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Smart Wireless Charging for Electric Vehicle

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ABSTRACT

The current and future strong demand for diesel and petrol, as well as concerns about worldwide safety, have prompted the introduction of electric cars in our nation. A charging station and cable are required to recharge the battery. We propose a concept for wirelessly charging batteries utilising induction coupling in this project. The transmitter coil and reception coil are located on the main side of the system. Electric car owners may take use of the inductive charging technology that allows their vehicles to charge themselves while parked near public spaces like parks, shopping malls, and entertainment venues. In this case, we are displaying voltage and efficiency metrics using a WIFI module that is serially connected to a server. Our project's wireless car charging mechanism minimizes the need for wires, and a web server is used to monitor the system's voltage and efficiency on an ongoing basis.

1. INTRODUCTION

A more sustainable option, electric automobiles, have diverted the attention of the car industry. To move and operate, electric vehicles (also referred to as EVs) rely on traction motors. A collector system draws power from distant power plants to charge an electric vehicle's batteries. The vehicle is powered by a massive traction battery, which has to be plugged into an electrical outlet in order to charge the battery. The primary issue with electric vehicles is their inefficient and dense electric batteries, which cannot match the performance of engines powered by petrol. Eliminating cables and infrastructure, providing mobility within transmission range, and doing away with power plug compatibility difficulties are the primary benefits of power transfer via wireless technology over wired. In order to charge an electric car efficiently, this research suggests a system that uses wireless means. The term "wireless power transmission" (WPT) encompasses a wide range of techniques, including microwave, inductive coupling, laser, magnetic resonance, and a host of others. Magnetic Resonant Coupling stands out as the most efficient and effective approach among the others. In magnetic resonance coupling, a resonance is generated and transmitted without electromagnetic wave-related radiation issues. Therefore, the circuit design is greatly affected by the resonance frequency. Based on changes in the wireless power transfer coefficients, this research primarily aims to provide the best way for wirelessly charging the electric vehicle. The main and secondary impedances of a WPT system must be matched for the power transfer efficiency to reach its full potential.

a) According to N. Z. Xu and C. Y. Chung research, the Smart Park electric vehicle charging station can efficiently handle the load's active, reactive, and harmonic power needs when converted into a shunt active power filter (SAF). Here, we analyse the Smart Park SAF system installed at a dc metro traction substation. The Icosφ algorithm is used by the Smart Park shunt active filter to offer compensation. A nonlinear load of 750 V DC metro traction has been simulated in Matlab. Smart Park's grid support for a metro rail system is feasible, according to the simulation findings [1].

b) The paper "Vehicle-to-grid transactions and shunt active filtering capability of Smart Parks with a modified Icos controller" by N. Rahbari-Asr and M.-Y. Chow discusses V2G services, like reactive power compensation and harmonic elimination, by using the converters used in Smart parks as shunt active filters. When demand is low, you may use the bidirectional converters to charge your batteries [2]. In the event that the parks generate more energy than they need for charging, they may contribute to the grid by storing it and then supplying it with compensation.

c) A. A. S. Mohamed, A. Berzoy, and O. A. Mohammed Examining the effects of electric cars, current methods of deployment, and cutting-edge charging technology Among the potential solutions to the problem of climate change, electrifying transportation stands out. Many industries, notably the electrical grid, have been profoundly affected by the widespread availability of electric vehicles. A number of regulations have been put in place to encourage the use of electric vehicles, and it is encouraging to see that their use has been on the rise recently [3]. Electric vehicle technologies have been continuously enhanced for greater acceptance thanks to developments in power train, battery, and charger technology. Charging electric cars has detrimental effects on the current network functioning, notwithstanding the positive effects on the environment and the economy. To address this problem, suitable methods of charge control may be put into place. To add to that, Teslas.

d) W. B. Heredia, K. Chaudhari, A. Meintz, M. Jun, and S. Pless on Power Transmission Systems from Electric Vehicle Loads. When it comes to providing cleaner, CO2-free transportation that doesn't harm the environment, electric vehicles (EVs) stand head and shoulders above the competition. Utilities must assess the effects on electrical system functioning of increasing the number of electric cars. Using a range of 0–50% EVs with varying charging capabilities, this study examines the impacts on critical power distribution system characteristics such as voltages, line decreases, system losses, etc. Electric car smart charging and dump modes are also used in this investigation [4]. The experiments are conducted using a representative primary distribution system for electricity in Denmark. Based on the modelling findings, the test equipment for the dump charged mode could only accommodate electric cars that fall below the 10% limit. The network could handle about 40% overall electric car demands using the smart charging option.

