicle infrastructure development is lacking. Even more so, existing research has focused on the here-and-now, while the focus of this work is on the intermediate and long-term future. In addition, the studies do not detail the ways in which these interests coincide or diverge. Q-methodology, a technique well-suited to revealing subjective thoughts on a topic, is what we utilize to uncover the stakeholders' common predictions for the future of electric vehicle charging. in contrast to stakeholder analysis, is predicated on the assumption that stakeholders' viewpoints are similar. This helps us see the big picture when it comes to the future of charging and pinpoints the most contentious areas where policymakers should focus their efforts. Previous research in the technology and business model domains has recommended using in future investigations. The results have also been put to use in model-building. This paper delves deeper into the application of forthcoming research and evaluates its outcomes in light of competing methods that seek to ascertain stakeholders' outlooks for the future. The results of a with 39 participants from 9 different businesses indicate that there are four distinct points of view on the future of charging infrastructure. To better understand which concerns are most pressing and how different groups of stakeholders across industries are distributed, we conduct a deeper analysis of the four vantage points. The findings highlight under-researched areas that stakeholders deem crucial. This work makes two contributions: a methodological one and a substantive one. Though the second contribution reads like it was written just for the Netherlands, it's worth noting that the country's situation is similar to that of a leader in public charging infrastructure. The study's findings on the role of smart charging, rapid charging, and the extent of government interference are expected to be contentious issues in many other nations in Europe and beyond. Conflicts like the one in the Netherlands are inevitable in the world's ever-increasing number of crowded cities.

1.6. Objectives

The following goals are intended to be achieved by conducting the related work

1.6.1. Primary Objectives

- To build a solar charging system
- To Increase fuel efficiency, decrease gas prices, and cut pollution.
- To store the charge in the storage
- To Electrical vehicle to examine

1.6.2. Secondary Objectives

- To the sake of people's health, it's important to keep EMC, EMI, and frequency levels below acceptable ranges.

1.7. Organization of Book Chapters

Chapter-2: Project Management

In this Chapter, the project Gantt chart has designed in this project management chapter. Then, analysis the different related issues as such strength of this project, weakness and opportunities.

Chapter-3: Methodology and Modeling

In this methodology chapter, the proposed designed with block diagram also mathematically

Chapter-4: Implementation of Project

In this the modified chapter, the proposed model will be described

Chapter-5: Results Analysis & Critical Design Review

All the graphs and project analysis will be shown

Chapter-6: Conclusion

Chapter 2

PROJECT MANAGEMENT

2.1. Introduction

Project management is a common method used to assure the success of a project. When it comes to project management, it's critical to have a clear picture of the objectives of the project, the resources this project needs, and achieve it. This chapter is all about getting down to business. The purpose of project management is to plan and execute a project in such a way that its stated goals and deliverables are met. Additionally, it includes the identification and control of potential risks, along with a thorough budgeting process and cross-organizational communication. Project schedules can benefit from using the Gantt chart. Money can be saved on the project's equipment by manipulating the data. Managing a project is a critical managerial ability. Planning, scheduling, and regulating actions to achieve a certain goal within a given time and budget are all part of the process. By completing initiatives that contribute to project aims, many businesses can meet the objectives. In most cases, projects have a specific start and end date, a specific number of participants, a specific number of resources, and a specific budget. This is planned and monitored by the group leader and adjusted just as needed.

2.2. S.W.O.T. Analysis

A project's opportunities and threats, as well as its strengths and weaknesses, can be analyzed using the SWOT framework. Using a functional approach, the internal analysis pinpoints the projects' strengths across the board (finance, management, infrastructure, procurement, production, distribution, marketing, reputational factors, and innovation) as well as its weaknesses (the same) and opportunities for growth (the same). Finding the source of competitive advantage requires a thorough internal study. In doing so, it identifies areas for investment in developing resources that will keep a team motivated. Potential advantages and disadvantages in the sector are uncovered through research on the surrounding environment, including the competition, the industry, and the broader economy. Analysis of the capabilities and assets of each competitor constitutes the competitive landscape. Competition, new entrants, suppliers, customers, and product substitution are analyzed as part of the industry's external environment using the five Forces Model. Political, economic, sociological, technological, environmental, demographic, ethical, and regulatory repercussions are examined in the context of the external environment [30]. The objective of doing a Strengths, Weaknesses, Opportunities, and Threats (SWOT) study is to inform a company's strategy development considering its specific context. In this using SWOT analysis, the strength and weaknesses are found.

Figure 2.0: S.W.O.T Analysis [30].

2.2.1. Strengths

- Eco-friendly
- Renewable energy
- Mechanism Simplified

2.2.2. Weaknesses

- Requires downtime to recharge
- Inadequate power-supply facilities
- Maintenance of batteries are costly.

2.2.3. Opportunities

- Property ownership grants from the government

- The rising price of fossil fuels

2.2.4. Threats

- Competition from vehicles that use alternative fuels or hydrogen engines. • The Increasingly Expensive Cost of Electricity

2.3. Schedule Management

Project activities and tasks are organized using a schedule management structure, which uses time variables to do so. Outlines what has to be done for the project's completion to be on time and within the budget. Implementing a schedule management system is crucial to getting a project off the ground, tracking its progress, and ensuring that it is completed on time. The given gantt chart shows the timeline and working stages of this project along with all the important deadlines.

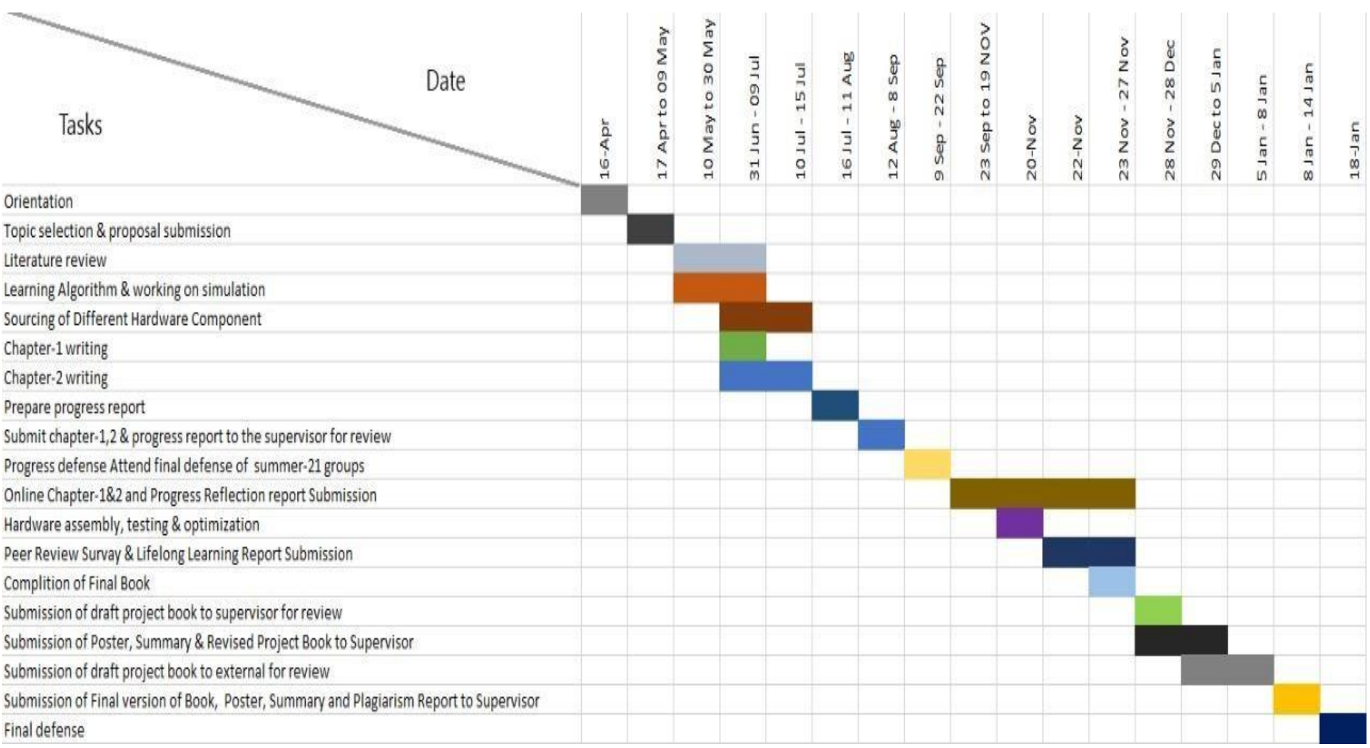

Figure 2.1: Gantt chart

2.4. Cost Analysis

The total cost analysis of both object detection and authentication devices is shown here. Here, the estimated price and the buying price of the components are shown. **Table 2.1:** Cost of component

SL	Name of the component	Unit Price	Quantity	Price (BDT)
1.	Solar Panel	399	1	399/-
2.	Charging Module - TP4056	59	2	118/-
3.	Battery 3.7v	90	4	360/-
4.	Wireless Power Transfer	1267	6	7602/-
5.	Adapter	761	1	761/-
6.	Arduino nano	650	1	650/-
7.	LCD Display	390	1	390/-
8.	Bluetooth Module	389	1	389/-
9.	LED	8	2	16/-
10.	Resistor	10	5	50/-
11.	Motor	100	4	400/-
12.	Motor Driver	300	1	300/-
13.	Battery 3.7v	350	4	1400/-
14.	Wireless Power Receiver	400	5	2000/-

Total	= 14835/-

Now according to the standard deviation formula equation,

For standard deviation calculation,

N=14

Sum, Σ X: Online price (BDT) + Final expenditure price (BDT)

= 14835

Mean, μ: Sum /N

$= \frac{14835}{14}$

Variance = $\sigma^2 = \frac{1}{N}\sum(xi-\mu)^2 = \frac{14835}{14-1}$ =1141.15

Standard deviation = $\sqrt{Variance}$ = $\sqrt{1141.15}$ = 33.78

2.5. P.E.S.T. Analysis

To assess a project's current situation, future prospects, and strategic course of action, the PEST analysis is an invaluable tool [31]. Businesses and other organizations often do market analyses by considering political, economic, social, and technological (PEST) issues. A PESTLE analysis takes into account other aspects, such as those related to the law and the environment.

