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Solar wireless electric vehicle charging system

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Abstract: The automotive industry has undergone a transformation with the growing popularity of electrical vehicles, which provide an eco-friendlier and cleaner substitute for conventional fuel-powered cars. However, the scarcity of EV charging stations is impeding the widespread use of electric vehicles. This research offers a novel wireless EV charging technology that runs on solar energy as a solution to this problem, providing EV owners worldwide with affordable and environmentally friendly options. The wireless power transmission technology at the centre of the suggested system allows EVs to charge without the need for physical hookups. This technology improves user accessibility and safety while doing away with the need for cords. By using solar energy, one can lessen their reliance on traditional power sources increasing the cost- and environmentally-effectiveness of the charging. Comparing this strategy to the conventional plug-in EV charging techniques reveals a number of benefits. The system's ability to charge electric vehicles (EVs) while they are in motion further improves user convenience and reduces discharge time. Solar power offers a sustainable and renewable energy source, minimizing reliance on the power grid and environmental impact. Wireless charging also eliminates the need for physical connections, improving safety and convenience. The purpose of this study is to solve the shortcomings of the conventional electric vehicle systems and offer an innovative solution that will further the development of sustainable transportation. The combination of solar energy and wireless charging for electric vehicles not only promotes the use of sustainable energy. It also encourages the growth of an energy ecosystem that is more flexible and interconnected, paving the path for more environmentally friendly and effective city transport in the future.

1 Introduction

The development of the solar wireless electric vehicle charging system was informed by many periodicals, utilizing comparable techniques but incorporating unique features for each model. [1] Capacitive wireless power transmission applies AC electricity to an H-bridge converter with power factor correction circuitry in order to transfer power using coupling capacitors rather than coils or magnets. The H-bridge generates high frequency AC, which is routed through coupling capacitors on the receiving end. In contrast to conventional inductive power transfer, CWPT may transfer power at low current and high voltage.[2] Unlike CWPT and IPT, magnetic gear wireless power transfer (MGWPT) uses two synchronized permanent magnets (PM) placed next to each other. In order to create mechanical torque on the primary, the transmitter winding receives the main power, which serves as the current source. Through mechanical interaction, the primary PM rotates due to the mechanical torque, which also exerts torque on the secondary PM. In generator mode, the primary PM functions. Through a power converter and battery management system (BMS), the secondary PM receives power and transfers it to the battery.[3] Resonant inductive power transfer is a technique that is regarded as more sophisticated than conventional IPT. To both primary and secondary windings, compensation networks are added in series and/or parallel arrangements. These networks minimize further losses and build the resonant case. When the resonance frequencies of the primary and secondary coils are matched, efficient power transfer occurs [4] By using the linear scalarization method, the optimization problem of the PV array for the charging systems is reduced to a single objective problem, which can then be optimized using a genetic algorithm. The optimization framework can be used to a case study to see if it lowers the annualized cost.[5] The earlier research mostly concentrated on EVs that could run on particular routes. For the purpose of assigning and sizing the dynamic wireless charging infrastructures, a long-term mathematical model is proposed. Mixed integer non-linear programming is used to tackle the optimization issue (MINLP). This model takes traffic patterns and power distribution networks into account when determining the best location and size for wireless EV charging facilities. [6] With the ability to charge some flagship smartphones wirelessly, people's interest in wireless power transmission has grown recently. However, there are drawbacks to WPT due to radiofrequency radiation. [7] The simulation model and model prototype used in this work are based on the previously covered elements from several published papers. The waveforms acquired at various system stages allow for a thorough analysis of the solar wireless electric vehicle

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charging system. The PV array harvests solar energy, which is supplied into the inverter circuitry—which consists of mosfets and a filter capacitor—where a separate driving circuit produces the pulses. Two-step down transformers reduce the supply voltage from 230 volts at 50 Hz to 12 volts, which powers the driving circuit and the integrated circuit. The inverter, which transforms DC into AC, provides energy to the transmitting coil. The primary coil induces the receiving coil, which displays the indication using an LED light and LCD display.

