EV Charging Station With Wireless Charging Using RFID

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Abstract- *The development of electric vehicles (EVs) has surged in recent years, driven by environmental concerns and advancements in technology. A critical component of the EV ecosystem is the charging infrastructure, which must be efficient, convenient, and accessible to support widespread adoption. This paper presents an innovative EV charging station that incorporates wireless charging technology using Radio Frequency Identification (RFID) systems. The proposed design aims to enhance user convenience and operational efficiency. The wireless charging system eliminates the need for physical connectors, thereby reducing wear and tear and minimizing user intervention. By integrating RFID technology, the system can automatically identify and authenticate vehicles, facilitating seamless billing and usage tracking. This approach not only streamlines the charging process but also improves security and user experience. The paper explores the technical architecture of the wireless charging system, detailing the components such as the charging pad, receiver coil, RFID reader, and associated software. We discuss the electromagnetic principles underlying wireless power transfer and the integration of RFID for vehicle identification and communication. Performance evaluation of the prototype demonstrates the feasibility of the system, with successful wireless charging and accurate vehicle identification under various conditions. Additionally, the implementation of smart grid connectivity ensures optimal energy management and supports sustainable energy practices.In conclusion, the combination of wireless charging and RFID technology offers a promising solution for the future of EV charging infrastructure. This integrated system has the potential to significantly improve the convenience, efficiency, and security of EV charging, thus encouraging broader adoption of electric vehicles. Future work will focus on scalability, cost reduction, and further enhancements in energy efficiency and user interface design..*

Keywords- Solar Panels, Wind Turbine, Buck-Boost Converter, Resonance Coupling, Mutual Inductance.

I. INTRODUCTION

The rapid advancement of electric vehicles (EVs) is transforming the automotive industry, driven by the need for sustainable transportation solutions to mitigate climate change and reduce dependence on fossil fuels. As the adoption of EVs continues to grow, the demand for efficient, reliable, and user-friendly charging infrastructure has become paramount. Traditional EV charging methods, which often require physical connections, present challenges such as wear and tear on connectors, user inconvenience, and potential safety hazards. Wireless charging technology offers a compelling alternative by enabling the transfer of power from the charging station to the vehicle without the need for physical cables. This technology, based on inductive power transfer principles, can significantly enhance the user experience by providing a more convenient and less intrusive charging process. However, to fully realize the benefits of wireless charging, an efficient system for vehicle identification and authentication thereby ensuring secure and seamless operation, is required.

In this context, the integration of Radio Frequency Identification (RFID) technology with wireless EV charging stations presents a novel solution. RFID technology allows for automatic identification and authentication of EVs, facilitating secure access and streamlined billing processes. By leveraging RFID, the proposed system can automatically detect and verify the vehicle when it arrives at the charging station, initiate the charging process, and handle payment transactions without requiring any manual intervention from the user. This paper aims to explore the design and implementation of an EV charging station that combines wireless charging with RFID technology. The proposed system is designed to enhance operational efficiency, user convenience, and overall security. The following sections will delve into the technical architecture of the system, the principles of wireless power transfer, and the role of RFID in vehicle identification and communication. We will also present the results of performance evaluations conducted on a prototype system and discuss the potential implications for the future of EV charging infrastructure. By addressing the limitations of traditional charging methods and incorporating advanced technologies, this integrated solution has the potential to significantly improve the EV charging experience, encouraging broader adoption of electric vehicles and supporting the transition to a more sustainable transportation ecosystem.

II. LITERATURE REVIEW

The convergence of wireless charging and Radio Frequency Identification (RFID) technologies in electric vehicle (EV) charging stations is an emerging field that addresses the growing demand for efficient and user-friendly charging solutions. This literature review synthesizes existing research on wireless EV charging, RFID applications in EV systems, and the integration of these technologies.

2.1 Wireless EV Charging Technology:-

Wireless charging, also known as inductive charging, uses electromagnetic fields to transfer energy between a charging pad and a receiver coil in the vehicle. This technology has been extensively studied and developed over recent years. Researchers such as Covic and Boys (2013) have demonstrated the feasibility of wireless power transfer (WPT) systems for EVs, emphasizing the importance of alignment and efficiency in power transfer . Studies by Bi et al. (2016) have focused on optimizing the design of the coils and the alignment systems to improve charging efficiency and minimize energy losses. Moreover, recent advancements have explored dynamic wireless charging, where EVs are charged while in motion. This concept, as discussed by Lukic and Pantic (2013), holds promise for reducing downtime and enhancing the convenience of EVs, though it presents significant technical and infrastructural challenges.