Figure 2.2: P.E.S.T analysis [31]

2.5.1. Political Analysis

The analysis of political structures, institutions, ideas, and behaviors, and most importantly, the political processes through which they are constantly formed and changed, is made accessible and engaging in Political Analysis. This project won't require approval from the government to carry out its initiative. This project can be implemented without any restrictions.

2.5.2. Economic Analysis

At first, it ranks projects according to their financial sustainability, allowing for more equitable distribution of available resources. Finding out how much good a project does for people is the objective of this research. It's a fair price, and the project's goal is for it to be affordable for anybody. Through every step of the project's execution, researchers must keep costs in mind.

2.5.3. Social Analysis

Analyzing stakeholder perspectives and priorities and involving as many relevant stakeholders as possible in the development process, are all components of social analysis. This analysis is conducted in the context of the socio-cultural, institutional, historical, and political environment of Bank-financed operations. It's a team project and its target market may be affected by certain societal trends, behaviors, or attitudes

2.5.4. Technological Analysis

Wireless vehicle have been featured in cars for aiding driver awareness of their surroundings and providing warnings to take preventative action in the event of a collision. Recently, technology has advanced to the point where it can act on behalf of a driver to avoid potentially disastrous situations including head-on crashes, backing into obstacles or traffic, or veering out of a delineated lane. The decisions made when driving, riding, and walking have a direct impact on public safety. However, modern automobiles can assist. Automobile safety is nowadays a great concern. So, the app-based authentication system now applies to most the smart vehicles to provide security.

2.6. Professional Responsibilities

The job of an engineer is to make sure that a system, method, or product is safe and effective. To make project a success, engineers must work well in groups and be able to work well with others. Engineers, customers, and businesses need to communicate effectively. Engineers are also responsible for the following:

- Using comprehensive drawings to draw out plans
- Preparing estimates and budgets for projects
- Defining the scope of the project
- Designing experiments in the field of engineering
- Producing customer-facing technical reports
- Completing safety-related regulatory documents
- On-time and within-budget completion of projects

- Informing clients and co-workers of findings and conclusions from the analysis

2.6.1. Norms of Engineering Practice

A "norm" refers to a set of moral rules or standards. To strike a balance between technological and ethical possibilities, normative design should be used while making trade-offs in design. Creating in this manner Engineers are obligated by law to undertake impact assessments to guarantee that designs have a favorable effect on society [33]. As a business owner, it's critical to make sure that staffs feel appreciated. To accomplish the tasks effectively, engineering managers must prioritize the development of the staff's talents. The manager needs to have a clear growth plan and open communication with staff about the abilities, needs, improvements, and aspirations.

2.6.2. Individual Responsibilities and Function as Effective Team Member

This table shows the individual responsibility of the group members. The project responsibility were divided into four categories and distributed to the group members in a suitable manner.

Table 2.2: Individual Responsibilities

Name	ID No	Responsibility
Karim,Merazul	19-40206-1	Project lead
Shafiq,Nahian Bin	19-40041-1	Hardware lead
Hossain,MD.Sakib	19-40007-1	Software lead
Zame,Tousif-ul Islam	19-39870-1	Simulation and designing

2.7. Management Principles and Economic Models

Economists use models to generate testable hypotheses about economic behavior by simplifying their descriptions of reality. Due to the lack of a universally accepted standard for gauging economic performance, economic models are inherently subjective in nature. Economists will arrive at varying conclusions about what is necessary to explain the world as they see it. The two main types of economic models are theoretical and empirical. Under the premise that agents maximize specified objectives within well-defined model constraints (such as an agent's budget), theoretical models attempt to deduce provable implications regarding economic behavior. They give in-depth analyses of complex issues, including the effects of asymmetric knowledge (where one party to a transaction knows more than the other) and the most effective ways to deal with market failures. Empirical models, on the other hand, try to turn the qualitative predictions of theoretical models into more concrete numerical outcomes. For instance, if we were to use a theoretical model of an agent's consuming behavior, we may predict that the outlays would increase as their income did. The theoretical model would be empirically adapted to try to put a dollar amount on the typical percentage rise in spending that occurs with a percentage increase in income.

2.8. Summary

Discussed in this section are the project's objectives, budget, task management, and SWOT analysis, as well as any potential dangers or advantages. Researchers can have faith in their decision to carry forward with the study because of what they have learnt from past initiatives and expense estimations. Due to the specified stakeholders, many more people will be able to take use of a wide variety of new possibilities.

Chapter 3

METHODOLOGY AND MODELING

3.1. Introduction

In terms of complexity, the proposed vehicle is simple. Construction-wise, it's a breeze compared to gas-powered cars. Design of an electric car. Two motors and their controllers, a reversing circuit, a battery pack, a solar photovoltaic (PV) module with a charge controller, and a speed controller are the essential components both controllers share a common accelerator to trigger. When the brakes are applied, the motors will stop running because of the brake switches. When you turn the car in the opposite direction of a motor, that motor will shut down. To accomplish this while the vehicle is in motion, the two phases and two control wires are switched. The reverse button is conveniently located on the steering column. To eliminate cumbersome cords, magnetic resonance technology has enabled wireless power transmission (WPT). Actually, the WPT uses the same fundamental principle as inductive power transfer, which has been studied and refined for at least three decades. As a field, WPT has seen remarkable advancement in recent years. power in milliwatts to kilowatts, the power transfer distance grows from a few millimeters to a few hundred millimeters at a load efficiency of higher. With these improvements, the WPT is increasingly appealing for use in stationary and dynamic EV charging applications. The technologies discussed in this session that can be used for EV wireless charging can be found in the Wide Power Transmission (WPT) domain. The problems of limited range, high costs, and inconvenient charging for EVs can be readily overcome with the implementation of WPT. Electric vehicles (EVs) have reached critical mass, and battery technology is no longer a limiting factor. We anticipate that researchers will be inspired by the state-of-the-art results and will use this motivation to further WPT and EV.

3.2. Block Diagram and Working Principle

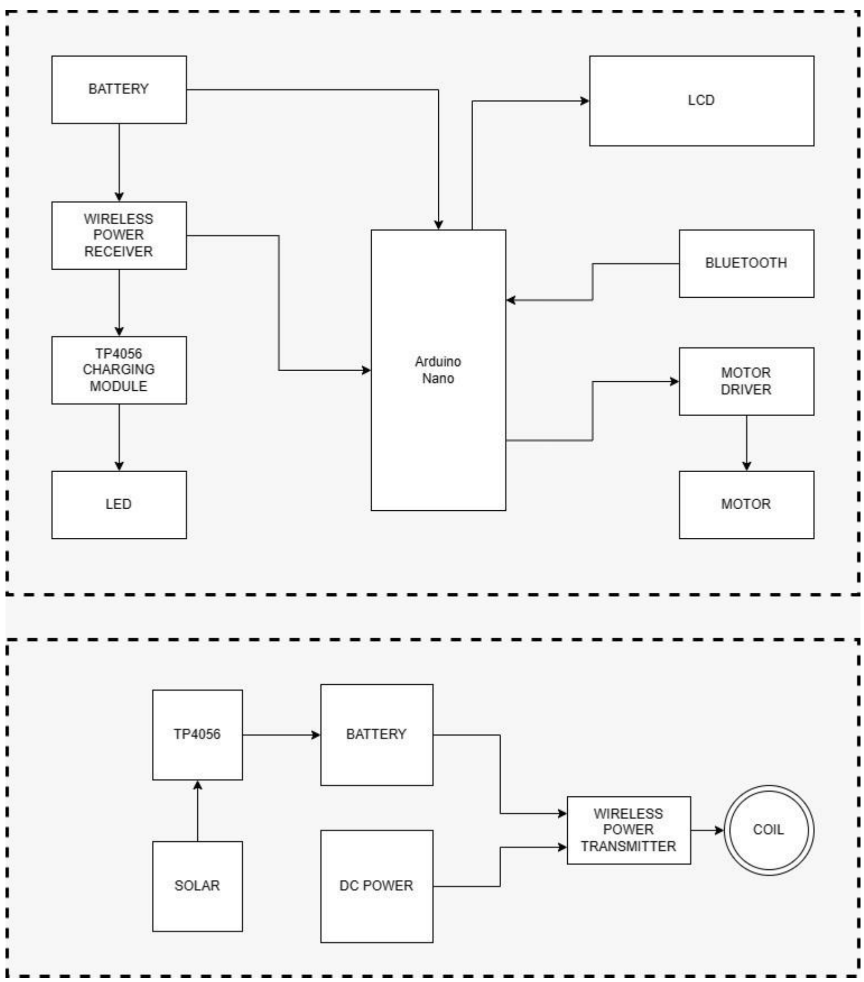

Figure 3.1: Block Diagram of the project

The transmitter coils are charged by a solar panel, which in turn charges the battery, which is then stored in the regulator. To avoid energy waste, the primary and secondary coils of a transformer are connected via a magnetic field that must be directed by the transformer's core. An induced electric current is recorded by the receiver coil as the net magnetic flux from the stimulated spin system oscillates. That wirelessly charges the receiver coil. The atmega controller is powered by the DC power generated by the AC to DC converter once the ac power has been converted. The vehicle's initials can be displayed on an LCD screen that has been integrated into the system.
That's just how the system works.

