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IoT Based EV Wireless Charging Station

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Abstract : As the new era of automobile industry is rapidly transforming from an IC engine vehicle to an electric vehicle, the demand for an electric vehicle is increasing. This leads to an increase in charging stations as well. In this project, a wireless charging system is used to charge the vehicle wirelessly via inductive coupling. We just need to park the car on the charging spot. The transmission of electrical energy from source to load from a distance without any wire or cables is called Wireless Power Transmission. The concept of wireless power transfer was the greatest invention by Nikola Tesla. This system doesn't require any human interaction. Wireless power transmission might be one of the technologies that is one step forward towards the future. This project can open up new possibilities of wireless charging that can be used in our daily lives.

Wireless power transfer (WPT) using magnetic resonance is the technology that could set human free from the annoying wires. In fact, the WPT adopts the same basic theory which has already been developed for at least 30 years with the term inductive power transfer. WPT technology has been developing rapidly in recent years. At milli watts to kilowatts power level, the power transfer distance increases from several millimeters to several hundred millimeters with a load efficiency above 90%. The advances make the WPT very attractive to electric vehicle (EV) charging applications in both static and dynamic charging scenarios.

The integration of IoT further elevates the capabilities of wireless charging systems. With IoT, the charging process becomes smarter and more connected. Real-time data can be collected and analysed, allowing for more efficient management of charging stations. IoT enables features such as remote monitoring, predictive maintenance, and dynamic load balancing. The seamless incorporation of WPT and IoT in EV charging addresses challenges related to charging time, range, and cost. This convergence renders traditional battery technology less critical in the mass market adoption of EVs. The project envisions researchers leveraging these state-of-the-art achievements to drive further advancements in WPT and foster the broader expansion of electric vehicles.

Keywords: IoT, Wireless charging, IR Sensor, Blynk, Relay, WPT.

I. INTRODUCTION

We live in a world of technological advancement. New technologies emerge each and every day to make our lives simpler. Despite all these, we still rely on the classical and conventional wired system to charge our everyday electronic gadgets. The conventional wired system create a mess when it comes to charging several electric vehicles simultaneously. It also takes up a lot of electric sockets at the charging port. At this point, a question might arise. What if a single technology can be used to charge these electric vehicles simultaneously without the use of wires and not creating a mess in the process? We gave it a thought and came up with an idea. The solution to this problem is inductive coupling, a simple and effective way of transferring power wirelessly.

Road transportation is the most used transportation in the entire world. Usage of cars has drastically increased and the need for petrol and diesel has increased. So recently, Electric vehicles (EVs) have become popular, as they decrease relying on fossil fuels and reduce greenhouse emissions. The problem with the Electric Vehicle is nothing else but the electricity storage technology, which is the major drawback today due to its unsatisfactory energy density, limited lifetime, and high cost. So, our project proposes a novel idea to charge the Electric vehicle wirelessly through the inductive power transfer principle using the transmitting and receiving coils while simultaneously decreasing the battery size and improving the convenience without the requirement of cables. The electric vehicle can be charged both by the static wireless power transmission (SWPT) and dynamic wireless power transmission (DWPT) methods.

II. LITERATURE SURVEY

[1] Supriyadi and Edi Rakhman demonstrated the effect of wire diameter (AWG) and the number of turns used is directly proportional to the amount of power that can be transferred. When the number of windings increases, more

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power will be transferred. When we use the enameled copper wire of 0.5mm diameter and keep the number of turns to 26, and apply the input frequency of 470KHz, the power efficiency obtained at a distance of 1 cm is about 1.51%. This result can turn on 1 Watt LED lamp.

[2] N.UthayaBanu and U.Arunkumar's study represents the various technologies related to the Wireless Power Transfer System, which is used to avoid flux leakage during the transmission of power and to operate the cars with high efficiency and improve the quality parameters. This project also shows the process of generating a power source through renewable energy.

