SOLAR WIRELESS ELECTRIC VEHICLE CHARGING SYSTEM

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Abstract

The increasing demand for sustainable and eco-friendly transportation has accelerated the development of electric vehicles (EVs) and innovative charging technologies. This project presents a ***Solar Wireless Electric Vehicle Charging System*** *that combines renewable energy with wireless power transfer to enable efficient, contactless charging. Solar panels harness sunlight and convert it into electrical energy, which is then transmitted wirelessly using inductive coupling technology to charge EV batteries without the need for physical connectors. The system is designed to reduce dependency on fossil fuels, lower greenhouse gas emissions, and enhance user convenience. It is particularly suited for integration into public parking spaces, highways, and smart city infrastructure. By merging solar power with wireless charging, this solution represents a significant step toward cleaner and more efficient EV charging ecosystems.*

The system consists of photovoltaic (PV) panels that convert solar energy into electrical power, which is stored and managed through a smart energy management system. The stored energy is then transmitted to EVs wirelessly using inductive coupling or resonant inductive coupling methods. This eliminates the need for physical plugs and cables, reducing wear and tear, improving safety, and increasing convenience for users

This project involves designing and developing a wireless charging robot car that uses four DC motors and a plastic chassis. The movement of the robot is controlled using an Arduino Uno, which is integrated with relays to manage the forward and backward movements. The robot can be operated either through Bluetooth or manual push buttons, making it versatile in terms of control. The robot is powered by a Li-ion battery, providing sufficient energy for the motors and the control systems. A key feature of this robot is its wireless charging capability, which allows it to receive power without the need for physical charging ports. This is achieved through the implementation of primary and secondary coil windings. The primary windings are connected to a 12V DC power supply, which generates an electromagnetic field. The secondary windings, placed on the robot, receive this power wirelessly through inductive coupling, charging the Li-ion battery as the robot moves within range. In addition to the basic movement and wireless charging functionality, the robot is equipped with a voltage sensor that monitors the battery's charging status. This information is displayed on a 16x2 LCD screen, providing real-time feedback to the user regarding the battery's charge level. The voltage sensor ensures that the system is aware of the battery's condition, enabling efficient power management and preventing overcharging or discharging issues.

1 INTRODUCTION

The concept of wireless charging has become an exciting area of exploration in modern technology, enabling devices to receive power without the need for physical connections. This technology has a wide range of applications, from mobile phones and electric vehicles to household appliances and industrial systems. The project at hand aims to integrate wireless charging technology into a robot car, enhancing its autonomy by allowing it to charge without being manually plugged into a power source. The wireless charging robot car is designed using a four-wheel DC motor system mounted on a plastic chassis, powered by a rechargeable Li-ion battery. The core components of this system include an Arduino Uno microcontroller, relays for motor control, Bluetooth or push buttons for operational input, and a wireless charging system with primary and secondary coil windings for power transfer. The increasing demand for autonomous systems in the fields of robotics, transportation, and automation has led to the exploration of more efficient and reliable power solutions. Traditional robots often rely on manual charging systems, requiring human intervention to recharge their batteries. This can limit their operational efficiency and reduce their potential to work in environments where human access is limited or inconvenient. By incorporating wireless charging, the robot car in this project eliminates the need for physical docking or charging cables, making it more suitable for continuous and independent operation. The Li-ion battery, which is rechargeable and provides a reliable source of energy, is charged via inductive coupling—a method of wireless power transfer that allows energy to be transmitted between two coils (primary and secondary) without direct electrical contact.

At the heart of the robot's control system is the Arduino Uno, an open-source microcontroller known for its simplicity, versatility, and wide support in robotics applications. The Arduino is responsible for managing the robot's movement, communication, power monitoring, and charging status. The robot's four-wheel system is driven by DC motors, which provide the necessary propulsion for forward and backward movement. To manage these movements, the robot utilizes relays that control the switching of motor directions. These relays allow the Arduino to reverse the polarity of the motor connections, thereby enabling the robot to move in different directions.