3.3. Modeling

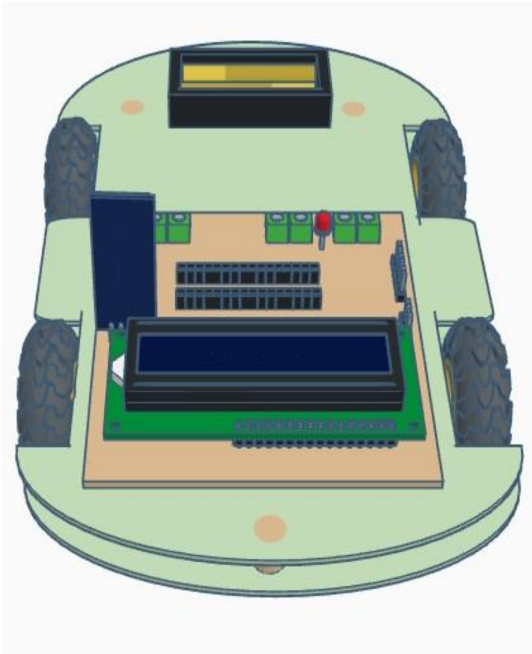

Figure 3.2: 3D model of Vehicle

Figure 3.2 illustrates the front view of the vehicle which is built in this project along with the used components and equipment.

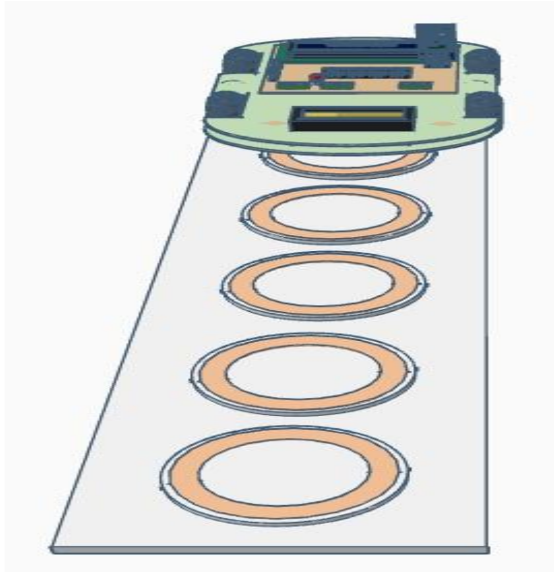

Figure 3.3: 3D Prototype for Road Figure 3.3 illustrated the total project summary.

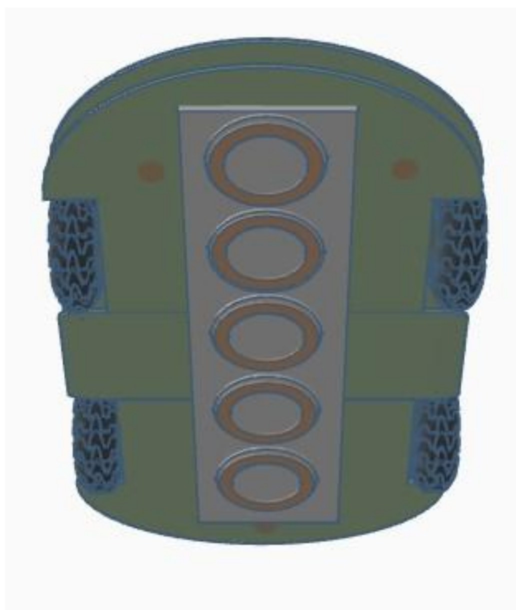

Figure 3.4: Receiving Coil

Figure 3.4 shows the coil situated beneth the prototypes vehicle design.

In fusion 360, a three-dimensional model was developed. The 3D model illustrates in detail how the whole mechanism is put together. It covers all of the necessary components and hardware, in addition to the locations of those components and gear. In addition, the movable components of the project are included in the hardware. A led shines light on the components of the car, which are grouped in the shape of a circular.

3.4. Summary

The rising need for fuel and the severe environmental pollution caused by the use of carbon-based vehicles make it urgently imperative to adopt a new energy source, such as solar power, which would be inexpensive, efficient, inexhaustible, and, of course, environmentally beneficial. As there is no burning fuel or exhaust in solar-powered electric vehicles, they are completely risk-free to operate. The vehicles produce no emissions of any kind and are completely silent and odorless. They can be charged quickly and easily almost anywhere, have fewer potential points of failure, and require less upkeep overall than conventional alternatives. Without a doubt, it's a fantastic value. Industries, college campuses, theme parks, etc. are only some of the potential markets for the solar-powered EV. Green transportation is aided by the SPEV's technological innovations.

Chapter 4

PROJECT IMPLEMENTATION

4.1. Introduction

The study of vehicle motion as it relates to practical user operations is known as vehicle dynamics, an area of engineering. It's a practical field that's put to use with a certain class of goods, in this case automobiles. Mechanical engineering/machine design is always a part of vehicle dynamics, but so are Control/Signal engineering and Human Behavioral Science.

4.2. Required Tools and Components

Figure 4.1: Arduino Uno [22]

When learning how to code for embedded systems, the Arduino Uno is the best board to use. This Arduino Uno board is great for tinkering if you're just getting started in this industry. The whole PCB layout and schematic for this open-source Arduino platform is available online. An extensive Arduino Uno home automation and Internet of Things project lesson may also turn up in a web search. The Arduino Software Development Environment (IDE) is used to program all Arduino boards and is available at no cost. The Arduino Software Development Kit (IDE) is available for download on Windows, Linux, and Mac computers. There are rumors that there are third-party mobile apps available for programming Arduino Boards. This makes me happy.

Figure 4.2: Lithium-ion [23]

Single cell 3.7V 1 Ah or higher lithium-ion (Li-Ion) cells, such 16550s, that don't have their own protection circuit can be safely charged using this compact module, the TP4056 1A Li-Ion Battery Charging Board Micro USB with Current Protection. The TP4056 charger IC and DW01 battery protection IC power this module, which provides a continuous 1A charge current before automatically shutting off. In addition to safeguarding against over-voltage and reverse polarity connection, the safety IC turns the load off when the battery voltage goes below 2.4V to prevent damage to the cell (it will usually destroy itself instead of the battery)

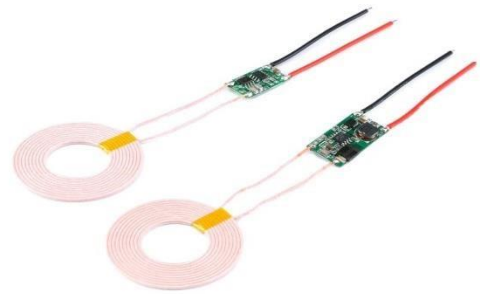

Figure 4.3: Wireless coil [24]

With its tiny size, easy usage, high efficiency, and low price, the 5V 2A Large Current Wireless Charger Module Transmitter Receiver Charging Coil Module is ideal for the creation and design of a wide range of small electronic devices, wireless charging, and power supply.

Mobile phone wireless charging, video game consoles, tanks, digital audio players, digital still and video recorders, electric razors, adult entertainment items, machine learning, healthcare, and many other applications all benefit from this technology. The goods are completely sealed, making them waterproof and dustproof; this is made possible using a Contactless charging power source.

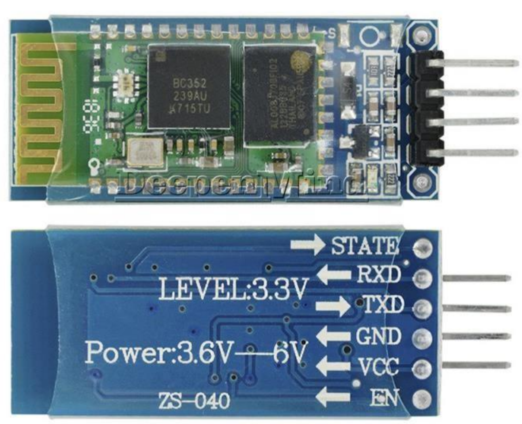

Figure 4.4: Arduino Bluetooth Module (HC-06) [25]

The HC-06 is a class 2 slave Bluetooth module designed for transparent wireless serial communication. Once it is paired to a master Bluetooth device such as PC, smart phones and tablet, its operation becomes transparent to the user. All data received through the serial input is immediately transmitted over the air.

Figure 4.5: LCD display [26]

LCD Display with a yellow and blue lighting. It works wonderfully with Arduino-based creations. This 16x2 standard LCD with a yellow/blue backlight is simple to connect to an Arduino or other microcontroller. Displayed information can be either plain text or numeric values read from the sensors (such as temperature or pressure) or even the number of cycles the Arduino is now executing.