[3] Govind Yatnalkar and Husnu Narman presented a survey that the duration of charging of Electric Vehicles is limited. Therefore, wireless charging is important for Electric Vehicles to overcome the charging duration problem. This paper also provides a current scenario of the art in electric vehicle wireless charging and the parameters that are required for the charging section. The most important parameters for electric vehicle wireless charging are the distance between the transmission and reception coils, the position of the coils placed on the Electric Vehicle, battery sizes, and the time for charging.

[4] In the review on Intelligent Wireless Charging Stations for Electric Vehicles, induction or magnetic coupling techniques are suitable methods in WPT for EV charging. In this study, an intelligent WPT system is introduced and simulated to charge EVs. The charging process is prescribed by misalignment, innovative method is required to improve the flexibility of EV wireless charging using the fingerprint method, this technique is able to align the transmitting coil with the receiving coil automatically. Proposed system is able to save required time, minimize mistakes made by human, minimizing the use of energy, and also able to charge car based on real time information about the system. It's quite beneficial in energy saving and electricity cost reduction for EV consumers. For EV charging, Wireless power transfer is a new field of development. The efficiency of resonant inductive coupling for EV charging is shown in this paper and the discussed techniques to improve wireless charging performance for high-frequency and high-power applications. Various coil alignment methods were discussed and the fingerprint method was presented as an economical technique for creating WPT intelligence.

[5] Another approach to the Electrical Vehicle (EV) charging scheduling problem is presented. This paper studies the charging problem under a parking garage which involves total use of time. When an EV arrives at the entrance of the garage, it takes information such as arrival time, suggested departure time, current and required battery SOCs, and garage charging management system (CMS). The CMS can decide whether to admit or decline the customer charging requirement. It manages the required power supply based on the decision. After completion of the process, it deactivates the power supply. All the charging units are under the control of an intelligent charging network. The power supply is controlled by CMS and all charging activities are automatically switched. The EVs whose charging service is not accepted by the system are parked in non-charging areas.

[6] Described research review of static and dynamic wireless electric vehicle charging system. It describes information regarding wireless charging as it is proposed in high power application, including EVs. Wireless charging has many advantages over plug in charging cause of its simplicity, reliability and user friendliness. The limitation is it can be utilized when vehicle is in stationary mode, like in parking.

[7] This paper mentioned that electricity is going to be a major part of transportation, due to EVs. At the same time, wireless charging plays an important role in charging facilities for EVs since it provides an efficient and flexible means of charging. Also, standardization of this technology is underway which will give more flexibility and freedom to charge vehicles at any wireless-enabled parking slot.

[8] With an increasing number of Electrical Vehicles (EVs), new charging infrastructures are needed. Compared with plugs and wires, wireless charging is more efficient. This paper studies the basic principle of resonant inductive power transfer which is commonly used in wireless charging. With an increasing number of these EVs, it needs to solve problems related to it. There are three types of charging methods: battery swap, conductive charging, and wireless charging transfer respectively. Nowadays Electrical Vehicles industry is developing the world widely at full speed which brings varies charging infrastructures to market. But still wireless power transfer has some difficulties due to a lack of complete and exhaustive standards.

[9] A review of the smart parking system. The proposed system has implemented smart parking system which is onsite deployment of slot model that is used to monitor the free space and book a parking slot. Smart parking can increase the economy by reducing fuel consumption and pollution in cities. Smart parking can be considered as one of the

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applications of IoT. It also gives a facility for booking slots. Once he enters the slot, time will get started and later user leaves the slot, and he needs to pay the amount for the time his car was in the slot.

III. IMPLEMENTATION

The implementation of the IoT-based EV wireless charging station involved several stages, including component selection, hardware assembly, software development, and system integration. Each stage was critical to ensuring the system's functionality and efficiency.

