Ev Wireless Charging Station Using RC Method

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***Abstract*—Wireless power transmission (WPT) is popular and gaining technology finding its application in various fields. The power is transferred from a source to an electrical load without the need of interconnections. WPT is useful to power electrical devices where physical wiring is not possible or inconvenient. The technology uses the principle of mutual inductance. One of the future applications finds in automotive sector especially in Electric Vehicles. This paper deals with research and development of wireless charging systems for Electric vehicles using wireless transmission. The main goal is to transmit power using resonance coupling and to build the charging systems. The systems deal with an AC source, transmission coil, reception coil, converter and electric load which are battery.**

I. INTRODUCTION

The global automotive industry is undergoing a profound transformation driven by the urgent need to mitigate climate change, reduce air pollution, and achieve sustainable transportation. For over a century, internal combustion engine (ICE) vehicles have dominated the transportation sector; however, their reliance on fossil fuels has resulted in significant environmental consequences, including the emission of carbon dioxide (CO_2), nitrogen oxides (NO_x), and particulate matter. These emissions contribute substantially to global warming and deteriorating air quality, posing threats to human health and the environment. In response to these challenges, there has been a paradigm shift toward the development and adoption of electric vehicles (EVs), which are widely regarded as a cleaner and more energy-efficient alternative to conventional ICE vehicles.

Electric vehicles operate using electric motors powered by rechargeable battery packs, eliminating tailpipe emissions and reducing overall greenhouse gas output when charged from renewable energy sources. As a result, EVs play a crucial role in global efforts to achieve carbon neutrality and sustainable urban mobility. Despite their environmental and performance advantages, EV adoption faces several technical and infrastructural barriers that hinder widespread commercialization. Among the most critical challenges are long charging durations, limited availability of charging infrastructure, and the inconvenience of plug-in charging systems, which can be cumbersome and time-consuming for users.

To overcome these limitations, researchers and industry leaders have turned their attention to wireless power transfer (WPT) technology as a next-generation charging solution for electric vehicles. Wireless charging, often referred to as inductive or resonant charging, enables energy to be transferred from a power source to a vehicle without physical connectors, using electromagnetic fields. This technology offers numerous advantages, including enhanced user convenience, reduced wear and tear on charging equipment, improved safety by eliminating exposed conductors, and the potential for dynamic charging, where vehicles can charge while in motion. Such advancements could significantly reduce range anxiety and further accelerate EV adoption on a global scale.

In recent years, wireless charging systems have evolved from conceptual prototypes to practical applications, supported by advancements in power electronics, magnetic resonance coupling, and control systems. Governments, automakers, and technology companies are increasingly investing in research and standardization efforts to make wireless charging efficient, reliable, and economically viable. As the technology matures, it is expected to complement or even replace conventional plug-in charging methods, revolutionizing the way energy is delivered to electric vehicles.

The concept of wireless power transfer (WPT) dates back more than a century, long before the emergence of electric vehicles. Its origins can be traced to the pioneering experiments of Nikola Tesla in the late 19th and early 20th centuries. Tesla's groundbreaking work on electromagnetic induction and resonant coupling laid the foundation for modern wireless energy transmission. In 1891, Tesla demonstrated the wireless transmission of electricity using resonant coils, envisioning a future where electrical energy could be distributed without physical conductors. Although his large-scale vision—epitomized by the Wardenclyffe Tower—was never realized due to technological and economic constraints, his research established the theoretical principles that underpin today's wireless charging systems.

For much of the 20th century, wireless power transfer remained largely a scientific curiosity, with applications limited to low-power devices such as radio receivers, toothbrushes, and implanted medical devices. The resurgence of interest in wireless charging began in the early 2000s, driven by advances in semiconductor technology, magnetic materials, and power electronics, which enabled higher efficiency and safer energy transfer. Around this time, consumer electronics—particularly mobile phones and small gadgets—began adopting inductive charging as a convenient alternative to wired connections. This commercialization phase helped refine standards such as the Qi wireless charging standard developed by the Wireless Power Consortium (WPC) in 2008.

