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Wireless Electric Vehicle Charging System

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Abstract---Electric vehicles require fast, economical and reliable charging systems for efficient performance. Wireless charging systems remove the inconvenience to plug in the device to be charged when compared with the conventional wired charging systems. Moreover, wireless charging is considered to be environment and user friendly as the wires and mechanical connectors and related infrastructure are not required. This paper presents basic structure, operating principles and distinct features for wireless charging of EVs. First, the general techniques for wireless power transfer are described and explained. Next wireless charging systems for electric vehicles are classified and discussed in depth. Both the stationary and the dynamic wireless charging systems are discussed and reviewed. In addition, innovative and unique solution proposed is Dynamic Wireless Charging System. Dynamic charging systems seek to charge an EV while it is in service and is moving. It based on magnetic coupled resonant power transmission in which the transmitting coil of this charging system can selectively turn ON/OFF for charging vehicles while driving. Due to this energy is not wasted as transmission coil is energized when vehicle came in contact with receiver coil. The magnetic flux, a voltage is induced in the receiver coil when comes in line with transmitting coil. Control system functions of a wireless charging system of an electric vehicle. Findings of this state of the art review are discussed and recommendations for future research are also provided.

Indexed Terms— Electric vehicle, Wireless charging, Dynamic Charging, Arduino UNO, IR Sensor

I. INTRODUCTION

Electric vehicles (EVs) are one of the promising solutions to improve economic efficiency and reduce the carbon footprint in the transportation sector. Earlier research is focused on the plug-in and conductive solutions for charging the EVs and addressed the challenges of integrating this technology into electricity networks. Plug-in EVs have limited travel range and require large and heavy batteries. Therefore, conductive charging strategies require long waiting time that limits the applicability of EVs compared to gasoline-powered vehicles. More recent research efforts introduced wireless or inductive charging solutions that enable in-motion charging of the EVs which makes EV more favourable for the daily use of many drivers [1]. Earlier publications addressed the quantified potential benefits and challenges of wireless charging [2]-[4], the power electronic interfaces utilized for this technology [5]-[8], WCS placement [4], and battery sizing of the EVs with wireless charging technology [9]. The main advantages of wireless charging technology include increasing the travel range, reducing the battery size and mitigating the prolonged waiting time for charging. Such advantages enhance the economic and environmental benefits as well as the adoption rates of EVs in the transportation networks.

Wireless charging – also referred to as in-motion charging is different from the conventional charging technologies as it enables charging the EV battery while driving in the transportation network. Therefore, the electricity demand for wirelessly charging the EVs is determined by the traffic volume in the transportation network and the decisions made for charging the EVs as they travel over the charging stations[10]. Therefore, unlike the conventional plug-in charging solutions, wireless charging technology underlines the interdependence between the traffic routing and the EVs' charging strategies. The EV routing determines the electricity demand at different WCS, which in turn, would affect the electricity charging prices at these stations. Therefore, as the number of EVs with wireless charging capabilities increase, the characteristics of the demand imposed by the wireless charging of EV the day-ahead operation of the electricity network. In this paper, the proposed decentralized approach addresses the interaction between the electricity and transportation networks by capturing the imposed wireless charging demand which is further determined by the traffic flow pattern and the price of electricity.

Wireless charging EV is a type of EV in which charging is done using wireless power transfer (WPT) technology, which does not require any physical contact in the process of transferring electric energy. WPT has been successfully applied for charging various handheld devices, such as medical devices, electronic toothbrushes, and smart phones. It has also been widely used for automated material handling systems in semiconductor fabrication and flat-panel display production lines. Wireless charging technology was first commercialized for automobiles to eliminate the conventional charging of 'plug-in' EVs – charged by connecting a wired cable from a charger to the vehicle. The first wireless charging technology to be deployed was stationary, the system having been designed to charge EVs in garages or public parking spaces, when the vehicle is not operating for an extended period. Because a physical connection is not required, there has been major interest in the possibility of charging EVs while they are in transit. Charging an EV while in motion is called dynamic wireless charging. A typical dynamic wireless charging EV is a pure, battery-only EV that takes its electrical charge in motion, remotely, from a wireless charger installed underneath the road surface. Roads capable of supplying electric power to wireless charging EVs are called electrified roads or charging lanes. There is also a third wireless charging category, quasi-dynamic wireless charging, in which the charging takes place when the EV decelerates to or accelerates from a resting position.

