

IoT Based Solar Wireless Power Transfer on Road for EV

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Abstract— The rapid adoption of electric vehicles (EVs) has created a growing demand for efficient, sustainable, and convenient charging infrastructure. This paper proposes an IoT-based solar-powered wireless power transfer (WPT) system integrated into roadways for dynamic charging of electric vehicles. The system utilizes photovoltaic panels installed alongside or beneath road surfaces to harness solar energy, which is stored and managed using intelligent energy storage systems. Wireless power transfer is achieved through inductive coupling between transmitter coils embedded in the road and receiver coils mounted on EVs, enabling real-time charging while the vehicle is in motion. The integration of Internet of Things (IoT) technology allows for continuous monitoring, control, and optimization of energy distribution, traffic conditions, and system performance. Sensors and communication modules collect real-time data, which is processed to ensure efficient power delivery and load balancing. This approach minimizes range anxiety, reduces dependency on stationary charging stations, and enhances energy efficiency by utilizing renewable energy sources. The proposed system presents a scalable, eco-friendly, and smart solution for future transportation infrastructure, contributing to reduced carbon emissions and sustainable urban mobility.

Keywords— Electric Vehicles (EVs), Wireless Power Transfer (WPT), Internet of Things (IoT), Solar Energy, Dynamic Charging, Inductive Coupling, Smart Transportation, Renewable Energy, Energy Management System, Sustainable Infrastructure.

I. INTRODUCTION

The reduction of fossil fuels and the need to reduce urban pollutants have made electric vehicles an appropriate alternative to internal combustion engines. Electric vehicles can also act as a source of energy by using vehicle-to-home (V2H) and vehicle-to-grid (V2G) capabilities. The V2G capability allows vehicles to act as a mobile storage device which can inject stored energy into the grid [3]. It also enables active power regulation, reactive power support, load modulation, harmonic filtering, and peak charge correction, thereby improving overall grid performance.

These factors provide services such as spinning reserves and voltage and frequency control for the power grid [4]. In addition to the above benefits, electric vehicles can participate in electricity markets and provide economic advantages to both the power grid and the vehicle owner through proper implementation of V2G. However, it is important to note that the economic benefits of V2G capability depend on how electric vehicles are charged and discharged. If the charging process is not properly controlled, charging periods may coincide with peak load times of the distribution system, thereby increasing peak demand and causing issues such as overload, excessive power losses, and voltage violations.

Therefore, charging patterns should be designed in such a way as to encourage users to shift charging periods to off-peak hours. The effects of the presence of plug-in hybrid electric vehicles (PHEVs) have been studied in several research works. In this paper, various strategies for coordinating the charging and discharging of PHEVs are proposed in an electric vehicle parking system with V2G capability. The proposed strategies include constraints on the amount of power exchanged with the distribution system, as well as the random and unpredictable nature of system parameters. Finally, the impact of each strategy on the amount of parking dividend is analyzed.

II. LITERATURE SURVEY

1. Title: Adaptive Charging Strategies for Electric Vehicles Considering State of Charge and Grid Demand

Author: Fatemeh Jozi, Kazem Mazlumi, Hadi Hosseini

Description

With the extensive use of electric vehicles, the need to charge them has become one of the important issues in the distribution system. Also, these vehicles are able to play the role of energy-generating sources by utilizing vehicle-to-grid (V2G) capabilities. Therefore, coordination of the charging

/discharging process of electric vehicle batteries is essential in order to optimally use these energy storage resources. In this paper, different strategies are proposed for charging /discharging electric vehicles regarding variable power costs, parking constraints for electric vehicles and the random and unpredictable nature of quantities, such as the entrance and

exit of electric vehicles to the parking lot. Such strategies address the time and state of charge of vehicles in order to increase the profit of electric vehicle parking lot, because parking lot is the responsible of charging and discharging. The results show that different strategies have different profits for parking.

2. Title: Catch Energy Saving Opportunity in Charge Depletion Mode, A Real- Time Controller for Plug-in Hybrid Electric Vehicles

Author: Amir Rezaei, Jeffrey B. Burl, Mohammad Rezaei, and Bin Zhou

Description

The energy management (EM) of plug-in hybrid electric vehicles (HEVs) is commonly divided into two modes: charge-depletion mode and charge-sustaining mode. This paper presents the optimal adaption law for any type of adaptive energy consumption minimization strategy (ECMS) in charge-depletion mode for plug-in HEVs. To present the optimal law, a particular adaptive ECMS is selected, known as CESO. CESO has previously been introduced for series and parallel HEVs in charge-sustaining mode. Here, by introducing the optimal adaption law in charge-depletion mode, CESO strategy is expanded to charge-depletion mode for plug-in HEVs.