2. PROPOSED SCHEME

In order for wireless charging systems to function properly, they include of many components. In Figure, you can see all the steps that include WPT. Straight current (AC) is transformed into direct current (DC) as it flows from the source. To convert AC to DC, a complete bridge rectifier is used. The inverter receives a high-frequency AC source from the rectifier's output [5, 6]. The inverter's high-frequency AC output powers the system's transmitter. Before being inputted into the transmitting circuit, the output of the inverter is protected from high voltage AC by means of a signal conditioning circuit.

A transmitting coil, a capacitor, and a resistor make up the majority of the transmitting circuit. Both the sending and receiving ends utilise the same circular planar copper coil. The power that is transferred from the coil that transmits is received by the receiving coil [7]. A capacitor and a resistor are connected in series with the receiving coil on the receiving side. Converting the AC on the load side to DC for storage.

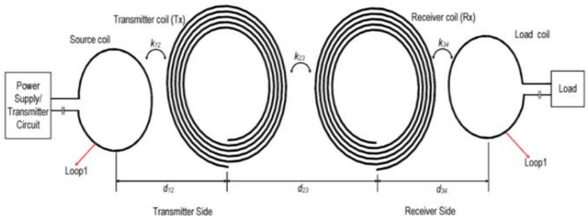


Fig:1 Power transmission through coils.

3. Working Principle

In order to maintain a high level of power and stability when racing, electric vehicle systems often consist of a number of components. Most of these parts are connected to the system that charges them [8]. Regarding this matter, a realistic approach to addressing concerns about electric vehicle range and lowering the price of onboard batteries is dynamic wireless power transfer. Designed to enable charging even while the car is in motion, wireless charging has long been prevalent with pure electric cars. However, due to the complexity of its working philosophy and the presence of several factors and factors, this approach is tough to analyse [9]. Multiple characteristics, including vehicle speed and the dimensions and sizes of the coil receivers, are defined by the vehicle's status, which includes whether it's in motion or not. A new approach to optimising the constantly changing wireless recharge system's performance is introduced in this study. A dynamic mathematical model is provided by the receiver coils in the suggested system, which allows for the description and measurement of source-to-vehicle power transfer even while the vehicle is in motion, thereby maximising charging power [10-13]. All of the physical characteristics that define the model were laid down and examined in the mathematical model that was suggested. The outcomes demonstrated that the suggested methodology was successful.

One such microcontroller board is the Arduino Uno, which uses the 8-bit ATmega328P. Supporting the microcontroller is a set of components that includes the ATmega328P, as well as a crystal oscillator, serial communication, voltage regulator, and so on [14]. A USB connector, a power barrel jack, an ICSP header, a reset button, and fourteen digital I/O pins (six of which are PWM outputs) make up an Arduino Uno. The board also has six analogue I/O pins [15].

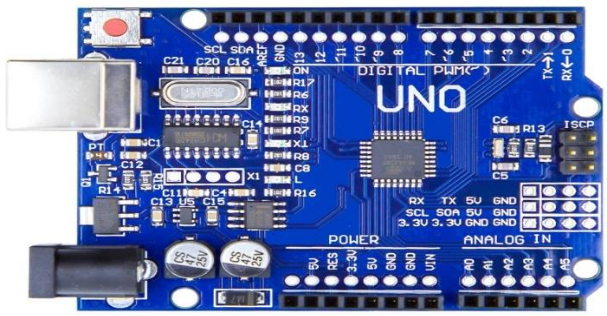


Fig:2 Microcontroller

4. Programming Arduino

Hook up the board to the computer via USB once you've loaded the Arduino IDE on your PC. Launch the Arduino IDE, go to Tools>Boards>Arduino/Genuino Uno, and then choose the right port by going to Tools>Port. The Arduino Uno may be programmed using the Wiring-based Arduino programming language. Simply load the sample code from Files>Examples>Basics>Blink to begin using the Arduino Uno board & blinking the built-in LED. Click the "upload" button on the top bar after you've loaded the sample code (as shown below) into your integrated development environment. The built-in LED on the Arduino should start flashing after the upload is complete. The code for blinking is shown below.