1.1 Block Diagram

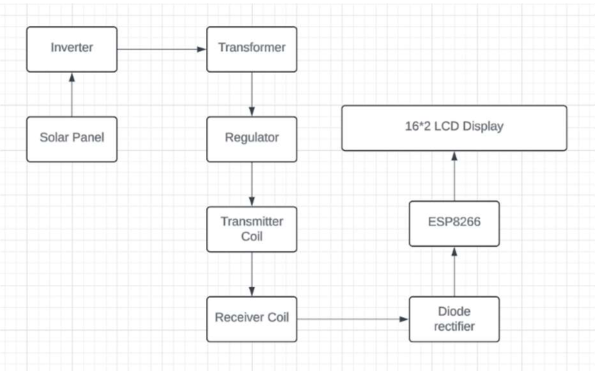

Fig 1: Block diagram

The PV array's harvested solar energy is routed into the inverter, which converts DC to AC and adds a capacitor for filtering. A regulator connects a transmitting coil to the inverter circuitry. The driver circuit generates the pulses required for the inverted function. An LCD display and an LED light can show the voltage induced in the induced coil. The LCD display is worked out using the help of a micro controller called ESP8266.

1.2 Solar Panel

Fig 2: Solar Panel 10w, 18v

The solar panel under discussion uses polysilicon cells and has an output power tolerance of ±3%. Its maximum power output is 10 Watts peak (Wp). It is an effective renewable energy source because of its conversion efficiency, which is more than 20%. The ideal voltage and current for the panel are 17.6 volts and 0.57 amps, respectively. This solar panel exhibits strong performance qualities, with an open circuit voltage of 21.6 volts and a short circuit current of 0.61 amps. The 4x9 arrangement of its 36 cells allows for a standardized system voltage of up to 1000 volts. The panel can function in a wide temperature range, from -40°C to +85°C, making it appropriate for a range of environmental circumstances. Its ability to tolerate pressure up to 30 m/s, or 200 kg/sq.m., guarantees stability and longevity even in windy circumstances. The 90-cm-long cable that comes with the solar panel has an exterior diameter of 3.5 mm and an interior diameter of 1.35 mm DC socket, making installation and connectivity simple. This makes it possible to integrate solar power systems into them seamlessly. Anodic oxidation aluminium alloy, used to build the solar panel's structure, offers strength and resistance to corrosion while limiting the panel's overall weight. The panel's overall measurements are 340 × 232 × 17 mm, which makes it small and appropriate for a range of uses, such as installations in homes, businesses, and industries.

1.3 Inverter Circuit

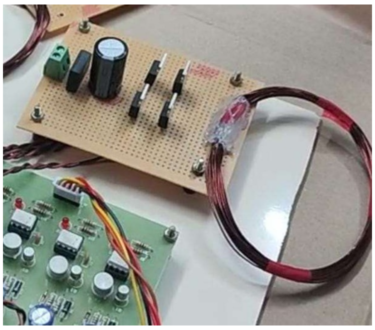

Fig 3: Inverter circuit

Most household appliances and gadgets run on AC (alternating current), which is produced by inverters, which transform DC (direct current) power from sources like solar panels or batteries. MOSFETs function as switches, regulating the circuit's current flow. Using MOSFETs in an oscillator circuit, the input DC voltage is first transformed into a high-frequency AC signal during operation. Capacitors help to reduce variations in the output voltage by storing electrical energy and releasing it when needed. This produces a power supply that is steadier and more reliable, which is important for delicate electronic equipment. Power from the solar panels or batteries is fed into the rectifier circuit, which transforms it from AC to DC before feeding it into the inverter's circuitry for processing further. This conversion makes sure that the inverter's internal parts are compatible with one another and makes it easier to generate the correct AC output voltage. This conversion makes sure that the inverter's internal parts are compatible with one another and makes it easier to generate the correct AC output voltage.

1.4 IN4007

Fig 4: Diode (IN4007)

Rectifiers in electronic circuits frequently use the 1N4007 diode, which is well-known for efficiently converting alternating current (AC) to direct current

(DC). It is appropriate for applications needing moderate power levels because it has a maximum repeated peak reverse voltage (VRRM) rating of 1000 volts and a forward current handling capability of up to 1 ampere. It is packaged in a DO-41 package and has axial leads and a cylindrical glass encapsulation. It can be mounted on printed circuit boards (PCBs) with ease, which makes it suitable for use in a wide range of electronic systems and devices. It is a top option for power supplies, voltage regulators, and other applications needing effective rectification of electrical currents because of its quick recovery time and dependable operation.