4.3. Implemented Models

4.3.1. Simulation Model

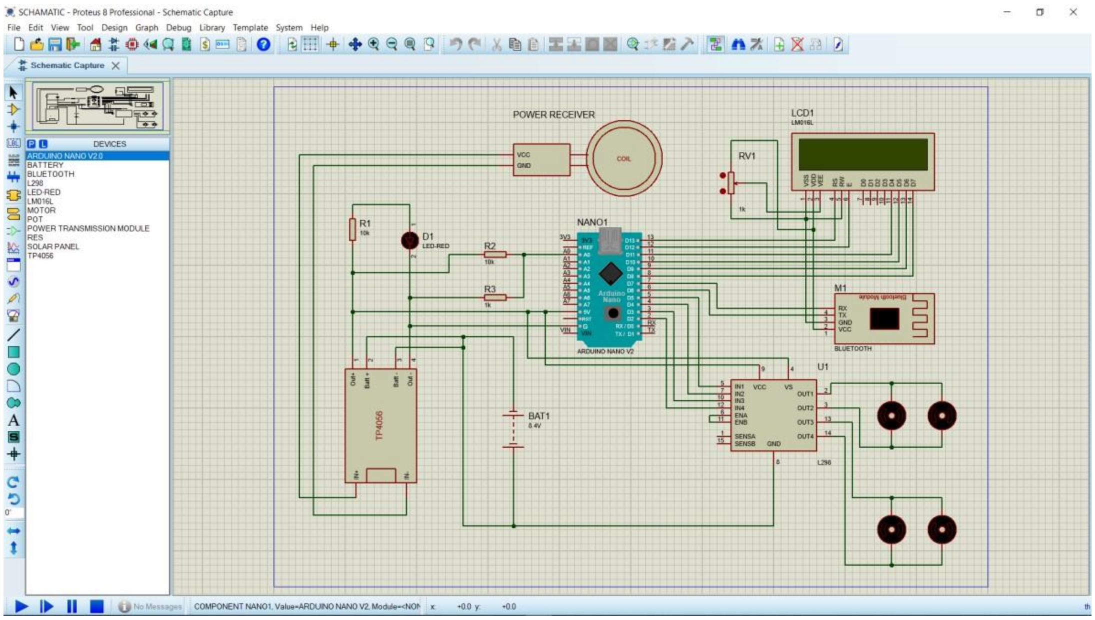

Figure 4.6: Proteus Simulation

This figure shows the proteus simulation of the vehicle control device. Here it can be seen that Arduino Nano is been used along with all the components of the project.

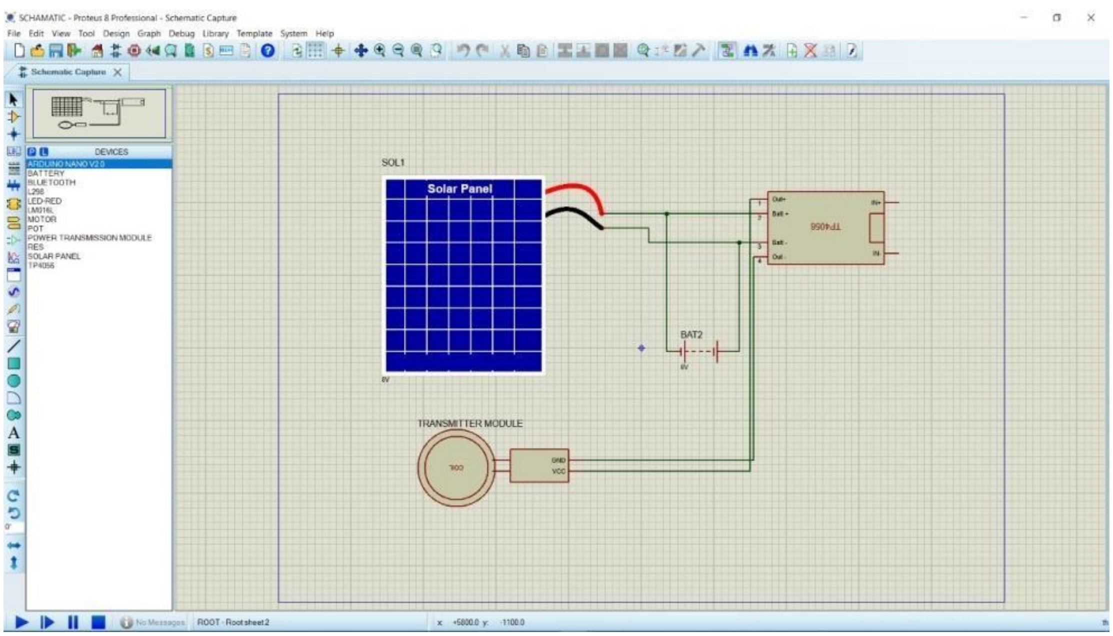

Figure 4.7: Proteus Simulation Transmission Part

This figures illustrated the power distribution of the project. Solar and the wireless system of the vehicle

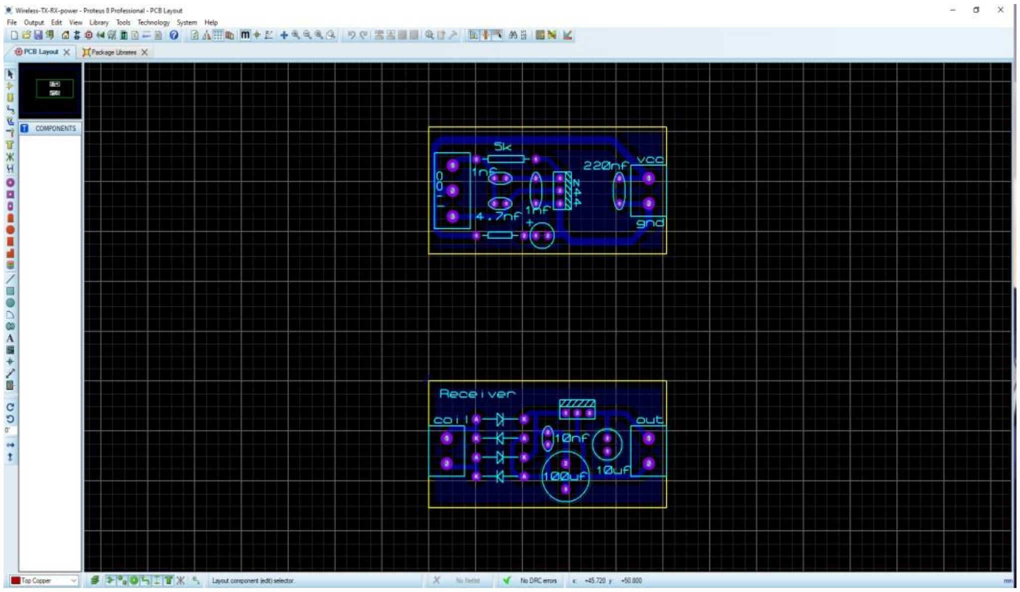

Figure 4.7: PCB design

This is the PCB layout of the receiver which is made manually.

4.3.2. Hardware Model

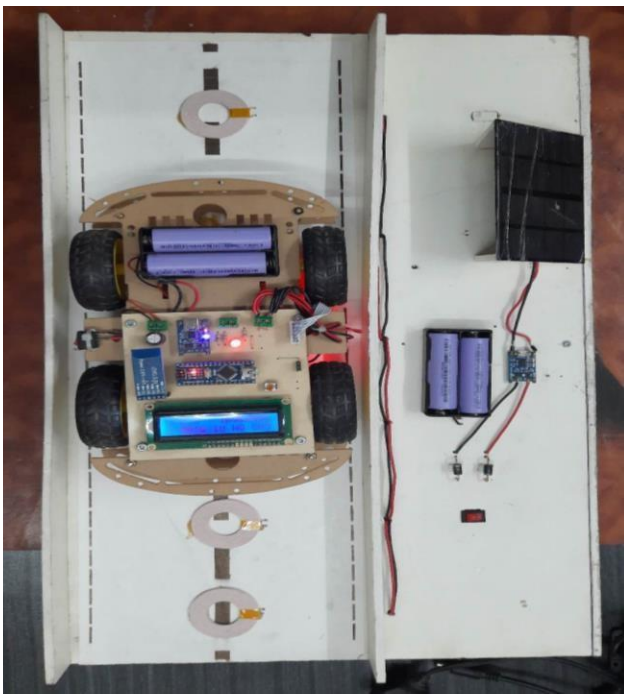

Figure 4.8: Full implemented hardware while operating

4.4. Engineering Solution in accordance with professional practices

So as to reach this objective. The numerous vehicle components were conceptualized, modeled, simulated, and analyzed with the help of computer assisted design (CAD) and auxiliary software. The vehicle's subsystems can be classified as either mechanical or electrical engineering. Cost, design adaptability, manufacturability, assembly purposes, and overall safety were used to determine the winning concepts. Models were created based on the chosen designs for the subsystems. To ensure that there would be no assembly-stage clearance problems, the models were then combined with the rest of the system. Some components were thoroughly tested in simulation before being bought or made. The chassis and the transmission are two examples of these components. Those aforementioned subsystems were built with the help of direct assistance. Simulation and analysis of additional subsystems are needed to ensure their security. Now that it's done, the production of the remaining parts may proceed as scheduled.