2.2 RFID Technology in EV Systems:-

RFID technology is widely used for identification and authentication purposes across various industries. In the context of EV charging, RFID can facilitate automatic vehicle identification, secure access control, and efficient billing. Research by Want (2006) outlines the fundamental principles of RFID and its applications in automated systems . Subsequent studies by Rizos et al. (2011) have investigated the application of RFID in intelligent transportation systems, highlighting its potential for enhancing the operational efficiency of EV charging stations. Integrating RFID into EV charging systems has been explored to some extent. For instance, a study by Kamarudin et al. (2013) demonstrated the use of RFID for secure and automated access to charging stations, simplifying the user experience and improving security . However, comprehensive integration with wireless charging systems remains underexplored, indicating a gap in the literature.

2.3 Integration of Wireless Charging and RFID Technology:-

Combining wireless charging with RFID technology in EV charging stations offers a promising avenue for innovation. This integration aims to create a seamless and automated charging experience, where vehicles are identified and authenticated wirelessly, and charging is initiated without physical connectors. Initial explorations into this integration by researchers such as Zhang et al. (2017) have shown potential benefits in terms of user convenience and system efficiency. However, the practical challenges and technical complexities of such an integrated system require further investigation. Issues such as interference between RFID signals and wireless power transfer, optimal placement of RFID tags and readers, and the robustness of the system under various environmental conditions are critical areas for future research.

III. HARDWARE IMPLEMENTATION

A. Solar Panel -20 watt each.

A solar panel is a device that converts sunlight into electricity by using photovoltaic (PV) cells. PV cells are made of materials that produce excited electrons when exposed to light. The electrons flow through a circuit and produce direct current (DC) electricity, which can be used to power various devices or be stored in batteries. Solar panels are also known as solar cell panels, solar electric panels, or PV modules. Solar panels are usually arranged in groups called arrays or systems. A photovoltaic system consists of one or more solar panels, an inverter that converts DC electricity to alternating current (AC) electricity, and sometimes other components such as controllers, meters, and trackers. Most panels are in solar farms, which supply the electricity grid as can some rooftop solar.

Fig. A Solar Panel

Features of Solar Panel:

- Voltage : 12 Volts
- Current : 0.4167 Amp
- Power : 5 Watt
- Size : 29 cm x 18.5 cm x 1.7 cm

B. MPPT Solar Charge Controller

MPPT solar charge controller is the second generation of e-Smart MPPT controller, based on e-Smart series MPPT controller, we update the display with LCD, control method, connect way, internal structure etc. It features an efficient MPPT control algorithm to track the maximum power point of the PV array. Greatly improve the utilization of solar panel. Its intelligent LCD and upper PC display, mostly convenient for customers checking, records and parameter setting. It widely used in off-grid solar system, communication base station solar system, household solar systems, street light solar systems, field monitoring and other fields etc This reference design is a Maximum Power Point Tracking (MPPT) solar charge controller for 12-V and 24-V batteries, that can be used as a power optimizer in the future.

Fig. B. MPPT Solar Charge Controller

Features

- 98.3% efficiency in 12-V systems and 98.5% efficiency in 24-V systems
- Wide input voltage range: 15 V to 60 V
- Flexible design supports 12-V and 24-V battery voltages
- High-rated output current: 16 A
- Battery reverse polarity, over-charge and over discharge protections
- System over temperature and ambient light detection capabilities
- Small board form factor: 95 mm × 68.2 mm × 25 mm

C. DC-DC Converters

DC-DC Converters There are three basic types of dc-dc converter circuits, termed as buck, boost and buck boost. In all of these circuits, a power device is used as a switch. This device earlier used was a thyristor, which is turned on by a pulse fed at its gate. In all these circuits, the thyristor is connected in series with load to a dc supply, or a positive (forward) voltage is applied between anode and cathode terminals.

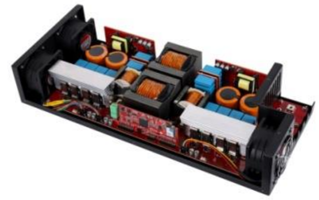


Fig. C. DC to DC Converter

The thyristor turns off, when the current decreases below the holding current, or a reverse (negative) voltage is applied between anode and cathode terminals. So, a thyristor is to be force-commutated, for which additional circuit is to be used, where another thyristor is often used. Later, GTO’s came into the market, which can also be turned off by a negative current fed at its gate, unlike thyristors, requiring proper control circuit.

