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WIRELESS ELECTRIC VEHICLE CHARGING SYSTEM

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Abstract **- Vehicles that run on electricity will contribute to the fight against rising fuel costs and greenhouse gas emissions. In electric cars, wireless transmission serves primarily as a short-range power transfer mechanism. An electromagnetic field that is flexible is used in wireless transmission technologies. The project "Automatic Wireless EV Charging System" offers a creative way to improve the sustainability and effectiveness of EV charging. With the use of RFID card identification and Arduino microcontrollers, this method simplifies charging and increases user convenience. Similar to recharge cards, RFID cards are used for simple and safe charging initiation. Physical plugs are no longer necessary thanks to wireless charging technology, which offers a smooth and convenient experience. With RFID cards, users may set the ideal charge length, encouraging efficient use of resources and avoiding overcharging.**

1. INTRODUCTION

The wireless charging system is based on the Arduino microcontroller. There are required components in this program that are mentioned in the subsequent pages. Over the past few decades, continuous research has led to the development of electric vehicles. People are starting to switch to electric vehicles because of global warming and the lack of fuel reserves. Although electric vehicles are

an alternative, there need to be improvements in their charging systems to make them the best mode of transportation. The charging systems need to be upgraded for this purpose. Solid charging systems are very reliable and easy to use. The width can be improved, and the battery size can be reduced. In big cities, this charging system can also be used as effectively as fuel-based vehicles. The cable coil in the base unit creates a magnetic field when the current passes through it. The field sends a stream to the coil. We connect this coil to the car by looking at it as a second turn. If the car, mounted on a coil, reaches the charging pad it will be charged automatically. The method is used to reduce air pollution and aids for reserving natural resources thereby maintaining the eco balance. [1] [2] [3] [4]

1.1 Principle of Operations

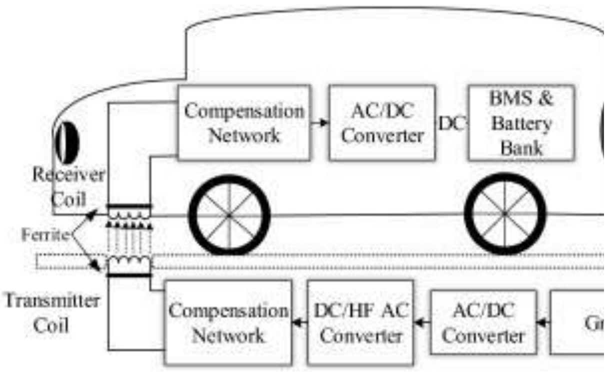

Fig:1:Design of Wireless Charging System

Figure 1 shows the basic block design of the stationary Wireless Charging System (WCS) for Electric Vehicles (EVs). The technology uses grid-supplied AC mains to create high-frequency AC through the use of DC/AC and AC/DC converters. Power transfer from the transmission coil to the receiving coil is facilitated by this high-frequency AC. To improve overall system efficiency, compensatory topologies using series and parallel combinations are incorporated into both the transmitting and receiving sides. The receiving coil, which is usually placed below the car, transforms high-frequency AC from oscillating magnetic flux fields. The constant DC supply produced by the high-frequency AC is subsequently used by the on-board batteries. The system incorporates communications, power control, and a battery management system (BMS) to guarantee steady functioning and reduce any possible dangers to health and safety. Magnetic planar ferrite plates are used at the transmitter and receiver to enhance the dispersion of magnetic flux and reduce any harmful leakage flux. [4] [5]

The introduction of this automatic wireless charging system for electric vehicles is in line with the wider goals of creating a greener and easier-to-use future for electric transport. Perfectly combining RFID technology and wireless charging, the project envisions a paradigm shift in how users interact with and use their electric vehicles. As the automotive industry adopts cleaner and more sustainable practices, this project is at the forefront of technological innovation in electric vehicle charging. Furthermore, a comparison of the many methodologies that are included in wireless power transfer (WPT) technologies is given in the accompanying table for additional assessment and analysis. [5]

