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Wireless Electric Vehicle Charging System

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Abstract:

This research paper presents a detailed study of a wireless electric vehicle charging system using ESP8266 microcontroller. The system transfers electrical power wirelessly using inductive power transfer between transmitting and receiving coils. An IR sensor is used to detect vehicle presence, a relay module ensures safe power switching, and an LCD display shows charging status. This system improves safety, convenience, and reliability by eliminating physical connectors. The proposed system is suitable for smart EV charging applications.

Keywords: ESP8266, Inductive Power Transfer, Transmitter Coil, Receiver Coil, IR Sensor, LCD Display, Relay Module

Introduction:

Electric vehicles (EVs) are becoming more popular because they help reduce pollution and save fossil fuels. However, one of the main challenges is the charging process, which usually requires plugging the vehicle into a wired charger. To solve this problem, wireless charging technology is used. It allows electric vehicles to charge without physical contact, using electromagnetic induction or resonant coupling. This makes the system safer, easier, and more efficient Electric vehicles (EVs) are becoming an important part of our world as people look for cleaner, safer, and more efficient ways to travel. EVs help reduce air pollution, save fuel, and support a healthier environment. As more people start using electric vehicles, the need for easy and convenient charging methods is also increasing. Traditional charging stations use cables and plugs, which can sometimes be difficult to handle, especially during bad weather, at night, or in busy areas. Cables can get damaged, become dirty, or may even be forgotten, which causes inconvenience to the user. This technology allows an electric vehicle to charge without any physical contact or cables. The driver simply parks the vehicle over a charging pad on the ground, and the charging begins automatically. The system works using magnetic fields and inductive power transfer, similar to how wireless mobile chargers work, but on a larger and more powerful scale. Wireless charging makes EV usage much more comfortable and user-friendly. It removes the need to connect and disconnect wires every time. It is also safer because there are no exposed cables or electrical parts, which reduces the chances of electric shocks or short circuits. This technology works in all weather conditions—rain, dust, snow—and requires very little maintenance.

Problem Statement:

Wired EV charging systems require manual plug-in and unplug operations, which may be inconvenient and unsafe in certain environments. Mechanical wear of connectors and cable damage are common issues. There is a need for a reliable and contactless EV charging solution.

Objective:

1. To learn **how wireless charging works** for electric vehicles.
2. To make a **small wireless EV charging model.**
3. To see how **charging without cables** is safe and easy.
4. To understand how **coil placement** affects charging.
5. To check how wireless charging can **help the environment.**
6. To create a **simple and useful solution** for future EV charging.

Literature Survey:

Kurs et al. (2007) – Wireless Power Transfer via Strongly Coupled Magnetic Resonances [3]

This foundational paper introduced a highly efficient wireless power transfer system using resonant inductive coupling. The authors demonstrated the capability to transfer power over mid-range distances with efficiency significantly higher than traditional inductive coupling. The work laid the groundwork for modern wireless charging modules that are now widely used for mobile device charging. This concept is critical in designing wireless charging stations where cablefree power delivery is essential, and inspired subsequent development in Qi standard chargers.

Liu et al. (2013) – Wireless Power Transfer System for Battery Charging with Photovoltaic Energy Harvesting [5]

Liu and colleagues proposed a hybrid system combining photovoltaic (PV) energy harvesting with wireless power transfer for battery charging applications. Their design integrated solar panels with wireless charging coils and a battery management system, emphasizing the sustainability of the system. This study highlights the potential of combining solar energy and wireless charging to create off-grid, eco-friendly power stations, which aligns with the objectives of the current project.

Zanella et al. (2014) – Internet of Things for Smart Cities [8]

This paper provides an overview of IoT technologies applied in smart city infrastructure, including energy management and remote monitoring. The authors discuss how IoT platforms facilitate real-time data collection and system control, improving efficiency and maintenance of urban services. The concepts presented support the integration of Arduinobased IoT monitoring in renewable energy projects, enabling remote access and data-driven decision-making in wireless charging stations.

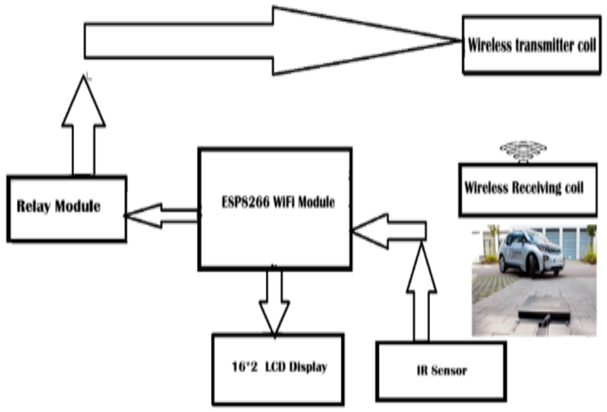
Chen and Rincon-Mora (2006): Accurate Electrical Battery Model for Runtime Prediction [12]

Chen and Rincon-Mora developed a detailed electrical model to predict battery runtime and performance under different loads. Their model supports improved battery management by accurately estimating state-of-charge and health, which is crucial in systems relying on battery storage for power continuity. This work informs the battery monitoring approach in solar-powered wireless charging stations to ensure reliable power supply and optimize battery life.