4.5. Summary

The project calls special attention to both mechanical and electrical technical details. All parts must be practical in the context of the Shell Eco-urban marathon's concept category. Raw materials will be obtained and components will be made to order.

Chapter 5

RESULTS ANALYSIS & CRITICAL DESIGN REVIEW

5.1. Introduction

Conductive charging refers to the more commonplace connected or plug-in methods of power delivery. However, there are a few issues with these hardwired charging methods. As an illustration, they need bulky charging cables and plugs. On top of that, both the power source and the gadget being charged must be attached to the charger by hand. Furthermore, the tethered charging solution is not pleasant to either users or the environment. There is a risk of a lethal electric shock if the insulation on the charging line breaks down owing to factors like excessive temperature or friction with the ground or the charging device itself. Using a large number of batteries or exchanging spent ones for fresh ones can cut down on charging time and the associated risks. If a specific quantity of batteries allows a car to drive a certain distance on a single charge, adding more batteries will expand the car's range. Alternately, at charging stations along the route, the vehicle's batteries can be swapped out for fully charged ones. But the batteries have their own issues. The batteries are expensive to buy and cumbersome to carry around, but they only last a short time before they need to be replaced. It may be impractical to transport more than a specific quantity of batteries due to their weight. If energy storage devices can be improved in the future, maybe we can solve these issues. However, the WPT is another option for addressing the batteryrelated issues. Use of the dynamic wireless power charging system, for instance, can eliminate the need for large, heavy batteries and lower the whole system's entry price. As a result of not having to deal with the clutter of wires and connectors typically found in manually plugged-in charging systems, the WPT technique is also very practical and user-friendly. As a result of its potential utility in many different industrial and engineering contexts, WPT and its practical implementations are the subject of extensive research. Application areas for WPT include electric cars (EVs), electronic gadgets.

5.2. Results Analysis

5.2.1. Simulated Results

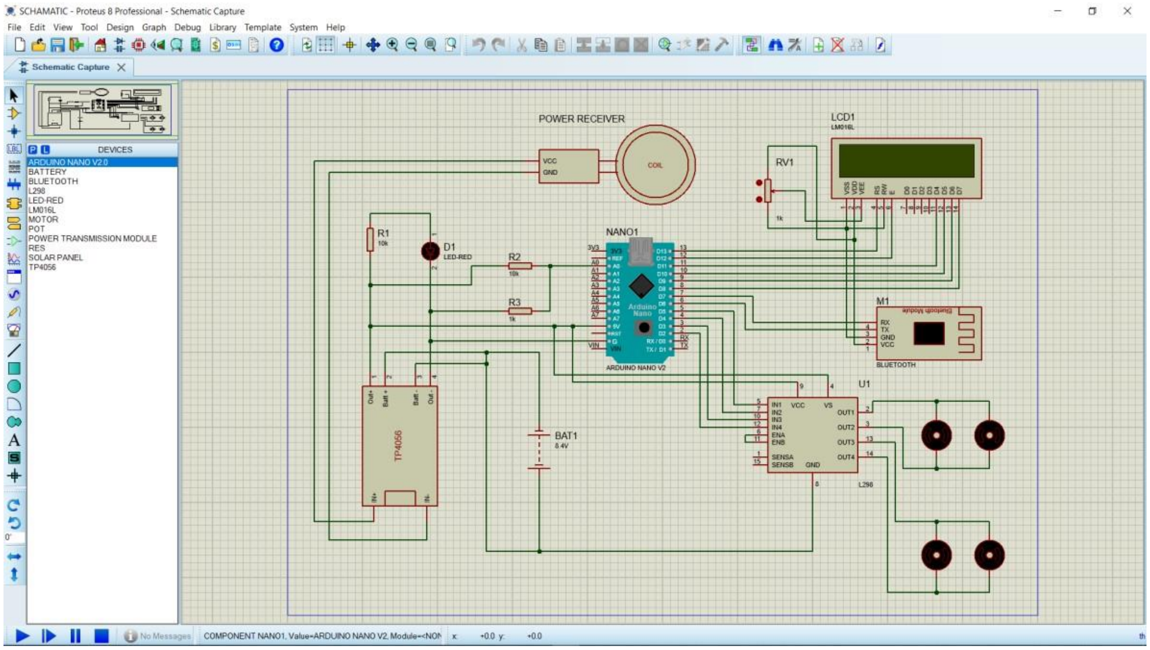

Figure 5.1: Proteus Simulation

5.2.2. Hardware Results

Figure 5.2: Both transmitting and receiving signal of coil for best case scenario

Figure 5.3: Both transmitting and receiving signal of coil for mid case scenario

Figure 5.4: Both transmitting and receiving signal of coil for worst case scenario

The “best case scenario”, term represents when three coil of both transmitting and receiving side are fully up to each other, “mid case scenario”, represents when both side’s coils are up to each other but not fully align. “Worst case scenario”, represents when two coils in both side are fully up to each other and that has considered as the worst possible case while charging the vehicle. The yellow-colored wave represents transmission and green colored wave represents receiving signal. After analyzing these three figure it can be consider that where the transmitting wave shape is always same while the receiving wave shape for three case is totally different. For best case, both signal are almost same, then for the mid case the it get low and for the worst case scenario that signal reached its lowest possible shape. This whole process represents the change of power for different cases.

At this time, we are also monitoring the input voltage with an atmega microcontroller and displaying that data on an LCD. In this way, the technology showcases a road-integrated, solarpowered wireless charging system for EVs.

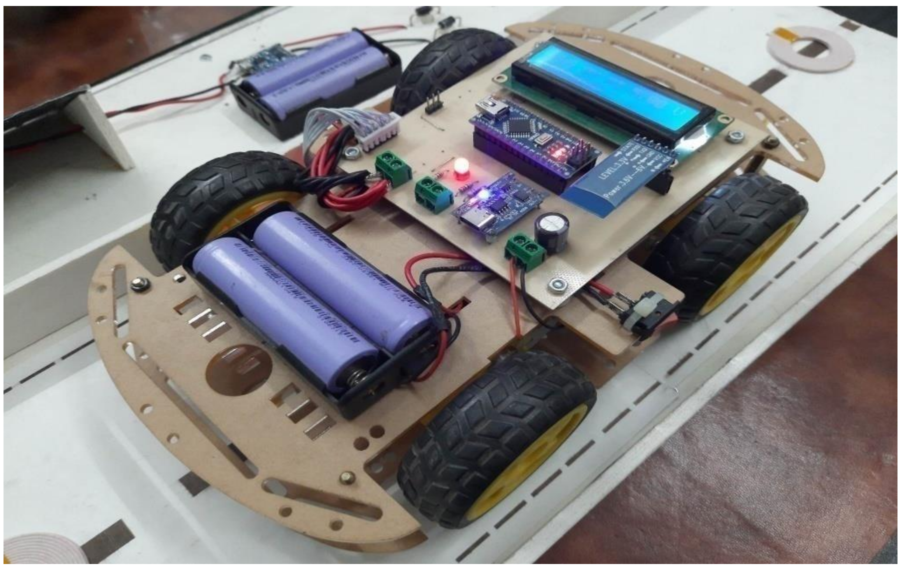

Figure 5.5: Output Voltage monitoring

A transformer and regulator circuits change the DC electricity to AC and keep it stable. Copper coils used in wireless energy transmission are now powered by this energy source. The electric vehicle also features a copper coil installed in its undercarriage.

