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Integration of Renewable Energy Solutions in Wireless Power Banks for Eco-Friendly Mobile Charging

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ABSTRACT

Solar power banks with wireless charging have become popular for charging mobile devices due to their convenience and environmental friendliness. However, these devices require sunlight, charge slowly, have limited capacity, and charge inconsistently inside or in shady areas. This literature analysis of 2017–2022 research demonstrates that while users like these gadgets, further research is needed to improve their performance and usability. Sunlight intensity, temperature, and device compatibility affect charging speed and efficiency. Understanding these pros and cons might help customers decide if a solar power bank with wireless charging suits their needs. Battery-powered device development and application face unprecedented technical problems due to low power density, high cost, and heavy weight. Wireless power transfer (WPT) is a revolutionary approach to energise electric devices, reducing battery dependence. This study describes WPT with primary and secondary inductive coils. Current research subjects and potential development trends in WPT systems are discussed in this study. This unique energy transmission method speaks to the widespread use of renewable energies. Primary and secondary coils have min 2A current transmission. AC voltage downgraded, passed through primary, transformed to dc, and charged EV. We used Arduino Controller to read battery and power transfer voltages in parallel.

Keywords: Power bank, Portable, Applications, Renewable Energy, Mobile Applications.

1. INTRODUCTION

In recent years, the demand for portable charging solutions has surged, driven by the need for uninterrupted connectivity and sustainable energy sources. One such innovative device, the solar power bank with wireless charging, has emerged as a practical and eco-friendly solution. By integrating solar panels and wireless charging technology, this portable device allows users to harness solar energy and charge their devices wirelessly, providing convenience and environmental benefits. Harnessing Solar Energy: At the core of a solar power bank is its ability to capture sunlight and convert it into electrical energy. The device features solar panels strategically placed on its surface, designed to absorb sunlight and generate power. These panels employ photovoltaic technology, utilizing semiconductor materials to convert solar energy into usable electricity. Through this process, the solar power bank accumulates energy and stores it in an internal rechargeable battery (Devi, K. G., Thakur, S. S., & Singh, S. K. ,2021). Wireless Charging Technology: The solar power bank with wireless charging goes beyond traditional wired connections, introducing the convenience of wireless charging. It features a charging pad on its surface that uses electromagnetic induction to transfer wireless power transfer (WPT) incredibly realizes the energy migration in a cordless way [1]-[2]. This seemingly magic way can change our traditional utilization patterns of the energy in various applications, such as portable electronic devices, implanted medical devices, integrated circuits, solar-powered satellites, electric vehicles (EVs), unmanned aerial vehicles (UAVs) and so forth. By means of its remarkable characteristics of flexibility, position-free and movability, the WPT technique has been taken as an ideal technical solution for energizing electric-driven devices within some specific regions in the near future, especially for smart home applications. The reason why WPT technologies is so crucial is regarding to two fundamental problems of battery-powered devices that limit their popularization - short battery life and high initial cost. Taking EVs as an example [3], although many automobile manufacturers claim that their products can run over 120 km per charge, when taking into account the range anxiety, most EV drivers only dare to run about 100 km. On the other hand, by significantly increasing the number of batteries installed in EVs, the driving range can be extended to over 400 km but the corresponding initial cost becomes unaffordable for the general public. Instead of waiting for the breakthrough of energy storage technology, a new energization way, namely the WPT technique, is attracting increasing attentions to bypass the current technical bottlenecks of batteries. By utilizing the WPT technique, battery-powered devices can harness wireless power from electromagnetic field in air and then charge their batteries cordlessly even in the moving state. This novel charging technology can fundamentally solve their problems of short battery life due to limited battery storage or high initial cost due to installation of a large number of batteries. The rest of this paper is organized as follows. actional charging, and security. The WPT technique has an ability of delivering the energy from the power supply to the target via the air instead of traditional wires. This novel energy accessing technique commonly consists of the far-field and the near-field transmissions. The far-field WPT can be realized by adopting the acoustic, the optical and the microwave as the energy carrier. The near-field technique utilizes the inductive coupling effect of non-radiative electromagnetic fields, including the inductive and capacitive mechanisms, which is exactly the emphasis of this paper. This thesis deals with wireless power transfer from an external source to embedded small devices (such as for conditioning monitoring, control etc.) located at different distances from the source. The proposed designs can be used in a variety of applications, including mobile phones, electric cars, unmanned aerial vehicles, robots, etc. where it could be very convenient to transmit power without wires/cables. The wireless charging method which avoids using conventional cables and wires for energizing or charging electrical devices has been one of the fastest developed recent technologies. The inductive coupling technique is one way to transfer power wirelessly and works fairly well over very short distances. For distances greater than the radius of the emitter, however, inductive coupling rapidly declines. An improved approach is to create inductive-capacitive resonance which improves efficiency and transfer distance, which was proposed by Tesla. Other methods using more than two coils have lately been proposed, which improve transfer characteristics even further. Several designs were proposed consisting of two, three and four coil combinations, with different shapes and sizes. A ferrite cored solenoid was also chosen as emitter in some setups over air cored solenoid, for better field enhancement in longitudinal energy transfer applications. To have low resistive high energy transfer, coil-capacitor designs were proposed. Several simulations were performed using COMSOL Multiphysics software to understand the magnetic field distribution and transfer to the adjacent coils in air medium. Based on this power transfer efficiency graphs were plotted for every proposed design. For validation, few simulations were contrasted with lab experiments. The focus was to develop and contribute to the improvement of existing techniques. For this, it is sometimes enough to transfer a small amount of power (e.g., 0.5W) at different distances and frequencies with different set ups. The results obtained from the simulation and measurements were used to evaluate the impact of frequency and transfer distance on energy transfer in wireless power transfer technique for proposed design. The analysis was used to suggest the improvements or part of future work in the designs such as use of Litz wire and ferrite concentrators with thin conductive laminates.

