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A Review on Solar and IoT Based Wireless Power Transmission Line on Road EV

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Abstract: The global shift towards sustainable transportation has created a strong demand for reliable and efficient charging solutions for Electric Vehicles (EVs). Conventional charging stations require vehicles to be parked and plugged in, which leads to time delays, range anxiety, and infrastructural limitations. To address these challenges, this project presents the design and implementation of a Solar and IoT-based Wireless Power Transmission (WPT) System on Roads for Electric Vehicles. The system integrates renewable energy harvesting, inductive wireless charging, and real-time monitoring to provide a dynamic and eco-friendly charging solution

I. INTRODUCTION

1) The rapid increase in electric vehicle (EV) adoption has created a strong demand for efficient, reliable, and sustainable charging infrastructure. Conventional plug-in charging systems suffer from limitations such as long charging duration, range anxiety, and dependency on fixed charging stations.
2) Wireless Power Transmission (WPT) technology embedded in road infrastructure provides a promising solution by enabling contactless and dynamic charging of EVs.
3) The integration of solar energy further enhances sustainability by utilizing renewable energy sources, while Internet of Things (IoT) technology enables intelligent monitoring, control, and optimization of the charging process.Use “Times New Roman” font in the whole document.
4) However, programming code may be in a monospaced font; Consolas font is preferred for monospaced content.
5) The incorporation of Internet of Things (IoT) technology further strengthens the system by enabling intelligent monitoring, data acquisition, and real-time control of power flow.
6) Through IoT-based automation, the performance, safety, and reliability of the charging process can be effectively managed and optimized.
7) Thus, the combination of Solar Energy, Wireless Power Transmission, and IoT presents a futuristic, eco-friendly, and efficient charging solution that can revolutionize the infrastructure for Electric Vehicles on roadways.
8) This dynamic charging approach eliminates the need for frequent stops, thereby enhancing the operational range and efficiency of EVs.
9) Furthermore, integrating solar power into the system ensures clean, renewable, and cost effective energy utilization, contributing significantly to environmental sustainability and reduction of carbon emissions

II.KEY WORDS /ACHIEVEMENTS

1) Successful wireless transfer of power using inductive coupling between transmitting and receiving coils.
2) Integration of IoT-based real-time monitoring through the ESP8266 module and ThingSpeak cloud platform.
3) Efficient switching of transmitter coils using IR sensors and relays for energy conservation.
4) Prototype validation demonstrating stable charging for a small-scale EV model powered by solar energy. • Data analysis showing efficiency above 75% under controlled laboratory conditions

III.LITERATURE SURVEY

The demand for sustainable and efficient charging technologies for Electric Vehicles (EVs) has become a key research area in recent years. With the increasing adoption of EVs, conventional plug-in charging stations are proving to be time-consuming, grid-dependent, and limited in coverage. This challenge has motivated the exploration of Wireless Power Transmission (WPT) systems and their integration with Solar Energy and Internet of Things (IoT) technologies to develop intelligent and eco-friendly EV charging infrastructure.

Research by J. Rahulkumar et al. (2023) analyzed various resonant inductive coupling designs, emphasizing that the alignment and geometry of coils are critical for achieving high efficiency [5Similarly, Latha et al. (2024) reviewed compensation networks such as Series-Series (SS), Series-Parallel (SP), and LCL topologies, noting their importance in reducing reactive losses and maintaining resonance under varying load conditions [3]

A. K. Yadav, P. K. Singh, and M. Kumar describe a solar-powered wireless charging facility for EVs with remote monitoring using IoT-based monitoring. The system uses solar panels and battery storage for power supply, while the power is made accessible through IoT modules to access it remotely a mobile app. It saves energy loss up to 10% but has a high cost of maintenance, for which cost-effective maintenance approaches are needed.

The study by N. Reddy, S. K. Sharma, and V. Kumar suggests an IoT-based solar wireless charging station energy management system. IoT sensor and cloud-based analytics optimize power distribution, resulting in a 18% boost in energy efficiency with dynamic load balances. Areas of difficulty are integrating various IoT protocols and maintaining data security, indicating the necessity for standardized protocols and strong security systems.