1. Component Selection

The components were chosen based on their compatibility and performance in the context of wireless power transfer and IoT applications. The key components included:

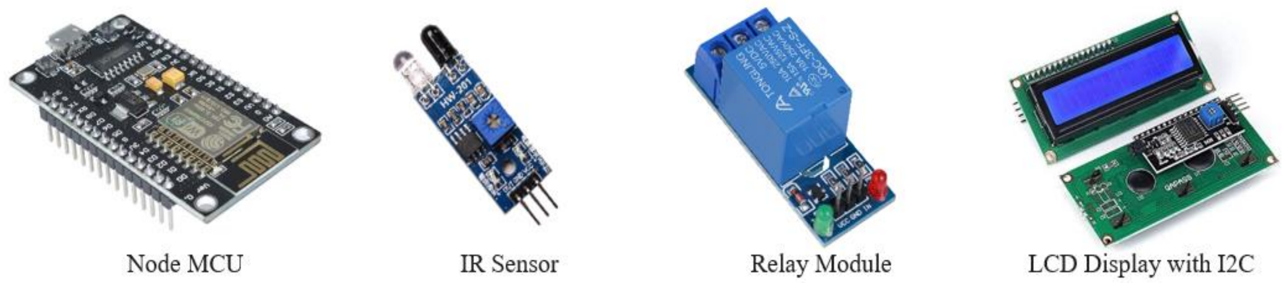

Fig. 1 Components for the project

NodeMCU (ESP8266-based): Selected for its built-in Wi-Fi capability and ease of programming using the Arduino IDE.
IR Sensors: Used to detect the presence of the vehicle. Two IR sensors were employed to ensure accurate detection.
Relays: Two relays were used to control the power supply to the charging coils.
Transfer and Receiver Coils: These coils were crucial for wireless power transfer.
LCD Display (16x2): Used to display the system status and charging information.
DC Power Adapter (12V 3A): Provided a stable power supply to the entire system.
Blynk IoT Platform: Facilitated remote monitoring and control through a mobile app.

2. Hardware Assembly

The hardware assembly involved connecting the components according to the block diagram. The NodeMCU was connected to the IR sensors, relays, and LCD display. The transfer and receiver coils were positioned to optimize the wireless power transfer efficiency. The DC power adapter ensured a steady power supply, which was critical for the system's stability.
The wiring connections were as follows:
IR Sensors to NodeMCU: Connected to the digital input pins for detecting the vehicle's presence.
Relays to NodeMCU: Connected to the digital output pins for controlling the charging process.
LCD Display to NodeMCU: Connected via I2C interface for displaying status messages.
Transfer and Receiver Coils: Wired to the relays for switching the power supply.

3. Software Development

The software for the NodeMCU was developed using the Arduino IDE. The primary tasks of the software included:
Initializing the IR sensors, relays, and LCD display.
Reading inputs from the IR sensors to detect the presence of a vehicle.
Controlling the relays based on the IR sensor inputs and commands received from the Blynk app.
Updating the LCD display with status messages such as "Welcome," "ACTIVE," and "CHARGING."
Integrating with the Blynk platform to allow remote monitoring and control.
The code was structured as follows:
Setup Function: Initialized the hardware components and established the Wi-Fi connection to the Blynk server.
Loop Function: Continuously monitored the IR sensors and controlled the relays and LCD display based on the sensor inputs and Blynk commands.

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4. System Integration and Testing

The system integration involved ensuring all hardware and software components worked together seamlessly. The following steps were undertaken:
Calibration of IR Sensors: Adjusted the sensors to accurately detect the vehicle's presence.
Testing Relays: Verified the relays' operation to ensure they could switch the power supply to the charging coils correctly.
LCD Display: Confirmed that the display showed the correct status messages.
Blynk Integration: Tested the Blynk app to ensure remote control and monitoring capabilities were functional.

5. Challenges and Solutions

Several challenges were encountered during the implementation, including:
Power Supply Issues: Initially, a 12V 1A power supply was used, which caused the relays to trigger continuously. Upgrading to a 12V 3A power supply resolved this issue by providing sufficient current to the system.
Sensor Calibration: Ensuring the IR sensors accurately detected the vehicle required precise calibration. This was achieved through iterative adjustments and testing.
Blynk Integration: Establishing a reliable connection between the NodeMCU and the Blynk server was crucial. This was accomplished by optimizing the Wi-Fi settings and ensuring robust code implementation.