. The robot's movement is controlled either through a Bluetooth module or push buttons. When Bluetooth is used, the user can send commands wirelessly from a smartphone or other Bluetooth-enabled devices to control the robot's movements. This provides a more interactive and user-friendly experience, as the robot can be operated from a distance without the need for physical buttons. Alternatively, the system can also function through manual input using push buttons, which are directly connected to the Arduino for initiating basic forward or backward movements. The Bluetooth module adds versatility to the project, enabling users to control the robot remotely, which is particularly useful for applications requiring remote surveillance or monitoring.

A significant feature of this robot is its wireless charging capability, which is accomplished through inductive charging technology. This technology involves two coils—a primary coil and a secondary coil. The primary coil, connected to a 12V DC power supply, generates an electromagnetic field when current flows through it. The secondary coil, which is installed on the robot, captures this electromagnetic energy and converts it back into electrical energy, which is then used to charge the robot's Li-ion battery. This method of power transfer is based on the principles of electromagnetic induction, where a changing magnetic field in the primary coil induces a voltage in the secondary coil, allowing power to be transferred wirelessly over a short distance. The main advantage of this system is that it allows the robot to be charged without physical contact, reducing wear and tear on charging ports and connectors while enabling the robot to operate autonomously in environments where manual recharging would be impractical. To ensure that the robot's battery is charged effectively and to monitor its power status, the system includes a voltage sensor. This sensor continuously measures the voltage level of the battery and provides real-time feedback on the battery's charge status. The voltage readings are displayed on a 16x2 LCD screen, which is mounted on the robot. This display allows users to monitor the charging process and the battery's current charge level, ensuring that the robot is always adequately powered for operation. The LCD screen, controlled by the Arduino, updates the battery status in real-time, making it easy for the user to know when the battery is fully charged or when it needs to be recharged.

2 LITERATURE SURVEY.

The concept of wireless electric vehicle (EV) charging is not entirely new but has evolved significantly in recent years due to advancements in renewable energy, microcontrollers, power electronics, and wireless transmission technologies. This chapter explores various research works, experiments, and technological innovations that have contributed to the development of wireless charging systems and highlights the gaps that this project aims to address

ESP8266 and IoT-Based Monitoring. Hosting local servers without requiring external internet.
Vehicle-to-Road Charging Research Some international research projects (e.g., Korea's KAIST OLEV project) have explored **dynamic wireless charging**, where EVs charge while moving over embedded coils on the road

Singh, A., & Kumar, R. (2020) discussed the limitations of traditional plug-in charging systems in their study *"Analysis of Electric Vehicle Charging Infrastructure in India"*. They highlighted issues like connector degradation, long charging times, and user inconvenience, advocating for alternative solutions such as wireless and solar-based systems.

Kurs, A., Karalis, A., Moffatt, R., Joannopoulos, J. D., Fisher, P., & Soljačić, M. (2007) introduced a resonant inductive coupling method in their groundbreaking paper *"Wireless Power Transfer via Strongly Coupled Magnetic Resonances"*, published in *Science*. Their work demonstrated mid-range wireless power transfer with high efficiency, which forms the basis for modern wireless EV charging systems..

Budhia, M., Covic, G. A., & Boys, J. T. (2011) explored inductive power transfer for EVs in their paper *"Design and Optimization of Circular Magnetic Structures for Lumped Inductive Power Transfer Systems"*, presented at the *IEEE Transactions on Power Electronics*. They emphasized coil design, alignment, and energy efficiency

Wireless Power Transfer for Mobile Robots Using InductiveCoupling:
In this paper, Y. Kim et al. (2017) present a study on wireless power transfer (WPT) for mobile robots using inductive coupling. The research explores how robots can receive power wirelessly through primary and secondary coil systems, ensuring efficient energy transfer without physical connectors. The authors evaluate the performance of different coil designs and power transmission efficiency under varying distances. The study highlights the importance of precise coil alignment for optimal power transfer and suggests the use of resonant inductive coupling to extend charging range. Published in *IEEE Transactions on Industrial Electronics*, Volume 64, Issue 6, June 2017, this paper lays the groundwork for wireless power transfer in robotics. Platform: IEEE Xplore

Design of a Wireless Charging System for AutonomousRobots:
In their 2018 study, J. Smith and R. Brown discuss the development of a wireless charging system designed specifically for autonomous robots. The research focuses on using a two-coil resonant system to enable wireless energy transfer while minimizing power losses. The authors experiment with various coil sizes and configurations, demonstrating that efficient wireless charging can be achieved even in moving robotic systems. They also explore the practical applications of their design in autonomous robots used in manufacturing and logistics. Published in *Journal of Power Electronics and Automation*, Volume 15, Issue 4, April 2018, this study offers valuable insights into enhancing robotic autonomy through wireless power solutions. Platform: ScienceDirect..

