WIRELESS CHARGING SYSTEM FOR EV'S

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1.ABSTRACT

Wireless charging system nowadays is a growing technology day by day. For electric vehicles wireless charging system is becoming a reliable technology day by day and it is very easy to handle. and it is going to be more popular in incoming days. The power is transferred from a source to an electrical load without the need of interconnections. Wireless charging power transmission is useful to power electrical devices where physical wiring is not possible or inconvenient. The technology uses the principle of mutual inductance.

KEY POINTS**:** Mutual Inductance , Wireless Energy Transfer.

2.INTRODUCTION

The cost of energy sources like petroleum and diesel has been consistently increasing due to the rising number of vehicles and excessive fuel consumption.
Conventional vehicles are major contributors to greenhouse gas emissions.
Wireless charging offers a convenient and efficient way to power up electric vehicles without the need for physical cables and plugs, revolutionizing the EV charging experience .Wireless charging for EVs relies on electromagnetic fields to transmit electrical energy from a charging station to the vehicle's battery pack, eliminating the need for manual connection .Wired charging also have some limitations like socket points, spacing occupied by the charging station, limited range of wire, vehicle has to change its orientation to connect to the charger. These can be addressed by wireless charging systems for electric vehicles. This provides flexible and hassle free charging and also systems can be built at home, parking lot, garage etc.These methods use coils to transmit power. Coil ill produce a short range magnetic field, when a second coil is placed an electric current will flow through it. The magnetic field has transferred power from one coil to other called Induction. Wireless EV charging has a number of advantages over traditional wired charging. It is more convenient, as drivers do not have to plug in their vehicles to charge them. It is also safer, as there is no risk of electric shock or fire. Additionally, wireless charging can be used to charge EVs while they are parked in public spaces, such as parking lots and garages. However, wireless EV charging also has some disadvantages. It is less efficient than wired charging, meaning that it takes more time to charge a vehicle wirelessly. Additionally, wireless EV chargers are more expensive than wired chargers. Despite these disadvantages, wireless EV charging is a promising technology that has the potential to make charging EVs more convenient and accessible. A number of companies are developing wireless EV charging systems, and some automakers are already planning to offer wireless charging on their vehicles in the near future. In addition to the challenges listed above, there are a few other factors that could slow the adoption of wireless EV charging. For example, wireless charging systems are not yet compatible with all EV models. Additionally, there is a lack of standardization in the wireless charging industry, which could make it difficult for drivers to find charging stations that are compatible with their vehicles. Despite these challenges, the potential

benefits of wireless EV charging are significant. As the technology continues to develop and become more widespread, it is likely to play an increasingly important role in the transition to electric transportation. Wireless EV charging using Arduino, LCD, voltage sensor, GSM to send SMS that charging done, wireless charging circuit, battery, and coil is a system that uses inductive coupling to transfer energy from a transmitter coil to a receiver coil without the need for physical contact. The Arduino microcontroller is used to control the system and ensure that the power is transferred safely and efficiently. The LCD is used to display the charging status and the voltage sensor is used to monitor the battery voltage. The GSM module is used to send an SMS message to the user when the battery is fully charged .The wireless charging circuit is used to convert the AC power from the power supply to DC power that can be used to charge the battery. The battery is used to store the energy transferred from the transmitter coil to the receiver coil. The coil is used to create a magnetic field that is used to transfer energy from the transmitter coil to the receiver coil.

3. WORKING PRINCIPLE

The wireless EV charging system works on the principle of mutual inductance. Mutual inductance is the phenomenon by which a changing magnetic field in one coil induces a voltage in another coil. When the EV parks over the charging pad, the magnetic field from the charging pad induces a voltage in the EV coil. This voltage is then used to charge the ev's battery. A wireless power transfer circuit is a circuit that allows power to be transmitted from one device to another without the use of wires. This is done by using electromagnetic fields to transfer the energy. There are two main types of wireless power transfer circuits: inductive coupling and resonant coupling. Inductive coupling is the most common type of wireless power transfer circuit. It works by using two coils of wire to create a magnetic field. When an alternating current is passed through the primary coil, it creates a magnetic field that induces an alternating current in the secondary coil. Resonant coupling is a more efficient type of wireless power transfer circuit, but it is also more complex. It works by using two resonant circuits to transfer energy between the transmitter and receiver. The resonant circuits are tuned to the same frequency, which allows the energy to be transferred more efficiently. The circuit consists of two coils of wire, a transistor, and a capacitor. The primary coil is connected to a power source, and the secondary coil is connected to a load. The transistor is used to switch the current flowing through the primary coil. When the transistor is switched on, current flows through the primary coil, creating a magnetic field. This magnetic field induces an alternating current in the secondary coil. The alternating current in the secondary coil powers the load. The capacitor is used to filter out any noise from the power source. It also helps to improve the efficiency of the circuit. This is just a simple example of a wireless power transfer circuit. There are many more complex circuits that can be used to achieve higher power transfer efficiency and longer distances.