WPT methods	Performance		Size/Volume	Complexity of design	Suitability for WEVCS
	Efficiency	Frequency range (kHz)			
Inductive	Medium/High	10–50	Medium	Medium	High
Capacitive	Low/Medium	100–600	Low	Medium	Low/Medium
Permanent magnet	Low/Medium	0.05–0.500	High	High	Low/Medium
Resonant inductive	Medium/High	10–150	Medium	Medium	High

Table 1: Analysis of WEVCS

1.2 Fundamental Circuit

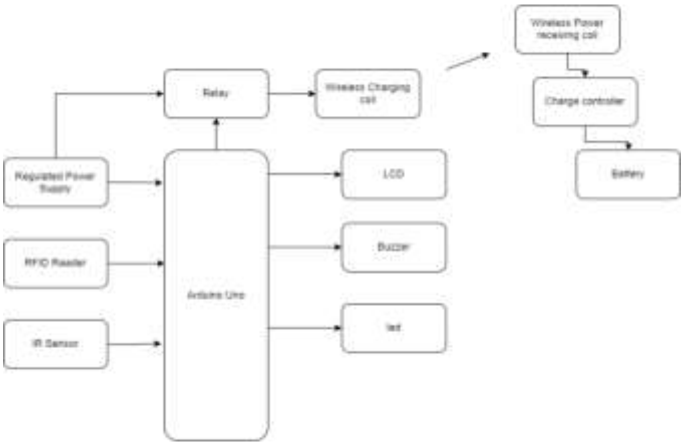

Fig 2: Block Diagram of the charging system

Figure 2 shows the block diagram of the proposed region. A transformer lowers the AC source voltage, which is then converted to DC by a reset circuit. An inverter is then used to convert this voltage to the needed AC voltage. The system transfer coil in the base unit receives the desired frequency voltage. The base unit will be installed on the road in the event of flexible wireless charging. The receiver will be installed beneath the vehicle. Inductive coupling is used to transfer power from the transmission coil to the receiving coil. The power is then adjusted and controlled to suit the battery requirements. Thus, battery charging will occur. [5]

2. IMPLEMENTATION OF WIRELESS CHARGING

Wireless charging helps eliminate the need to hold cables and thus the potential loss of conductivity from the wire can be completely eliminated. Also, handling the wires while loading and unloading the plug can sometimes be dangerous if not done correctly. Thus, human intervention can be avoided for security purposes.

Although wireless charging appears to be time-saving and efficient, it has some limitations. A key part of the implementation is the infrastructural development that must be done to achieve the goal. It requires a significant investment in all stages of the project and is therefore expensive. The first developed wireless charging technology is standard equipment; the system is designed to charge electric cars in garages or public parking lots where the vehicle is not used for a long time. Since there is no need for a portable connection, there has been great interest in the possibility of charging electric cars while moving. Charging an electric car on the go is called flexible charging. [3] [4]

2.1 Static Wireless Electric Vehicle

Wireless Electric Car Charging System (WECCS) allows drivers to simply alter the plug charger, addressing safety concerns such as travel risks and electrical shocks. Figure 2 depicts the fundamental configuration of the current WECCS. The power is converted from AC to DC and then sent via a power converter to a battery bank. In order to prevent any security concerns, power controls and battery management systems have been placed in the wireless communication network to get any response from the main side.