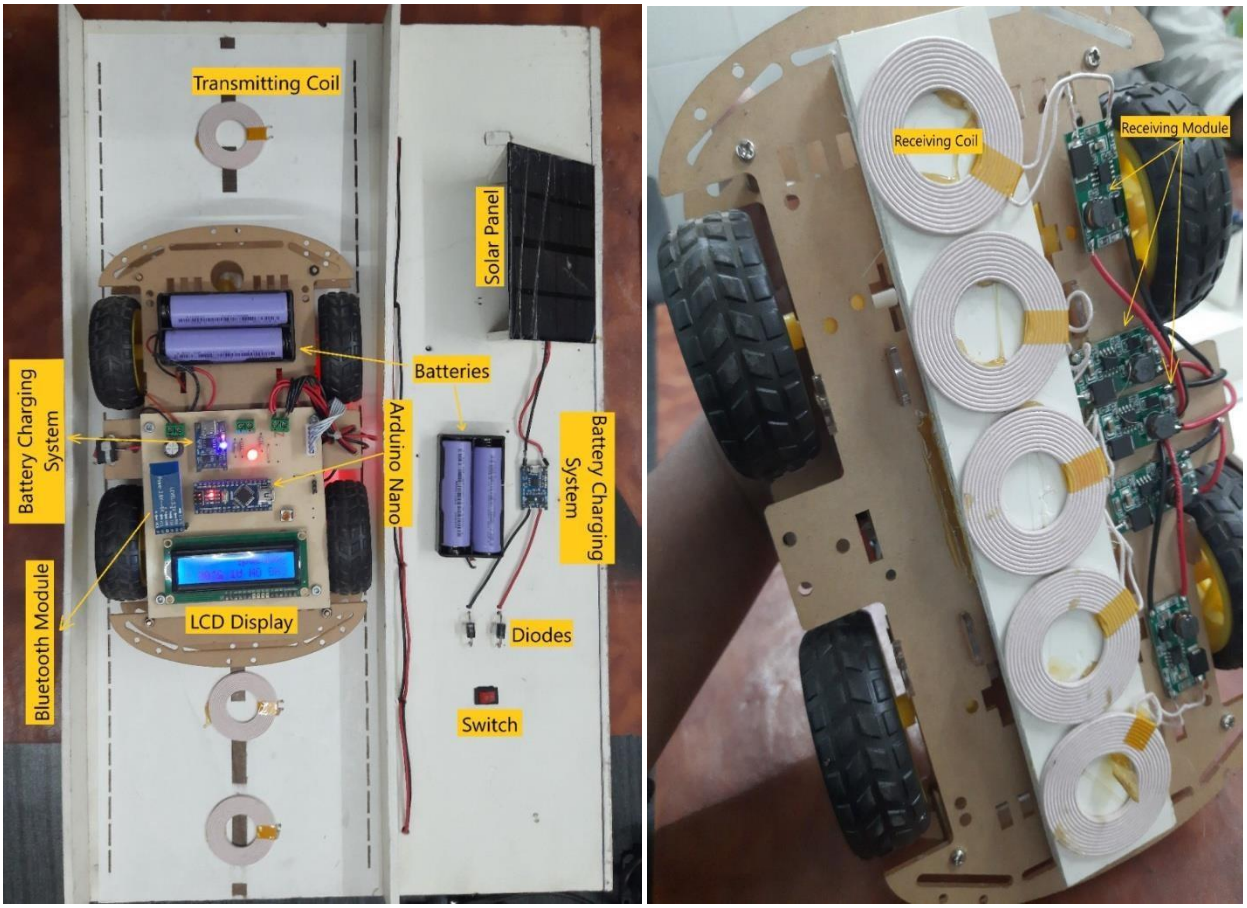

Figure 5.6: Reading of overall output voltage on best case scenario

Power is sent from the transmitter coil to the ev coil as the vehicle travels through the coils. Keep in mind that the energy being inducted into this coil is still DC current [16]. To charge the EV battery, we must now convert this back to DC. In order to get DC current again, we require an AC to DC converter.

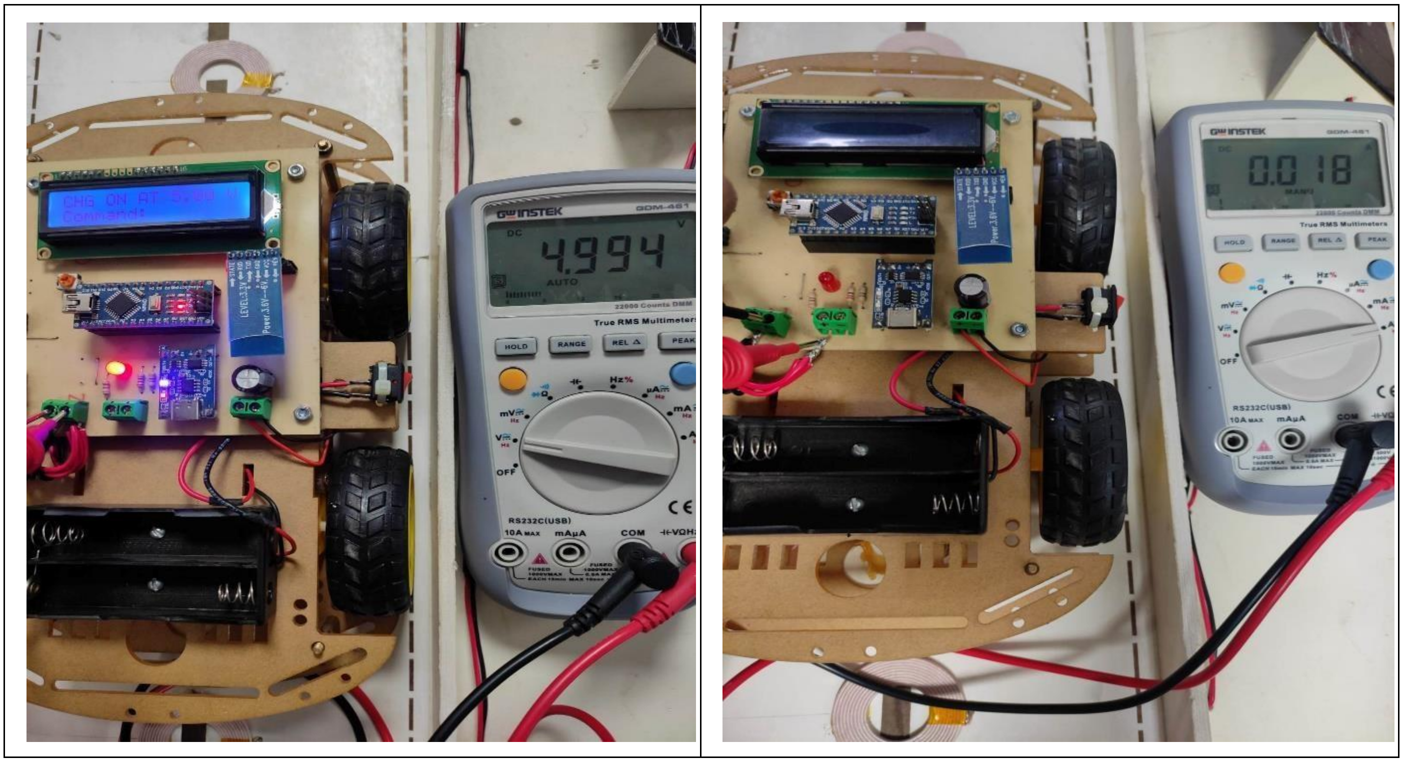

Figure 5.7: Transferred output voltage and current for best case scenario

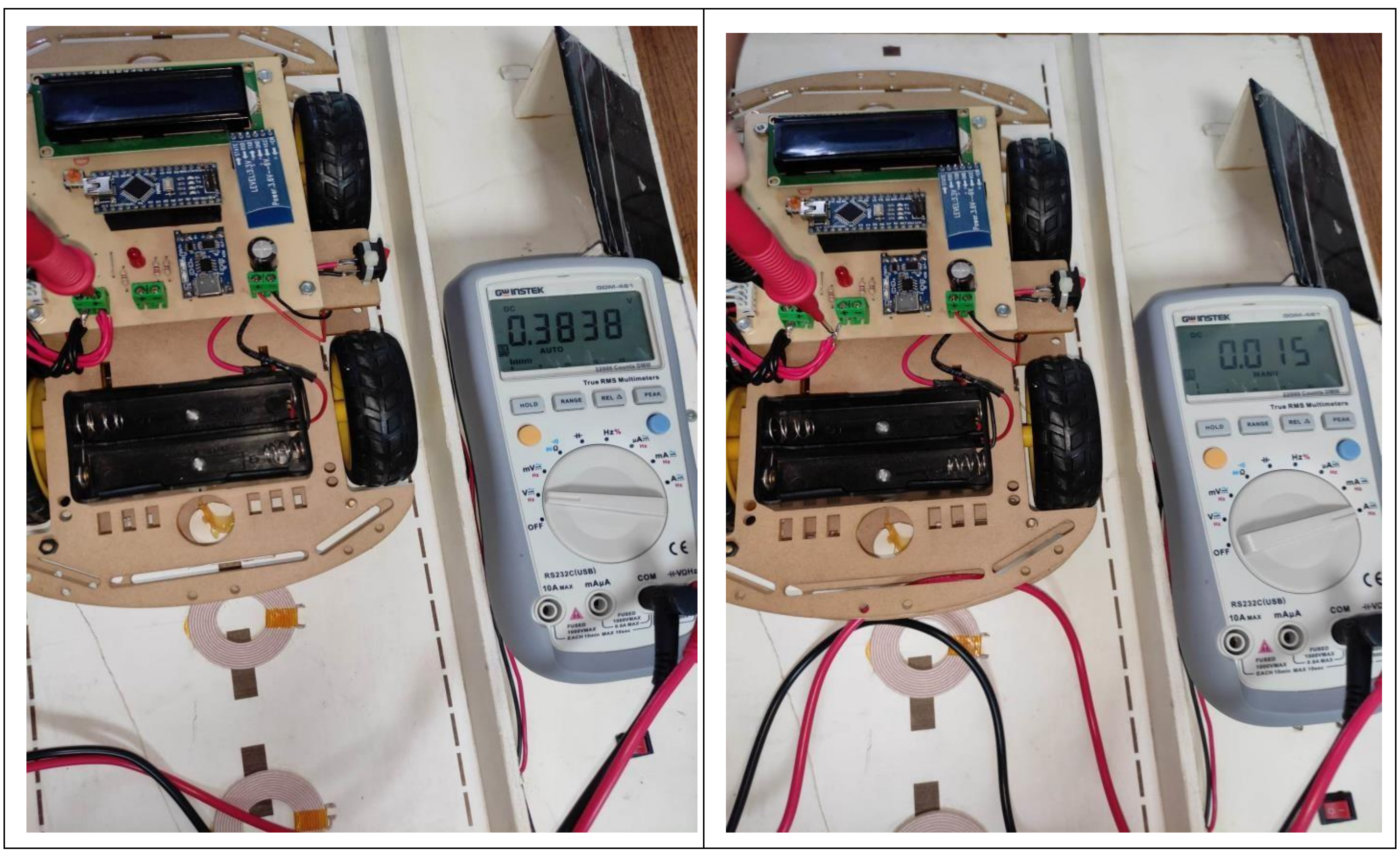

Figure 5.8: Transferred output voltage and current for best case scenario

The DC output voltage and current for the best-case scenario are 5 volt and 0.018 ampere.

