Solar Powered Automobile Wireless Charging Station and Diagnosis

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***ABSTRACT* — Electrical vehicles are introduced for today world, as it is thriving to use day by day new technology everywhere. Even if electrical vehicles are use, it has its own limitations like heating while charging, charging run out, less charging stations and cost also high for installing charging stations. To rectify these limitations, wireless electrical vehicle charging station with monitoring pave, avoid over charging, monitoring the levels of battery, cost effective, eco-friendly and placing charging stations in urban areas. Wireless charging can be seen as key enabling technology to increase the adoption of electric vehicle. These can be installed in parking areas, shopping malls, remote areas as well. Wireless Power Transmission [WPT] is very reliable, efficient, noiseless and pollution free technology. It feels like a normal car while parking and no need to plug the charging cable).**

I. INTRODUCTION

Oil crises is eminent all over the world. As know that Coal mines are shortage. In this scenario, it is necessary to shift the axis from the non-renewable sources to the renewable resources. The renewable sources are available in different forms like solar energy, wind energy, tidal energy, geo- thermal energy and many forms are available in nature. Renewable energy sources are used to meet the peak load demand with the conventional source. The fuel cost of renewable energy source is less. Transportation system play a vital role in this modern era. At the same time, it accounts for about 27% of the carbon emission. Carbon emission is crucial as it increases global warming to an alarming state. Global warming is threat to human life, at the same time, it leads to drastic changes in the climate. Electrical vehicles are introduced for today world, as it is thriving to use day by day new technology everywhere.

Electric Vehicles must be the future means of transportation. The electrical vehicle uses the electricity to store the dc energy in the battery instead of fossil fuel and carbon emission gases. Electric vehicles have become more competitive when compare to the conventional internal combustion engine vehicles due to lower carbon dioxide emission and raising fossil fuels. They have a low running cost, reduce noise pollution, higher efficiency and also eco- friendly.

Even if electrical vehicles are use, it has its own limitations like heating issue, charging ran off, less charging stations and cost also high for installing charging stations. To rectify these limitations wireless power transmission is taken into consideration. It needs time to charge the electrical vehicle. The electrical vehicle is damaged or fired due to over flow charging. Keeping or leaving the charging connection for more time this causes a low efficiency and becomes more danger.

Wireless Power Transmission (WPT) is considered as a plug less alternative for electric vehicle charging. The most used technology for these is two types they are inductive coupling and magnetic resonance. These resonance type has operating frequency of mhz. and also can transfer power to serval meters which is used for mid-range distance. On the other hand, the inductive coupling which is mostly used in transformer with an air gap. The inductive coupling is used for wireless transmission. The inductive coupling coil consists of group of wires are wounded and makes in circular in shape which is going to transfer in the form of magnetic field. Developing the wireless power transmission becomes high reliable, safe and convenience. It is quite beneficial in energy saving and an electricity cost reduction for EV consumers. The inductive coupling coil consists of two coils namely primary coil and secondary coil. The system efficiency is mainly depending on the strong function of quality factor of the coils.

And also considering with monitoring pave, avoid over charging, monitoring the levels of battery, cost effective, eco-friendly and placing charging stations in urban areas. These can be installed in parking areas, shopping malls, remote areas as well. In this prototype is going to implement an auto charging and automatically disconnected when its fully charged. The disadvantage of electric vehicle is not suitable for longer distance journey because of charging. This can be rectified by implementing a charging station between major connecting centres or urban areas.

Advances in wireless power transfer and semiconductor for sophisticated technology have been studied and developed over the few years. This semiconductor technology has empowered a wide variety of uses in fields like medical, industries, electronic etc.

This paper examines the charging of electrical vehicle more than one car at a time by using renewable energy sources, making wireless charging and also providing auto charging when car enters into parking area, also auto disconnect when the vehicle is fully charged and monitoring battery charge levels. Thus, is more reliable, without any wire connection and safer for human beings.