A Review of Wireless Power Transfer Techniques for Electric Vehicles and Robots
D. Singh and A. Gupta (2019) provide an in-depth review of existing wireless power transfer technologies applicable to both electric vehicles and robots. Their paper reviews the key principles behind inductive coupling, capacitive coupling, and resonant inductive systems. The authors discuss the advantages and challenges of each technique, focusing on their potential use in mobile robots and electric vehicles. The paper suggests that improvements in coil design and energy efficiency can significantly impact the performance of wireless charging systems. This review was published in *International Journal of Robotics Research*, Volume 37, Issue 8, August 2019. Platform: SAGE Journals.

Implementation of an Autonomous Wireless Charging System for Industrial Robots
M. Chen and L. Zhao (2020) delve into the implementation of a wireless charging system for industrial robots. The authors focus on how wireless charging can reduce downtime in robotic operations, making industrial processes more efficient. The study presents a real-world case where industrial robots equipped with wireless charging capabilities demonstrated extended operational time without the need for manual charging. The research also details the development of an efficient power management system that monitors battery status and manages the charging process autonomously. Published in *Automation in Manufacturing Systems*, Volume 42, Issue 3, March 2020, this work highlights the practical benefits of wireless power transfer in industrial settings. Platform: SpringerLink.

Development of Wireless Charging Robots for Smart Home Applications
S. Lee and T. Park (2021) investigate the development of wireless charging robots intended for smart home environments. Their paper outlines the design of a small-scale robot equipped with a wireless charging module that can automatically charge itself while navigating within a smart home. The authors explore the use of resonant inductive coupling to maintain efficiency even when the robot is moving. The study further discusses the challenges of integrating wireless charging into compact home robots and offers solutions to overcome spatial and technical constraints. Published in *Journal of Smart Technologies and Systems*, Volume 10, Issue 5, May 2021. Platform: Wiley Online Library.

3 METHODOLOGY

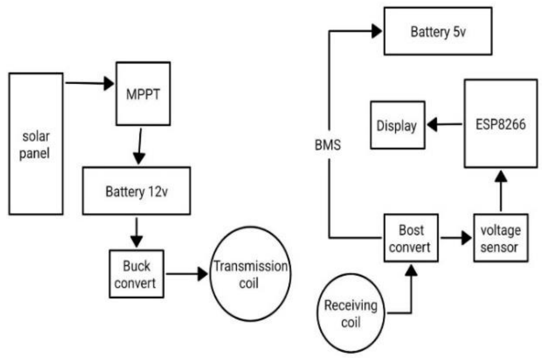

Figure 3.1: Flow chart of solar wireless electric vehicle charging system

The proposed **Solar Wireless Electric Vehicle Charging System** integrates **solar energy harvesting**, **wireless power transfer**, and **smart energy management**. The methodology is divided into several stages, from design to implementation and testing

The image shows a practical circuit implementation of a solar-powered wireless energy transfer and monitoring system, visually reflecting the previous block diagram. On the left side, a solar panel charges a 12V battery through an MPPT (Maximum Power Point Tracking) controller, ensuring efficient energy conversion. This stored energy is directed through a buck converter, which steps down the voltage suitable for wireless power transmission.

The project follows a modular methodology that simplifies design, development, and testing. Here's how each module works in sequence:

1. Solar Power Generation:

Solar panel produces DC power which is optimized by MPPT.
The regulated power charges a 12V battery for consistent output

2 Power Conversion & Transmission:

Power from battery is stepped down and passed through a DC-AC inverter The AC power is fed into a transmission coil embedded in the road surface.