For both dynamic and quasi-dynamic wireless charging, charging can be done while the EV is in transit. These new charging mechanisms extend the operational range of EVs with both rapid boost charging during brief station stops and dynamic or "on the fly" charging opportunities.

Stationary wireless charging makes the charging process safer and more convenient. However, in terms of charging time, frequency, the operation of the vehicle, and charging station allocation, stationary charging is not significantly different from conventional plug-in conductive charging. In contrast, dynamic and quasi-dynamic wireless charging enables the EVs battery to be charged while in operation. This capability has raised new operations and infrastructural design issues that had never been raised for conventional plug-in EVs. These issues are the focus of this paper. Note that in this paper, references to "wireless charging EV" indicate dynamic and quasi-dynamic wireless charging EVs, if not specified.). It should also be stated that although the term wireless charging EV suggests a single vehicle unit, it should be understood as a system comprised of EVs and the charging infrastructure. Further terminological and categorical distinctions are discussed in subsequent sections.

II. METHODOLOGY

If wired charging system is built at various charging stations. Wired charging station having more disadvantages such as space required is more, socket are different types, a small substation required, converter circuit is installed at every charging station, range of wire is limited and also time required for charging is more. This all problems is solved by wireless electrical vehicle charging system.

The traditional wired or plug-in charging systems are not user and environment friendly. To reduce the charging time, a large number of batteries can be used or the drained batteries can be swapped with the charged batteries when needed. There is energy waste due to line loss when the coil is conducted for long time. Its service life will be decreased because of continuous working.

III. BLOCK DIAGRAM

The block diagram consists of the Arduinouno, IR sensor, transmitter coil, receiver coil, AC to DC converter, relay, battery, DC motor, LED as shown in figure 1.

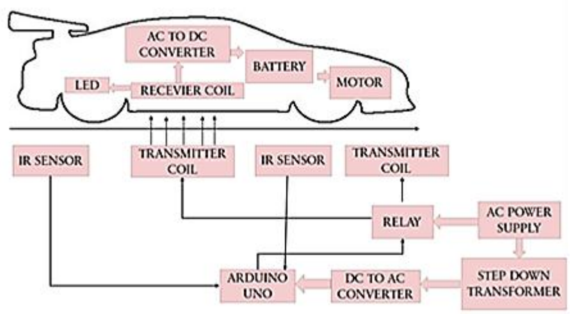

Figure 1: Block Diagram

Arduinouno is the main component of the project as it control and monitor the parameters, IR sensor will detect the presences of the vehicle and sends the signal to Arduinouno. Depending upon the vehicle position, relay is turned on to energize the transmitter coil.

The receiver coil present in the vehicle gets energized by the transmitter coil by mutual coupling, the energy produced is given to AC to DC converter, and the converter is connected to the battery. The battery gives power to the motor to run.

IV. WIRELESS CHARGINGARCHITECTURE

Wireless charging system architecture consisting of AC supply which is used as the source to fed the transmission coil. From the principle of resonant coupling, the reception coil is coupled. The output is given to AC-DC converter to obtain rectified DC to charge the battery which is connected to load. The coils in the project which is used to transmit power wirelessly are called magnetic resonators. This creates magnetic field in the region around a transmission coil, tune a reception coil to the same resonant frequency as the source, it will couple resonating anywhere within that region, converting oscillating magnetic field into an electrical current within the reception coil this response is called coupled magnetic response. The power can be fed to the load for charging a battery. Block diagram of wireless charging system is shown in Fig. 2 connected in series to series topology [6].

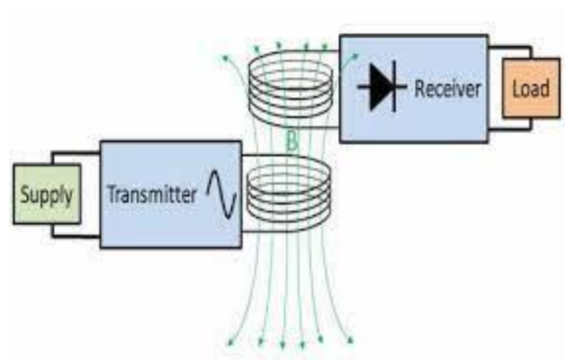

Figure 2: Wireless Charging

V. HARDWARE COMPONENTS

The power supply unit will provides +5V for the components to work. IC LM7805 is used for providing a constant power of +5V. The ac voltage, typically 220V, is connected to a transformer, which steps down the ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

A regulator circuit removes the ripples and also retains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

A fixed three-terminal voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated dc output voltage, Vo, from a second terminal, with the third terminal connected to ground.