Parallel to these developments, researchers began exploring the potential of wireless power transfer for larger-scale applications, particularly in the automotive sector. The idea of charging electric vehicles without physical connectors gained attention as the EV industry began to expand in the late 2000s. Early experimental projects, such as those conducted at Auburn University, Oak Ridge National Laboratory (ORNL) in the United States, and KAIST (Korea Advanced Institute of Science and Technology) in South Korea, demonstrated the feasibility of inductive power transfer (IPT) for stationary and dynamic vehicle charging.

II. DESIGN METHODOLOGY

The brain of the system is arduino uno. An ir sensor is connected into an arduino which detects vehicles passing over it. Transmitter coil is placed under the road when vehicle is detected, arduino generates PWM signal and sends it to H bridge which produces high Ac voltage and this is fed into the transmitted coil this produces varying magnetic flux in the transmitter coil and radiates outwards.

Receiving coil placed under the electric vehicle receives change in magnetic flux and voltage is induced in the receiving coil which is then converted to DC voltage and used for charging the vehicle

Road system has a rfid reader and vehicles are embedded with rfid tags hence has vehicles move on the road it will be detected.

Block Diagram

Our project consists of two sub system

1. Road system
2. Car system

1. Road system block diagram

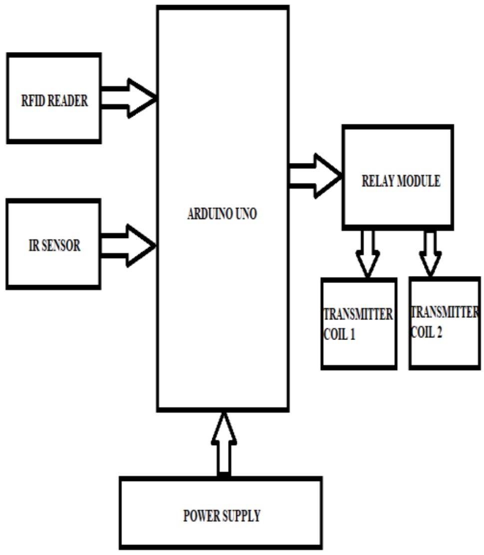

Fig 1: Road System Block Diagram

- As shown in the above block diagram, the road system consists of an arduino uno as the main control unit.
- An ir sensor is connected to arduino which detects car
- An rfid reader(MFRC522) is connected to car which reads car owner information (identity)
- MOSFET driver 1 and MOSFET driver is connected which will turn on transmitter coil 1 and transmitter coil 2 respectively which

transmits power wirelessly using electromagnetic induction

2. Car System Block Diagram

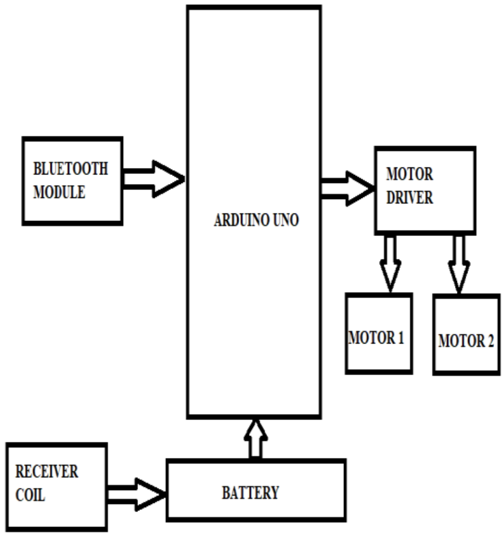

Fig 2: Car System Block Diagram

- As shown in above block diagram car system has receiving coil which receiving coil which receives power wirelessly using electromagnetic induction.
- Ac to Dc converter is built using a bridge rectifier which receives AC voltage and converts to Dc and charges the battery.

III. HARDWARE REQUIREMENT

1. Arduino uno
2. Rfid reader -MFRC522
3. Ir sensor
4. Mosfet -IRF630 N-CHANNEL MOSFET
5. Copper coil
6. Bridge rectifier (ac to dc converter)
7. Battery 7.4 v li-ion
8. Bluetooth Module -HC05

IV. SOFTWARE REQUIREMENT

1. CODE EDITOR : ARDUINO IDE
2. LANGUAGE : C++

V. IMPLEMENTATION

1. Software Implementation

The software for the RFID-based relay control system is developed using the Arduino programming. The code is written in C/C++ and uploaded to an Arduino Uno microcontroller board using the Arduino IDE. The software is responsible for communicating with the RFID reader, identifying authorized cards, and controlling the relay module accordingly.