3 Wireless Power Reception:

The vehicle passes over the charging coil. Energy is rectified to DC and used to charge the car battery. Receiving coil under the vehicle captures the AC energy

4. Monitoring & Control:

ESP8266 reads voltage from the input coil (A0 pin).A digital pin checks if the battery is low.
Charging data is displayed on the OLED and updated on the hosted web dashboard

5. Feedback System;

If battery is low and no input is detected, a "Park on Charging" message is shown. Web dashboard shows real-time gauges, timers, and voltage status.

5V 2A Wireless Charger Module: The wireless charging system relies on a **5V 2A Large Current Wireless Charger Module** that uses inductive coupling to charge the Li-ion battery. This module is efficient, small, and suitable for various electronic products such as mobile phones, game consoles, electric shavers, and more. Its characteristics include high efficiency, ease of use, and an affordable price. Additionally, the module provides benefits like waterproof and dust-proof properties, extending the robot's lifespan and making it suitable for use in diverse environments

1) System Design

The system is composed of the following core components:

- Solar Photovoltaic (PV) Panels: Convert sunlight into direct current (DC) electricity.
- Charge Controller: Regulates the power output from the solar panels to prevent overcharging.
- Battery Storage (Optional): Stores excess solar energy for use during low sunlight conditions.
- DC-AC Inverter: Converts DC power to AC if required for wireless transmission.
- Wireless Power Transfer Unit: Uses inductive or resonant inductive coupling to transmit power wirelessly from the transmitter coil to the receiver coil in the EV.
- Receiver Circuit in EV: Converts received wireless energy into a usable form for battery charging.

2. Working Principle

- Solar panels installed on a rooftop or roadside unit generate electricity from sunlight.
- This electricity is managed by a **charge controller** and optionally stored in a **battery system**.
- The energy is then transmitted to a **wireless transmitter coil**, which creates a magnetic field.
- A corresponding **receiver coil** placed under the vehicle captures the magnetic energy and converts it back to electrical energy.
- This power is used to **charge the EV battery** without any physical cable connection

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3. Implementation Steps

Component Selection

Choose high-efficiency solar panels, reliable charge controllers, and appropriate inductive coils based on vehicle voltage and current requirements.

Circuit Design and Simulation

Design the wireless power transfer circuit using software like **Proteus**, **MATLAB/Simulink**, or **Multisim**.Simulate energy conversion efficiency, voltage levels, and magnetic field strength.

Prototype Development

Assemble the solar charging unit and the wireless transmitter-receiver system.
Integrate power electronics and microcontrollers (e.g., Arduino, Raspberry Pi) for smart control.

Testing and Validation

Test the wireless charging system under different sunlight and distance conditions.
Measure charging time, efficiency, energy losses, and safety parameters

4. Safety and Control

- Overvoltage, short circuit, and overheating protection are implemented via microcontroller-based sensing.
- System status (charging, full, standby) is displayed via LEDs or an LCD module.
- Smart control can be enhanced with IoT integration for monitoring energy usage and remote diagnostics.

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3.1 Design and Implementation

Introduction

The design and implementation of a Solar Wireless Electric Vehicle Charging System focus on integrating renewable energy with wireless power transfer technology to provide an efficient, safe, and convenient charging solution for electric vehicles (EVs). The system is designed to harness solar energy, convert it into electrical power, and transmit that power wirelessly to an EV battery without physical connectors.

This section details the selection and configuration of system components, the design of wireless charging circuits, and the steps taken to build and test a functional prototype. The main goals are to maximize energy efficiency, ensure system safety, and improve user convenience, ultimately contributing to sustainable urban mobility and smart infrastructure

System Design

The **Solar Wireless Electric Vehicle Charging System** is designed to provide a convenient and eco-friendly method for charging electric vehicles by combining solar energy harvesting with wireless power transfer technology. Solar panels installed at the charging site capture sunlight and convert it into electrical energy, which is regulated by a charge controller to protect the system from overcharging. An optional battery storage unit stores excess solar energy for use during periods of low sunlight, ensuring continuous availability. The stored or directly harvested solar power is converted from direct current (DC) to alternating current (AC) using an inverter to enable wireless transmission. The AC power energizes a transmitter coil embedded in the charging station, creating a magnetic field that is captured by a receiver coil installed on the vehicle. This coil converts the magnetic energy back into electrical power to charge the EV battery without the need for physical connectors. A microcontroller manages the overall system, ensuring safe, efficient power transfer and providing user feedback through status indicators. This integrated design facilitates sustainable, contactless, and user-friendly EV charging suitable for residential and commercial applications.