3. Title: Design of a High Power Transfer Pickup for On-Line Electric Vehicle (OLEV)

Author: Boyune Song, Jaegue Shin, Seokhwan Lee, Seungyong Shin, Yangsu Kim, Sungjeub Jeon and Guho Jung.

Description

Recent electric vehicle technology with battery has faced many problems: high cost, weight, driving distance, long charging time and danger of electric shock. An inductive power transfer pickup for electric vehicles such as pickup of traditional transformer enables electric vehicles to overcome these problems by using contactless power transfer. Also, inductive power transfer pickup has many advantages including high efficiency, high power, a large air gap and lightweight. In this paper, proposed inductive power pickup was developed using series capacitor with ferrite cores and multi-windings and was

tested for its ability to transfer electricity wirelessly. When tested for output power and efficiency of pickup, output power of 20kW and efficiency of 86.7% were achieved at 20 kHz and 250mm air gap.

4. Title: Reserving Charging Strategy for Electric Vehicles Based on Combined Model of Road- Charging Station- Electric Vehicle

Author: Haoming Liu, Man Niu, Weijie Wang

Description

Charging resources in the charging stations are limited. How to make electric vehicles get charging service with small cost is worth studying. The reserving charging model for electric vehicles is built based on the customer requirement model, considering the road condition of traffic system and available charging resources in the charging stations. All factors that influence the reserving charging are translated into weights and then being Department of Electrical Engineering

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assigned to corresponding edges of traffic network graph. The Dijkstra algorithm is introduced to achieve the solution of the model built in this paper. Finally, a supposed traffic network is used to conduct a simulation, and the results show that the proposed optimization model of reserving charging for electric vehicles can satisfy users' different demands.

System Design and Block Diagram:

Ground Assembly

Rectifier with PFC (AC to DC Conversion): Converts AC power from the grid into DC while ensuring power factor correction (PFC) to minimize energy losses.

DC-AC Inverter (High-Frequency): Converts the DC power into high-frequency AC power required for efficient wireless power transfer.

Primary Coil (Transmitting Coil): Generates a time-varying magnetic field when high frequency AC is passed through it. This coil is embedded in the ground.

Vehicle Assembly

Secondary Coil (Receiving Coil): Installed under the vehicle, it receives energy from the magnetic field generated by the primary coil through magnetic induction.

AC-DC Converter: Converts the induced AC power in the secondary coil back into DC power.

Battery Charger: Manages the charging of the vehicle's battery using the DC power.

Communication System

Both assemblies (ground and vehicle) communicate to exchange data about alignment, power requirements, charging status, and efficiency optimization.

Physical Representation

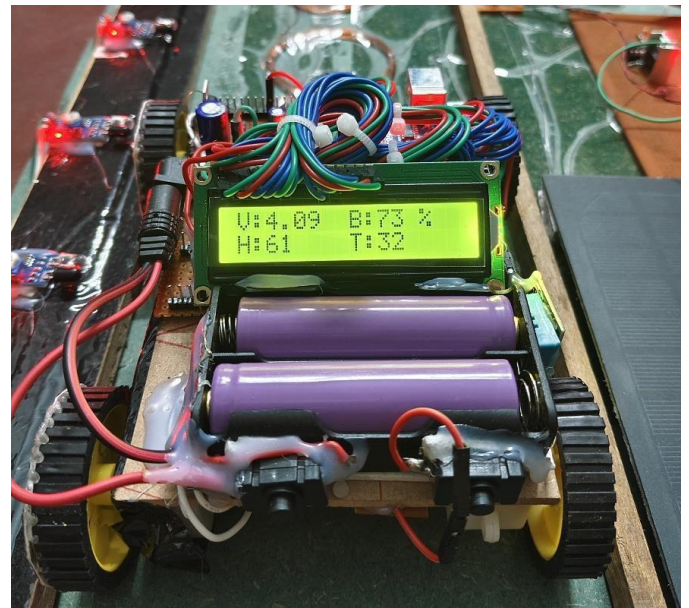
This shows the actual placement of components in the system -
Transmitting Coil: Placed on the ground (charging pad).