2. LITERATURE SURVEY

The wireless power transfer (WPT) technology eliminates direct contact by delivering electric power from the transmitter to the receiver via energy-containing fields [2]. A time-varying electromagnetic field is used to deliver electricity wirelessly. Its basic process has been known since Michael Faraday discovered electromagnetic induction in 1831. The motion of a magnet near a coil of wire caused a voltage between the two ends of the wire, which subsequently drove a current through a galvanometer in his original experiment, without any electrical contact between the magnet and the coil. A changing magnetic field creates an electric field, according to Maxwell's equations (and vice versa), which determines the power delivered to the circuit [3]. Modern wireless power transfer systems do not employ a swinging magnet to transfer the power. The magnetic field can be produced to fluctuate far quicker than a swinging magnet when power transfer is provided by a function generator plus an amplifier. Another coil can be driven with a time-varying current to directly produce such a field [3].

The magnetic field around the source coil stores energy as current runs through it behaving as an inductor. This field is restricted close to the source coil and diminishes rapidly as distance increases. A receiving coil "coupled" to the source coil can wirelessly extract electricity by intercepting portion of the field. Power transmission can still be very efficient despite the quick fall in field strength since energy not transmitted to the receiving coil returns to the source coil. This energy is not wasted. It can be stored in the circuit's electric field, for example, by employing a capacitor [3]. The stored energy may build up to high levels when energy is transferred between the magnetic and electric fields, a phenomenon known as resonance [5, 6, 7]. A resonance may be built up in the receiving coil in the same way to improve its interaction with the oscillating field. Nikola Tesla invented and popularized such a system in the early 1900 s. Tesla designed and proved non-radiative power transfer methods, but he was opposed to the concept of propagating fields being beneficial for power transfer [6]. Instead, his most famous work on power transmission was predicated on the incorrect assumption that the earth and atmosphere could be utilized as a conductive channel for successfully transferring power. His set of experiments involved spectacular "Tesla coils" intended to generate sufficiently high voltages to establish such a path [5, 8]. There are various wireless power transfer systems based on the categories of energy transfer fields, such as acoustic power transfer (APT), optical power transfer (OPT), microwave power transfer (MPT), inductive power transfer (IPT), and capacitive power transfer (CPT), Far-field WPT (radiative) : It refers to the large amount of energy transfer between two positions, where the distance is much greater than the diameter of the device(s). Although the transmission distance might be long, the energy should be directed toward the receiver [9]. It includes microwave, RF, photoelectric, laser, and acoustic techniques [10]. 2. Near-field WPT (non-radiative) : It refers to the distance of transfer energy within the wavelength (λ) of the transmitter antenna. It includes magnetic resonant-, inductive-, capacitive- and magneto dynamic coupling [10]. The transfer efficiency is determined as a ratio of received power to input power at transmitter coils [9], and its effectiveness is mainly determined on the technique used [10]. The transmission efficiency for various wireless power transfer techniques the electromagnetic induction (Inductive coupling) [10] can realize high power transfer efficiency of 70-90 % due to close proximity of transmitting and receiving coils. However, to achieve such high efficiency, precise alignment of the two coils is required. The magnetic resonance coupling can be created between the two coils through connection of C and/or L and because of strong coupling power transfer range becomes greater. The typical efficiency of this method is 40-60 %. Typical frequencies used for this method are from 1 MHz to several tens of megahertz. But to notice with