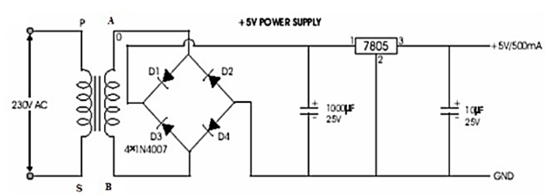

Figure 3: Circuit Diagram of Power Supply

Arduino Uno:- The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

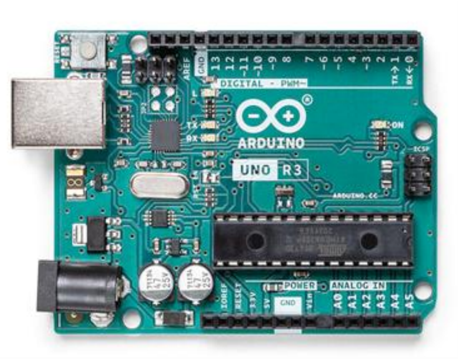

Figure 4: Arduino Uno

Wireless Power Supply Transmitter Receiver Charging Coil Module:-The 12V 2A Large Current Wireless Charger Module Transmitter Receiver Charging Coil Module is for a variety of small electronic products, wireless charging, power supply development, and design, with a small size, easy to use, high efficiency, and low price characteristics.

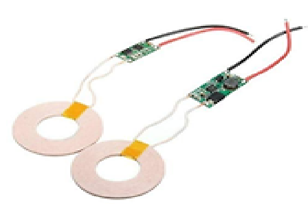

Figure 5: Transmitter Receiver Charging Coil

Specifications:

- Model: XKT-412.
- Input Voltage: 12V.
- Output Voltage: 12V.
- Operating Current: 1.2-2 A.
- Receive Coil: 3mm, the receiver output 5V / 1A current
- Transmitter Length × Width × Height(mm) : 17 * 12 * 4
- Receiver Length × Width × Height(mm) : 24 * 10 * 3
- Coil Height: 2mm
- Coil Diameter: 38mm

Dc Motor with Gear Box:-A DC motor in simple words is a device that converts direct current (electrical energy) into mechanical energy. We in our project are using brushed DC Motor, which will operate in the ratings of 12v DC 0.6A.

The speed of a DC motor can be controlled by changing the voltage applied to the armature or by changing the field current. The introduction of variable resistance in the armature circuit or field circuit allowed speed control. Modern DC motors are often controlled by power electronics systems called DC drives.

Figure 6: DC Motor with Gear Box

Relay:- A relay is an electromechanical switch, which perform ON and OFF operations without any human interaction. General representation of double contact relay is shown in fig. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal.

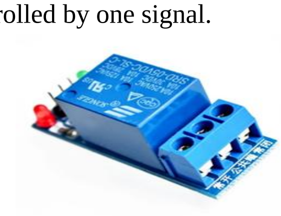

Figure 7 : Relay

Battery:-A battery is a device that converts chemical energy directly to electrical energy. It consists of a number of voltaic cells; each voltaic cell consists of two half-cells connected in series by a conductive electrolyte containing anions and cations. One half-cell includes electrolyte and the electrode to which anions (negatively charged ions) migrate, i.e., the anode or negative electrode; the other half-cell includes electrolyte and the electrode to which cation (positively charged ions) migrate, i.e., the cathode or positive electrode.

Figure 8: Battery

IR Sensor:-An IR (Infrared) sensor is a type of electronic device that is used to detect the presence of infrared radiation. Infrared radiation is a form of electromagnetic radiation that is invisible to the human eye, but can be detected by electronic sensors.

IR sensors typically consist of an IR source, such as an LED, and an IR detector, such as a photodiode or phototransistor. The IR source emits a beam of infrared radiation, which is reflected off of objects in its path. The reflected radiation is then detected by the IR detector, which generates an electrical signal that is proportional to the intensity of the reflected radiation.

Figure 9: IR Sensor

Wireless charging EV is a type of EV in which charging is done using wireless power transfer (WPT) technology, which does not require any physical contact in the process of transferring electric energy. The wireless charging EV is one of emerging transportation Systems for EV's. The system makes use of charging infrastructure embedded under the surface of the road that transfers electric power to the vehicle while it is in transit.