5. Hardware Components

A. *Buzzer*

Electronic signalling devices, such as buzzers or beepers, are commonplace in modern vehicles, home appliances (such microwave ovens), and even certain game shows. The first electromechanical buzzers, which were powered by stepped-down AC voltage from the line at 50 or 60 cycles, gave rise to the name "buzzer" due to the rasping sound they produced. Ringing or beeping are two other typical ways that buttons are indicated to have been pushed.

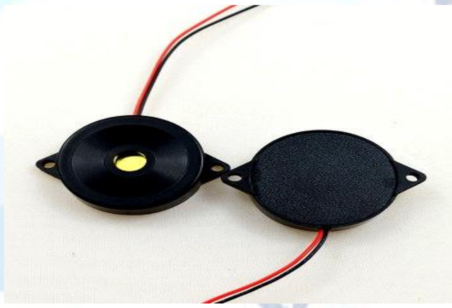


Fig:3 Electrical Buzzer

B. *Humidity Sensor*

One way to measure anything is via a sensor, which is also called a detector. These devices take readings of quantifiable attributes and turn them into signals that an observer or instrument may interpret. For instance, in order to read the temperature on a calibrated glass tube, a mercury-in-glass thermometer first measures the amount by which a liquid expands and contracts. A thermocouple is a device that can measure temperature and produce a voltage that a voltmeter can read. The relative humidity may be measured via a humidity sensor. So, it's able to gauge both the dryness and wetness of the air. As a percentage, relative humidity measures how much moisture is really in the air as compared to the maximum amount that air at the same temperature can contain. Because warmer air can retain more moisture, relative humidity fluctuates in response to changes in temperature.

Fig:3 Humidity sensor

C. Battery

For electrical equipment like mobile phones, torches, and electric automobiles, there is an energy source called a battery. This consists of one or more battery cells that are connected externally [1]. The cathode is the positive terminal of a battery and the anode is the negative terminal while the battery is providing electric power.[2] in An external electrical system will allow electrons to flow from the terminal labelled negative to the positive terminal. Connecting a battery to an outside electric load causes a redox reaction to occur, which changes the energy of the reactants from high to low. The electrical energy that results from this process is called free energy difference. The lead-acid batteries that are used in automobiles and the lithium-ion batteries found in computers and cell phones are two such examples.

Fig:4 Battery

D. Photovoltaic Energy System

The solar cells that make up solar panels are responsible for transforming the sun's rays into usable electricity. A battery stores the transformed electrical energy, making it accessible for later use. Solar panels often make use of silicon crystal as their primary material. As is well known, DC electrical energy is produced when solar photons, or light energy, hit these silicon crystals. Electricity generated by the solar panels is 18 volts & 23 watts.

E. PV Module

As illustrated in figure 3.2, a PV module may be constructed by connecting many PV cells in either a grid configuration (both serial & parallel) or a very low voltage configuration (about 0.4 V). We link PV cells in series when we require a higher voltage and in parallel when we need a greater current to meet the load demand. The standard number of cells found in PV modules is 36 or 76. We are using a module with 54 cells. The PV cell is housed inside a transparent front side of the module, which is typically constructed of low-iron & transparent glass material. Due to reflections from the covering of glass and frame, a module's efficiency is lower than that of a PV cell.