D. Buck Converters (dc-dc)

A buck converter (dc-dc) is shown in Fig. a. Only a switch is shown, for which a device as described earlier belonging to transistor family is used. Also a diode (termed as free wheeling) is used to allow the load current to flow through it, when the switch (i.e., a device) is turned off. The load is inductive (R-L) one. In some cases, a battery (or back emf) is connected in series with the load (inductive). Due to the load inductance, the load current must be allowed a path, which is provided by the diode; otherwise, i.e., in the absence of the above diode, the high induced emf of the inductance, as the load current tends to decrease, may cause damage to the switching device. If the switching device used is a thyristor, this circuit is called as a step-down chopper, as the output voltage is normally lower than the input voltage. Similarly, this dc-dc converter is termed as buck one, due to reason given later.

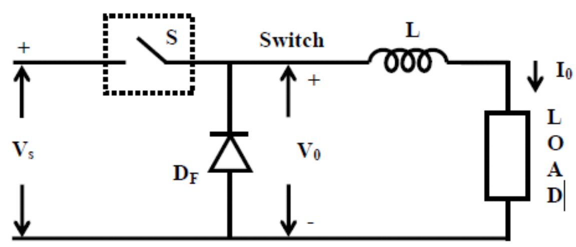


Fig. D. Buck Converter Line Diagram

E. Light Dependent Resistor (LDR)

Light Dependent Resistor (LDR) The light-dependent resistor is also known as a photo resistor or photocell. It is a light-controlled variable resistor. In photo resistor resistance decreases when light intensity increased and resistance increases with light intensity decreased. So that we can say that the resistance of the photo resistor is maximum at low light and minimum as light increases. LDR is mainly used for the detection of day and night. It can turn ON/OFF street light according to the change in light intensity or day/night time.

Fig. E. Light Dependent Resistor (LDR)

A Light Dependent Resistor (LDR) or a photo resistor is a device whose resistivity is a function of the incident electromagnetic radiation. Hence, they are light sensitive devices. They are also called as photo conductors, photo conductive cells or simply photocells. They are made up of semiconductor materials having high resistance. There are many different symbols used to indicate a LDR, one of the most commonly used symbol is shown in the figure below. The arrow indicates light falling on it

F. Resistors

Fig. F. Resistors

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses. High-power resistors that can dissipate many watts of electrical power as heat may be used as part of motor controls, in power distribution systems, or as test loads for generators. Fixed resistors have resistances that only change slightly with temperature, time or operating voltage.

G. EM18 RFID Module

EM18 is a RFID reader module which is used to read RFID tags of frequency 125 kHz. After reading tags, it transmits unique ID serially to the PC or microcontroller using UART communication or Wiegand format on respective pins. Radio-frequency identification (RFID) is the wireless non-contact use of radio-frequency electromagnetic fields to transfer data, for the purposes of automatically identifying and tracking tags attached to objects. The tags contain electronically stored information. This EM-18 RFID Reader is a Tiny, simple to use RFID reader module. With a built in antenna, the only holdup is the 2mm pin spacing.

Fig. G. EM 18 RFID Module

Features:-

- Operating Voltage: 5V DC Supply
- Reading Distance: 6-10 cm.
- Read frequency: 125 kHz.
- EM4001 64 – bit RFID tag compatible.
- 9600bps ASCII output.
- Current : <50 mA
- Operating Frequency : 125 Khz
- Read Distance : 5 cm
- Compatible Tags : 125KHz EM4100 Tags

H. Lithium-Ion Batteries:-

A lithium-ion battery or Li-ion battery is a type of rechargeable battery. Lithium-ion batteries are commonly used for portable electronics and electric vehicles. In this battery, lithium ions move from the negative electrode through an electrolyte to the positive electrode during discharge, and back when charging. Li-ion batteries use an intercalated lithium compound as the material at the positive electrode and typically graphite at the negative electrode. The batteries have a high energy density, no memory effect and low self-discharge. Nominal, Maximum & Cut-off Voltage, these are the few Lithium-Ion batteries that I have been using for very long for many of my projects. Some of the batteries have a simple attached Battery Management System Circuit for over-voltage protection, balanced charging, short-circuit protection.

