International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 05 | May - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Wireless Charging Station for Electric Vehicles

K. SAI TEJA[1], K. SAI PRASAD [2], R. SAI KIRAN [3], Y. ROHITH [4], K. RAM PRASAD [5],
[1,2,3,4,] Students, Department of Mechanical Engineering, Nadimpalli Satyanarayana Raju Institute of Engineering and Technology (Autonomous), affiliated to JNTUGV, Visakhapatnam – 531173, AP, INDIA
[5,] Assistant Professor, Department of Mechanical Engineering, Nadimpalli Satyanarayana Raju Institute of Engineering and Technology (Autonomous), affiliated to JNTUGV, Visakhapatnam – 531173, AP, INDIA

Abstract

The project mainly focuses on the model of wireless charging station for electric vehicles. In this charging station the user no need to use physical cables for charging their electric vehicles. When the car arrives on the particular slot for charging the IR sensor detects the vehicle and sends signal to the Arduino Board, then the required voltage is transferred to the transmitter coil which is placed in the parking slot, with the help of magnetic induction principle the energy from transmitter coil is transmitted to the receiver coil which is placed in the bottom of the vehicle.

Introduction

The concept of this paper is to create wireless charging station for electric vehicles, now a days many are using electric vehicles for transportation to reduce the pollution and the harmful gases which are being released by the petrol and diesel engines. So many people have a fear to charge the electric vehicles with the help of cables because in the rainy season there must be an improper earthing to the individual houses and the cables may become wear and tear after certain usage. The project mainly consists of Transmitter coil which transmits the energy from the Relay, Receiver Coil which receives the electricity from the transmitter coil, and the status of the particular slots is shown on the LCD screen.

Descriptions:

This project Wireless Charging Station for Electric Vehicles can be done by using Arduino Board and with some electronic components. There are some other components like Raspberry pi, Onion Omega2+, NVIDIA Jetson Nano Developer Kit, ASUS Tinker Board S, ClockworkPi, Rock64 Media Board, and PocketBeagle which can be used in the place of arduino Board. The Arduino UNO board is very popular among all electronic circuits, thus we employed Arduino UNO board our project model. The controlling of the components is done by Arduino Board which means the input devices like IR sensor, Bluetooth module, and the output devices like LCD screen, Relay etc. they all runs in a sequence with the help of a Program code which is uploaded in the Arduino Board, this code can be written in the Arduino IDE software.

Literature Review

There are many questions on this model that the required voltage is not being transferred for charging the vehicle, the charging of vehicle is taking so much time, to overcome this type of problems the researchers are conducting many experiments to overcome the problems which are facing by the users. The components like transmitter, resistor are being overheated when the vehicle is charging.

Maximize power transfer efficiency. Research by Wu et al. (2018) [3]

Advancements in resonance-based charging techniques, as investigated by Li et al. (2020).

The work by Zhang et al. (2021) [4] provides insights into the EMC performance of wireless charging systems

Components used:

The components used in the model are:

1. Arduino UNO
2. IR sensor
3. 5v Relay Module
4. LCD display (16*2)
5. I2C display module
6. 9v DC adapter
7. Bluetooth Module
8. Transmitter Coil
9. Receiver Coil
10. Transistor 2N2222A
11. Resistor 27k

Working Of Wireless Charging Station:

- When the IR sensor detects the car in the particular slot and sends the signal to the Arduino Uno Board, That car has been arrived to the particular slot for charging.
- We can control the charging station with the Bluetooth module HC-05.
- By using Android mobile app called Arduino Bluetooth control, in the Terminal pad give the saved data type to switch on the charging.
- The status of the slots can be seen on the 16*2 LCD screen, if the slot-1 is activate then the status in the LCD screen of slot-1 is charged is shown in the LCD screen.
- After giving the particular data type through the Bluetooth app it is communicated through the arduino Uno Board then sends the signal to particular Relay to switch on.