After putting this value on a power equation P=V*I,

Power, P = 5*0.018

=0.09 watt or 0.1 watt

And the DC output voltage and current for the worst-case scenario are 0.39 volt and 0.015 ampere.

Similarly, power will be,

Power = 0.39*0.015

=0.006 watt

5.3. Comparison of Results

an instructional and research-focused wireless power transfer (WPT) system on electric vehicle (EV) charging. Based on coupled magnetic resonance technology, which allows for the transfer of power in the non-radiative near field, the simulation. The topology of a streamlined power transfer system is suggested and put into practice. It is done to simulate and analyze the proposed charging scheme mathematically. Based on this architecture, simulation and analysis were done on the counter-electromotive force (counter EMF, CEMF) in the receiving coil in relation to constant transfer distance and driving frequency. Significant implications are drawn from the simulation analysis of the wireless charging system, and specific design recommendations are offered. The simulation can be employed as a tool for additional investigation into WPT optimization for EVs.

It is cumbersome, costly, and dangerous to charge an electric vehicle battery with a charger and wire. If drivers are to make long trips, electric vehicle charging stations must be available. A series of these stations must be placed strategically to span large distances. Additionally, recharging a battery completely often takes three hours, which is a lot longer than the time required to refuel a gas-powered car. unsecured charging cords on the floor could be a tripping hazard. In colder climates, leakage from outdated, damaged cable may present the owner with additional concerns. The efficiency of wireless power transmission can be affected by variations in lateral distance and primary-secondary coil spacing. Anxiety about a car's range, or the concern that it won't have the power to reach certain distances

5.4. Summary

There will be an increase in the use of electric vehicles and corresponding charging stations in the near future. The ability to charge electric vehicles will be crucial. The lack of a widespread charging network is the biggest obstacle to increasing EV demand in the market. We looked at the portable EV charger that uses renewable energy to shorten the recharging period for electric vehicles. The work presented herein presents a novel service to long-distance electric vehicle travelers using a hybrid power system for a vehicle battery charging station. However, there is a lack of convenient charging sites for drivers of electric vehicles along interstates and highways. To avoid plugging in, the wireless EV charger is the best option for charging their automobiles.

Chapter 6

CONCLUSION

6.1. Summary of Findings

Electric cars (EVs) are essential in the present when the environment has worsened so significantly. The government of plans to completely phase out diesel cars by the year 2030. Because waiting for an electric vehicle to charge is the biggest drawback to EV adoption, rapid charging technology and charging stations are essential to the widespread acceptance of EVs. A reliable charging network will be essential to the success of this shift. The broad adoption of EVs has the potential to significantly disrupt the reliability of the power grid. A renewable energy system is at the heart of the "solar-based wireless EV charging" initiative. A lead-acid battery stores the electricity generated from the sun. The BMU allows for the installation of a completely wireless charging infrastructure. This saved power is used to refuel EVs.

6.2. Novelty of the work

When remote charging is fully implemented, it will provide a number of benefits. True freedom: Self-driving cars are still in the development stages; therefore their use is not universally recognized just yet. Until there is a pressing need to halt the flow of traffic in order to charge individual vehicles, the traffic may continue on its merry way. As a result, their applicability and utility may increase. To avoid the need for a charging station: No strong reason exists to integrate a link with remote charging, suggesting that this method is more straightforward. Now you can go about your day without worrying about remembering to charge the car; it will take care of it on its own. Miniature battery packs: Since there are now more places to charge, the battery pack may be made smaller. The vehicle's price and weight are both reduced because of this.

6.3. Cultural and Societal Factors and Impacts

Rather than implementing the higher targets roads to be constructed every day, developing countries should reduce the aim and develop solar road to strengthen the economy with infrastructure. An electric vehicle's range can be significantly increased by using a wireless dynamic charging technology while the vehicles are in motion. When using an electric vehicle (EV), there will be no need to locate a charging station, and drivers would not have to worry about running out of juice. Solar highways are responsible for conceptualizing and developing solar road technology. Strong work is needed to examine solar energy systems and to implement them. Glass with the required transparency, self-cleaning abilities, and traction and impact resistance To prevent flux leakage and short circuits caused by cables, several different solutions have been developed for wireless power transmission systems. Researchers in the field of wireless power transmission will find this information useful. Cars may now be operated with greater efficiency and higher quality criteria thanks to wireless power transmission. The generation of electricity from renewable sources is a current focus of this project.

6.4. Limitations of the Work

As a result of these and other benefits, electric vehicles (EV) are being considered as a viable alternative to the more common internal combustion (IC) engine cars in the transportation sector. Most EV owners today opt for wireless charging of their batteries rather than the other available options. In this work, we conduct a comprehensive analysis of the current literature on the topic of wirelessly charging an electric vehicle's battery. The electric vehicle battery can be charged using either a static EV charging approach or a dynamic EV charging technique, both of which transfer power wirelessly. Although both inductive and capacitive methods can be used to transfer power during static wireless EV battery charging, only inductive methods are used during dynamic wireless EV battery charging. This paper provides a comprehensive examination of these methods, covering everything from the many converters and controllers used in a WPT system to the various types of core utilized in magnetically linked inductors. A static wireless EV battery charging system's design and corresponding circuit analysis are also offered here. In addition, this study explains the difficulties of wirelessly charging EV batteries and the progress that will likely be made in this area in the future.

6.5. Future Scopes

In light of the new policies and technology that emerge. The purpose of this section is to speculate on the WEVC of the future. Today, electric vehicle stockpiles around the world are growing rapidly.

How to guarantee a sustainable rise of EV ownership and how to allow full play of scalable development are two potential orientations in WEVC under the trend of industrial prosperity. Furthermore, developing technologies, materials, and theories can help WEVC become even more competitive. Additionally, power electronics can gain by using modern materials. For one reason, switching loss is a significant cause of energy waste in a WEVC system, alongside flux leakage. Though static WEVC can free up operators' hands, it does little to improve charging station adaptability. Here, the benefits of dynamic WEVC become clear. Broadly speaking, trambased and on-road varieties of this technology exist.

6.6. Social, Economic, Cultural and Environmental Aspects

6.6.1. Sustainability

Inductive chargers, which use wireless power transfer, have an induction coil that generates an electromagnetic field within the charging station. The magnetic field's kinetic energy is absorbed by a second induction coil in the portable device, which then turns it into a current that may be used to charge the battery. To prevent energy loss and safeguard against electrical shock, the resonance frequency of these coils is standardized. Manufacturing and packaging conventional chargers uses a lot of energy and natural resources, while wireless charging eliminates these problems. It also helps cut down on the quantity of harmful and non-biodegradable garbage produced by regular chargers. Wireless charging technology is now being used by multiple companies to power electric automobiles. With the advent of wireless charging technology, electric vehicle drivers no longer have to worry about forgetting to plug in their cars. Dynamic charging for stationary support is provided by this technology, putting range anxiety to rest. Because batteries are so compact, electric vehicles can save both weight and money.

6.6.2. Economic and Cultural Factors

Electric vehicles (EVs) that use inductive charging or other wireless power transfer technologies to charge their batteries from a charging infrastructure are called "wireless charging" or "inductive charging" EVs. Both static and moving wireless charging stations exist for electric vehicles. Electric vehicles (EVs) with dynamic charging capabilities can be charged wirelessly while in motion, while EVs with stationary charging capabilities can charge while parked. One example of a transportation system that uses dynamic charging is the online electric car created at the Korea Advanced Institute of Science and Technology. One of the benefits of dynamic charging, according to a number of studies, is that it paves the way for the use of smaller and lighter batteries by allowing them to be recharged frequently utilizing the charging infrastructure installed under highways. In this study, we use a mathematical optimization model to quantitatively examine the advantages of dynamic charging, based on an economic model of battery capacity and charging infrastructure allocation. In particular, we examine how much money can be saved by decreasing battery size and by how much that decrease may be achieved with the model. Additionally, we demonstrate that dynamic charging can extend battery life.

6.7. Conclusion

Electrical vehicles are the means of transportation of the future because they can maximize the efficiency of charging stations. There will be a major role for electric vehicle charging stations. Increasing EV demand in the market requires addressing the fundamental barrier to EV adoption: a dearth of public charging stations. We looked at the portable EV charger that uses renewable energy to speed up the charging process. The work presented herein presents a novel service to long-distance electric vehicle travelers through the use of a hybrid power system for a vehicle battery charging station. Unfortunately, there is a severe lack of convenient charging infrastructure for drivers of electric vehicles along interstates and highways. The wireless EV charger is the best option for charging their electric automobiles.

REFERENCES

[1] Ram vara prasad, bugatha & geethanjali, m & sonia, m & ganeesh, s & krishna, p. (2022). *Solar wireless electric vehicle charging system*. Interantional journal of scientific research in engineering and management. 06. 10.55041/ijsrem14449.

[2] Ram vara prasad, bugatha & deepthi, t. (2021). *Solar charging station for electric vehicles*. 7. 10.48175/ijarsct-1752.

[3] Singh, sagolsem & hasarmani, totappa & holmukhe, rajesh. (2012). *Wireless transmission of electrical power overview of recent research & development*. International journal of computer and electrical engineering. 207-211. 10.7763/ijcee.2012.v4.480.

