Solar Wireless Electric Vehicle Charging System

Devika B P
Department Of Electrical & Electronics Engineering
Smt. Kamala and Sri. Venkappa M. Agadi
College Of Engineering and Technology
Lakshmeshwar-582116

Malatesh S H
Department Of Electrical & Electronics Engineering
Smt. Kamala and Sri. Venkappa M. Agadi
College Of Engineering and Technology
Lakshmeshwar-582116

Ranju F M
Department Of Electrical & Electronics Engineering
Smt. Kamala and Sri. Venkappa M. Agadi
College Of Engineering and Technology
Lakshmeshwar-582116

Sakshi K J
Department Of Electrical & Electronics Engineering
Smt. Kamala and Sri. Venkappa M. Agadi
College Of Engineering and Technology
Lakshmeshwar-582116

Prof. Manjunath Hombal
Department Of Electrical & Electronics Engineering
Smt. Kamala And Sri. Venkappa M. Agadi
College Of Engineering and Technology
Lakshmeshwar-582116

***Abstract*—Electric vehicles (EVs) are increasingly being adopted worldwide and are gradually becoming a significant part of modern transportation. In addition to their environmental advantages, EVs help reduce travel costs by replacing conventional fuels with electricity, which is comparatively more economical. However, to further enhance their reliability and practicality, improvements in battery charging technologies are essential. The proposed "solar-based wireless EV charger" utilizes renewable energy to address these challenges. In this system, solar energy is converted into electrical energy and stored in a lead-acid battery. A battery management unit is employed to regulate and manage the stored energy, which is then used to charge electric vehicles. Wireless charging technology operates by transferring power through an electromagnetic field across a certain cases, eliminating the need for physical connections. EV batteries can be charged either through conventional plug-in methods at charging stations or via wireless power transfer systems. These wireless systems can be implemented as either static charging, where the vehicle is stationary or dynamic charging, which enables charging while the vehicle is in motion. The underlying principle of wireless power transfer in this system is inductive coupling, where energy is transmitted from the source to the vehicle battery through transformer-like windings. This approach offers a promising solution for efficient, contactless, and sustainable charging of electric vehicles.**

I. INTRODUCTION:

The increasing need to reduce emissions from transportation has accelerated the shift from conventional internal combustion engine (ICE) vehicles to alternatives powered by cleaner energy sources such as batteries and fuel cells. However, unlike ICE vehicles, electric vehicles (EVs) are still evolving, particularly in terms of driving range and autonomy. As a result, significant research efforts from both academia and industry are focused on enhancing their overall performance.

To improve vehicle autonomy, several strategies are being explored. These include developing batteries with higher energy density, integrating supercapacitors to handle peak power demands during acceleration and regenerative braking, implementing fast-charging infrastructure, and enabling dynamic (on-the-move) charging.

Typically, EV batteries are recharged either at residential locations or at designated parking and charging stations using conductive charging methods. These chargers are broadly classified into two categories: on-board and off-board chargers. On-board chargers are integrated within the vehicle and allow charging from standard utility outlets or public charging points during routine use. In contrast, off-board chargers are external systems designed to deliver high power levels, enabling rapid charging similar to conventional refueling stations.

Most battery charging systems allow power flow only from the grid to the vehicle battery and are therefore referred to as unidirectional battery chargers (UBCs). These chargers are simpler in design, require less complex grid integration, and tend to reduce battery degradation. Alternatively, bidirectional battery chargers (BBCs) enable power flow in both directions, allowing the vehicle to not only draw energy from the grid but also supply energy back. This capability supports grid services such as peak load shaving and reactive power compensation.

Electric vehicle charging can be achieved through either wired (conductive) or wireless methods. Wired charging involves a physical connection between the power source and the vehicle's charging port. Although widely used, this approach has certain drawbacks, including cable management issues and safety concerns, particularly in wet or harsh environmental conditions.

II. LITERATURE SURVEY:

Wireless Power Transmission (WPT) technology was first introduced by Nikola Tesla in the late 19th century. His vision was to develop an electrical supply system that could operate without wires, leading to the invention of inductive and capacitive coupling methods. He also developed the Tesla Coil, which remains a fundamental component in wireless energy transfer research. Building on this concept, Erhuvwu Ayisire proposed ideas related to wireless charging systems specifically for electric vehicles (EVs).