II. LITERATURE SURVEY

THE PAPER 1 - "Wireless Charging of Battery in Electrical Vehicle using Solar Energy" by Patil, Manoj D., et al. (2020) describes the wireless charging of battery in electrical vehicle using solar energy. This paper gives the knowledge about the charging of electrical vehicle through wireless charging system. The most important of wireless charging technology has designed with copper coil with operating voltage of 5v. [1]

THE PAPER 2 - "Solar Wireless Electric Vehicle Charging System" by Prasad, Bugatha Ram Vara, M. Geethanjali, M. Sonia, S. Ganeesh and P. Sai Krishna (2022) describes about the battery charging method for electrical vehicles from wired to on road wireless charging given the different types charging system. The provides the difference between the wired charging and wireless charging. [2]

THE PAPER 3 - "Intelligent Wireless Charging Station for Electric Vehicles" by A. Sultanbek, A. Khassenov, Y. Kanapyanov, M. Kenzhegaliyeva and M. Bagheri (2017) describes the analysis experimental result and range adaptation of magnetically coupled resonators for wireless power transfer. It gives the distance between the primary coil and secondary coil. The parameter of coils is shown according to their distance. [3]

III. BLOCK DIAGRAM

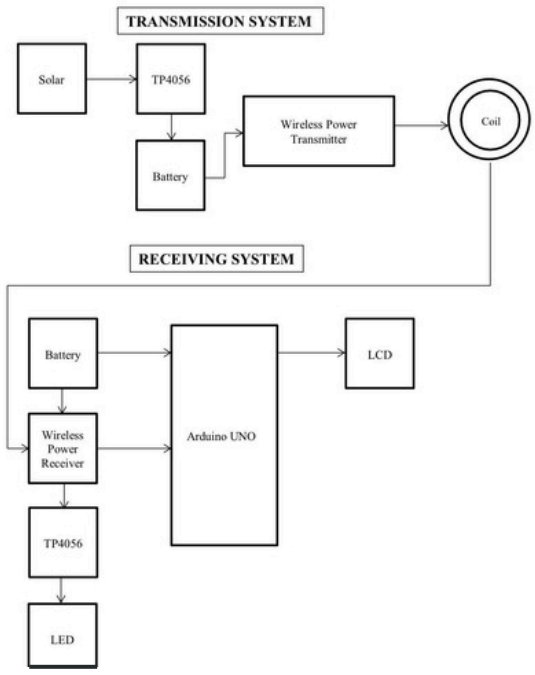

Fig 1. Block Diagram for Solar based Wireless Charging System

The above figure is the main block diagram of solar wireless charging station. The solar panel to the primary coil is in fixed position which charges the vehicles at a time.

The secondary coil is placed in the vehicle are to be designed for wireless charging system.

IV. MAIN COMPONENTS

4.1 ARDUINO UNO

The Arduino Uno R3 is an open-source hardware computing platform which features a removable dual-inline package (DIP) ATmega 328 AVR microcontroller. This microcontroller has 20 digital input/output pins, 6 of which can be used as PWM outputs and another 6 for analog inputs. It can be used for applications that work in a standalone or connected environment and includes support libraries and hardware add-on shields.

The Arduino Uno R3 operates at a voltage of 5V, with an input voltage range of 7V to 12V and a DC current of 20mA per input pin. Its 3.3V pin has a DC current of 50mA, and the power supply can be provided through an external power source, USB connection, or batteries.

The Arduino Uno R3 board is popular for its programming language which is done using the IDE software. It is the third version of the Arduino board, released in 2011 and can be used to operate devices automatically. Additionally, any mistakes can be rectified due to its flexibility. The Arduino Uno R3 is also cost-effective and is a great choice for beginners.

4.2 TP4056

The TP4056 is a lithium-ion battery charging module. It regulates the charging process, ensuring safe and efficient charging for single-cell lithium-ion or lithium polymer batteries. It incorporates features like overcharge protection, over- discharge protection, and current limiting. Additionally, it typically includes indicator LEDs to show charging status.

4.3 IR SENSOR

An InfraRed sensor circuit is one of the basic and popular sensor modules in an electronic device. This sensor is analogous to human's visionary senses, which can be used to detect obstacles and it is one of the common applications in real-time. This circuit comprises the following components.

4.4 5V SPDT RELAY

The 5v SPDT relay is a high -quality single pole double throws scaled relay. The relay coil is rated upto 5v dc with a minimum switching voltage of 5v. It is an electromechanical switching device can control the both ac and dc devices. Through the 5v dc relay coil the specification of 5v relay are the current capacity is 10A and the coil current is 50mA for the 5v and the terminals are the COM, NC, NO.