IV. WORKING

This project involves creating an electric vehicle (EV) wireless charging station that leverages IoT technology to manage and control the charging process. The key components used in this project include a NodeMCU, IR sensors, relays, transfer and receiver coils, and an LCD display. The Blynk IoT app is utilized for remote control and monitoring.
The NodeMCU microcontroller is the central unit of the system, responsible for executing the program that controls the entire operation. It is programmed to interface with the IR sensors, relay, and LCD display. The NodeMCU also connects to the Blynk IoT app, allowing for remote control and monitoring of the charging process.
Two IR sensors are used in the project to detect the presence of a vehicle at the charging spots. When a vehicle is detected at a specific spot, the corresponding IR sensor sends a signal to the NodeMCU. For instance, if IR sensor 1 (IR1) detects a vehicle, it indicates that Spot 1 is occupied. Similarly, IR sensor 2 (IR2) indicates the status of Spot 2. This information is crucial for the system to know when a vehicle is in position for charging.
Relays are used to control the power transfer from the charging station to the vehicle. When the NodeMCU receives a signal from the IR sensor indicating that a vehicle is present, and if the user activates the switch via the Blynk IoT app, the NodeMCU triggers the corresponding relay. This action allows the power to be transferred through the transfer coil to the receiver coil in the vehicle, initiating the charging process.

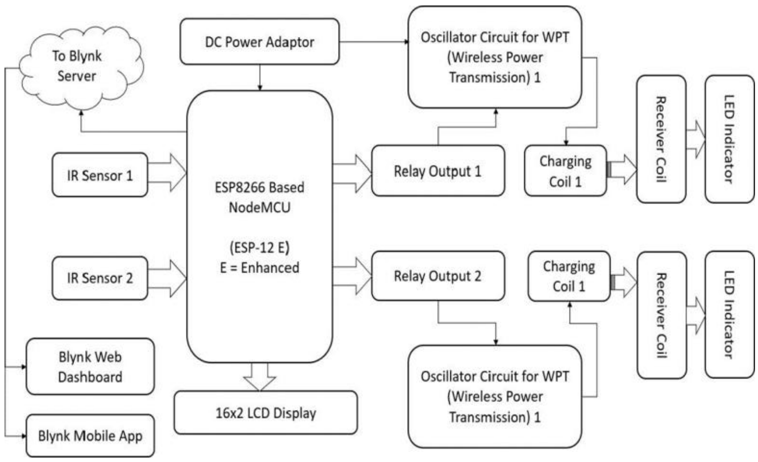

Fig. 2 Block diagram

An LCD display is integrated into the system to provide real-time feedback to the user. When a vehicle is detected by an IR sensor and the relay is switched on, the LCD display shows the status as "CHARGING" for the respective spot. For example, if Spot 1 is occupied and charging is active, the LCD will display "Spot 1: CHARGING." This feature ensures that users can easily monitor the charging status.
The Blynk IoT app is employed to offer a user-friendly interface for remote control and monitoring. Users can use the app to turn on the switch for the charging process. When the app's switch is activated, the NodeMCU receives the command and, if the corresponding IR sensor has detected a vehicle, triggers the relay to start the power transfer. This integration allows for convenient and efficient management of the EV wireless charging station.