P. S. Rao, A. Sharma, and R. K. Gupta discuss a solar-powered wireless charging system for IoT-enabled smart homes. The system charges wireless charging pads for home devices, with IoT monitoring of energy consumption and system health, with an 87% charging efficiency. It has limitations in solar panel output during conditions of low sunlight levels, suggesting the need for better energy storage solution

IV.PROBLEM STATEMENT

The increasing demand for Electric Vehicles (EVs) has highlighted the need for a more reliable and efficient charging infrastructure. Conventional static charging systems require vehicles to halt for long durations, resulting in energy loss, time delays, and inconvenience to users. Moreover, the dependency on grid-based electricity further adds to the carbon footprint and limits the sustainability of these systems. To overcome these challenges, the project aims to develop a **Solar and IoT-based Wireless Power Transmission (WPT) System** that enables dynamic charging of electric vehicles while in motion. This system utilizes renewable solar energy as the primary source and employs IoT technology for intelligent monitoring and control. The proposed model not only ensures continuous power supply to EVs but also enhances energy efficiency, sustainability, and real-time system management

V.FUTURE SCOPE

To enhance the system and transition it toward large-scale application, the following improvements are proposed:

1) Implementation of solid-state switching (MOSFET/IGBT-based) for faster coil activation and reduced mechanical wear.
2) Integration of MPPT (Maximum Power Point Tracking) for efficient solar power utilization under varying irradiance
3) Use of supercapacitors or battery banks as buffer storage for continuous operation during low sunlight conditions.
4) Application of advanced compensation networks (LCL/CLC) and resonance tuning for higher transfer efficiency
5) Adoption of edge computing and secure MQTT protocols for scalable IoT data management.
6) Development of larger-scale road-embedded prototypes with robust weatherproof ing and safety compliance (SAE J2954)

VI.ALGORITHMIC FLOW

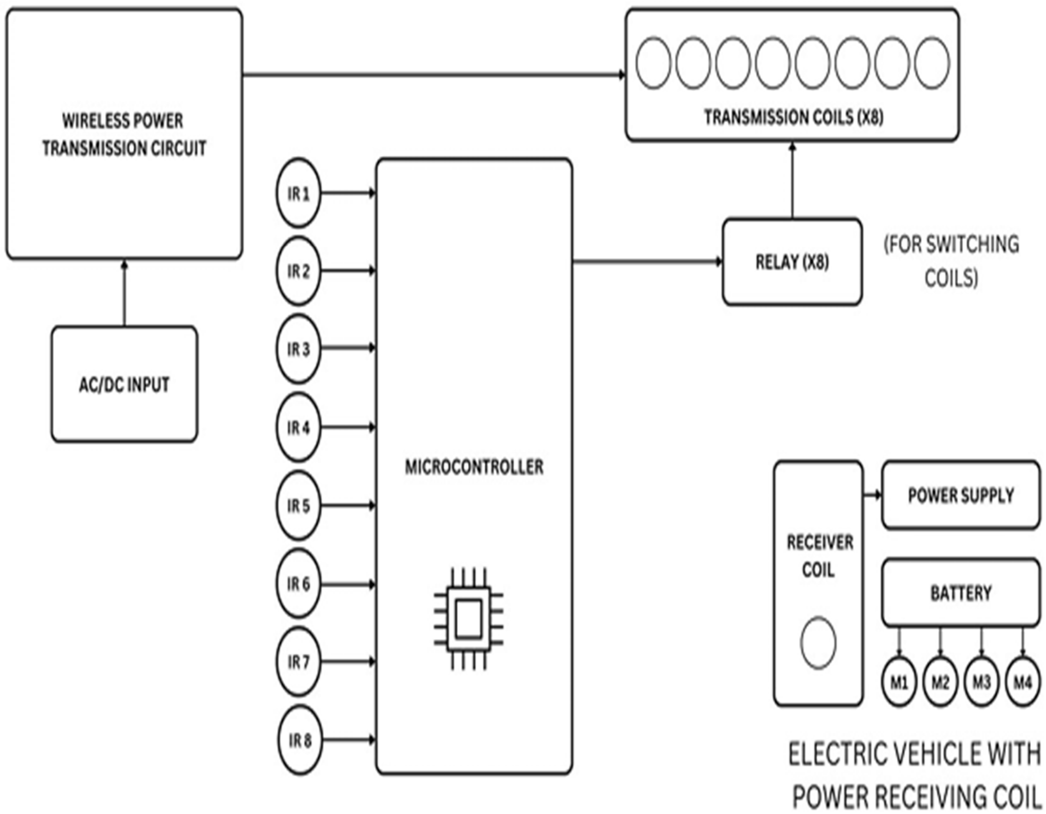
The operational logic of the software can be described as follows:

1) Start the system and initialize all input/output pins, serial communication, and Wi-Fi connection.
2) Continuously read IR sensor data to detect the presence of an electric vehicle.
3) If the IR sensor detects a vehicle: 30

- Activate the corresponding relay to switch ON the respective transmitter coil.
- Measure voltage and current using analog sensors.
- Send the measured data to the IoT module.

4) If no vehicle is detected: • Deactivate all coil relays to prevent energy loss.
5) Transmit system parameters (voltage, current, coil status) to the cloud server.
6) Repeat the above steps continuously in a loop.

VII.BLOCK DIAGRAM



VIII.WORKING PRINCIPLE

The proposed Solar and IoT-Based Wireless Power Transmission (WPT) System for Electric Vehicles is designed to charge moving or stationary vehicles dynamically using solar energy as the primary power source. The entire process integrates three major subsystems: the Power Generation Unit, the Transmitter Section with Wireless Power Transfer, and the Receiver and IoT Monitoring Unit.

1. Power Generation Unit Solar photovoltaic (PV) panels convert sunlight into DC electrical energy. This energy is fed to an MPPT (Maximum Power Point Tracking) charge controller, which ensures that the PV modules operate at their highest power efficiency point. The output is regulated and stored in a DC bus or battery bank, ensuring continuous energy availability even under variable sunlight conditions. This stage provides a clean, renewable, and grid-independent power supply to the rest of the system. 19

2. Inverter and Transmitter Section The stored DC power from the solar module is converted into high-frequency AC using a DC-AC inverter. This inverter operates typically in the tens of kilohertz range to facilitate efficient electromagnetic coupling. The high-frequency AC is then fed to the Transmitter Coil Array, which is embedded under the road surface in sequential segments. Each coil segment is controlled by an individual relay module connected to the microcontroller. The IR sensors positioned along the road detect the presence and movement of the electric vehicle. Based on these sensor inputs, the microcontroller activates only the relevant coil segment beneath the vehicle, minimizing energy loss and improving overall system efficiency. This forms the foundation of dynamic wireless charging.

3. Wireless Power Transfer Mechanism When the vehicle passes over an active coil segment, the high-frequency alternating magnetic field generated by the transmitting coil induces an electromotive force (EMF) in the receiving coil installed at the bottom of the electric vehicle. The phenomenon is governed by the principle of mutual inductance, as described by Faraday's Law of Electromagnetic Induction. The induced AC voltage in the receiver coil is then rectified and filtered to obtain a stable DC voltage. This DC output is used to charge the vehicle's onboard battery pack or directly drive its DC motor system, depending on the configuration.

4. Receiver and IoT-Based Monitoring Unit The receiver section houses a rectifier circuit, filter capacitor, and a voltage regulator to ensure consistent charging voltage for the EV battery. The system parameters such as coil voltage, current, and temperature are continuously monitored by the microcontroller. An IoT module (ESP8266/ESP32) is integrated for wireless data transmission to an online cloud platform or mobile application. This enables remote supervision of charging status, system health, fault conditions, and performance statistics. The data can also be used for predictive maintenance and energy analytics. 5. Control and Safety Features To ensure operational safety, the control unit isolates all coil segments when no vehicle is detected. Overvoltage, overcurrent, and temperature protection circuits are embedded to 20 prevent hardware failure. The system's intelligent control algorithm ensures sequential coil activation, maximizing efficiency