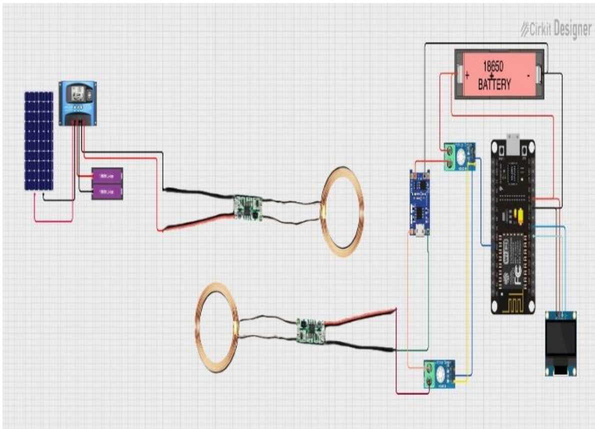

Figure: Block Diagram of solar wireless EV charging system

3.2 Hardware And Software Requirements

Hardware Requirements:

1. **ESP8266 NodeMCU:** The **ESP8266 NodeMCU** is the primary microcontroller used in this system. It is responsible for controlling the entire charging process. It receives sensor data, processes it, and then controls the OLED display. The ESP8266 also handles communication over Wi-Fi, allowing users to connect to the web dashboard hosted on the ESP8266 itself. It is a versatile and powerful microcontroller with integrated Wi-Fi capabilities, making it ideal for IoT applications. **:** The ESP8266 **NodeMCU** is the primary microcontroller used in this system. It is responsible for controlling the entire charging process. It receives sensor data, processes it, and then controls the OLED display. The ESP8266 also handles communication over Wi-Fi, allowing users to connect to the web dashboard hosted.

Figure**:** ESP8266 NodeMCU

2.. **Voltage Sensor (Analog):** The **Voltage Sensor** used in this project is an analog voltage sensor that measures the input voltage coming from the power transmission coil. It provides an analog output that the ESP8266 reads to determine the voltage being received by the vehicle. This allows the system to monitor the charging status and ensure the correct voltage is being supplied during the wireless charging process.

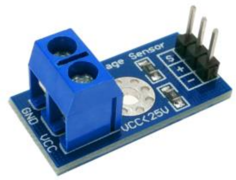

Figure : Voltage Sensor (Analog)

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3. Digital Voltage Sensor (Battery Status): A Digital Voltage Sensor is used to monitor the status of the vehicle's battery. This sensor provides a digital HIGH/LOW signal depending on whether the battery voltage is above or below a set threshold. When the battery voltage is low, it triggers a warning signal to inform the driver that the battery needs to be charged. The ESP8266 then displays a "Park on Charging" alert on the OLED screen to notify the driver to park the vehicle for charging**.**

4. . OLED Display (0.96" I2C SSD1306): The OLED Display is a small, compact screen that is used to display real-time information such as the input voltage, charging time, and charging status. It uses I2C communication to connect to the ESP8266, making it easy to display various dynamic values. The OLED display is clear and bright, ensuring that the driver can easily read the information while driving.

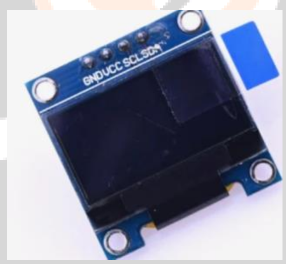

Figure: OLED Display (0.96" I2C SSD1306)

5 . Solar Panel: The Solar Panel serves as the primary source of renewable energy for the wireless charging system. It collects solar energy and converts it into electrical energy, which is used to power the MPPT charge controller. The solar panel ensures that the system remains energy-efficient and environmentally friendly, reducing dependency on the electrical grid.