The power of the source, the size of the charging pad, and the separation between the two windows all affect how long it takes to charge. The expected normal spacing between lightweight vehicles is 150-300 mm. It is also possible to mount WEVCS vertically. [3] [5]

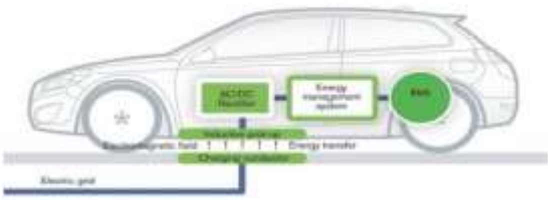

Fig 3: Static wireless EV charging

3. HARDWARE AND SOFTWARE REQUIREMENTS

3.1 Arduino UNO

Fig 4: Arduino Uno

The ATmega328 serves as the foundation for the Arduino Uno microcontroller board. It contains six analog inputs, a 16 MHz crystal oscillator, 14 digital input/output pins (six of which may be used as PWM outputs), a USB port, a power connector, an ICSP header, and a reset button. It comes with everything needed to support the microcontroller; all you need to do is power it with a battery or an AC-to-DC adapter or connect it to a computer via a USB cable to get going. Rather, it has the Atmega8U2 configured to function as a serial-to-USB converter. "Uno" is an Italian word for one, and it was chosen to commemorate the impending introduction of Arduino 1.0. The Uno, the most recent of a line of USB Arduino boards, serves as the platform's reference model. [3]

3.2 LCD Display

Fig 5: LCD Display

The 16x2 LCD gets its name from the fact that it contains 16 columns and 2 rows. The 16x2 LCD is the most often used configuration, however there are other others as well, such 81, 82, 102, and so on. It therefore comprises 32 characters in total, each of which is made up of 588 pixel points. LCD is an abbreviation for liquid crystal display. This kind of electronic display module is utilized in a wide range of circuits and gadgets, including computers, televisions, mobile phones, and calculators. These screens work best with seven segments and multi-segment LEDs. The primary benefits of utilizing this module are its low cost, ease of programming, animations, and limitless display options for unique characters, special effects, and animations, among other things. [1]

3.3 Relay Coil

Fig 6: Relay Coil

Relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations thereof. [1]

3.6 IR Sensor

Fig 7:IR Sensor

Infrared sensors are non-electrical devices used to detect infrared light. Infrared light is a type of electromagnetic radiation that cannot be seen by the human eye, but is detectable by electronic sensors. An infrared sensor usually consists of an infrared source, such as a light emitting diode (LED), and an infrared detector, such as an infrared photodiode (IR phototransistor). The IR source emits infrared light that is reflected off of objects in its way. The reflected light is then detected by the IR detector, which produces an electrical signal that is proportional to the reflected light. [3]

3.7 Induction coils

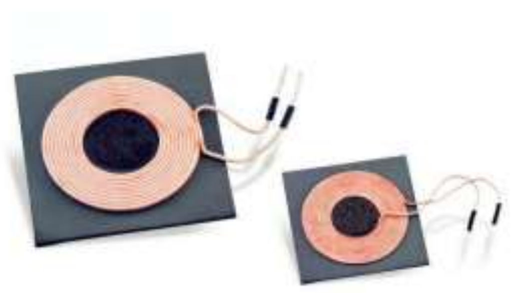

Fig 8: Induction Coils

Typically, an inductor has two types of coils: one that is typically known as the primary coil and one which is commonly used as secondary coil. When an electric current passes through the primary coil, it creates a magnetic field that is connected to the secondary coil. The primary coil acts as a coil that can store the energy associated with the magnetic field. If the electric current in the primary winding is suddenly interrupted, the magnetic field quickly collapses.

This collapse of the magnetic field induces a high-voltage pulse in the secondary winding through electromagnetic induction. This phenomenon is fundamental to the operation of various devices and systems, including transformers, electromagnets and wireless power transmission systems. By manipulating the coupling between the primary and secondary windings, electromagnetic devices can efficiently transfer energy from one winding to another, enabling a wide range of applications in electronics and electrical engineering. [1] [5]

3.7 Wireless Power Transfer Modules

Fig 9: Wireless Power Modules

Wireless power transfer and charging module is a portable power supply that can be used to charge electronic devices from a distance. It consists of a transmitter (a smaller integrated circuit) and receiver (a larger integrated circuit).