1.5 COILS

Fig 5: Copper Coils

When an electrical current is applied to the transmitter coil, sometimes referred to as the primary coil, it produces an alternating magnetic field. The field radiates from the coil and facilitates the wireless transfer of energy to the receiving coil. On the other hand, the secondary coil, also known as the receiver coil, absorbs this magnetic field and uses electromagnetic induction to create an alternating current inside of it. The electric vehicle's battery pack is then charged by rectifying and regulating this generated current to create a steady DC voltage. By eliminating physical connectors or cords, the system provides improved safety, convenience, and ease of use for both the electric car and the charging station. This is accomplished using a wireless power transfer mechanism.

1.6 16*2 LCD Display

Fig 6: LCD display

Presentation of alphanumeric characters, symbols, and even unique artwork can be done with flexibility on 16x2 LCD panels. Because of this versatility, developers are able to improve the usability of electronic devices and systems by creating user-friendly interfaces like menus, status indicators, and informational displays. In addition, 16x2 LCD screens frequently have movable contrast levels that let users tailor the legibility of the content to suit their tastes and surroundings. The whole user experience is improved by this adaptability, which guarantees clear and sharp text rendering over a broad variety of viewing angles and lighting circumstances. Furthermore, by utilizing common communication protocols like SPI or I2C, these displays can be interfaced with microcontrollers, such as Arduino boards or Raspberry Pi. This interoperability makes it easier to integrate into projects, makes it easier to update dynamic information, and allows for data logging and real-time monitoring.

1.7 Transformer

Fig 7: Transformer

12 volts AC is obtained using step-down transformer from 230 volts AC. The purpose of this kind of transformer is to lower voltage from a greater amount. This is achieved in this instance by having the secondary winding have fewer turns than the primary winding. The ratio of the main winding's turns to the secondary winding's turns yields the transformation ratio. The main purpose of a step-down transformer is to supply a safe, steady voltage level that may be used to power electronics, appliances, and lighting systems—all of which need lower voltage. It makes sure these devices are compatible with the voltage requirements by reducing the voltage from 230 volts to 12 volts. Apart from its function of voltage conversion, the step-down transformer also aids in isolating the load from the primary power supply, offering a degree of defence against variations in voltage and electrical disturbances. By isolating connected equipment, this helps guard against harm from power surges and other electrical disruptions.

1.8. ESP8266

Fig 8: Node MCU (ESP8266)

The world-famous ESP8266 is a little device with a tremendous punch. At its core is a 32-bit Tensilica L106 CPU, which may run at 80 MHz or 160 MHz to provide seamless functionality. It may be combined with up to 16MB of external flash memory, providing sufficient storage for your Internet of Things applications, and has

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32KB of internal RAM for quick data handling. But the ESP8266's wireless capabilities are what really make it stand out. Integrated Wi-Fi b/g/n features make it easy to connect to your Wi-Fi network, and on-board antenna parts do away with the need for large, cumbersome external attachments. With 17 GPIO pins available for attaching sensors and actuators, this little chip provides a wide range of interface possibilities.

1.9 Voltage Sensor

Fig 9: voltage sensor

The voltage sensor module that is being explained here functions according to the basic ideas of a resistive voltage divider. Because of its design, the input terminal voltage can be reduced five times, making it compatible with the maximum voltage allowed on the ADC (Analog-to-Digital Converter) side, which is set at 5 volts. The maximum input voltage that can be used in this setup is 25 volts. It is noteworthy, nonetheless, that safety measures must be included to guarantee that the input voltage does not exceed 165 volts when a voltage as high as 33 volts is applied. This emphasizes how crucial it is to maintain the intended input voltage range of 0 to 25 volts for both safety and best performance. The module's interface is extremely clear: a positive connection denoted by a "+" sign means that the voltage output is scaled to be 5 volts for every 33 volts at the input. On the other hand, the "s" terminal designates the AD pin and allows for easy integration with the ADC for accurate voltage measurement and monitoring. The "-" terminal denotes the ground connection.