Several researchers have further contributed to advancements in EV charging technologies. N. Uthaya Banu, U. Arunkumar, A. Gokulakannan, M. K. Hari Prasad, and A.

B. Shathish Sharma explored battery charging using solar energy, with a detailed analysis of both primary and secondary sides of the system. Their work also emphasized that coil design is one of the most critical and challenging aspects of wireless charging systems.

Abhijith Nidmar et al. (2019) presented a solar-powered wireless charging approach in which solar panels serve as the primary energy source. In their system, direct current is managed using 555 timer circuits, and inductive coupling is employed for power transfer.

Adel El-Shahat et al. (2019) discussed the fundamental requirements for electric vehicle charging and compared different wireless charging techniques. Their study highlighted inductive power transfer as one of the most efficient methods and provided a detailed prototype for its implementation.

A. M. Alsomali et al. (2017) investigated various EV charging strategies, including the use of pulse width modulation (PWM) to regulate voltage levels. They also introduced a time-multiplexing technique to reduce charging time, demonstrating its effectiveness through simulation.

Bhuvanesh Arulraj et al. (2019) proposed a hybrid renewable energy-based EV charging system that integrates both solar and wind sources. In their design, separate batteries are used to store energy from each source, and an Arduino-based control system selects the appropriate source for wireless charging based on voltage comparison.

III. METHODOLOGY AND WORKING PRINCIPLE

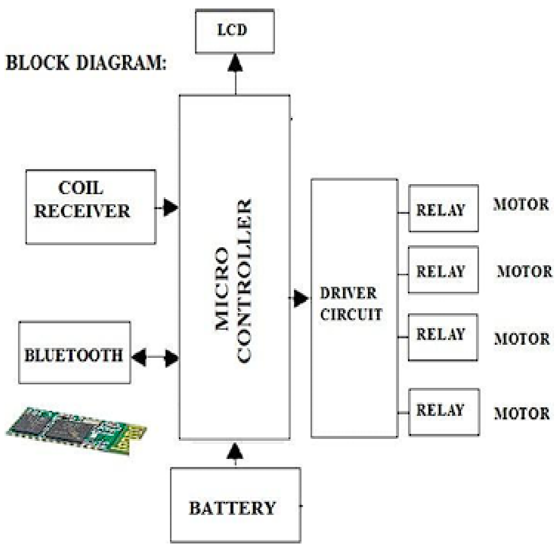

Fig. 1.

A. Working Description

- The block diagram represents the functional operation of the Solar Wireless Electric Vehicle Charging and Control System. The system mainly consists of a receiver coil, microcontroller, Bluetooth module, LCD display, driver circuit, relays, motors, and battery.
- The receiver coil receives wireless power transmitted from the charging station through electromagnetic induction. The received power is processed and supplied to the microcontroller, which acts as the central control unit of the system.
- A battery is connected to the microcontroller to store energy and provide a stable power supply for system operation. The battery ensures continuous functioning of the system even when wireless power is temporarily unavailable.
- The Bluetooth module enables wireless communication between the system and a mobile device. Using Bluetooth, control commands such as motor ON/OFF operations can be sent to the microcontroller remotely.
- The microcontroller processes inputs from the receiver coil and Bluetooth module and executes control logic accordingly. It also sends output signals to the LCD display, which displays system status information such as charging status, connection status, or motor operation details.
- The output control signals from the microcontroller are fed to the driver circuit. Since the microcontroller cannot directly drive high-power loads, the driver circuit amplifies the control signals to suitable levels.
- The driver circuit activates the relay units, which act as switching devices. These relays control the operation of multiple motors, representing vehicle components or drive mechanisms.
- Thus, the coordinated operation of all blocks ensures efficient wireless power reception, system monitoring, remote control, and motor operation in the electric vehicle system

B. System Architecture:

The architecture of the proposed Solar Wireless Electric Vehicle Charging and Control System is designed around a microcontroller-centric architecture, integrating wireless power reception, communication, monitoring, and actuator control. The architecture is divided into three main layers: Power Layer, Control & Communication Layer, and Actuation & Display Layer

1) Power Layer

The power layer consists of the wireless receiver coil and battery unit. The receiver coil captures energy transmitted wirelessly from the charging station using electromagnetic induction. This received energy is conditioned and used to charge the onboard battery. The battery serves as the primary power source for the microcontroller and other electronic components, ensuring stable and uninterrupted system operation.