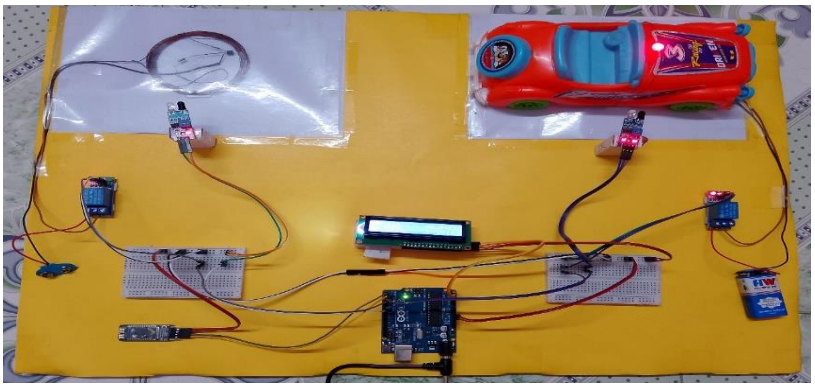

Fig 1: Electric vehicle is parked in charging slot

- The Relay is connected to the particular output pin of arduino board, relay is type of electromechanical switch that is activated by a 5V signal.
- The relay send the required voltage to the Transmitter Coil.
- The Receiver Coil is placed in the bottom of the car, when the car is parked at a desired location then according to the principle of electromagnetic resonance, resonant-based chargers inject an oscillating current into a coil to create an oscillating electromagnetic field.
- When the battery is fully charged then the car moves from the parking slot then the transmission of electricity to the Transmitter coil stops automatically.

1. Arduino UNO Board:

Arduino UNO is based on an ATmega328P microcontroller. It is easy to use compared to other boards, such as the Arduino Mega board, etc. The board consists of digital and analog Input/output pins (I/O), shields, and other circuits. The Arduino UNO includes 6 analog pin inputs, 14 digital pins, a USB connector, a power jack, and an ICSP (In-Circuit Serial Programming) header. It is programmed based on IDE, which stands for Integrated Development Environment. It can run on both online and offline platforms. To communicate with Arduino Board we have a Particular software called Arduino Ide, we have to upload a program into microcontroller so that set up runs only once and the loop runs frequently.

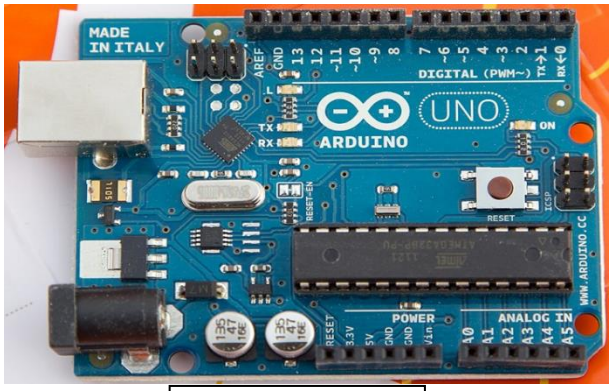

Fig 2: Arduino IDE

2. IR sensor:

An IR sensor, or infrared sensor, detects infrared radiation in its surroundings. This type of sensor is commonly used in various applications such as motion detectors, proximity sensors, temperature sensors, and object detection systems. The basic principle behind IR sensors is the detection of infrared radiation emitted or reflected by objects. They typically consist of an IR emitter, which emits infrared radiation, and an IR detector, which detects the radiation. When an object is in proximity to the sensor, it reflects or emits infrared radiation, which is then detected by the IR detector. The sensor can then detects the object and sends the signal to the input pin of Arduino Uno Board.

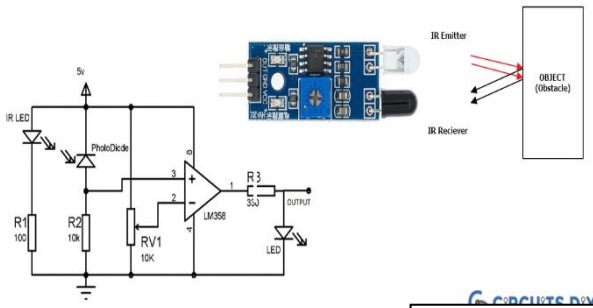

Fig 3: IR sensor

3. 5V Relay Module:

A 5V relay is an electromechanical switch that is activated by a 5V signal. It's commonly used in electronic circuits and projects to control high-voltage devices or appliances using a low-voltage microcontroller or other control circuitry.