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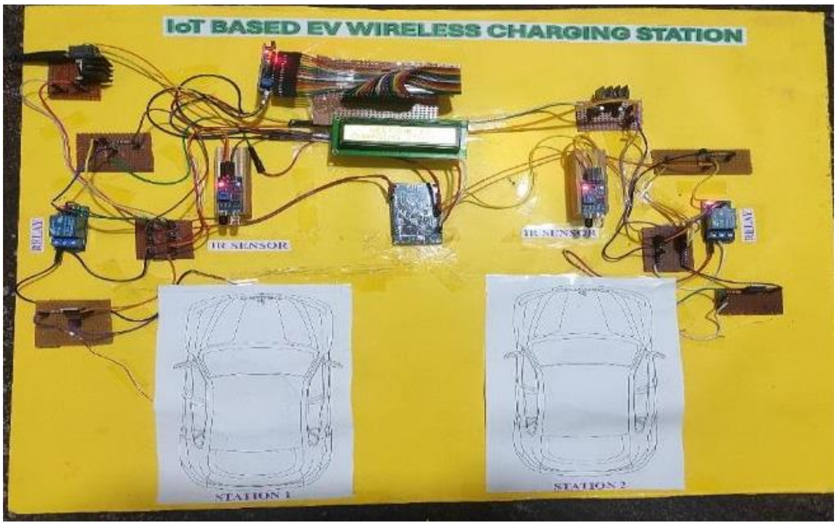
In summary, the EV wireless charging station project combines the capabilities of IoT with various sensors and relays to create an automated and remotely controllable charging solution. The NodeMCU serves as the brain of the system, coordinating the actions of the IR sensors, relays, and LCD display, while the Blynk IoT app provides a seamless interface for user interaction.

V. RESULT

The IoT-based EV wireless charging station demonstrated several successful outcomes, aligning with the project's goals and objectives. The results can be categorized into several key areas, highlighting the system's performance, user experience, and overall efficiency.



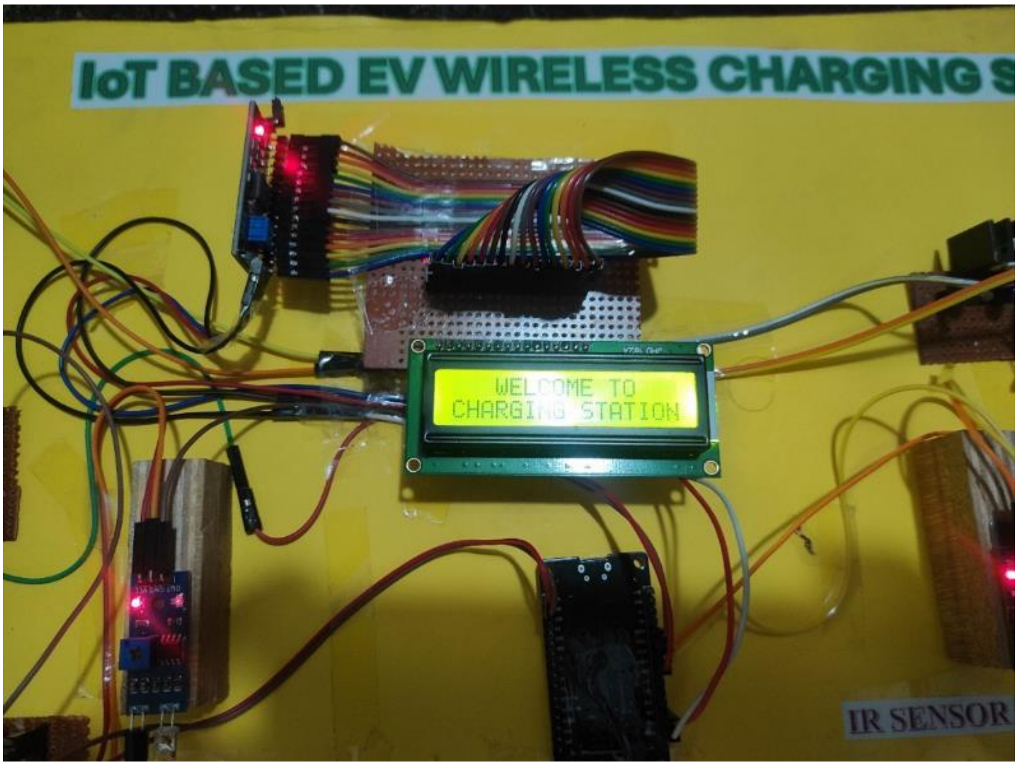


Fig. 3 Project output

1. Vehicle Detection Accuracy

IR Sensor Performance: The IR sensors accurately detected the presence of a vehicle within the charging area. The calibration process ensured that the sensors were sensitive enough to detect various vehicle sizes and shapes without false

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triggers. During the testing phase, the sensors consistently provided reliable inputs, which were crucial for initiating the charging process.
Detection Speed: The response time of the IR sensors was swift, ensuring that the system promptly transitioned from idle to active state when a vehicle was detected. This quick detection capability is essential for user convenience and efficiency in real-world applications.