1.10 PIC16F877A

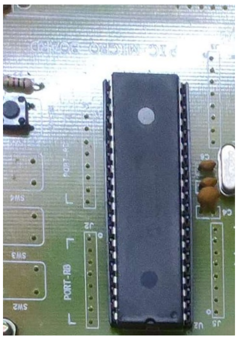

Fig 10: Micro Controller (PIC16F877A)

In the world of microcontrollers, the PIC16F877A is a mainstay. Its combination of strong performance and simplicity of programming has led to many applications using it. It achieves an outstanding balance between power and simplicity with its lightning-fast instruction execution time of only 200 nanoseconds and its condensed instruction set of just 35 single-word instructions. This 8-bit microcontroller, which comes in a 40- or 44-pin package, is built on CMOS FLASH technology, and has Microchip's well-known PIC® architecture. The PIC16C5X, PIC12CXXX, and PIC16C7X devices are among its predecessors, thus developers used to those versions can easily make the switch. The PIC16F877A boasts several notable features, including as its 256 bytes of EEPROM data memory, which allows for flexible data storage and retrieval. in addition to self-programming features that improve adaptability and user-friendliness. It also has an In-Circuit Debugger (ICD) for quicker debugging procedures that improve the effectiveness of development cycles. The PIC16F877A excels in applications requiring analog-to-digital conversion thanks to its 8 channels of 10-bit analog-to-digital (A/D) conversion, offering the accuracy and precision required for challenging jobs. Its two comparators further increase its usefulness in applications that need voltage comparison. Two capture /compare/PWM (Pulse Width Modulation) operations increase the functions' adaptability and enable accurate timing and modulation in a range of applications. In addition, the synchronous serial port can be freely set up as a 2-wire Inter-Integrated Circuit (I-CTM) bus or a 3-wire Serial Peripheral Interface (SPITM) bus to accommodate various communication requirements.

2 Results

The MPPT controller sends periodical pulses to control the power of the solar panel. However, just as the electricity we receive is unstable due to changes in the sun, the current is also unstable. At first, the voltage is low but fast. Once the power stabilizes, we get a stable power curve. The voltage stabilizes and reaches approximately 110 volts. However, sometimes the voltage drops, which affects the current going to the DC load, making it decrease a bit. This stabilization process involves rectifying the power, which essentially means converting it into a more stable form. After rectification, the power curve becomes more consistent, showing a more reliable flow of energy. The same goes for the voltage curve, which becomes steadier after rectification. This process ensures that the power and voltage supplied to the load are more reliable, minimizing the impact of fluctuations in sunlight and a more consistent supply of energy from the solar panel system.

Duty cycle from MPPT controller circuit

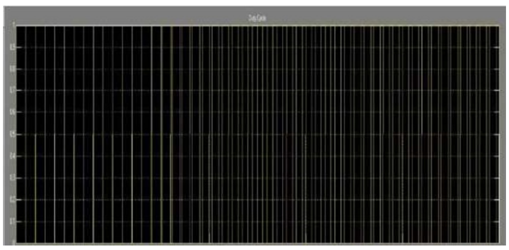

Fig 11: Duty cycle (Y-axis) vs Time (X-axis)

Unstabilized DC power obtained from PV array:

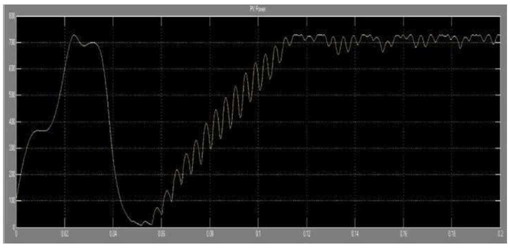

Fig 12: PV power (Y-axis) vs Time (X-axis)

Unstabilized Current obtained from PV array.

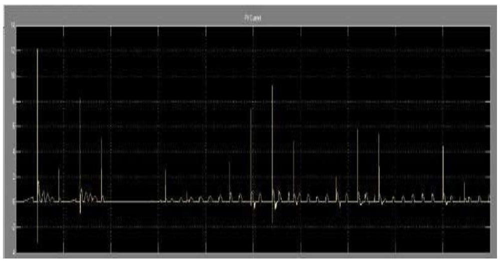

Fig 13: PV current (Y-axis) vs Time (X-axis)

Unstabilized DC voltage reaching the values about 300V.