The transmitter circuit can be used to replace a wired power supply, and the receiver circuit can be used for close-range charging. The module has a stable output voltage of 5V, and can produce a maximum output of 600mA.

The module is compact and has an insulated coil, which makes it suitable for integration into a variety of wireless projects. It works on the electromagnetic induction principle, where an alternating electric field is generated in the transmitter circuit by an inductive coil.

This electric field is then captured by a second inductive coil in the receiver circuit, which converts the electromagnetic field back into an electrical current. The receiver circuit then outputs a stable voltage of 5V and a maximum output capacity of 600mA, which can be used to power a variety of electronic devices. [3]

3.8 RC522 RFID Module

Fig 10: RFID Card &Keychain

The RC522 is a popular RFID (Radio Frequency Identification) module that operates at 13.56 MHz. It is built around the MFRC522 driver circuit developed by NXP Semiconductors. This module is versatile and can be connected to various communication protocols such as I2C (Inter-Integrated Circuit), SPI (Serial Peripheral Interface) and UART (Universal Asynchronous Receiver-Transmitter). Usually, the RC522 module comes with RFID cards and a lock key when purchased. These RFID cards and keys contain embedded RFID chips that the RC522 module can read and write.The RC522 module is widely used in time attendance systems, access control systems and various person/object detection applications. It enables efficient and convenient identification of people or objects through wireless data transmission between the module and RFID tags.

RC522 Features

- 13.56MHz RFID module
- Operating voltage: 2.5V to 3.3V
- Communication: SPI, I2C protocol, UART
- Maximum Data Rate: 10Mbps
- Read Range: 5cm
- Current Consumption: 13-26mA
- Power down mode consumption: 10uA (min)

RC522 is an RF module consisting of an RFID reader, an RFID card and a key. The module operates at 13.56 MHz, which is an industrial (ISM) frequency, so it can be used without licensing issues. The module normally operates at 3.3V and is therefore often used in 3.3V models. It is typically used in applications where a specific person/object must be identified by a unique identifier.

3.9 Arduino IDE

The Arduino IDE (Integrated Development Environment) is a software tool designed for programming Arduino microcontrollers. It provides a user-friendly interface that allows users to easily write, compile and upload code to Arduino boards. Arduino IDE supports multiple programming languages such as C and C++, so it is versatile for different programs. Although Arduino IDE is the first choice for programming Arduino boards, other IDEs (Integrated Development Environments) such as Eclipse can also be used. , also for Arduino development. However, the Arduino IDE is often popular for its simplicity and ease of use, especially for beginners. One advantage of the Arduino IDE is its compatibility with several operating systems, including Windows, Linux, and macOS. This allows users to work with Arduino boards on any desired platform without special drivers or additional components. In addition, a transcompiler is a tool that compiles code to a target platform other than the one it was programmed for. This can be useful if you are developing software for embedded systems or other platforms where the development environment may differ from the target environment. However, for Arduino development, the Arduino IDE usually handles target platform translation automatically, simplifying the development process for the users. [3]