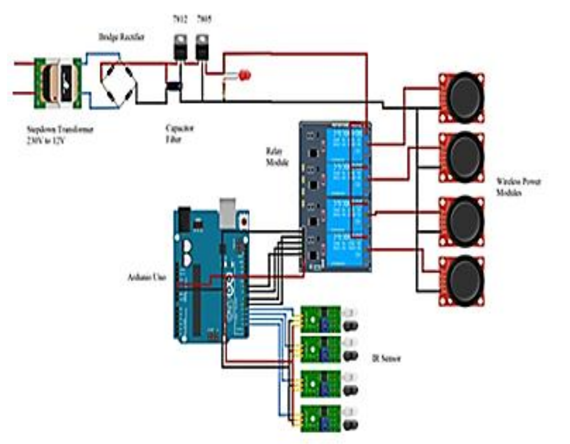

Figure 10: Circuit Diagram

VI. IMPLEMENTATION

Arduino Software:-You'll need to download the Arduino Software package for your operating system. When you've downloaded and opened the application you should see something like this:

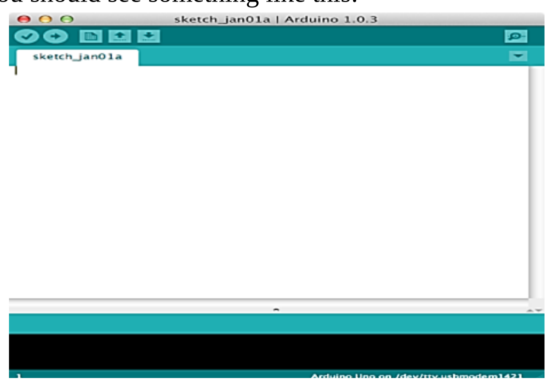

Figure 11: Arduino IDE

This is where you type the code you want to compile and send to the Arduino board.

The code you write for your Nodemcu esp8266 are known as sketches. They are written in C++.

Every sketch needs two void type functions, setup() and loop(). A void type function doesn't return any value.

The setup() method is ran once at the just after the ESP8266 is powered up and the loop() method is ran continuously afterwards. The setup() is where you want to do any initialization steps, and in loop() you want to run the code you want to run over and over again.

- The Initial Setup

We need to setup the environment to Tools menu and select Board.

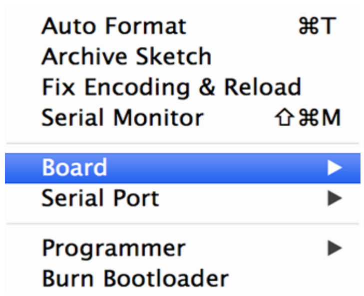

Figure 12: Select Board

Then select the type of Arduino you want to program, in our case it's the ESP8266.The code you write for your Nodemcu esp8266 are known as sketches. They are written in C++.

- Compiling the Code

If this is your first time you've ever compiled code to your Arduino before plugging it in to the computer go to the Tools menu, then Serial Port and take note of what appears there. Here's what mine looks like before plugging in the Arduino UNO:

Plug your Arduino UNO board in to the USB cable and into your computer. Now go back to the Tools > Serial Port menu and you should see at least 1 new option of serial ports appear.

On Windows you should see *COM* followed by a number. Select the new one that appears. Once you have selected your serial or COM port you can then press the button with the arrow pointing to the right.