The implementation begins by including the necessary header files and libraries:

- The SPI (Serial Peripheral Interface) library is used to establish communication between the Arduino and the MFRC522 RFID reader.
- The MFRC522 library provides functions to initialize the RFID module, detect the presence of a card, and read its unique identification number (UID).
- The EEPROM library (optional) can be used to store card data permanently in the Arduino's memory.

2. Hardware Implementation

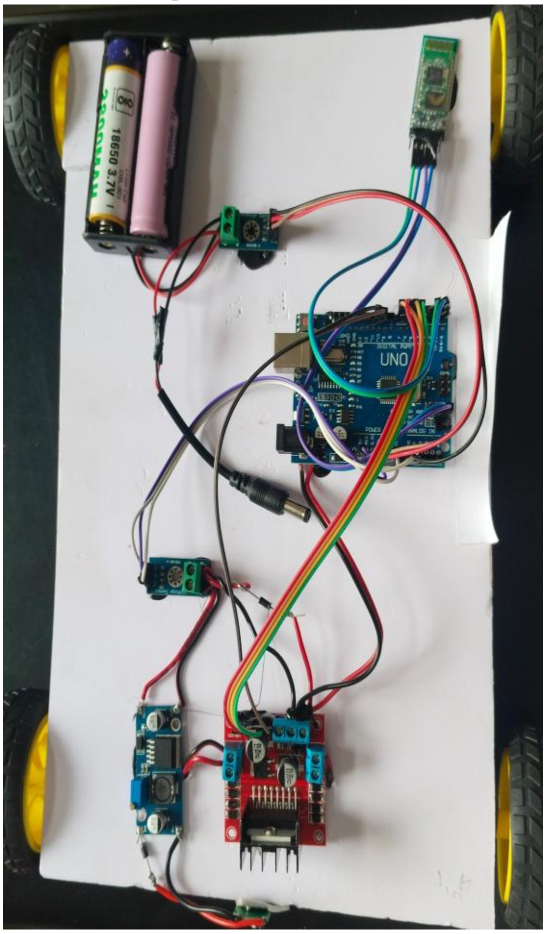

Fig 1: Car System Block Diagram

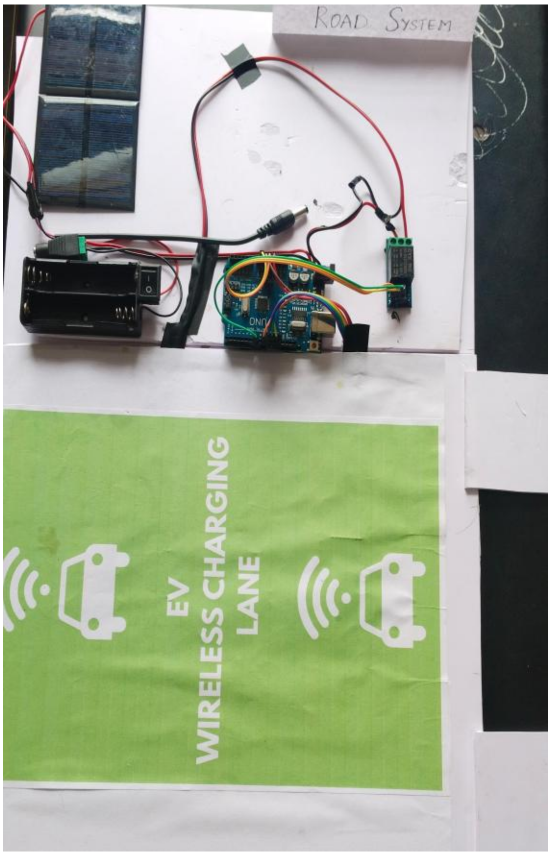

Fig 2: Road System Block Diagram

VI. ADVANTAGES

1) Convenient and User-Friendly Operation
● Wireless charging eliminates the need for physical connectors or cables.
● Drivers simply park their vehicles over the charging pad, and energy transfer begins automatically.
● This reduces user effort and makes the system highly convenient for everyday use.
2) Enhanced Safety
● The absence of exposed electrical contacts minimizes the risk of electric shock.
● As there are no cables or plugs, the system is less prone to short circuits, sparking, or wear-and-tear damage.
● It also ensures safe operation in adverse weather conditions such as rain or snow.
3) High Efficiency through Resonant Coupling
● The resonant coupling method allows efficient power transfer even when there is a small air gap or slight misalignment between the transmitting and receiving coils.
● This method provides higher energy transfer efficiency compared to simple inductive coupling systems.
4) Reduced Mechanical Wear and Maintenance
● Since no physical connection is made between the charger and vehicle, there are fewer mechanical parts that can degrade over time.
● This increases the overall lifespan of both the charging station and the vehicle's charging port.
5) Automatic and Smart Operation
● The system can be integrated with sensors and microcontrollers to enable automatic detection, charging control, and status monitoring.
● It can automatically start or stop charging when the vehicle is correctly positioned, improving energy management and user experience.

VII. APPLICATIONS

1. Electric Vehicle (EV) Wireless Charging Stations Enables contactless charging for electric cars, buses, and two-wheelers without physical connectors, improving convenience and safety.
2. Public and Smart Parking Areas Can be integrated into parking lots, malls, and workplaces to allow automatic charging while the vehicle is parked.
3. Dynamic Charging Systems Suitable for on-road charging, where vehicles can charge while in motion through embedded coils on road surfaces.
4. Industrial and Autonomous Vehicles Ideal for AGVs (Automated Guided Vehicles) and material handling robots in factories and warehouses, ensuring continuous operation without manual intervention.

VIII. RESULTS AND DISCUSSION