Here's how a typical 5V relay works:

1. Electromagnet: The relay consists of an electromagnet coil that, when energized with a 5V signal, generates a magnetic field.

2. Switch Contacts: The magnetic field generated by the electromagnet causes a metal armature to move, closing or opening one or more sets of switch contacts.

3. Switching High-Voltage Loads: The switch contacts of the relay can be used to control the flow of current to a high-voltage load, such as a motor, light bulb, or other electrical device. When the relay is energized, the switch contacts close, allowing current to flow through the load. When the relay is de-energized, the switch contacts open, interrupting the current flow.

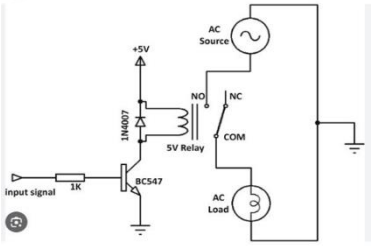

Fig 4: Relay and Relay working

4. LCD display (16*2):

A 16x2 LCD screen is a common type of liquid crystal display (LCD) module that is widely used in electronic devices for displaying alphanumeric characters. The "16x2" specification means that the LCD has a display area of 16 characters in width and 2 lines in height. Each character position on the screen can display one alphanumeric character, symbol, or custom character. These screens are often used in microcontroller-based projects, embedded systems, consumer electronics, and various electronic devices where a simple and compact text display is required. The interface 16x2 LCD screen typically involves connecting it to a microcontroller or other control circuitry using a set of parallel data lines for sending character data and control signals for functions such as clearing the display, moving the cursor, and setting the display mode.

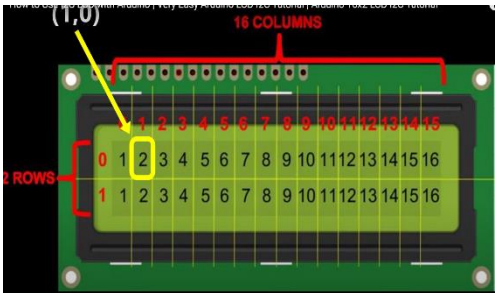

Fig 5: LCD screen

to control a

5. I2C display module:

Using an I2C (Inter-Integrated Circuit) module with a 16x2 LCD screen is a convenient way to simplify the wiring and reduce the number of pins required to control the display, especially in projects with limited available GPIO pins on the microcontroller. The I2C module typically consists of an I2C backpack that interfaces with the LCD screen and allows communication with the microcontroller using the I2C protocol. This backpack often includes an I2C controller chip, such as the popular PCF8574, which acts as an interface between the LCD screen and the I2C bus.

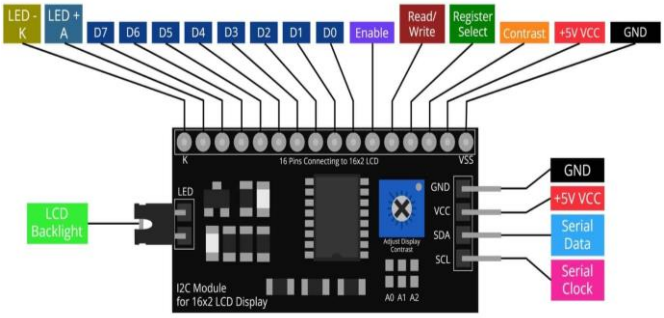

Fig 6: I2C display module

6. 9v DC adapter:

The use of adapter is to convert the Alternating current into required voltage of Direct current. So that the low power components like Arduino, sensors, LCD screen, Relay works.