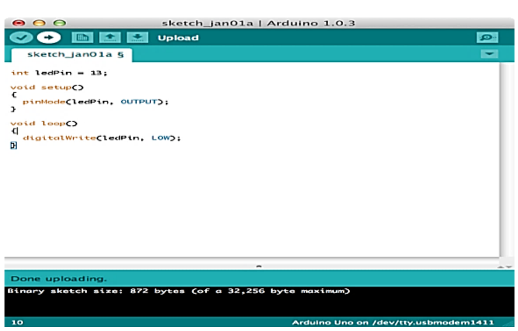

Figure 13: Compiling Uploading Program

- Flowchart:-

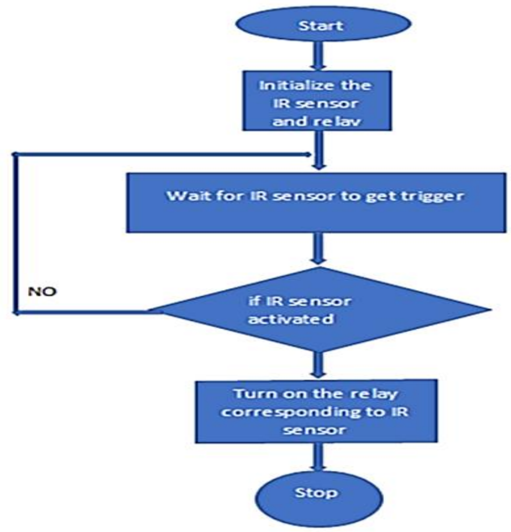

Figure 14: Flow Chart

VII. RESULT

The transmitting coils are buried under the road at certain distance, and that can selectively on/off for charging vehicles while EVs are in motion. The transmitting coils are connected by the relays to the cable. The Vehicle communication module will detect the entry of vehicle by use of sensors which are connected to Arduino module. The Arduino signals the relay to open the transmitting coil when the EV runs to the transmitting coil L1, the sensor will signal the contact of the relay S1 to on, and the transmitting coil L1 will be energized, resonating with the receiving coil, transmitting energy wirelessly to the EV. Meanwhile, transmitting coil L2 is standby. When the EV runs on the interval between two transmitting coils, L1 and L2 will be connected in series. This charging method can avoid the impact caused by suddenly energizing of transmitting coils on the wireless charging system. While the EV pulls away, S1 will be open and L1 will be de-energized. The transmitting coils can staged charge the EV by selective on/off.

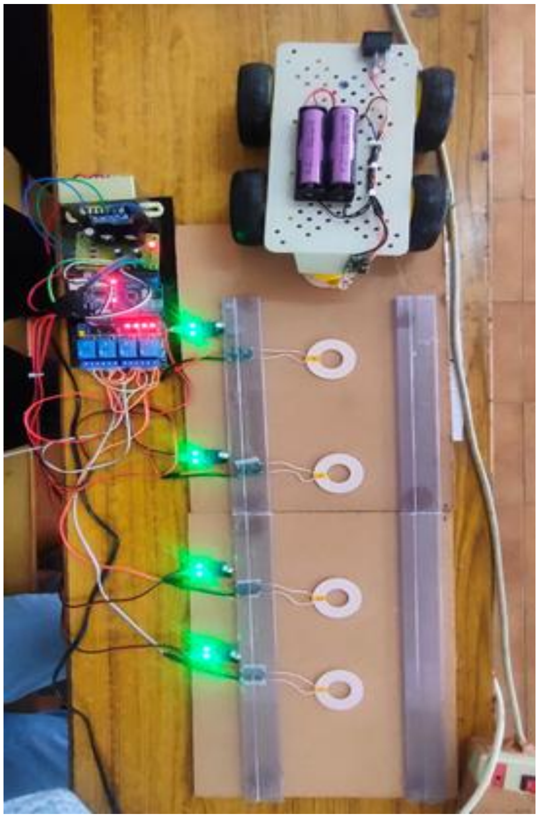

Figure 15: Complete Project Photo

CONCLUSION

We have discussed and reviewed charging of electric vehicles using wireless power transmission. Wireless charging is considered a better alternative to traditional wired charging systems as it is user and environment friendly. Furthermore, it eliminates the need for wires and mechanical connectors, and therefore, avoids the associated Wireless charging systems for electric vehicles hassles and hazards. Wireless charging systems also reduce the range anxiety and enhance the system efficiency. The wireless power transmission, in general, takes place using either microwave, laser or mutual coupling. However, only mutual coupling based techniques are generally used for wireless charging. The mutual coupling based techniques, inductive and capacitive power transfer, are employed for contactless power transfer and charging of electric devices. Both these techniques are discussed, compared and contrasted, and it is concluded that the inductive power transfer has advantages and is the prime method for wireless charging of electric vehicles. For this purpose, static, semi or quasi dynamic or completely dynamic methods of wireless charging can be employed. These modes of wireless charging of electric vehicles are explained in this article. In addition, important aspects of a wireless charging system, such as, charging pad, compensation topologies, system misalignment, communication and control are reviewed and discussed. As various parameters of a charging system are determined by the batteries, a brief overview of battery types and models is also provided.

ACKNOWLEDGMENT

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