Ali et al. (2021) – Advances in Wireless Power Transfer Technologies for IoT Applications [20]

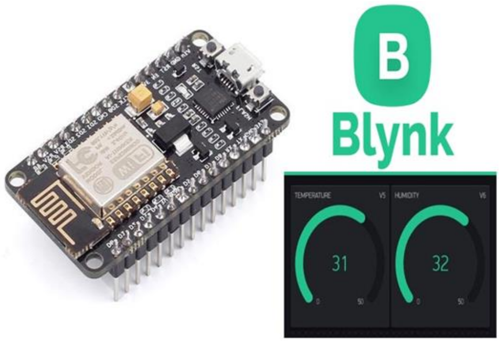
This recent review paper surveys the latest developments in wireless power transfer technologies tailored for IoT devices. It covers efficiency improvements, range extension, and integration with renewable energy sources.

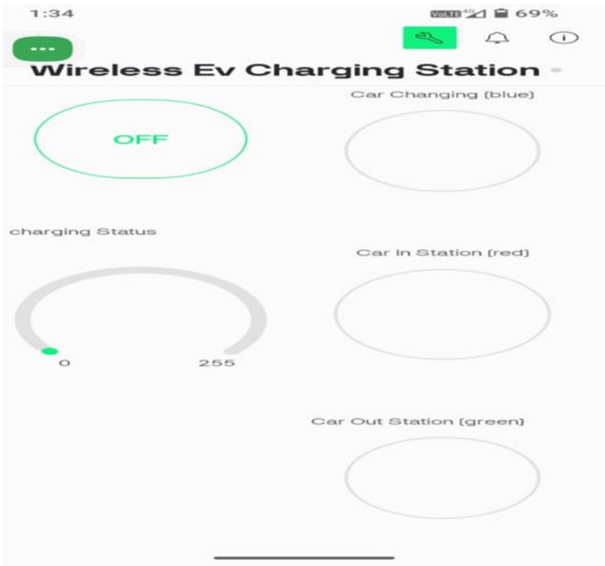
Block Diagram:



Working:

The wireless EV charging system works on the principle of inductive coupling. When the system is powered ON, the ESP8266 Wi-Fi module acts as the main controller and continuously monitors the IR sensor. When an electric vehicle is placed on the charging pad, the IR sensor detects the vehicle and sends a signal to the ESP8266. After receiving this signal, the ESP8266 activates the relay module, which allows power to flow to the wireless transmitter coil. The transmitter coil generates an alternating magnetic field, which is transferred wirelessly through air. This magnetic field is received by the wireless receiving coil placed in the vehicle, where voltage is induced due to electromagnetic induction. The induced voltage is used to charge the EV battery. During charging, the ESP8266 updates the charging status on the 16×2 LCD display, showing messages such as “Charging” or “Charge Done.” Once the battery is fully charged or the vehicle is removed, the ESP8266 turns OFF the relay, and wireless charging stops safely.





Advantages:

1. Charging is wireless, so no physical cable is required.
2. It is safe because there is no exposed connector.
3. There is less wear and tear compared to wired charging.
4. Charging is easy and user-friendly.
5. It works even in rain and dust conditions.
6. Automatic charging is possible.
7. Risk of electric shock is reduced.
8. It improves charging convenience.

Applications:

1. Electric cars
2. Electric buses
3. Electric two-wheelers
4. Public EV charging stations
5. Home EV charging systems
6. Parking lot charging

7. Smart city infrastructure
8. Autonomous vehicles
9. Warehouse electric vehicles
10. Electric delivery vans
11. Campus transportation vehicles
12. Industrial electric carts
13. Research and educational projects
14. Future smart transportation systems

Conclusion:

The system works using **electromagnetic induction,** in which energy is transferred from a **transmitter coil** to a **receiver coil** through a magnetic field. The **ESP8266 microcontroller** is used to control and monitor the charging process. An **IR sensor** detects the presence and correct position of the vehicle before charging starts. A **relay module** is used for safe switching of power. The **LCD display** shows the current charging status to the user. Wireless charging improves **safety**, reduces **cable damage**, and requires **less maintenance**. This project proves that wireless EV charging is a **reliable and future-ready technology.** With better coil design and higher efficiency, this system can be used in **real EV charging stations.**

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