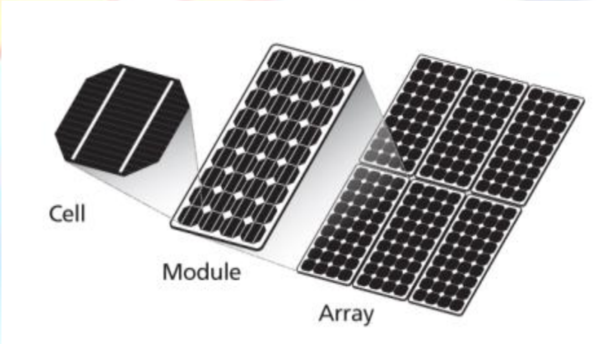


Fig:5 Photovoltaic system

F. Working of PV Cell

According to the photoelectric effect, the electrons in a semiconductor are excited and move from the valence band to the conduction band when a light particle hits a photovoltaic cell, allowing them to move freely. This is the fundamental theory underlying how PV cells work. Electron movement generates a potential difference between two terminals, one positive and one negative. An electric current begins to flow across a circuit when an external connection is made between these terminals.

G. WIFI

Like mobile phones, TVs, and radios, a wireless network transmits data using radio waves. Data is converted into a radio signal and sent via an antenna using a computer's wireless adapter. It is deciphered by a wireless router that receives the signal. Through a real, wired Ethernet connection, the router transmits the data to the Internet. In the other direction, data is sent from the router to the computer's wireless adapter after first arriving at the router via the Internet. Wireless local area network (Wi-Fi) radios are quite similar to those used in mobile phones, walkie-talkies, and other similar devices. They are capable of sending and receiving radio waves, as well as converting between radio waves and binary numbers. However, there are a few key distinctions between traditional radios and Wi-Fi radios:

Either 2.4 GHz or 5 GHz is the frequency at which they communicate. The frequencies used by mobile phones, walkie-talkies, and TVs are much lower in comparison to this one. With a higher frequency, the signal may transport more data. 802.11 networking standards are used.

6. Software Implementation

Installing the Arduino Desktop IDE is necessary if you want to programme your Arduino Uno when it is not connected to the internet. As with all of our boards, the Uno may be programmed using the Arduino Software (IDE). Installing the Arduino Software (IDE) on your personal computer is a must to moving on, as outlined on the main page of our Getting Started guide. Use an A to B USB connection, often known as a USB printer cable, to link your Uno board.

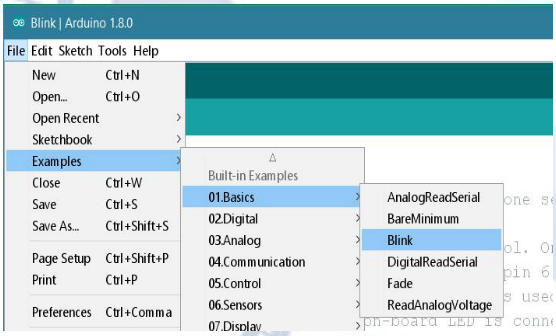


Fig:6 Select the board driver

A. Burning the boot loader

To upload a sketch to your Arduino board, you need to install a little bit of software called the boot loader. This programme establishes a connection between your board and the Arduino IDE. An external programmer, such as the Arduino ISP, is often required to load programmes into microcontrollers. Because it contains the protocol that enables your computer to programme the flash memory of the AVR, the boot loader removes the requirement for an external programmer.

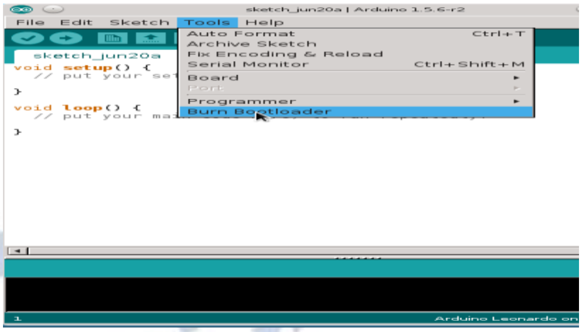
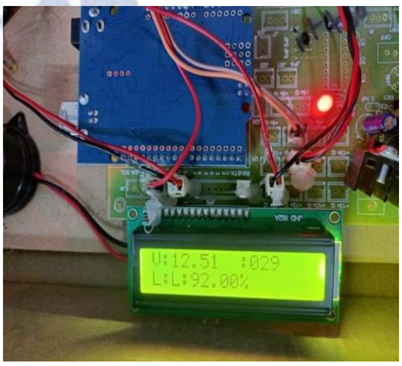