increase in distance the coupling coefficient decreases between the emitter and receiver and so, the efficiency decreases [11]. Microwave and laser [10] effectiveness is around 30 % lower than the previous two techniques; moreover, it falls rapidly as the transfer distance increases. With a high-quality factor of the coils, the efficiency of inductive and magnetic resonant coupling techniques may be enhanced, and it is dependent on the coupling coefficient between resonators. The performance metrics for near-field WPT approaches are summarized in Figure 4. To power various devices such as WSN (Wireless Sensor Network) smart gadgets, on-body medical implant devices, WSN objects, and so on, where continuous power transfer can be done without relying on battery replacement or connection to an external power supply, using a potential technique of Near-field WPT. The magnetic resonant coupling technology has a greater transmission distance of 5 m and operates at a high frequency of tens of megahertz, however, as compared to other methods, this approach has a lower transmission efficiency (i.e., inductive and capacitive coupling) [10]. Capacitive coupling, also known as electric coupling, is a type of coupling that is dependent on the electric field coupling between two plates. Capacitive coupling works like a capacitor, with one metal plate in the transmitter and the other in the receiver, with a dielectric medium in between. Power can be transferred between the two plates in the form of a displacement current. Because the electric field interacts with a variety of materials, the capacitive coupling approach requires extremely high voltages, so it has few applications only. In comparison to inductive coupling, capacitive coupling offers a few advantages. The magnetic field is mostly restricted between the capacitor plates, decreasing interference and increasing immunity to transmitter and receiver misalignment difficulties. Capacitive coupling can therefore be employed in charging portable devices, smartcards, and RF integrated circuits to transmit power across layers of a substrate [12].

3. PROPOSED SYSTEM

The near-field WPT technique is embracing a high-speed development period in recent years. There are increasing academic researchers and industrial engineers who focus on improving the energy transmission performance with emphasizes on the efficiency, capability, applicability, flexibility, security and so forth. In this section, this paper will overview key technical challenges for non-radiative electromagnetic WPT systems.

The transmitted power capability is one of the most important performance indexes for WPT systems. Due to working in a relatively high frequency range, the power level is limited by the switching component, the topology of power-electronic inverters, and the associated control scheme. Regarding to the switching component, an enhanced gallium nitride (eGaN) device was utilized to improve the output power capability in MHz frequency band. For the circuit topology, a LCL load resonant inverter was investigated for maximum power transfer, which is operated in the discontinuous current mode and controlled by a variable frequency scheme. The presented work successfully predicted the inverter operating point and ensured the optimal value of the series inductance. In, a multiphase parallel inverter was proposed to improve the output power capability for WPT systems. In a 6-kW parallel IPT power supply topology was proposed in a cost-effective manner, which can minimize uneven power sharing due to component tolerance without additional reactive components for parallelization. Regarding to the control scheme, an offline-tuning scheme was proposed to ensure the WPT system to output the maximum power in instead of the online frequency regulation. Accordingly, the constant operating frequency can effectively avoid the violation caused by the variation of operating frequency. The key to maximum power transfer is to ensure the impedance matching. In, a hybrid impedance-adjusting scheme was developed by combining the continuous conduction mode and the discontinuous conduction mode, which can effectively extend the adjusting range and thus ensure the full utilization of the power capacitor for WPT systems.