Fig 7: DC adapter

7. Bluetooth Module:

Bluetooth Version: The HC-05 module typically supports Bluetooth 2.0 and 2.1 standards, which include the Serial Port Profile (SPP). This allows it to establish a wireless serial communication link between devices.

Communication Interface: The HC-05 module communicates with a host microcontroller or device using UART (Universal Asynchronous Receiver-Transmitter) serial communication. It has RX (receive) and TX (transmit) pins for serial communication.

Operating Voltage: The operating voltage of the HC-05 module is typically 3.3V, although some modules may be tolerant of 5V logic levels on the RX and TX pins.

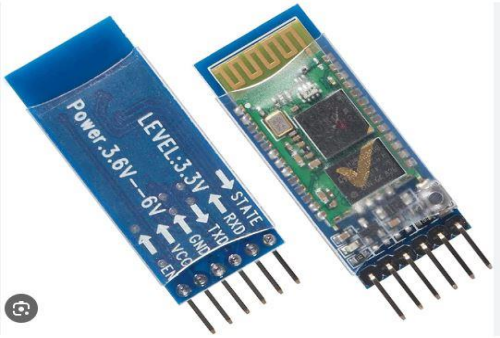

Fig 8: Bluetooth Module

Pairing and Connections: The HC-05 module can act as both a master and a slave device, allowing it to connect to other Bluetooth devices such as smartphones, tablets, or other HC-05 modules. Pairing with another device typically involves entering a predefined PIN code (usually 1234 or 0000) or using a custom PIN code set in the module's settings.

Connect the TX pin on the Bluetooth module to RX pin in the Arduino Uno Board and RX pin on the Bluetooth module to TX pin in the Arduino Uno Board.

8. Transmitter Coil:

A transmitter coil, often referred to as a primary coil, is a coil of wire used in electromagnetic induction systems such as wireless charging, inductive power transfer, or wireless power transfer (WPT) applications. In wireless power transfer systems, the transmitter coil is connected to a power source, typically an alternating current (AC) power supply or a power oscillator circuit. When an alternating current flows through the transmitter coil, it generates a changing magnetic field around it according to Faraday's law of electromagnetic induction.

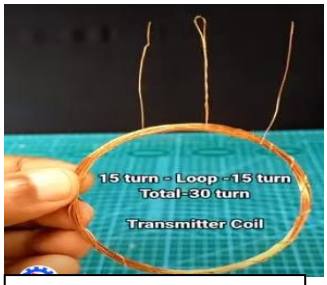

Fig 9: Transmitter Coil

9. Receiver Coil:

A receiver coil, also known as a secondary coil, is a coil of wire used in electromagnetic induction systems such as wireless charging, inductive power transfer, or wireless power transfer (WPT) applications. In wireless power transfer systems, the receiver coil is placed in close proximity to a transmitter coil, which is connected to a power source. When an alternating current flows through the transmitter coil, it generates a changing magnetic field around it according to Faraday's law of electromagnetic induction. Receiver coils play a crucial role in enabling wireless power transfer technologies, providing a convenient and cable-free method of charging or powering electronic devices.

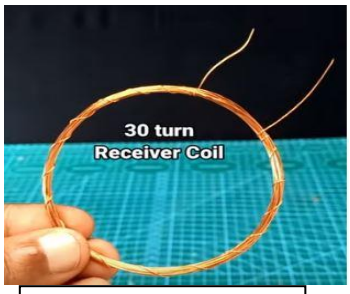

Fig 10: Receiver Coil

10. Transistor 2N2222A:

The 2N2222A is a commonly used bipolar junction transistor (BJT) in electronic circuits. It's an NPN (negative-positive-negative) type transistor, which means it has three terminals: the collector (C), the base (B), and the emitter (E). Here's some key information about the 2N2222A transistor:

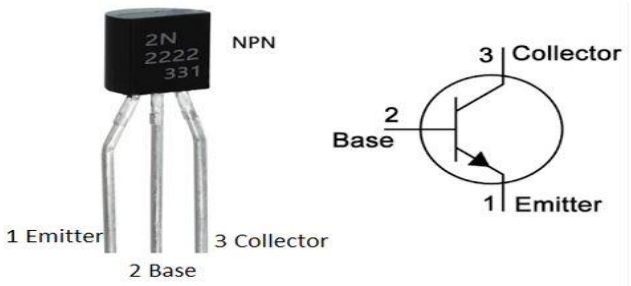

Fig 11: Transistor 2N2222A

1. Emitter (E): The terminal through which the current exits the transistor when it's in the active mode.

2. Base (B): The terminal that controls the flow of current between the collector and emitter. Applying a small current or voltage to the base can control a much larger current flowing between the collector and emitter.