2) Control and Communication Layer

The microcontroller acts as the core processing unit of the system. It receives input signals from the receiver coil indicating power availability and manages battery charging and power distribution.A Bluetooth module is interfaced with the microcontroller to enable wireless communication with external devices such as smartphones. Through Bluetooth, user commands for controlling vehicle functions (such as motor operation) are transmitted to the microcontroller. The microcontroller processes these commands and executes control decisions based on programmed logic. It also monitors system status parameters and communicates relevant information to the display unit.

3) Actuation and Display Layer

The LCD display is connected to the microcontroller to provide real-time visual feedback, including charging status, Bluetooth connectivity, and motor operation status. For controlling high-power loads, the microcontroller outputs are connected to a driver circuit, which amplifies low-level control signals. The driver circuit energizes multiple relay units, which act as electrical switches. These relays control the operation of motors, representing the electric vehicle's drive or auxiliary mechanisms

C. Working Principle

The Solar Wireless Electric Vehicle Charging System operates by integrating solar energy conversion with wireless power transfer based on electromagnetic induction. This approach enables charging of electric vehicle (EV) batteries without physical connectors, enhancing both user convenience and operational safety.

At the charging station, solar panels first capture sunlight and convert it into direct current (DC) electricity through the photovoltaic effect. This DC output is then passed through a charge controller, which regulates the voltage and protects the system against overcharging and fluctuations. The controlled power can either be stored in a battery bank or directly supplied to the wireless charging module.

For wireless energy transfer, the DC power is converted into high-frequency alternating current (AC) using an inverter or oscillator. This high-frequency AC is applied to a transmitter coil located on the charging platform, producing an alternating magnetic field around it.

A receiver coil installed in the electric vehicle is placed in proximity to the transmitter coil. Through mutual induction, this varying magnetic field induces an AC voltage in the receiver coil without any direct electrical contact. The induced AC is then rectified into DC and further regulated to meet the battery charging requirements.

Finally, the conditioned DC power is delivered to the EV battery, enabling efficient, safe, and contactless charging. By utilizing renewable solar energy, the system offers an environmentally friendly and reliable solution for electric vehicle charging.

D. Working model

This project utilizes components such as a solar panel, battery, charge controller, driver and regulator circuits, copper coils, an HC-05 Bluetooth module, an ATmega microcontroller, and an LCD display to develop a solar-powered wireless charging system.

Initially, the solar panel generates electrical energy, which is used to charge the battery through a charge controller. A diode is placed between the solar panel and the battery to prevent reverse current flow. The battery stores the generated DC power, and a voltage regulator is employed to maintain a stable output despite variations in input voltage.

The system incorporates copper coils for wireless power transfer. A transmitter coil is embedded in the road infrastructure, while a receiver coil is mounted beneath the electric vehicle. When the vehicle moves over the transmitter coil, energy is transferred wirelessly to the receiver coil through electromagnetic induction.

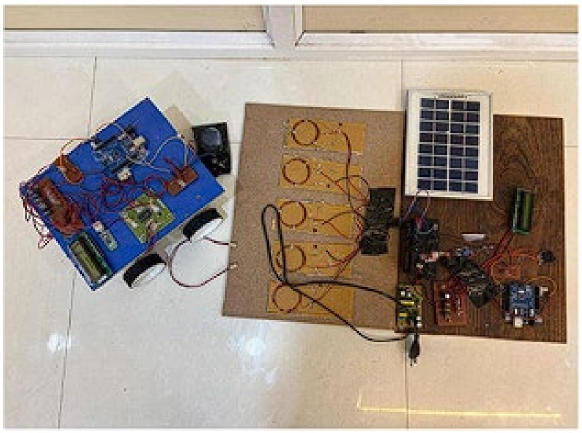

Fig. 2. Working Model

Additionally, the ATmega microcontroller is used to monitor the input voltage, and the measured values are displayed on an LCD screen for real-time observation. The system also integrates an HC-05 Bluetooth module, which enables control of the vehicle's movement through an Android application in multiple directions.