4.5 LCD DISPLAY

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.

4.6 LITHIUM-ION BATTERY

A Li-ion battery is a type of rechargeable battery that uses the reversible intercalation of Li+ ions into electronically conducting solids to store energy. In comparison with other commercial rechargeable batteries, Li-ion batteries are characterized by higher specific energy, higher energy density, higher energy efficiency, a longer cycle life.

4.7 WIRELESS MODULES TX/RX

The pair of transmitter and receiver modules are small and cost-effective, and are usually used for short-distance applications up to 5 to 6 meters. They are widely used for wireless charging of various small electronic products, such as cell phones, game machines, MP3 players, digital cameras, machine learning tools, medical supplies, and other underwater applications.

The transmitter and receiver modules are designed to be small in size and incredibly easy to use. They feature high efficiency and low costs, as well as offering a non-contact power supply, which makes the product completely isolated, waterproof, and dustproof, thus increasing its life and usability.

Distance	Voltage
3mm	12V
5mm	10V
8mm	7V
10mm	5V

Table 1. Variations of Voltage and Distance between the Primary and Secondary Coil

The above Table-1 shows the voltage and distance in wireless modulator gives the voltage measured in receiver coil. The primary coil is placed at the ground as shown in fig.1. When the distance between the primary and secondary coil is 3mm, then 5V/2A is received in the receiver coil which is placed on the bottom of the vehicle as shown in fig.3. The minimum distance is 3mm which reads high efficiency. When the distance is minimum between the two coils gives the higher efficiency.

V. CONSTRUCTION

In our prototype the electrical vehicle is charged through renewable source. So solar energy is used as a source.

The vehicle parking area with a IR sensors and having three relay coil and current sensor with a led display.

Firstly, solar panel focussed to sun light and light energy is converted into electrical energy. This energy is stored in lead-acid battery of 12V dc battery. Diode is connected in series with battery and panel, to avoid the reverse current

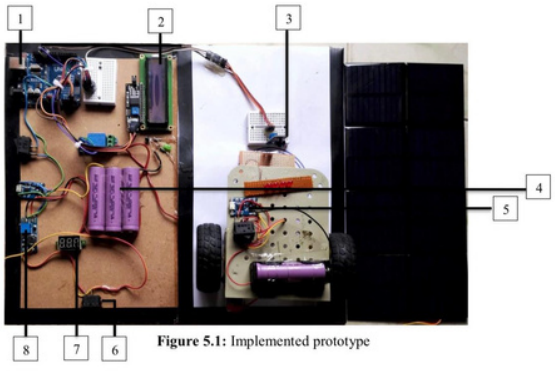

Figure 5.1: Implemented prototype

1 – Arduino UNO
2 - LCD
3 – IR Sensor
4 – Lithium-ion Battery
5 – TP4056
6 – Switch
7 – Seven segment Display
8 – DC-DC Step up Converter

Fig 2. Hardware kit

The battery is connected to 12V-5V buck converter is stepdown the voltage to 5v. This 5v is connected to Arduino 5v port. The IR sensor are placed at every parking area to detect the vehicle is entered or leaved. These IR sensor act as alarm when vehicle or car is entered into parking area and these are operated at 5v. These IR sensor signals are connected to the analog terminals of Arduino.

Arduino pins are connected to the resistive type relays. These relays are connected for each vehicle. These are relays are electromechanical device that uses an electromagnet principal, to operate a contact from an open position to closed position. These relays take a small amount of power to operate the relay coil. It mainly used in motors, heaters and also in ac circuit also. These relays are operated at low power or off happens it isolates the rest of the system from faulty section. It also acts as a protective device.

Current sensor is connected to the analog ports in the Arduino. The current sensor is a device that converts current to an easily measurable output current. These are based on open or closed loop hall effect technology. These sensors are connected in between the Arduino and relays.

The primary coils are connected from the relay with a operating voltage of 12V dc. Its wireless transmitter coil, which is static device. It consists of copper coil are wounded in circular form. These coils are placed where vehicles is to be parked with a measurable range.