3. Collector (C): The terminal through which the current flows into the transistor when it's in the active mode.

11. Resistor 27k:

A 27k ohm resistor is a type of fixed resistor with a resistance value of 27,000 ohms. Resistors are passive electronic components that limit the flow of electric current in a circuit. Resistors are used in a wide range of electronic circuits for various purposes, including voltage division, current limiting, biasing transistors, and setting the gain of amplifiers, among others. A 27k ohm resistor might be used in applications where a specific resistance value is needed to achieve the desired circuit behavior.

Fig 12: Resistor 27k

Conclusion:

Wireless charging has several advantages in the society, there is no need of physical cables for charging the electric vehicles. By using Arduino UNO we can control the input devices like sensors, and output devices like relays, LCD screen. Wireless charging station is environmentally friendly and reduces the hazards.

There is still a lot of development in this project like overheating issues, compatibility, and efficiency. Etc.

Future Scope:

Future advancements in wireless charging technology will likely focus on improving charging efficiency and reducing energy loss during the charging process. As battery technology continues to evolve, wireless charging stations will be designed to support higher power levels and faster charging speeds. Future wireless charging systems may incorporate dynamic charging capabilities, allowing EVs to charge while in motion

References:

[1] G.A. Covic and J.T. Boys "Modern trends in inductive power transfer for transportation applications", IEEE Trans. Journal of JESTPE, June 2013, pp. 28-41
[2] C. C. Mi; G. Buja; S. Y. Choi; C. T. Rim "Modern Advances in Wireless Power Transfer Systems for Roadway Powered Electric Vehicles" IEEE Trans. on Industrial Elect. 63, no 10, 2016 pp: 6533 - 654
[3] Society of Automotive Engineers (SAE), "Wireless Power Transfer for Light-Duty Plug-In/Electric Vehicles and Alignment Methodology," 2017 http://standards.sae.org/j2954 201711/
[4] O. Simon; J. Mahlein; F. Turki; D. Dörflinger; A. Hoppe "Field test results of interoperable electric vehicle wireless power transfer" 18th European Conference on Power Electronics and Applications (EPE'16 ECCE Europe) 2016 pp. 1-10
[5] H.H. Wu, A. Gilchrist, K.D. Sealy, D. Bronson "A High Efficiency 5 kW Inductive Charger for EVs Using Dual Side Control" IEEE trans. Indus. Elect. Vol 8 no 3 Aug 2012 pp. 585-595
[6] Lin, F. Y., Covic, G. A., & Boys, J. T. "Leakage flux control of mismatched IPT systems." IEEE Trans. on Transport. Electrification, 3 no. 2 pp. 474-487, 2017
[7] Y. Nagatsuka, N. Ehara, Y. Kaneko, S. Abe, T. and Yasuda "Compact Contactless Power Transfer System for Electric Vehicles" Int. Power Elect. Conf. ECCE Asia, IPEC 2010, Sapporo Japan June 21-24 2010, pp. 807- 813
[8] J.T.Boys,G.A. Covic and. A.W. Green "Stability and Control of inductively coupled power transfer systems", IEE Proc. EPA, 147. pp 37-43
[9]F.Y. Lin, G.A. Covic, J.T. Boys "Evaluation of Magnetic pad sizes and topologies for electric vehicle charging", IEEE Trans. Power Electronics Society, 30 no. 11, pp. 6391-6407, Nov. 2015
[10]S.Y. Jeong; S.Y. Choi; M.R. Sonapreetha; C.T. Rim "DQ-quadrature power supply coil sets with large tolerances for wireless stationary EV chargers" IEEE PELS Workshop on Emerging Technologies: Wireless Power (2015 WoW), 2015 pp. 1 - 6
[11]F. Turki; M. Detweiler; V. Reising "Performance of wireless charging system based on quadrupole coil geometry with different resonance topology approaches" IEEE PELS Workshop on Emerging Technologies: Wireless Power Transfer (WoW) 2016 pp: 104 - 109
[12]S. Kim, G.A. Covic and J.T. Boys "Comparison of Tripolar and Circular Pads for IPT Charging Systems", IEEE Trans. Power Electronics Society pp 1-11, available early access DOI: 10.1109/TPEL.2017.2740944
[13]U.K. Madawala and D.J. Thrimawithana, "A Bidirectional Inductive Power Interface for Electric Vehicles in V2G Systems" IEEE trans. on Indus Electron. 58, no 10 pp. 4789-4796, 2011
[14]A. Zaheer, M. Neath, H.Z.Z., Beh, G.A. Covic "A Dynamic EV Charging System for Slow Moving Traffic Applications." IEEE Trans. on Transport. Electrification, 3 no. 2, pp. 354-369, 2017
[15]F. Turki; V. Staudt; A. Steimel "Dynamic wireless EV charging fed from railway grid: Magnetic topology comparison" Int. Conf. on Electrical Systems for Aircraft, Railway, Ship Propulsion and Road Vehicles (ESARS), 2015 pp.1 - 8
[16]A. Tejeda, C. Carretero, J.T. Boys, G.A. Covic "Ferrite-less Circular Pad with Controlled Flux Cancellation for EV Wireless Charging." IEEE Trans. on Power Electronics, 32 no. 11 pp. 8349-8359, 2017
[17] J. Sampath, A. Alphones, H. Shimasaki, Coil design guidelines for high efficiency of wireless power transfer (WPT), in: 2016 IEEE Region 10 Conference (TENCON), IEEE, 2016, pp. 726–729.