2. Power Control and Wireless Charging Efficiency
Relay Operation: The relays effectively controlled the power supply to the charging coils. When the system detected a vehicle and received a command from the Blynk app, the relays switched on, allowing wireless power transfer to begin. The transition was smooth, and the relays' operation was verified to be reliable and consistent.
Charging Performance: The wireless charging system, comprising the transfer and receiver coils, performed as expected. The power transfer efficiency was optimized through careful positioning of the coils and fine-tuning of the oscillator circuits. The system successfully charged EV batteries within a reasonable timeframe, demonstrating its practical applicability.

3. User Interface and Experience
LCD Display Feedback: The 16x2 LCD display provided clear and real-time status updates to the user. Messages such as "Welcome," "ACTIVE," and "CHARGING" were displayed at appropriate times, ensuring that users were informed about the system's status. The display's readability and update speed contributed to a positive user experience.
Blynk App Integration: The integration with the Blynk IoT platform enabled remote monitoring and control. Users could check the status of the charging process and manually control the relays via the Blynk mobile app. The app's user-friendly interface and reliable connectivity added a significant convenience factor, allowing users to manage the charging process from a distance.

4. System Stability and Reliability
Power Supply Adequacy: Upgrading the power supply to a 12V 3A adapter resolved initial issues with relay stability. The system operated without any interruptions or malfunctions, highlighting the importance of providing adequate power to all components.
Continuous Operation: The system was tested over extended periods to ensure continuous and stable operation. The hardware and software components worked harmoniously, maintaining functionality without overheating or performance degradation.

5. Challenges and Solutions
Initial Power Supply Issues: The initial use of a 12V 1A power supply caused continuous triggering of the relays. This issue was resolved by switching to a 12V 3A power supply, which provided sufficient current for stable operation.
Sensor Calibration: Fine-tuning the IR sensors' sensitivity was crucial to avoid false triggers and ensure accurate vehicle detection. Iterative adjustments and testing led to optimal sensor performance.
Wi-Fi Connectivity: Ensuring a stable Wi-Fi connection between the NodeMCU and the Blynk server was critical for the system's IoT functionality. The implementation included robust error-handling mechanisms to maintain connectivity and recover from potential network issues.

6. Overall System Performance
Efficiency and Convenience: The system achieved its goal of providing a convenient and efficient wireless charging solution for electric vehicles. The combination of accurate vehicle detection, reliable power control, user-friendly interface, and robust IoT integration contributed to a seamless user experience.
Scalability and Future Improvements: The project demonstrated the potential for scalability, with possibilities for further enhancements. Future improvements could include optimizing the wireless power transfer efficiency, integrating additional sensors for enhanced functionality, and expanding the IoT capabilities for more advanced monitoring and control.

VI. CONCLUSION

This paper presents a novel IoT-based wireless charging station for EVs, offering a seamless and efficient charging solution. The integration of NodeMCU, IR sensors, relays, and the Blynk app allows for effective control and monitoring, addressing common issues associated with traditional wired charging stations. Future work will focus on enhancing the system's scalability and exploring additional IoT features for improved functionality.

In this system, we are presenting the Wireless Power Transmission. As the electric vehicle in the market is increasing. We can use the wireless charging system to charge our vehicles. This system shows the efficiency and implementation

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of the charging station in future technology. Overall, this paper compares various smart parking, charging, and combined charging-parking systems, which can help to solve various issues related to it. Also, it contains a table of comparison of various research papers. There are various types of methods and techniques used for parking and charging are discussed.

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