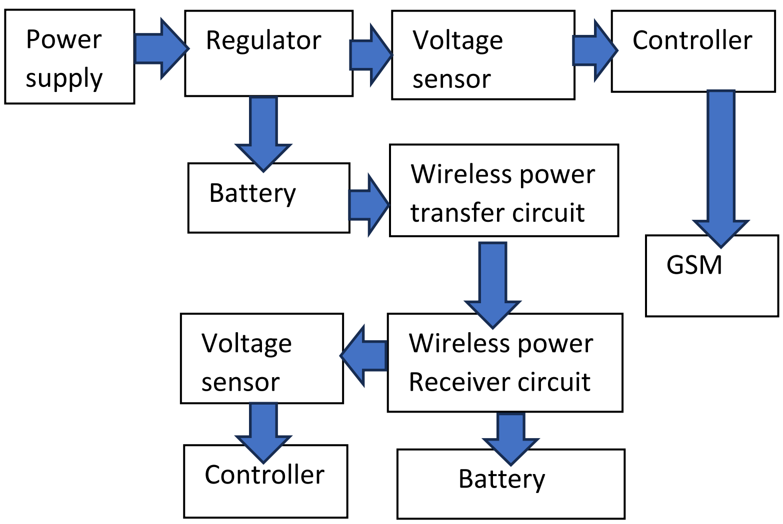

FIG-1 BLOCK DIAGRAM FOR WIRELSS CHARGING SYSTEM

5.DESCRIPTION OF PROPOSED WORK

1. The power supply provides power to the wireless power transfer circuit.
2. The voltage regulator regulates the voltage from the power supply to the wireless power transfer circuit.
3. The voltage sensor monitors the voltage of the battery.
4. The controller monitors the voltage of the battery and the power output of the wireless power transfer circuit. It also controls the operation of the wireless power transfer circuit to ensure that the battery is charged safely and efficiently.
5. The wireless power transfer circuit transfers power from the power supply to the battery without the need for physical contact.

4.BLOCK DIAGRAM

6. The wireless power receiver circuit rectifies and regulates the voltage from the wireless power transfer circuit to the battery.

7. The power supply provides power to the wireless power transfer circuit. The power supply can be any type of power supply that can provide enough power to charge the EV battery at the desired rate. Common types of power supplies used for wireless EV charging include AC power supplies, DC power supplies, and solar power supplies.

The voltage regulator regulates the voltage from the power supply to the wireless power transfer circuit to the correct voltage. This is necessary to ensure that the wireless power transfer circuit operates at the correct voltage. The voltage regulator can be any type of voltage regulator that can regulate the voltage to the wireless power transfer circuit to the correct voltage. Common types of voltage regulators used for wireless EV charging include linear voltage regulators and switching voltage regulators. The voltage sensor monitors the voltage of the battery. This information is used by the controller to regulate the power output of the wireless power transfer circuit and to prevent the battery from overcharging. The voltage sensor can be any type of voltage sensor that can monitor the voltage of the battery. Common types of voltage sensors used for wireless EV charging include analog voltage sensors and digital voltage sensors. The controller monitors the voltage of the battery and the power output of the wireless power transfer circuit. It also controls the operation of the wireless power transfer circuit to ensure that the battery is charged safely and efficiently. The controller can be any type of controller that can monitor the voltage of the battery, the power output of the wireless power transfer circuit, and control the operation of the wireless power transfer circuit. Common types of controllers used for wireless EV charging include microcontrollers, microprocessors, and digital signal processors. The wireless power transfer circuit transfers power from the power supply to the battery without the need for physical contact. The wireless power transfer circuit typically consists of two coils: a transmitter coil and a receiver coil. The transmitter coil is connected to the power supply and the receiver coil is connected to the battery. When the transmitter coil is powered, it creates a magnetic field. When the receiver coil is placed within this magnetic field, an electric current is induced in the receiver coil. This current can then be used to charge the battery.