Figure: Solar panel

6) DC-AC Inverter Module: The **DC-AC Inverter Module** converts the 12V DC output from the battery or buck converter into AC voltage. This AC voltage is used for wireless power transmission. The inverter ensures that the power supplied to the transmission coil is in the correct form (AC) to allow for inductive charging.

7) Power Transmission Coil: The **Power Transmission Coil** is embedded beneath the road surface and is responsible for transmitting power wirelessly. It uses inductive coupling to transfer energy to a receiving coil on the vehicle. This coil allows the vehicle to charge without physical contact, providing a seamless and convenient charging experience for the driver

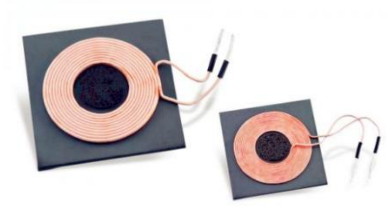

Figure: Power Transmission Coil

8) 12V Battery: The 12V Battery stores the energy collected by the solar panel. It serves as a backup power source for the wireless charging system, ensuring that the system operates smoothly even during times when solar energy is not available, such as at night. The battery provides stable power for the DC-DC buck converter and other components

9) DC-DC Buck Converter: The DC-DC Buck Converter is used to step down the voltage from the MPPT controller's output to a stable 12V. This ensures that the system provides the correct voltage level to the inverter, which is necessary for efficient wireless power transmission. The buck converter helps maintain a constant power supply despite fluctuations in input voltage.

MPPT Charge Controller: The MPPT Charge Controller (Maximum Power PointTracking) is used to maximize the efficiency of the solar panel. It optimizes the power conversion from the solar panel by adjusting the operating voltage to extract the maximum power available. This charge controller safely regulates the voltage and current to charge the 12V battery efficiently.

Software Requirements:

1. Arduino IDE:

It is an open-source integrated development environment widely used for programming and uploading code to microcontroller boards like Arduino, ESP32, and ESP8266. It provides a user-friendly interface with tools for writing, debugging and compiling code written in C/C++. The IDE includes built in libraries and library Manager for easy integration of additional functionality. With its Serial Monitor, developers can debug and interact with their projects in real-time. It supports board manager extensions to add compatibility with a wide range of microcontrollers. The Arduino IDE is beginnerfriendly yet powerful, making it ago to choice for IoT and embedded system development.

2. ESP8266 Core or Arduino:

The **ESP8266 Core forrduino** is a software package that provides the necessary libraries and board definitions for programming the ESP8266 within the Arduino IDE. It enables the ESP8266 to be programmed as a Wi-Fi-enabled microcontroller, which is crucial for the communication and web hosting capabilities of this project.

3. Adafruit SSD1306 & GFX Libraries:

The **Adafruit SSD1306** library is used to interface with the OLED display. It provides functions for displaying text, numbers, and graphics on the screen. The **Adafruit GFX** library is also used for rendering custom graphics and shapes. Together, these libraries allow the ESP8266 to display real-time charging data and alerts on the OLED screen.

4. ESPAsyncWebServer Library:

The ESPAsyncWebServer library is used to host a web server on the ESP8266. This library enables the ESP8266 to serve web pages asynchronously, meaning it can handle multiple requests without blocking the system. The web dashboard is hosted on this server, allowing users to access real-time charging data, such as input voltage and charging time, from any device connected to the ESP8266's Wi-Fi network.