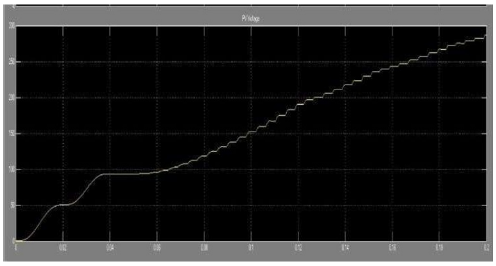

Fig 14: PV voltage (X-axis) vs Time (Y-axis)

DC link voltage

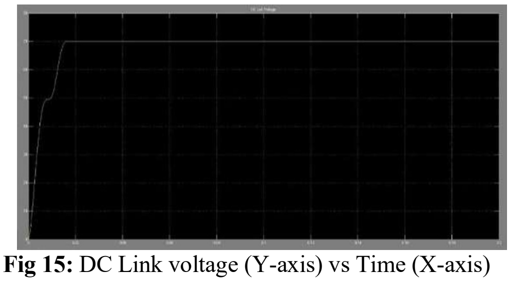

Fig 15: DC Link voltage (Y-axis) vs Time (X-axis)

High frequency AC voltage converted for the transmittingcoil to induce increased from 70V to 110V.

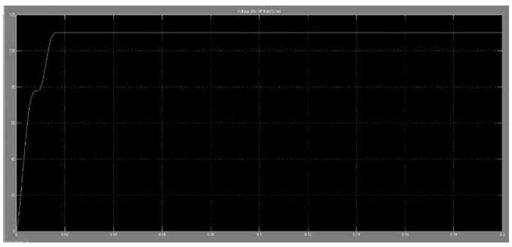

Fig 16: HF transformer voltage (Y-axis) vs Time (X-axis)

DC load voltage after rectification in the secondary

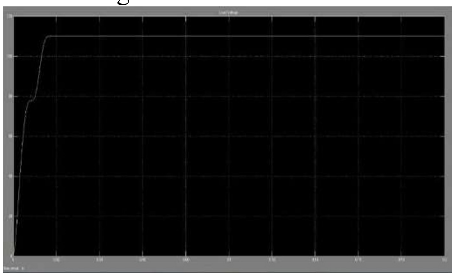

Fig 18: Load voltage (Y-axis) vs Time (X-axis)

DC load current after rectification in the secondary

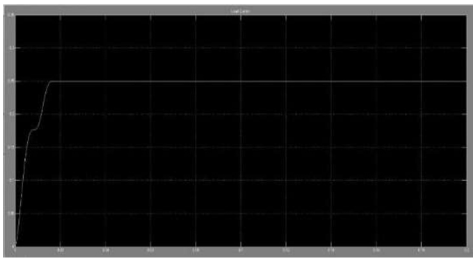

Fig 17: Load current (Y-axis) vs Time (X-axis)

3 Conclusion

Expanding on this groundbreaking initiative, the wireless EV charging system fueled by solar energy not only addresses the current challenges in electric vehicle adoption but also presents a vision for the future of sustainable transportation. The elimination of physical connectors not only streamlines the charging process but also reduces wear and tear on charging infrastructure, contributing to long-term cost savings and system durability. The integration of renewable solar power not only underscores the commitment to clean energy but also positions the system as a resilient and self-sufficient solution, especially in regions with abundant sunlight. Moreover, the environmental impact of this wireless charging system extends beyond reduced emissions. By harnessing solar energy, the project actively participates in mitigating the environmental footprint associated with conventional electricity generation. The reduction in dependency on traditional power grids aligns seamlessly with global efforts to transition towards renewable energy sources, fostering a more sustainable and resilient energy ecosystem. The emphasis on charging EVs while in motion introduces a paradigm shift in user behaviour and convenience. This feature not only addresses range anxiety concerns but also establishes the wireless charging system as a dynamic and adaptive solution for urban mobility. As electric vehicles become an increasingly integral part of the transportation landscape, the ability to charge seamlessly during transit opens new possibilities for urban planning and traffic management, ultimately contributing to a more efficient and responsive city infrastructure. Furthermore, the commitment to user safety and accessibility is a cornerstone of this project. The absence of physical connectors minimizes the risk of accidents and enhances the overall safety of the charging process.

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