6.STATIC AND DYNAMIC WIRELESS CHARGING

Wireless charging system of an electric vehicle charges the vehicle by electromagnetic field to transfer the energy. This methodology of charging the electric vehicle can be classified into two categories:

1. Static Wireless charging.
2. Dynamic Wireless charging.

6.1.STATIC WIRELESS CHARGING: In this type of wireless charging system, the batteries of the vehicle can be charged autonomously while the vehicle is being parked in static mode where the transmitter enclosed with the primary coil is installed underneath the ground along with additional power converters and its circuitries. Here, a very high frequency AC is transmitted from the transmitter coil. The receiver coil which is enclosed with the secondary coil is mounted on the underside of the vehicle receives the AC. The received energy is converted from AC to DC using the power converter and is transferred to the battery bank. For safety measurements, the receiver coil is enclosed with battery management system (BMS) and power control with a wireless communication network to receive any feedback from the primary side . The charging duration of an electric vehicle depends on their charging pad sizes, power supply level and distance (air gap) between the transmitter and the receiver. The distance between the transmitter and the receiver coil is approximately 150- 300mm. This concept of wireless charging can be well suited for mass transit applications, where it can be used at parking areas at shopping mall, garages, commercial buildings etc. An implementation of this system can be done by installing an automatic guidance system in the vehicle to help the driver align the vehicle directly above the primary charging pad. The transmitter end of the charging station and the receiver coil of the vehicle can exchange data using the inductive link or through short range communication methods. This feature allows the charging stations to adjust the charging procedure according to the condition of the battery and according to the driver's preference.

6.2 DYNAMIC WIRELESS CHARGING: In static wireless charging, sufficient amount of charge must be present in the vehicle before starting. So, in order to store the charges, bigger batteries are required to provide constant power to the vehicle. But use of bigger batteries results in system inefficiency. Revolution in wireless charging motivated researchers to use dynamic wireless vehicle charging [13]. In this type of wireless charging system, the battery size is reduced and vehicles are charged while they are in motion, where the transmitter is enclosed with a primary charging pad which is installed beneath the concrete of the road along the pathway with high frequency AC along with its circuitries and the receiver enclosed with a secondary coil is placed below the front of the vehicle with power converter and battery management system which converts high frequency AC into DC and charges the battery bank.
But the primary charging pad which is installed on the vehicle moving path, can be classified into two categories:

1. Lumped charging pad (Single coil design)
2. Segment charging pad (Multiple coil design)

1 LUMPED CHARGING PAD

In lumped charging pad, one single winding coil is used as the primary coil of the transmitter side. This technique is basically used for static wireless charging because when the displacement occurs the mutual

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inductance of the primary and the secondary coil will change which will result in deflection of the magnetic flux. In this case of dynamic charging there should be a control strategy which will correct the flux deflections. The number of power converters and controllers used are less in lumped type. Due to this, the power transfer capability is limited.

2 SEGMENT CHARGING PAD

In segment charging pad, the primary winding of the coil is divided into segments and placed throughout the pavements of the road for power transfer. A particular segment is energized when vehicle moves over the segment. During this process, the remaining segments which is not energized remains in off state. This reduces the power loss of the system. But disadvantage of this process is that individual inverters and controllers are employed for each segment which increases the complexity and cost of manufacturing the system. As the vehicle moves on the pavement there is chance of misalignment between the transmitter and receiving pads which affects the system performance. Various controlling methods have to be proposed in order to overcome it . Two different methodologies of installing the primary charging pad has been mentioned above. On a higher note, the future holds the self driving cars, it is efficient and practical for the transmitter unit to be aligned beneath the concrete in a pre-defined route. This application can be incorporated in electric buses, rails and rapid rails. Initial cost of installing would be high but on a broader prospect it is efficient. In order to know the development prospect of dynamic wireless charging system, the table has been mentioned below.