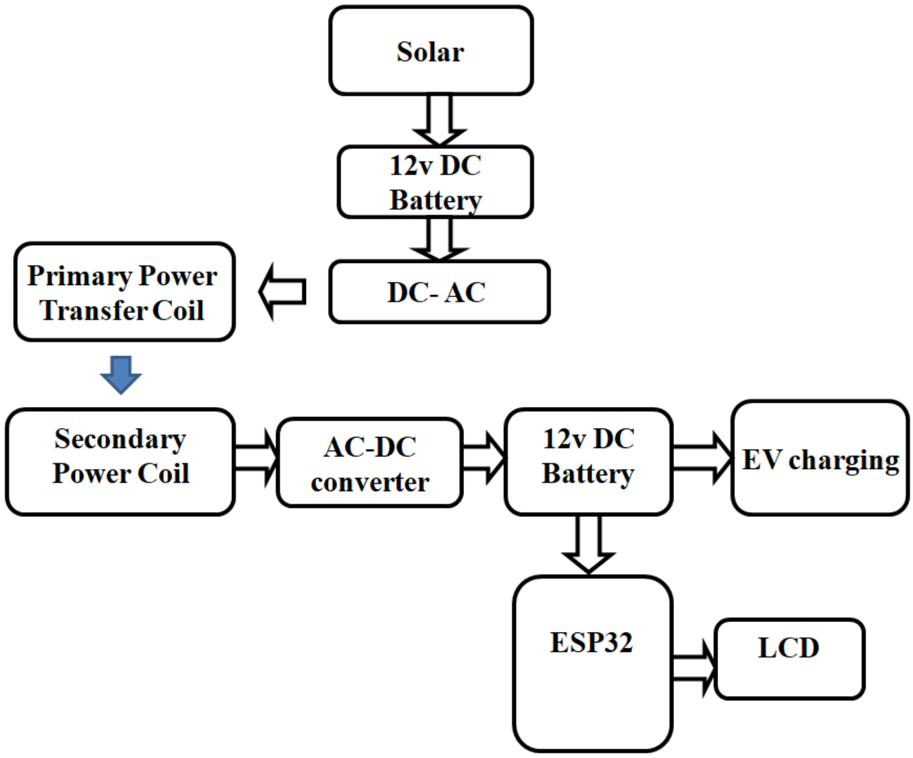

Figure.1: Block Diagram

4. Result

Renewable energy powered wireless power bank for portable mobile applications.

Figure.2: Solar Power Connection with Deceive is Showing. The LCD display

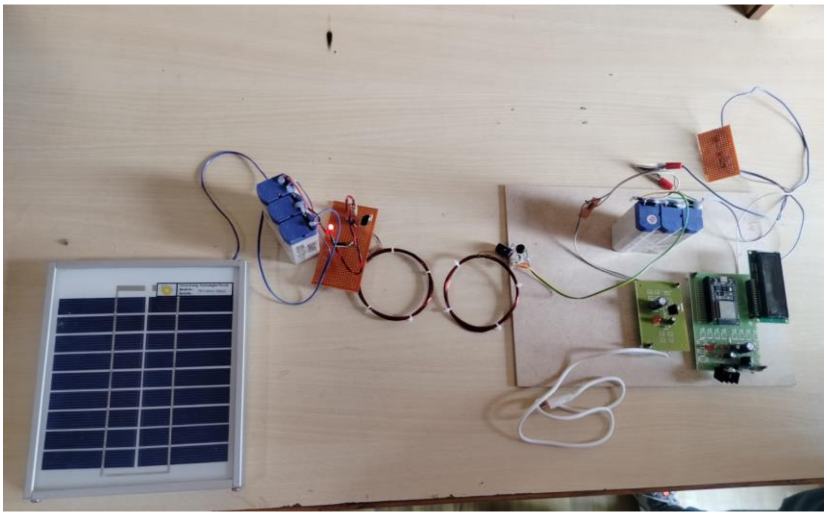

Figure.3: Solar Plane Connect with Decive.

5. CONCLUSION

The solar power bank with wireless charging combines the benefits of solar power generation and wireless charging technology, providing users with an ecofriendly and convenient charging solution. By leveraging the power of the sun, this portable device allows individuals to charge their devices wirelessly while on the move. As sustainable energy becomes increasingly important in our daily lives, the solar power bank with wireless charging stands as an innovative and practical tool, enabling us to stay connected while reducing our carbon footprint. We designed and implemented wireless power transfer system with automatically charging for electric devices like mobile charging. We used primary coil and secondary coil with min 2A current transfer. AC voltage step downed and transferred through primary and then converted to dc and charged the EV. We integrated ESP32 Microcontroller which reads the Battery voltage and Power Transfer Voltage parallel using ESP32Controller.

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