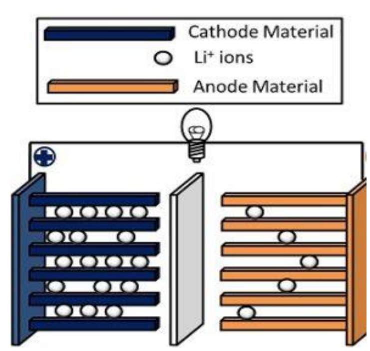
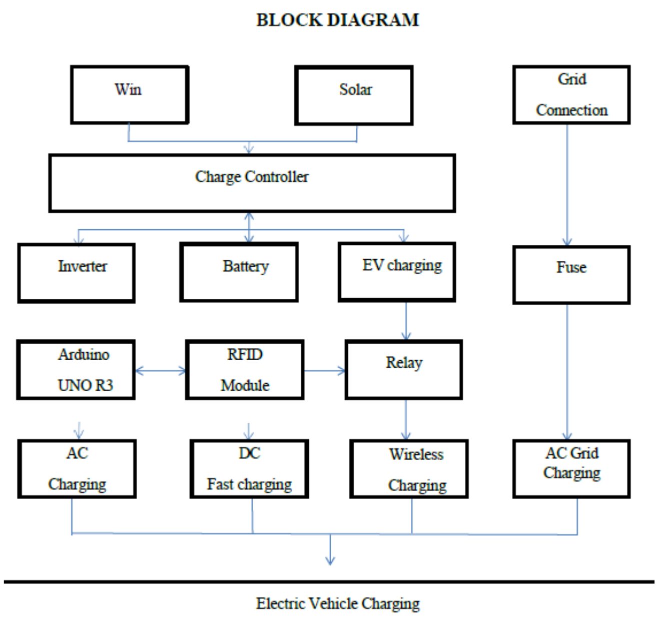
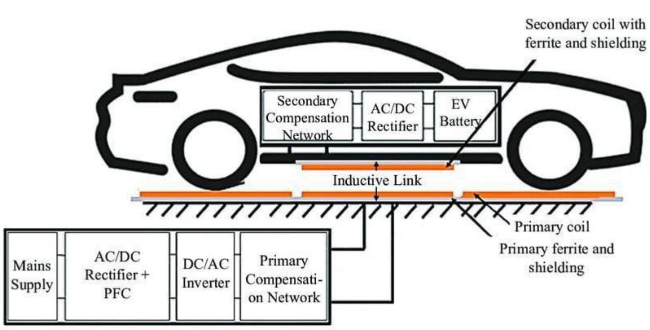


Fig. H. Li-Ion Battary

A lithium-ion (Li-ion) battery is an advanced battery technology that uses lithium ions as a key component of its electrochemistry. During a discharge cycle, lithium atoms in the anode are ionized and separated from their electrons. The lithium ions move from the anode and pass through the electrolyte until they reach the cathode, where they recombine with their electrons and electrically neutralize. The lithium ions are small enough to be able to move through a micro-permeable separator between the anode and cathode.

IV. BLOCK DIAGRAM





V. WORKING PRINCIPLE

The Smart EV Charging Station on Grid Green Power and Wireless Charging operates on various principles. In this the electricity is generated in solar plant and wind plant is given to the battery through the Invertors. Battery can store the generated electricity in solar and Wind. Battery connected to the charge controller and Charge controller play a crucial role that is system by regulating the flow energy. From charge controller the AC charging is provided to charge the E-Vehicle. The DC charging is provided from the Battery and the wireless charging is provided to the charging the E-Vehicle. Additional Grid charging is provided when the electricity is not generated through the solar plant and wind plant. As the Vehicle comes at AC charging point it can charge itself by using connecting the pin. After that it comes at DC charging point it can also charge the Vehicle with the pin. But it comes at wireless charging point where Arduino and RFID module can installed. Here there is not visual/wired connection between the E-Vehicle and Charging point. So the permission granted vehicles are charged at the wireless charging point. Here the E-Vehicle owner which has not a REID card the RFID declined it which can show on display. The RFID card is given to customer who is a regular customer of the station and charge the vehicle Daily. With the help of Arduino we can set a limit of time to charge the E-Vehicle. Hence the electricity is not generated through the Solar and Wind then we can use the Grid Charging to charge the E-Vehicle for Emergency purpose. For number and many types of charging is provided at a station which can not disappoint the customer