7.CIRCUIT DIAGRAM

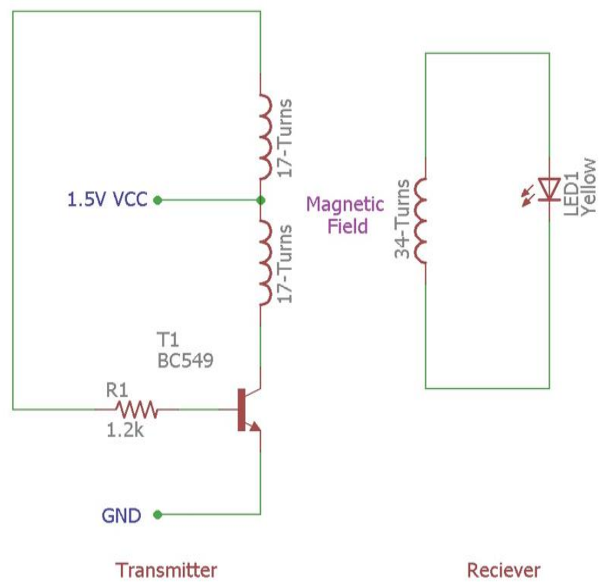
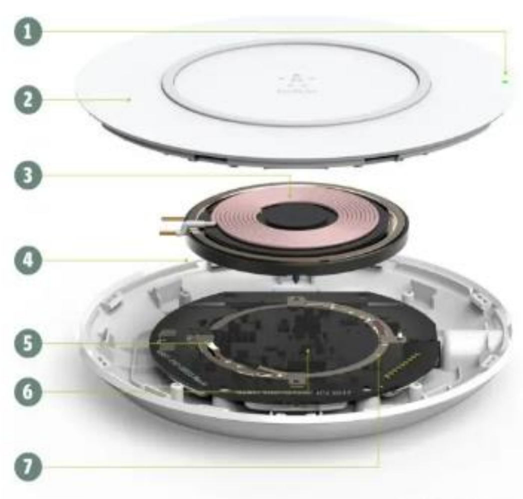


FIG 2: CIRCUIT DIAGRAM FOR WIRELESS CHARGING SYSTEM FOR EVS

WHAT'S INSIDE WIRELESS CHARGING SYSTEM



1.LED charging indicator light

2.Non slip pad surface

3.7.5w transmitter coil

4.Fanless design for quiet operation

5.Wireless charging cheapest controls the flow of electricity

6.Thermal protection sensor can dial back power for safer operation

7.Foreign object detection circuit to prevent conductive material from receiving power from the charger

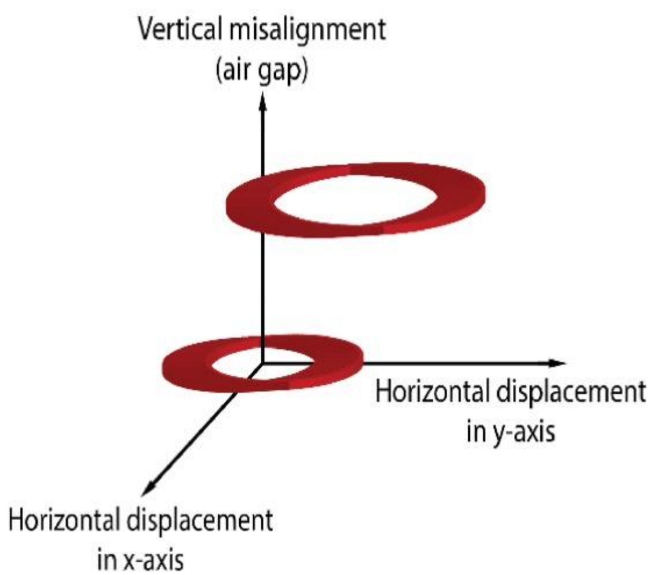


FIG 3: COIL ALIGNMENT

8.CALCULATION

Coil length

The coil length is determined by the frequency of the alternating current (AC) flowing through the coil and the number of turns in the coil. The following equation can be used to calculate the coil length:

$L = (N^2 * \mu0 * \mu r * r^2) / f$

where:

•L is the coil length in meters

•N is the number of turns in the coil

•μ0 is the permeability of free space ($4\pi \times 10^{-7}$ H/m)

•μr is the relative permeability of the core material (1 for air)

•r is the radius of the coil in meters

•f is the frequency of the AC current in Hz

Coil turns

The number of turns in the coil is determined by the desired voltage and current output of the wireless charger. The following equation can be used to calculate the number of turns in the coil:

$N = (Vout * sqrt(2)) / (Iout * \pi * f * r)$

where:

•N is the number of turns in the coil

•Vout is the desired voltage output of the wireless charger in volts

•Iout is the desired current output of the wireless charger in amperes

•π is the mathematical constant pi (3.14159)

•f is the frequency of the AC current in Hz

•r is the radius of the coil in meters

Efficiency

The efficiency of a wireless charger is determined by the losses in the coil and the circuit. The following equation can be used to calculate the efficiency of a wireless charger:

Efficiency = (Pout / Pin) * 100%

where:

•Efficiency is the efficiency of the wireless charger in percent

•Pout is the power output of the wireless charger in watts

•Pin is the power input to the wireless charger in watts

we want to design a 12V wireless charger that can output 1A of current. The frequency of the AC current is 1MHz. The radius of the coil is 5cm.

To calculate the coil length, we can use the following equation:

$L = (N^2 * \mu 0 * \mu r * r^2) / f$
$L = (N^2 * 4\pi \times 10^{-7} H/m * 1 * 0.05^2 m^2) / 1MHz$
$L = 0.0125 * N^2$

To calculate the number of turns in the coil, we can use the following equation:

$N = (Vout * sqrt(2)) / (Iout * \pi * f * r)$
$N = (12V * sqrt(2)) / (1A * \pi * 1MHz * 0.05m)$
$N = 20$

To calculate the efficiency of the wireless charger, we can use the following equation:

Efficiency = (Pout / Pin) * 100%

The efficiency of a wireless charger typically ranges from 70% to 90%. For this example, let's assume an efficiency of 80%.

The power output of the wireless charger is calculated as follows:

Pout = Vout * Iout
Pout = 12V * 1A = 12W

The power input to the wireless charger is calculated as follows:

Pin = Pout / Efficiency
Pin = 12W / 0.8 = 15W

Therefore, the efficiency of the wireless charger is:

Efficiency = (Pout / Pin) * 100%
Efficiency = (12W / 15W) * 100% = 80%

9.APPLICATION AND FUTURE INFLUENCE OF WIRELESS CHARGING OF ELECTRIC VEHICLE

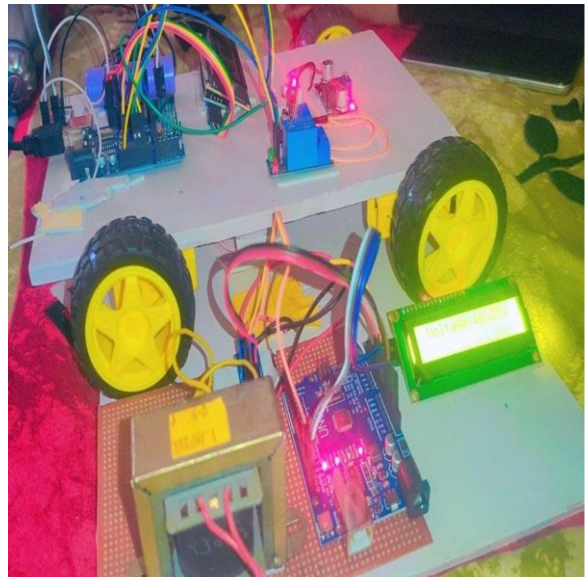
Wireless Charging of Electric Vehicle, approach revolutionizes the changes in electric vehicle Industry. In the last few years, trends suggest a rise in interest among the common masses for electric cars in comparison to electric two-wheelers and internal combustion engine vehicles or petrol/diesel cars. At a fundamental level, electric cars comparatively offers a lower operating cost compared to conventional internal combustion engines. On average, electric vehicles are 75- 80% cheaper from fuel and maintenance perspective, which is an important factor for many consumers who have high usage. This reality holds true across factors because it’s materially cheaper to charge a battery compared to refueling a conventional liquid fuel tank. The electric vehicles comparatively induced with dynamic wireless charging technique takes lesser time than the electric vehicles which are charged statically. With reduced new battery capacity using dynamic wireless charging system electric vehicles can be charged under motion. Comparatively, with wireless charging system range and cost are the setbacks plug-in charging systems are facing currently. With the growing impact of fuel-driven vehicles on the environment, electric taxi fleets in congested urban streets is critical in cutting transport emissions and cleaning up the air. With more people opting for electric mobility, the new technology can also be rolled out broadly for public use. This in turn would help everyday drivers of electric cars charge more conveniently on the go. However, the time taken to charge wirelessly could reduce a taxi driver's earning potential, a problem which is known and being worked upon.