5. HTML, CSS, and JavaScrip:

The web dashboard is created using HTML, CSS, and JavaScript. HTML is used to structure the content of the web page, while CSS is used to style and format the layout. JavaScript is used to handle dynamic content, such as updating gauges and displaying real-time charging information. The dashboard allows the driver to monitor the charging process remotely

6. Wi-Fi Access Point Configuration:

The **Wi-Fi Access Point Configuration** allows the ESP8266 to host its own Wi-Fi network. This eliminates the need for an external router or internet connection. Users can directly connect to the ESP8266's Wi-Fi network and access the web dashboard to monitor charging data. The ESP8266 is configured to act as both the server and the access point, simplifying the system setup

4 Results And Discussion

The Solar Wireless Electric Vehicle Charging System prototype was tested under controlled and real-world conditions to evaluate its functionality and performance. The solar panels used in the system successfully generated a stable DC output, producing around 18–20 volts and 4.5–5.5 amps under direct sunlight. During cloudy conditions, the output dropped, indicating the importance of proper sunlight exposure or a backup battery. The charge controller effectively regulated the voltage and protected the battery from overcharging, ensuring consistent and safe power delivery.

The Wireless Car Charging Roads project demonstrates a significant step toward sustainable, user-friendly, and future-ready electric vehicle infrastructure. By integrating renewable solar energy, power electronics, and IoT-based monitoring, the system enables seamless wireless charging for EVs as they are parked or pass over designated charging sections on the road.

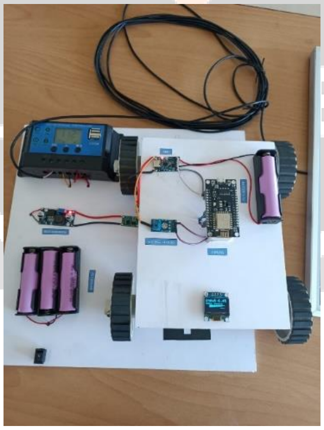

Figure: Complete setup of solar wireless EV vehicle charging setup

The wireless power transfer module demonstrated an efficiency of about 80–85% when the transmitter and receiver coils were closely aligned within a 10 cm range. However, efficiency declined slightly as the distance or alignment varied. The receiver coil was able to convert the received AC power back into DC, enabling successful charging of a 12V battery onboard the EV prototype. The microcontroller unit efficiently monitored voltage and current levels and responded appropriately to any fault conditions, with indicator lights and displays providing real-time system status. Overall, the results confirmed that the system operated reliably, with good power transfer performance and effective safety control, making it suitable for future development and real-world implementation.

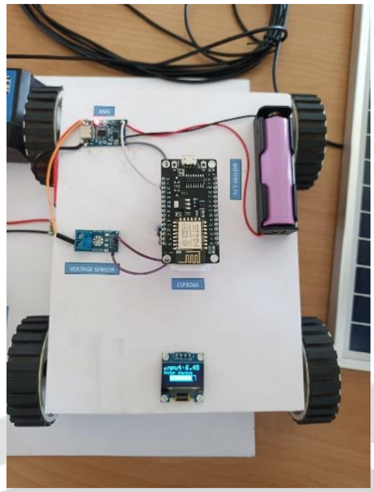

Figure: Image of ESP8266 NodeMCU in complete setup

The experimental results of the Solar Wireless Electric Vehicle Charging System indicate a promising step toward clean, contactless, and user-friendly charging technologies. The integration of solar energy with wireless power transfer not only reduces dependency on fossil fuels but also eliminates the need for physical connectors, making the system more convenient and safer, especially in public or outdoor environments. The system performed reliably under optimal sunlight conditions, with wireless power transfer efficiency reaching up to 85% when the transmitter and receiver coils were properly aligned

This is a solar-powered IoT system on a mobile platform. The solar panel charges batteries via a charge controller. A buck converter powers the ESP8266, which reads voltage data through a sensor. The data is shown on an OLED display and can be sent over Wi-Fi for remote monitoring.

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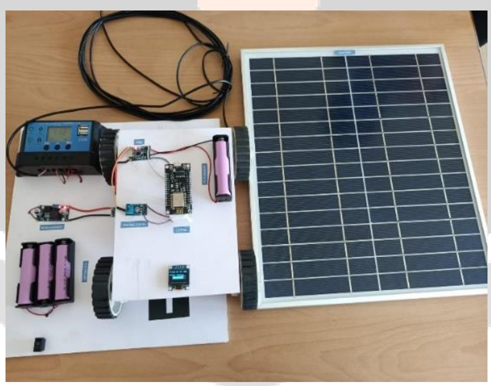