Fig :7 Burn Boot loader

B. IoT Cloud

Things like hardware boards, which are examples of devices, may be found within many products (e.g., MKR WiFi 1010). The software, sensors, actuators, and communication via the Arduino IoT Cloud are all handled by these pieces of hardware. With as little emphasis on the underlying hardware as possible, things stand in for the object's intrinsic features. A set of characteristics (such temperature and light intensity, for example) describes every object. The features that make up a system are defined by its properties. To signal that the Arduino IoT Cloud may read the data but cannot alter its value, a property might have a "read-only" (RO) option, for example. If the Arduino Internet of Things Cloud could remotely update the value of a property and send a notification of an event to the device, it may be built as "read and write" (RW). One helpful aspect of the Arduino IoT Cloud is that it can automatically produce a Sketch when you set up a new object [33]. Additional interaction mechanisms supported by Arduino IoT Cloud include Websockets, Javascript, Command-Line Tools, MQTT, and HTTP REST API.

7. Experimental Results



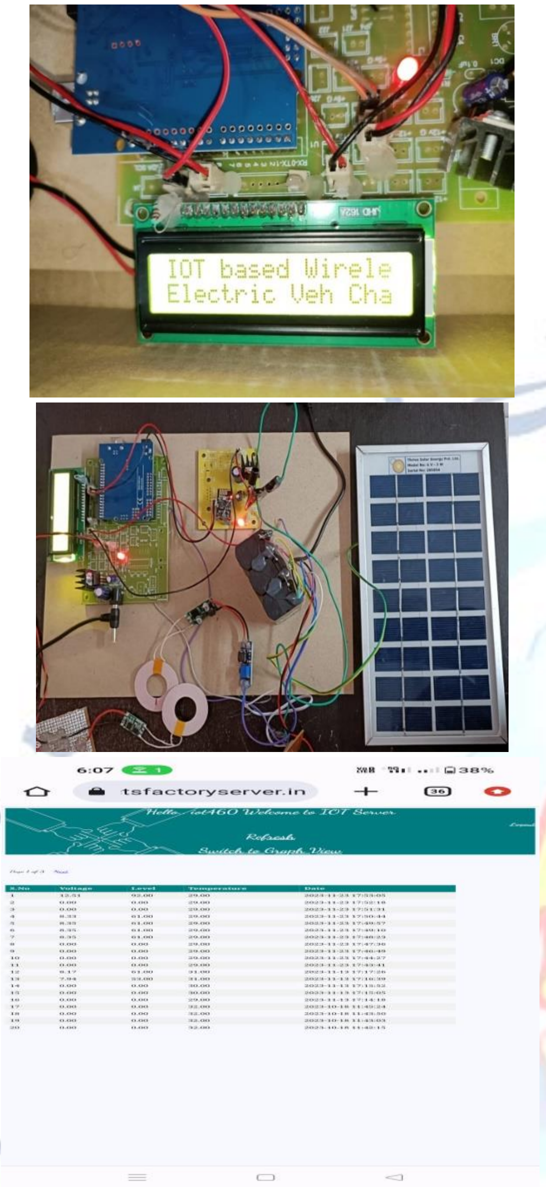


Fig:6 Experimental results of smart wireless charging for electric vehicle

8. CONCLUSION

These days in the electric car market, conductive automatic charging systems are rising to prominence. Charging automobiles is becoming more difficult due to the fact that wires are becoming excessively big due to increased charging power. Some experimental projects have already implemented automatic charging systems, although they are all still in the prototype stage. The above project idea provides a high-level framework for considering potential solutions. In the aforementioned initiative, the significance of wireless car charging is highlighted. Renewable energy sources, such as solar power, are better for the environment, and infrared sensors shield people from the harmful electromagnetic radiation generated by the charging process. So, electric vehicles that use wireless charging are more efficient, have less power loss, are completely autonomous, and cost less.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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