Receiving Coil: Installed underneath the vehicle.

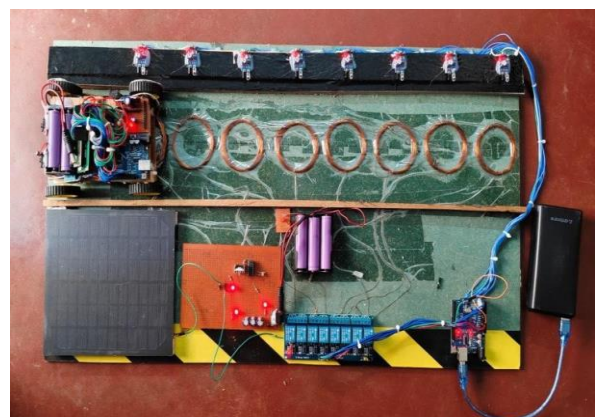
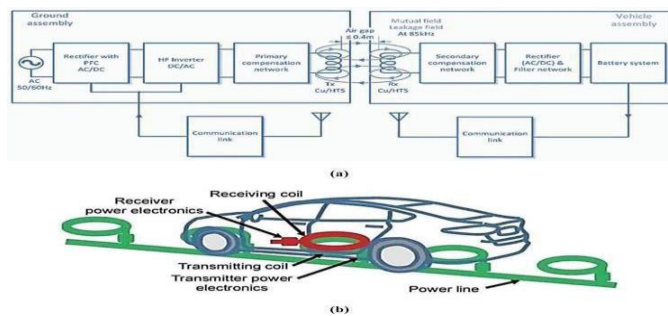
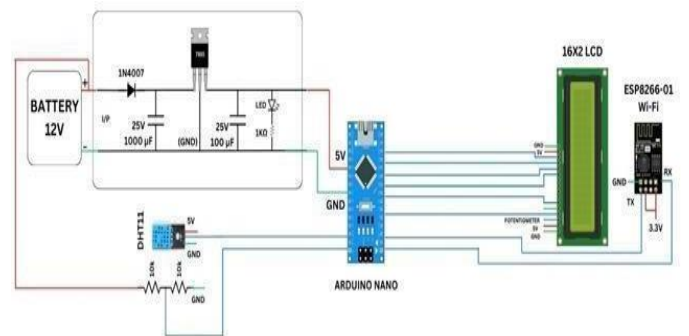
Power Electronics: Enable the conversion processes and manage efficient power transfer. The wireless transfer happens through magnetic resonance coupling between the transmitting and receiving coils. Proper alignment of these coils ensures maximum efficiency.

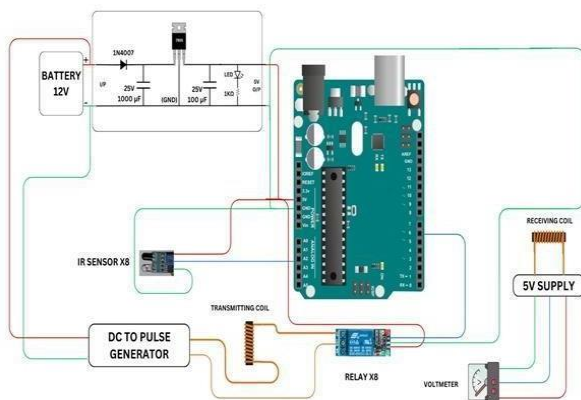
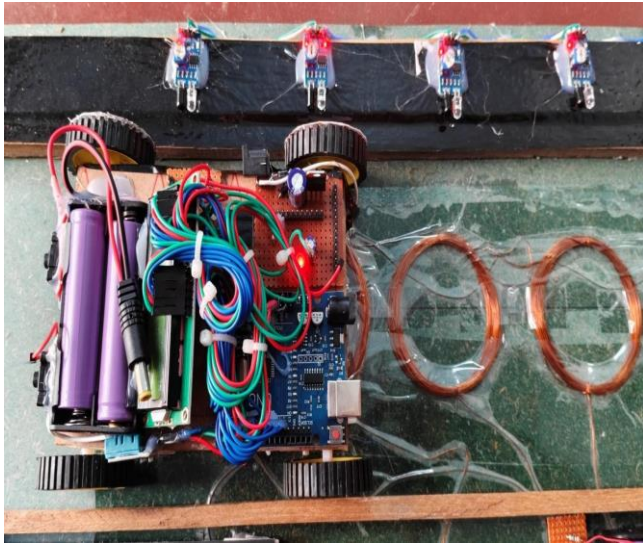
Working Principle of Wpt