From the secondary coil are placed in vehicle. The power transfer from the primary to secondary without any wire connection is known as wireless transformation. The secondary coil receives a 5V/2A, which is going to charge firstly, mostly lithium batteries are used in electrical vehicle. They have high energy ratio, good high-temperature performance and also low self- discharge.

VI. WORKING

When the car is entered into the parking area then the IR sensor in parking area is activated. It sends signal to the Arduino to charge the vehicle at parking area. The Arduino will send the signal to activate the transmitter coil, which is at parking p1 and starts charging.

Initially the display shows the Wireless EV charging station and display "No vehicle".

As the vehicle is enters into parking area p1, then display shows the “Charging ” next with that voltage, current, power and capacity are displayed. The parameters are measured in receiver coil when vehicle is charging. The parameters from the EV vehicle while charging is recorded and shown in below figure.

Although when a parking area of the station is empty and no vehicle is parked yet, then the display shows the "No Vehicle".

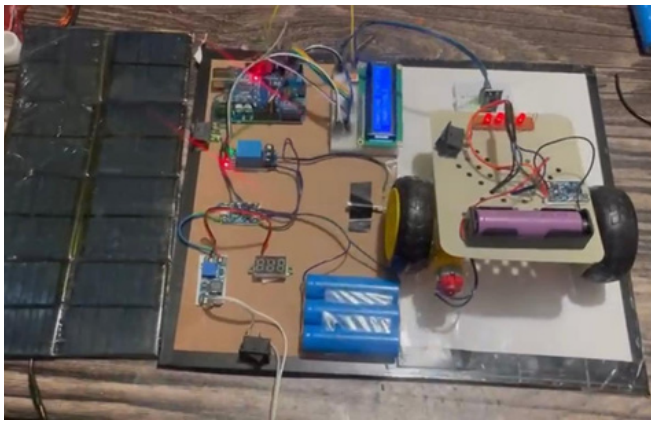

Fig 3. Implementation and Working of Prototype

It displays by using Arduino with background code. Then if vehicle in parking area is fully charged, then the lcd display will shows the vehicle is fully charged. The parking area circuit is disconnected from the supply by the resistive type relay.

Fig 4. "NO VEHICLE" State

Fig 5. "CHARGING" State

VII. CALCULATION

Mainly wireless charging efficiency is calculated based on total time taken by the vehicle to fully charged. Charging time is depends on the capacity of battery and current flow in the receiver coil. The vehicle contains different type of rating of the battery. The capacity of the battery is measured in mAh and current in mA. The charging time is measures in mAh/mA.

Charging time =
Capacity of battery in vehicle / Current flow in secondary winding

Headings or heads are organizational devices that guide the reader throughout the paper. Those are two types; they are component heads and text heads.

The formulae is used for normal batteries whereas for lithium batteries the capacity of battery is multiplied with 1.5.

Charging time =
1.5 * Capacity of battery in vehicle / Current flow in secondary winding

For example, considering the charger current is 160mA supplies to 1500mAh battery, then the charging time is calculated as 2250mAh/ 160mA. Then it gives charging time is about 14hours.

The constant current charger has simple structure, stable operation. This is a better way to recharge, less effect on battery life. But it also has its limitations. First, you need to calculate time. In addition, with the capacity of nickel metal hydride batteries is bigger, the constant current lithium battery charging time required is getting more longer it becomes inconvenience to consumers. Therefore flash/turbo automatic charger gradually is used and became popular in recent years.

VIII. CONCLUSION

Wireless charging technology for electric vehicles (EVs) has the potential to be a game-changer for the EV industry. While wired charging is currently more common, wireless charging offers numerous advantages, including greater convenience, ease of use, and reduced wear and tear on charging ports. With the development of more advanced and powerful wireless charging systems, EV drivers can expect to see significant improvements in charging times, making long-distance travel more feasible than ever before. Although wireless charging is currently more expensive than wired charging, the cost is expected to decrease as the technology becomes more widely adopted. Therefore, wireless charging technology has the potential to significantly improve the EV charging experience and help accelerate the adoption of EVs, which can ultimately reduce carbon emissions and help mitigate the effects of climate change.

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