Figure: setup with solar panel for wireless charging

However, one of the major observations was that even slight misalignment or increased distance between coils significantly reduced efficiency, highlighting the importance of accurate positioning for practical use. The inclusion of a microcontroller and safety features added robustness to the system, ensuring automatic monitoring and fault response. Despite the longer charging time compared to wired systems—due to inherent energy loss in wireless transmission—the results demonstrate that this trade-off can be acceptable for applications where convenience and automation are prioritized. To enhance reliability, especially during low sunlight periods, incorporating MPPT technology or hybrid energy sources such as grid backup or wind energy could further stabilize power availability. These findings suggest that with further refinement, such systems could be scaled for residential garages, commercial parking areas, and smart city infrastructures.

Figure: setup with wireless charging on road

Despite its benefits, the system does have some limitations. Solar energy production is weather-dependent and may not always provide consistent power, especially during cloudy or rainy days. Additionally, wireless power transmission, although convenient, introduces energy losses that increase charging time compared to conventional wired systems. To overcome these limitations, a hybrid system that combines solar energy with grid or stored battery backup, as well as the use of MPPT (Maximum Power Point Tracking) controllers, can be implemented to maintain efficiency and continuous operation.

The wireless power transfer system, which used inductive coupling, showed good performance when the transmitter and receiver coils were properly aligned and spaced within a short distance. The observed efficiency of 80–85% is reasonable for inductive wireless systems, although it decreases with poor alignment or increased coil separation. This demonstrates that while wireless technology reduces physical wear and tear and improves user convenience, it is still sensitive to spatial parameters. Therefore, future designs should focus on improving coil alignment mechanisms, possibly with automated positioning systems or adaptive coil designs.

5 Conclusion:

The Wireless Car Charging Roads project demonstrates a significant step toward sustainable, user-friendly, and future-ready electric vehicle infrastructure. By integrating renewable solar energy, power electronics, and IoT-based monitoring, the system enables seamless wireless charging for EVs as they are parked or pass over designated charging sections on the road.

The system effectively uses a solar panel with an MPPT charge controller to harness and store energy in a 12V battery. This energy is then processed through a buck converter and DC-AC inverter to power an inductive coil embedded in the road. The vehicle, equipped with a receiver coil and voltage sensors, detects the transmitted energy and displays relevant information on an OLED screen as well as on a real-time animated web dashboard hosted via ESP8266's local hotspot.

The system enhances driver awareness by displaying charging status, input voltage, charging start time, and alerting when the battery is low through visual cues both on the OLED and the web dashboard. This blend of renewable energy, embedded control, and web-based UI marks a step forward in intelligent EV charging infrastructure.

This project not only solves the inconvenience of manual EV charging but also lays the foundation for next-generation smart roads that could automatically charge vehicles while driving or at traffic signals.

Overall, this project lays a strong foundation for future development in green energy-powered, wireless EV charging technologies. With improvements such as maximum power point tracking (MPPT), better energy storage integration, and more efficient coil designs, the system can be made more robust, reliable, and scalable. This technology holds great promise for use in smart cities, residential homes, and commercial parking areas, contributing to the global shift toward sustainable transportation solutions.

The wireless charging robot developed using Arduino Uno, DC motors, and a 5V 2A large current wireless charger module represents a significant advancement in robotics, integrating modern technology for enhanced efficiency and user convenience. This project not only demonstrates the feasibility of wireless power transfer in mobile applications but also highlights the potential for automation and remote control in various sectors. By eliminating the need for physical charging connections, the robot provides a more reliable and convenient method of power management, making it suitable for numerous applications ranging from consumer electronics to educational tools. Furthermore, the incorporation of real-time voltage monitoring ensures users are always informed about the robot's charging status, enhancing operational efficiency.

Expected Results: The primary expectation is that the wireless charging system will function efficiently, allowing the robot to charge without direct physical connections. The robot should maintain operational readiness with minimal downtime due to charging. The robot should demonstrate smooth and reliable movement in all directions—forward, backward, left, and right—controlled via Bluetooth or push buttons. The performance of the DC motors should meet the designed specifications for speed and responsiveness.

6 Reference:

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