- **Power Input:** The system starts with AC power supplied by the grid to the ground assembly.
- **Conversion to High-Frequency AC:** The rectifier converts AC to DC, and the high-frequency inverter generates AC suitable for wireless power transfer.
- **Magnetic Coupling:** The transmitting coil produces an alternating magnetic field. This field induces a current in the receiving coil located in the vehicle.
- **Power Conditioning:** The induced current is converted back to DC by the vehicle assembly and regulated to charge the battery efficiently.
- **Communication Feedback:** Real-time communication ensures proper alignment, adjusts power levels, and optimizes safety and performance.



Proposed Configuration for the Iot Enabled Electric Vehicle





Future Scopes

In light of the new policies and technology that emerge. The purpose of this section is to speculate on the WEVC of the future. Today, electric vehicle stockpiles around the world are growing rapidly. How to guarantee a sustainable rise of EV ownership and how to allow full play of scalable development are two potential orientations in WEVC under the trend of industrial prosperity. Furthermore, developing technologies, materials, and theories can help WEVC become even more competitive. Additionally, power electronics can gain by using modern materials. For one reason, switching loss is a significant cause of energy waste in a WEVC system, alongside flux leakage. Though static WEVC can free up operators' hands, it does little to improve charging station adaptability. Here, the benefits of dynamic WEVC become clear. Broadly speaking, tram-based and on-road varieties of this technology exist.

III. CONCLUSIONS

The integration of dynamic wireless power transfer with IoT and cloud connectivity presents a transformative solution for the future of electric vehicles (EVs). By enabling seamless charging on the move, this system addresses critical challenges such as range anxiety and long charging times, fostering increased EV adoption. The real-time monitoring and data analysis enabled by IoT and cloud integration enhance operational efficiency, travel convenience, and road safety. Additionally, the use of renewable energy sources, such as solar panels, minimizes environmental impact, contributing to a significant reduction in greenhouse gas emissions. This project not only paves the way for sustainable transportation but also revolutionizes the EV ecosystem by combining cutting-edge technology with eco-friendly practices. It marks a crucial step toward a greener, smarter, and more connected future.

Updated Performance Analysis

The size of the battery is 4.6 volts. Battery charging started by running the car on the coil at 15:19:14, with the initial battery voltage recorded as 4100.7 mV. By 15:28:13, the battery voltage rose to 4579.7 mV, indicating that the battery is successfully charging.

After the Specified Duration

The voltage change was 479.0 mV over approximately 8.98 minutes, showing a steady increase. The rate of voltage change was calculated to be 53.32 mV per minute, which corresponds to a 1.16% increase in battery voltage per minute.

After that, the rise in voltage began to saturate and slightly reduced as components like the LCD and DHT sensor started draining power.

REFERENCES

1. L. Cheng, Y. Chang, Q. Wu, W. Lin and C. Singh, "Evaluating charging service reliability for plug-in EVs from the distribution network aspect," *IEEE Transactions on Sustainable Energy*. IEEE, vol. 5, pp.1287-1296, 2014.
2. N. Xu and Y. Chung, "Reliability evaluation of distribution systems including vehicle-to-home and vehicle-to-grid," *IEEE Transactions on Power Systems*. IEEE, vol. 31, pp.759-768, 2016.
3. A. Alahyari, M. Fotuhi-Firuzabad and M. Rastegar, "Incorporating customer reliability cost in PEV charge scheduling schemes considering vehicle-to-home capability," *IEEE Transactions on Vehicular Technology*. IEEE, vol.64, pp. 2783- 2791, 2015.

4. S. Habib, M. Kamran and U. Rashid, "Impact analysis of vehicle-to-grid technology and charging strategies of electric vehicles on distribution networks--a review," *Journal of Power Sources*. Elsevier, vol. 277, pp.205- 214, 2015.
5. M. Ansari, A. Al. Awami, E. Sortomme and M. Abido, "Coordinated bidding of ancillary services for vehicle-to-grid using fuzzy optimization," *IEEE Transactions on Smart Grid*. IEEE, vol. 6, pp. 261-270, 2015.