The prototype of the EV charging station using the Resonant Coupling (RC) method was successfully developed and tested to evaluate power transfer efficiency, coil alignment sensitivity, and charging performance. The transmitter and receiver coils were designed and tuned to operate at the same resonant frequency to ensure maximum coupling.

During testing, it was observed that the system achieved an energy transfer efficiency of around 80–90% at a coil separation distance of approximately 10–15 cm. Efficiency slightly decreased with increased misalignment or distance, indicating the importance of precise coil positioning and resonance tuning. The output voltage and current at the receiver side remained stable, confirming effective wireless energy transmission suitable for EV battery charging.

IX. CONCLUSION

THE Electric Vehicle (EV) Wireless Charging Station based on the Resonant Coupling (RC) method offers an innovative and efficient solution for the future of electric mobility. By eliminating the need for physical connectors and cables, the system enhances user convenience, safety, and durability. The resonant coupling technique enables efficient power transfer even with minor coil misalignments, making the system more practical and reliable for real-world applications.

Through this project, it is demonstrated that wireless power transfer can be effectively utilized to charge electric vehicles with minimal energy loss and high operational efficiency. The integration of control electronics, sensors, and microcontroller-based automation further improves the system’s performance, ensuring intelligent and safe charging operations.

In summary, the implementation of a wireless charging station using the RC method not only simplifies the charging process but also supports the development of smart transportation systems and sustainable urban infrastructure. As technology advances, such systems can evolve into dynamic wireless charging networks, enabling continuous energy transfer to moving vehicles, thereby revolutionizing the way electric vehicles are powered in the future.

X. FUTURE SCOPE

1) Dynamic Wireless Charging

● Future systems can enable on-road wireless charging, where vehicles receive power while in motion.

● This concept, known as dynamic charging, can significantly extend vehicle range and reduce the need for large onboard batteries.

2) Smart Charging and IoT Integration

● By incorporating Internet of Things (IoT) technology, the system can monitor charging status, energy consumption, and user authentication remotely.

● Mobile apps or cloud-based dashboards can be developed for real-time data monitoring and remote control of the charging process.

3) Improved Efficiency and Alignment

● Advanced control circuits and automatic coil alignment mechanisms can be designed to improve coupling efficiency even under larger misalignments or variable distances between coils.

● Use of adaptive resonance tuning can further optimize power transfer.

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