IX.CONCLUSION

The successful implementation of the Solar and IoT-Based WPT System demonstrates that wireless and renewable-based EV charging is technically feasible and highly promis ing for future transportation networks. The project achieves the core objectives of sustainability, automation, and energy efficiency while providing a foundation for future research in intelligent transport systems. The integration of renewable solar energy with smart IoT control not only enhances energy utilization but also contributes toward the vision of greener and smarter cities. In conclusion, the system serves as a proof-of-concept for next-generation electric vehicle infrastructure—one that is autonomous, eco-friendly, and aligned with the goals of sustainable technological innovation

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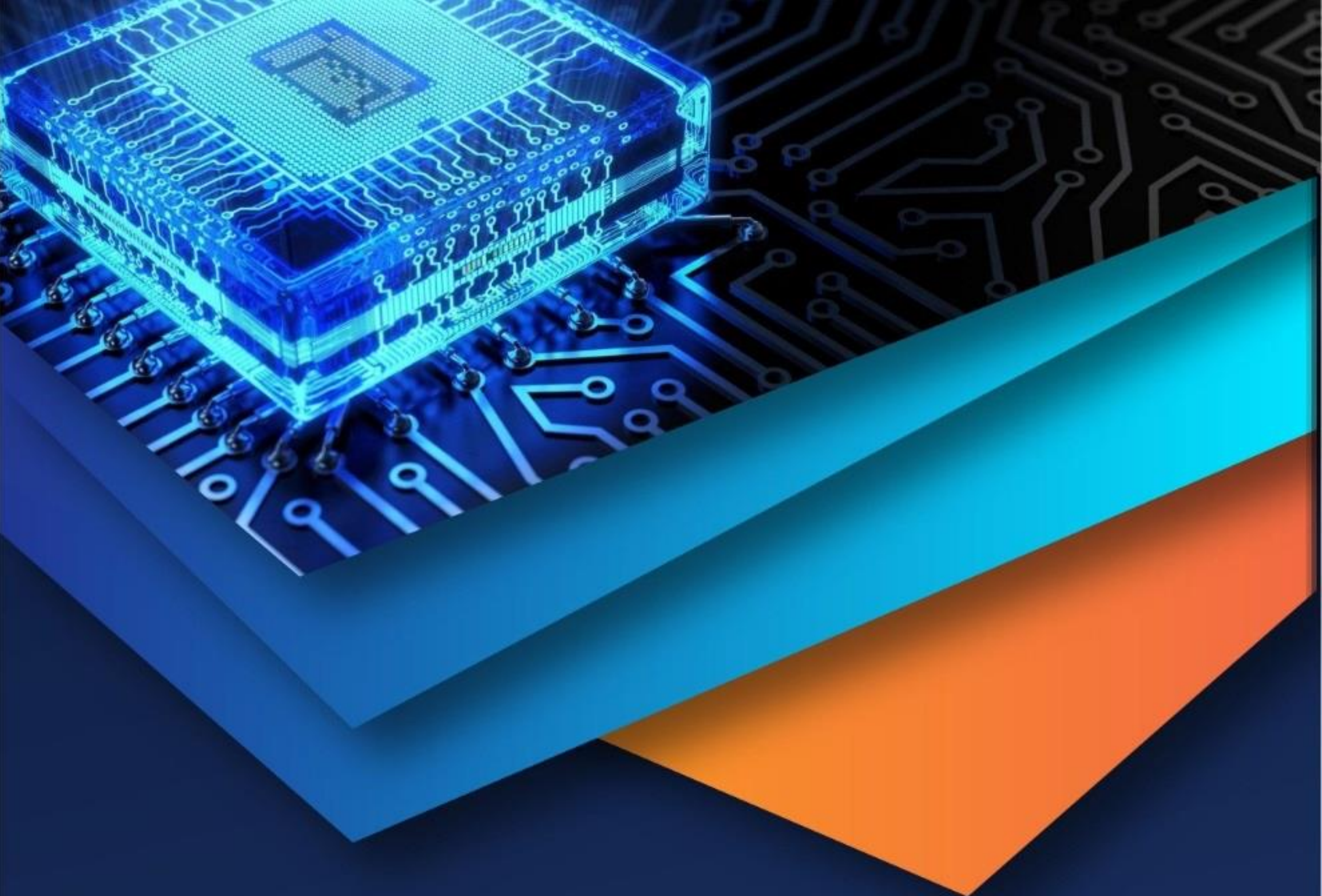

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