10.DRAWBACKS OF WIRELESS ELECTRIC VEHICLE CHARGING SYSTEM (WEVCS)

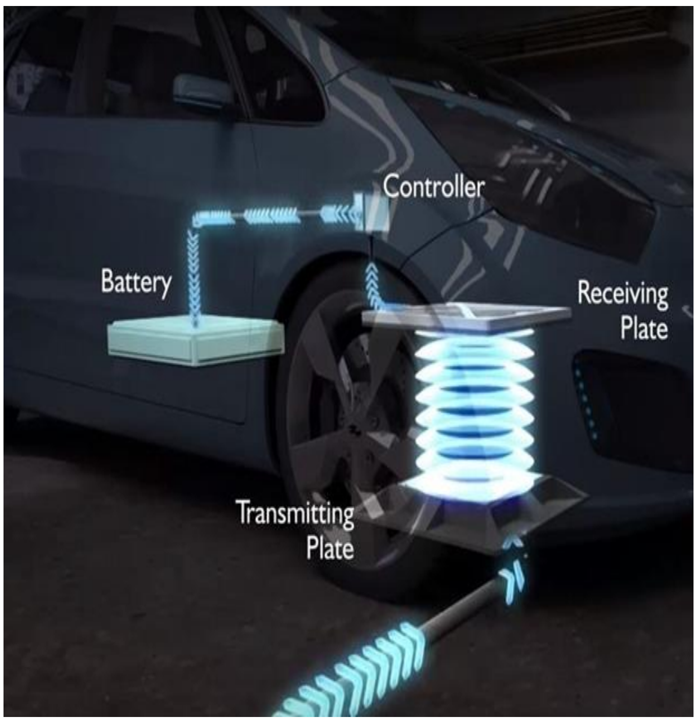
1. Inefficient transfer of electricity: The energy efficiency via wired charging of the electric vehicles is somewhere between 90 – 93%, which makes it obvious that efficiency from wireless charging of EV will be much less. However, with time the efficiency is likely to be improved.

2. Health and safety issues: As wireless charging of electric vehicles works in high voltage and current levels, safety concerns become most important. We definitely need strict monitoring in order to transfer so much electricity wirelessly without having adverse effects on the living organisms. Besides that, the long-term effect of the electromagnetic field can also affect the living organisms which needs to be inspected thoroughly. However, it also comes with three important potential health and safety issues namely electrical, magnetic and fire hazards. Sometimes due to breakdown of devices or physical damage or by environmental conditions it can also produce electrical shocks.

11.RESULT



12. DESIGNING



13.CONCLUSION

Wireless charging of electric vehicle has the potential to revolutionize the road transportation from the automotive industry. With the advancement of electric vehicle technology, wireless charging technique is expected to increase significantly by next decade. The main agenda of this paper is to give an overview of various wireless charging techniques out of which inductive wireless transfer has proven to be the best method of wireless charging. This paper also attempts to review about the application of static and dynamic wireless charging and how battery plays an important role in the electric vehicle. Here, the battery size is effected by wireless charging techniques which lowers the overall cost of the electric vehicle. The electric vehicle batteries which were to take quite a lot time to charge up to the rated value will be charged within less time comparatively as their battery capacity is reduced. However, simplicity and minimum driver intervention are key features that win out time-and time again and when these features are coupled with high power transfer efficiency, wireless charging of electric vehicle is a winning combination.

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