[4] Javor, dario & raicevic, nebojsa & klimenta, dardan & janjic, aleksandar. (2022). *Multi-criteria optimization of vehicle-to-grid service to minimize battery degradation and electricity costs*. Electronic ir elektrotechnika. 28. 24-29. 10.5755/j02.eie.31238.

[5] C.e.kennedy and h.price "*progress in development of high temperature solarselective coating*", proceedings of isec2005, august 6-12 2005, orlando, florida,usa.

[6] Society of motor manufacturers and traders: 'ev and afv registrations'.january 2018. Available at https://www.smmt.co.uk/2018/02/january-evregistrations/, accessed 10 march 2018

[7] Society of motor manufacturers and traders: 'ev and afv registrations'.

[8] (January 2018) Available at https://www.smmt.co.uk/2018/02/january-

[9] Evregistrations/, accessed 10 march 201

[10] R. A. Mastromauro, m. Liserre, and a. Dell 'aquila, "control issues insingle-stage photovoltaic systems: mppt, current and voltagecontrol," ieee trans. Ind. Informat., vol. 8, no. 2, pp. 241–254, may. 2012.

[11] Kumar, sujit & paliwal, himani & vyas, shripati & sekhor, sasanka & dave, vikramaditya & rao, srawan. (2021). Dynamic wireless power transfer in electric vehicles. Journal of physics: conference series. 1854. 012014. 10.1088/1742-6596/1854/1/012014.

[12] Bareli, sahar & geri, lidor & nikulshin, yasha & nahum, oren & hadas, yuval & yeshurun, yosef & yaniv, eyal & wolfus, shuki. (2021). Effect of coil dimensions on dynamic wireless power transfer for electric vehicles. 10.36227/techrxiv.14852559.v1.

[13] Patil, devendra. (2019). Dynamic wireless power transfer for electric vehicle.

[14] Ahn w, jung s, lee w, kim s, park j, shin j, kim h, koo k (2012) design of coupled resonators for wireless power transfer to mobile devices using magnetic field shaping. In: 2012 ieee international symposium on electromagnetic compatibility (emc)

[15] Sauras, pablo & gil, andrea & taiber, joachim. (2014). Communication requirements for dynamic wireless power transfer for battery electric vehicles. 10.1109/ievc.2014.7056176.

[16] C. Qiu, k. T. Chau, c. Liu and c. C. Chan, "overview of wireless power transfer for electric vehicle charging," 2013 world electric vehicle symposium and exhibition (evs27), 2013, pp. 1-9, doi: 10.1109/evs.2013.6914731.

[17] Bertoluzzo, manuele & di monaco, mauro & buja, giuseppe & tomasso, giuseppe & genovese, antonino. (2020). Comprehensive development of dynamic wireless power transfer system for electric vehicle. Electronics. 9. 1045. 10.3390/electronics9061045.

[18] S. Y. Choi, b. W. Gu, s. Y. Jeong and c. T. Rim, "advances in wireless power transfer systems for roadway-powered electric vehicles," in ieee journal of emerging and selected topics in power electronics, vol. 3, no. 1, pp. 18-36, march 2015, doi: 10.1109/jestpe.2014.2343674.

[19] Gill, j., bhavsarb, p., chowdhuryb, m., et al.: 'infrastructure cost issuesrelated to inductively coupled power transfer for electric vehicles'. Proc. 5thint. Conf. On sustainable automotive technologies, hasselt, belgium, 2014,vol. 32, pp. 545–552

[20] Rezgui, j., cherkaoui, s.: 'smart charge scheduling for evs based on two-way communication'. Proc. 2017 ieee int. Conf. On communications (icc),paris, may 2017, pp. 1–6

[21] Zhang, l., li, y.: 'a game-theoretic approach to optimal scheduling ofparking-lot electric vehicle charging', ieee trans. Veh. Technol., 2016, 65,(6), pp. 4068–4078[24] zhu, z., lambotharan, s., chin, w.h., et al.: 'a mean field game theoreticapproach to electric vehicles charging', ieee. Access., 2016, 4, pp. 3501–3510

[22] Yang, z., li, k., foley, a.: 'computational scheduling methods for integrating plug-in electric vehicles with power systems: a review', renew.sust. Energy rev., 2015, 51, pp. 396–416

[23] Tushar, w., saad, w., poor, v., et al.: 'economics of electric vehicle charging:a game theoretic approach', ieee trans. Smart grid, 2012, 3, (4), pp. 1767–1778

[24] Ovalle, a., hably, a., bacha, s.: 'optimal management and integration ofelectric vehicles to the grid: dynamic programming and game theoryapproach'. Proc. Ieee int. Conf. On industrial technology (icit), seville,spain, march 2015, pp. 2673–2679

[25] The university of edinburgh: 'weather station data', august 2016. Availableat

https://www.ed.ac.uk/geosciences/weather-station/weather-station-data,accessed 10 march 2018

[26] Jeong, seungmin & jang, young jae & kum, dongsuk. (2015). Economic analysis of the dynamic charging electric vehicle. Ieee transactions on power electronics. 30. 1-1. 10.1109/tpel.2015.2424712.

[27] Kang miao, bidirectional battery charger for electric vehicles, asia (isgt asia) 2018.

[28] Pinto, j. G. Bidirectional battery charger with grid-to-vehicle, vehicle -to-grid and vehicle-tohome technologies, ieee 2020

[29] Xiao lu, ping wang, dusit niyato, dong in kim, and zhu han" wireless charging technologies: fundamentals, standards, and network applications"

[30] Mohammad shidujaman, hooman samani, mohammad arif "wireless power transmission trends ".

[31] D.m. vilathgamuwa and j.p.k. sampath “wireless power transfer (wpt) for electric vehicles (evs)—present and future trends”.

[32] Konrad woronowicz, alireza safaee and tim dickson “effects of parallel load-side compensation in wireless power transfer”.

[33] Juan l. Villa, andrés llombart, and josé fco. Sanz “optimal design of icpt systems applied to electric vehicle battery”.

[34] Fanpeng kong graduate school—new brunswick rutgers, the state university of new jersey “coil misalignment compensation technique for wireless power transfer links in biomedical implants”.

[35] Siqi li, member, ieee, and chunting chris mi, fellow, ieee “wireless power transfer for electric vehicle applications”.

Appendix A

Datasheet of the ICs used

```
#include <LiquidCrystal.h>

#include <SoftwareSerial.h>


SoftwareSerial bth(6, 5);

LiquidCrystal lcd(12, 11, 10, 9, 8, 7);


#define pwm 3

#define IN1 4

#define IN2 2

#define IN3 13

#define IN4 A0


void setup() {

Serial.begin(9600);

bth.begin(9600);   lcd.begin(16,

2);   pinMode(pwm,

OUTPUT);   pinMode(IN1,

OUTPUT);   pinMode(IN2,
```

```
OUTPUT);   pinMode(IN3,
OUTPUT);   pinMode(IN4,
OUTPUT);

  lcd.print("WL Charging Sys.");
delay(1000);   lcd.clear();
}

void loop() {   float voltage =
analogRead(A1);   voltage =
(voltage / 1023.0) * 5;

  lcd.setCursor(0, 0);   lcd.print((String) "CHG ON
AT " + voltage + " V");

  lcd.setCursor(0, 1);
lcd.print("Command: ");   if
(bth.available() > 0) {     char msg =
bth.read();
    Serial.println(msg);
```

```
   if (msg == 'F') {
Forward();
lcd.setCursor(9, 1);
lcd.print("Forward");
   } else if (msg == 'B') {
Back();
lcd.setCursor(9,        1);
lcd.print(" Back  ");
   }

   else if (msg == 'L') {
Left();
lcd.setCursor(9,      1);
lcd.print(" Left  ");
   }

   else if (msg == 'R') {
Right();      lcd.setCursor(9,
1);      lcd.print(" Right ");
   }
```

```
   else if (msg == 'S') {
Stop();
lcd.setCursor(9,        1);
lcd.print(" Stop  ");
   }
 }
 delay(100);
}

void Stop() {
analogWrite(pwm, 0);
digitalWrite(IN1, 0);
digitalWrite(IN2, 0);
digitalWrite(IN3, 0);
digitalWrite(IN4, 0);
}

void Forward() {   analogWrite(pwm,
80); //max 70-255   digitalWrite(IN1,
1);   digitalWrite(IN2, 0);
```

```
digitalWrite(IN3, 0);

digitalWrite(IN4, 1);

}


void Back() {   analogWrite(pwm,

80); //max 70-255   digitalWrite(IN1,

0);   digitalWrite(IN2, 1);

digitalWrite(IN3, 1);

digitalWrite(IN4, 0);

}

void Left() {   analogWrite(pwm, 100);

//max 70-255   digitalWrite(IN1, 1);

digitalWrite(IN2, 0);

digitalWrite(IN3, 0);

digitalWrite(IN4, 0);

}


void Right() {   analogWrite(pwm,

100); //max 70-255   digitalWrite(IN1,

0);   digitalWrite(IN2, 0);
```

digitalWrite(IN3, 0);

digitalWrite(IN4, 1);

}

Appendix B

iThenticate Plagiarism Report

SOLAR WIRELESS ELECTRIC VEHICLE CHARGING SYSTEM

ORIGINALITY REPORT

11%
SIMILARITY INDEX

PRIMARY SOURCES

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