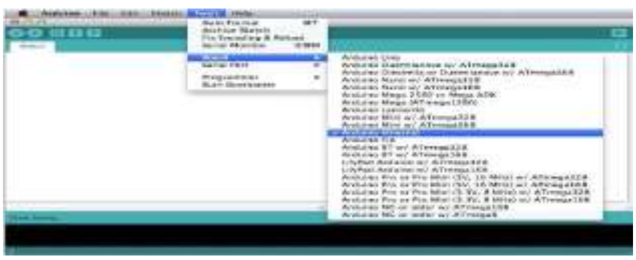

Fig 11: Arduino IDE

4. CIRCUIT SETUP

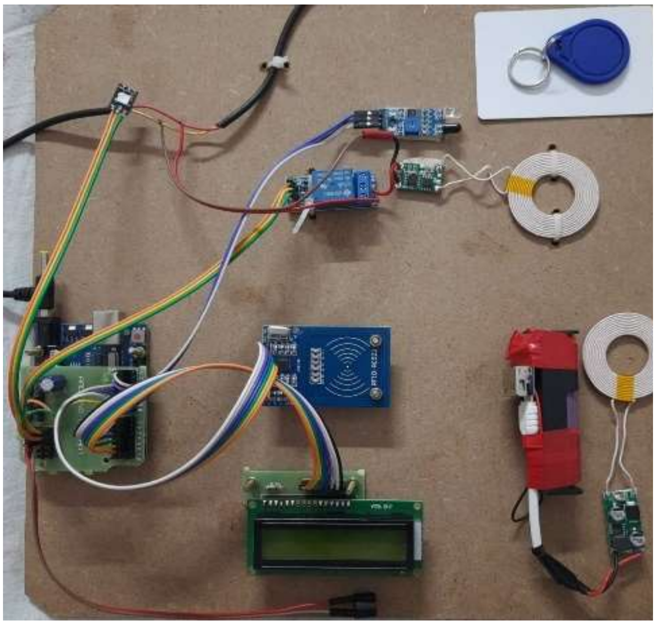

Fig 12: Overall Circuit Representation

5. MERITS AND DEMERITS OF WIRELESS CHARGING SYSTEM

A) Merits:

a) Environmentally Friendly - The most compelling reason to drive an electric vehicle is to help the environment. When compared to gasoline-powered vehicles, they do not emit poisonous emissions that pollute the air.

b) No Costs of Fuel or Gas - Because electric automobiles do not require fuel or gas to operate, consumers may avoid the escalating costs of these items. All you have to do now is connect and you'll be ready to travel the additional 100 miles.

c) Simple to charge - Charging an electric car is simple. You won't need to stop at a gas station to refuel your automobile before hitting the road! An electric car can be charged using any ordinary household outlet.

Electric automobiles are quieter than regular cars because they have less moving parts. When

they're working, they're incredibly silent. A gasoline-powered indoor car engine is significantly quieter and smoother than an electric car.

B) Demerits:

a) A scarcity of charging stations - One of the major benefits of utilizing an electric vehicle is that it does not require any gasoline or diesel to run. Instead, all it takes is a charging station to connect the automobile and get it ready to go. However, one of the main roadblocks to its widespread acceptance is a scarcity of charging outlets. For example, India has a scarcity of electric vehicle charging facilities. Even if you acquire an electric vehicle, you won't be able to use it until you have access to a charging station. To increase the reception of these vehicles, a sufficient number of charging stations must first be constructed.

Expensive - Purchasing an electric vehicle is still costly. There are a variety of petrol automobiles on the market, each with its own set of features and pricing. Electric vehicles, on the other hand, have fewer options, and the best are also the most expensive. Governments should strongly encourage the usage of electric vehicles by providing grants and incentives to users and manufacturers alike. Even batteries remain costly, though they are expected to drop in price in the near future.

c) Lower power and range – When compared to electric vehicles, gasoline-powered vehicles accelerate faster. Although Tesla and Volkswagen manufacture longer-distance electric vehicles, the mid-range electric vehicle can easily travel 100 to 200 miles on a single charge. As a result, consumers are still cautious to use electric vehicles for lengthy trips or highway driving.

Low Pollution - Electric vehicles do not emit zero pollution. Even so, they contribute to some indirect pollution. Batteries and the electricity necessary to charge them are not made from renewable resources.

5. FUTURE SCOPE

The future scope of electric vehicle (EV) wireless charging systems is promising and covers several key areas of development and deployment. Future wireless charging systems will focus on improving efficiency and performance. This includes increasing the charging speed and efficiency of wireless charging platforms to reduce charging times and improve comfort for electric vehicle users. Advanced technologies such as resonant charging and beamforming are further refined to optimize energy transfer. It considers various advances such as Wireless Vehicle Networking, In Wheel WCS and many others.