Overall, the proposed system demonstrates the feasibility of integrating solar-powered wireless charging infrastructure into roadways, allowing electric vehicles to be charged dynamically while in motion, thereby eliminating the need for stationary charging.

E. Advantages:

Electric vehicles (EVs) offer several advantages over conventional vehicles (CVs), particularly in terms of environmental impact, efficiency, and sustainability. One of the most significant benefits is their environmentally friendly nature. Increased adoption of EVs can substantially reduce air pollution and overall energy consumption, contributing to a cleaner ecosystem.

Another key advantage is the reduced dependence on fossil fuels. Since EVs operate fully or partially on electricity, they significantly lower reliance on conventional fuels. Additionally, electricity is generally more economical than gasoline, which helps in reducing operating costs. The concept of fuel economy in EVs also differs from that of traditional vehicles due to their reliance on electrical energy.

EVs are also highly energy efficient. Approximately 86% of the electrical energy stored in the battery is utilized to drive the motor, whereas conventional vehicles typically convert only around 20% of the fuel energy into useful mechanical output.

In terms of sustainability, EV batteries are largely recyclable, with nearly all battery components capable of being reused or processed, thereby minimizing disposal concerns and environmental hazards.

Finally, EVs provide a quieter and smoother driving experience. Electric motors generate minimal noise, offer better acceleration, and require less maintenance compared to internal combustion engines, enhancing overall user comfort and reducing upkeep costs.

F. Disadvantages:

Electric vehicles (EVs) also have certain limitations. One of the primary drawbacks is the time required for charging. Compared to conventional vehicles, which can be refueled quickly, EV batteries take significantly longer to recharge. Although overnight charging is possible, it may still be less convenient for users requiring immediate use.

Another concern is the source of electricity used for charging. In many regions, a large portion of electrical energy is still generated from fossil fuels such as coal. As a result, the indirect consumption of fossil fuels remains an issue, which can reduce the overall environmental benefits of EVs.

IV. CONCLUSION:

This project deals with the basic overview of present and future scenario of electric vehicles. Now a days EVs are essential in the present when the environment has worsened so significantly. The government of plans to completely phase out diesel cars by the year 2030. Because waiting for an electric vehicle to charge is the biggest drawback to EV adoption, rapid charging technology and charging stations are essential to widespread acceptance of EVs. Hence we implemented an portable EV charging system. The broad adoption of EVs has the potential to significantly disrupt the reliability of the power grid.

A renewable energy system is at the heart of the “Solar-based wireless EV charging” initiative. A lead-acid battery stores the electricity generated from the sun. An electric vehicles range can be significantly increased by using a wireless charging technology while the vehicles are in motion. When using an electric vehicle, there will be no need to locate a charging station, and drivers would not have to worry about running out of juice.

To prevent flux leakage and short circuit caused by cables, several different solutions have been developed for wireless transmission systems. The generation of electricity from renewable source and implementation of EVs charging is a current focus of this project.

REFERENCES:

[1] C.C.Chan, “The state of the art of electric, hybrid, and fuel cell vehicles,” Procof IEEE, vol. 95, no. 4, pp. 704-718, 2007 J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.

[2] IEEE for Interconnecting Distributed Resources with Electric Power Systems, IEEE1547, 2003. K. Elissa, “Title of paper if known,” unpublished.

[3] Power Quality Requirements for Plug-in Vehicle Chargers - Part 1: Requirements, SAE International, Standard J2894, 2011.

[4]] N.S.Pearre, W.Kempton, R.Guensler, and V.V.Elango “Electric vehicles: How much range is required for a day’s driving?,” Transportation Research Part C, vol.19, no.6, pp.1171-1184, Dec 2011.

[5] T.Franke, I.Neumann, F.Bühler, P.Cocron, and J.F.Krems “Experiencing range in an electric vehicle - understanding psychological barriers,” Applied Psychology: An International Review, pp.1-6, August 2011.