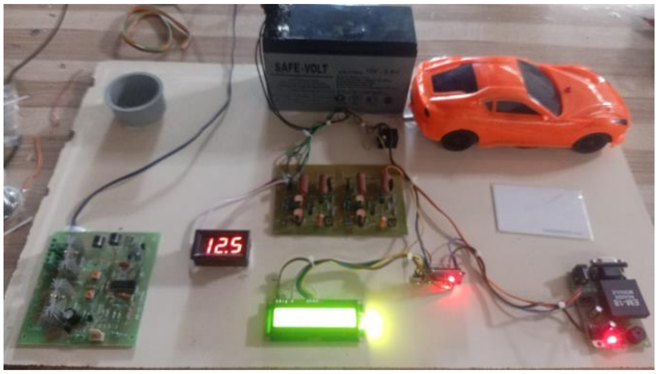
Overall the Charging the E-Vehicle through the Non-renewable source does not make any sense because we moving towards a Electric mobility. Due to use of E-Vehicle there is no pollution produced in the Nature.

Fabricating the E-Vehicle according to the following step

- The critical study of various research paper
- Gather all the information about the project
- Collect all the components
- Fabricate the all types of renewable energy sources
- Presenting the report and research paper

The EV charging station and wireless charging is designed for charge the vehicle without producing a pollution. The adoption of EV charging station a long distance is not covered at one attempt so that necessary point we have to install the Charging station.

- Solar and Wind Plant.
- Invertors & Charge Controller.
- Battery.
- Arduino & RFID Module.
- Frame support for Solar and Wind plant.
- Relays and some electronic and electrical components.



Prototype Model

4 Types of Charging –

- AC charging
- DC charging
- Wireless charging
- Grid charging.

A. Advantages

- Renewable energy source.
- One of the most significant advantages of solar-powered charging stations is that they use renewable energy from the sun to recharge EVs.
- Reduced carbon footprint.
- Reduce dependence on nonrenewable energy sources.
- Low-cost energy source.

B. Disadvantages

- Power outputs vary between charging stations, but DC fast chargers can deliver between 7 and 50 times more power than a regular AC charging station. While this high power is great for quickly topping up an EV, it also generates considerable heat and can put the battery under stress.
- Wireless charging for electric vehicles offers several advantages, including convenience, enhanced safety, and environmental sustainability. However, challenges such as lower efficiency, higher implementation costs, and standardization issues need to be

VI. CONCLUSION

Increasing pollution and rapid depletion of fossil fuels has a paved a way to the entry of EV's in the market. But charging of E-Vehicle through conventional/Non renewable energy sources will can make the pollution. It indicates significant advancements in both wireless EV charging and RFID technology, but the integration of these technologies remains in its nascent stages. Existing studies provide a strong foundation, yet there is a clear need for more comprehensive research to address the technical and practical challenges of combining wireless charging with RFID for EVs. This integrated approach promises to enhance the convenience, efficiency, and security of EV charging stations, supporting the broader adoption of electric vehicles and contributing to a sustainable transportation future. By building on the existing body of knowledge and addressing the identified gaps, this paper aims to advance the understanding and implementation of integrated wireless charging and RFID systems for EV.

REFERENCES

[1] Covic, G. A., & Boys, J. T. (2013). Inductive power transfer. Proceedings of the IEEE, 101(6), 1276-1289.

[2] Bi, Z., Song, L., De Kleine, R., Mi, C. C., & Keoleian, G. A. (2016). Plug-in vs. wireless charging: Life cycle energy and greenhouse gas emissions for an electric bus system. Applied Energy, 146, 11-19.

[3] Lukic, S. M., & Pantic, Z. (2013). Cutting the cord: Static and dynamic inductive wireless charging of electric vehicles. IEEE Electrification Magazine, 1(1), 57-64.

[4] Want, R. (2006). An introduction to RFID technology. IEEE Pervasive Computing, 5(1), 25-33.

[5] Rizos, C., Gan, H., Tang, J., & Wang, J. (2011). Advanced technologies in transportation systems. Journal of Transportation Technologies, 1(2), 53-61.

[6] Kamarudin, K. R., Kamarudin, S. K., & Mohamed, A. (2013). RFID-based system for secure and automated access to charging stations for electric vehicles. International Journal of Smart Grid and Clean Energy, 2(1), 52-58.

[7] Zhang, W., Mi, C. C., Maguire, T., & Keoleian, G. (2017). Wireless charging of electric vehicles: An overview and application. In Electric Vehicles-The Benefits and Barriers. In tech Open.