[18] K. Hwang, J. Cho, D. Kim, J. Park, J. H. Kwon, S. I. Kwak, H. H. Park, S. Ahn, An autonomous coil alignment system for the dynamic wireless charging of electric vehicles to minimize lateral misalignment, Energies 10 (3) (2017).
[19] R. K. Yakala, S. Pramanick, D. P. Nayak, M. Kumar, Optimization of circular coil design for wireless power transfer system in electric vehicle battery charging applications, Transactions of the Indian National Academy of Engineering 6 (3) (2021) 765–774.
[20] J. Kim, J. Kim, S. Kong, H. Kim, I.-S. Suh, N. P. Suh, D.-H. Cho, J. Kim, S. Ahn, Coil design and shielding methods for a magnetic resonant wireless power transfer system, Proceedings of the IEEE 101 (6) (2013) 1332–1342
[21] S. A. Zaini, S. H. Yusoff, A. A. Abdullah, S. Khan, F. Abd Rahman, N. N. Nanda, Investigation of magnetic properties for different coil sizes of dynamic wireless charging pads for electric vehicles (ev), IIUM Engineering Journal 21 (1) (2020) 23–32.
[22] H. Wang, K. W. E. Cheng, An improved and integrated design of segmented dynamic wireless power transfer for electric vehicles, Energies 14 (7) (2021) 1975.
[23] C. Cai, M. Saeedifard, J. Wang, P. Zhang, J. Zhao, Y. Hong, A cost-effective segmented dynamic wireless charging system with stable efficiency and output power, IEEE Transactions on Power Electronics 37 (7) (2022) 8682–8700
[24] Chen, Y., He, S., Yang, B., Chen, S., He, Z., Mai, R.: Reconfigurable rectifier-based detuned series-series compensated IPT system for anti-misalignment and efficiency improvement. IEEE Trans. Power Electron. 38(2), 2720–2729 (2023). https://doi.org/10.1109/TPEL.2022.3204592