Future wireless charging systems may support bidirectional power, where electric cars can not only receive power from the charging platform, but also provide power back into the grid or power other devices. This two-way capability also allows for vehicle-to-grid (V2G) integration, where electric vehicles act as mobile energy storage devices, helping to stabilize the grid and optimize energy distribution operations. [2] Overall, the future of wireless charging systems for electric vehicles is promising. The continuous development of technology, infrastructure and standardization, paves the way for a more convenient, efficient and sustainable transport ecosystem. With wireless charging, physical connectors and wires are not necessary, making charging easier to use and smoother user experience.

Because of its ease, more individuals may decide to convert to electric vehicles, advancing environmentally friendly mobility. IoT-enabled wireless charging stations may gather data that can yield insightful information. Stakeholders can better grasp the dynamics of EV charging by examining charging trends, energy usage, and user behaviour. [2] [5]

6. RESULT

Wireless charging operates on the principle of electromagnetic induction, where a magnetic field is created when a power cable passes through a coil. This magnetic field induces an electric current in a second coil located remotely, enabling electricity to be transferred between devices without physical contact. Common implementations of wireless charging typically involve a charger and a receiver being in close proximity, known as the "near-field" charging.

In the electric vehicle industry, wireless charging systems simplify the charging process by eliminating the need for a special socket or cable. In standard charging mode, electricity is still provided by a charging station or Wall box. However, instead of plugging in a cable, the electric power is transmitted wirelessly to the car through a charging pad. As a result, drivers no longer need to manoeuvre their vehicle close to the charging station or fumble with cables. Charging begins automatically when the output and receiver coils align, providing a seamless and convenient charging experience.

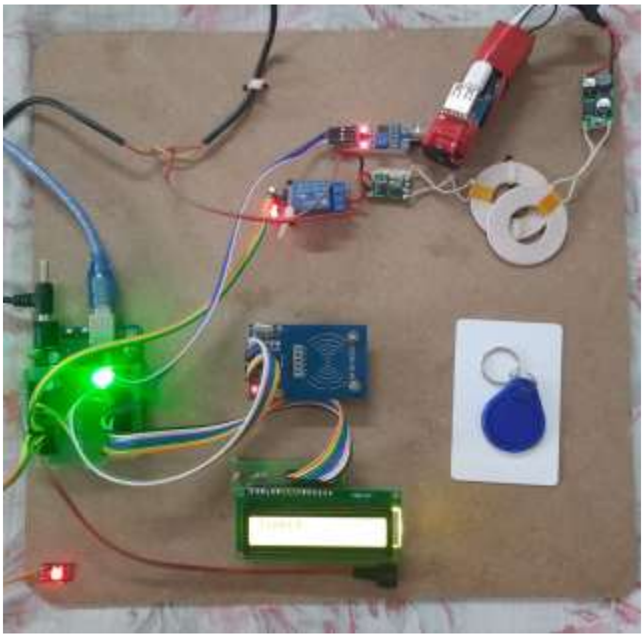

Fig 12: Working of the Circuit

Fig 13: Countdown Timer and Neopixel(left) indicating working of the setup

7. CONCLUSION

We have discussed and evaluated wireless charging of electric cars. Wireless charging is considered a better alternative to traditional wired charging systems because it is user and environment friendly. In addition, it eliminates the need for wires and mechanical connectors, avoiding the complications and dangers associated with wireless charging systems for electric vehicles. Wireless charging systems also reduce distance anxiety and improve system efficiency. Wireless power transfer is usually done either by microwave, laser, or interconnection. However, wireless charging generally only uses connection-based technologies. Inductive charging has its advantages and is the most popular method of wireless charging for electric vehicles. With the development of EV technology, charging infrastructure and grid integration areas, EV popularity is expected to grow significantly over the next decade. Multiple leading car manufacturers are showing their interest in adopting EVWC technology, including Delphi, Toyota, Mitsubishi, Audi, Nissan, Chevy, BMW, Daimler. [4]

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