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Design and Implementation of Wireless Power Transfer in Wireless Mobile Chargers

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Abstract : This paper introduces a magnetic inductance-based wireless mobile charger system utilizing resonant inductive coupling for efficient power transfer between a transmitter and receiver. The transmitter generates a magnetic field at a specific frequency, which the receiver captures and converts into electrical power for charging mobile devices. Key components include resonant coils, power management circuits, and microcontrollers. Advanced power electronics and intelligent control algorithms optimize energy transfer, while a communication interface enables real-time monitoring and adjustment of charging parameters. Experimental evaluations confirm the system's effectiveness in power transfer efficiency, charging speed, and reliability. The scalability of the system suggests potential deployment in public spaces, catering to multiple device charging simultaneously. This technology promises practical and efficient charging experiences, addressing the need for cable-free charging solutions.

Index Terms - MOSFET, DIODE, Transmitter, Receiver, Magnetic Induction, Copper Wire.

I. INTRODUCTION:

The ever-increasing reliance on mobile devices in our daily lives has fueled the demand for charging options that go beyond being efficient and convenient. Traditional wired chargers, while effective, come with the drawback of cables and physical connections. To address these limitations, the creation and application of a Magnetic Inductance-Based Wireless Mobile Charger System have been undertaken. This paper introduces a revolutionary wireless charging system that leverages magnetic inductance technology to transmit power wirelessly between a transmitter and a receiver, providing a cable-free charging experience for mobile devices. Magnetic inductance, specifically resonant inductive coupling, forms the backbone of this system, enabling efficient energy transfer over short distances. The proposed system consists of two primary components: a compact transmitter and a receiver embedded within the portable device. The transmitter generates a resonant magnetic field and the receiver picks up this field, converting it into electrical power to enable charging without requiring any physical connections. The resonant inductive coupling ensures optimal power transfer, minimizing energy losses and maximizing charging efficiency.

Key considerations in the design and implementation include advanced power electronics, intelligent control algorithms, and safety features to create a reliable and user-friendly wireless charging experience. The system's adaptability to various mobile devices, adherence to safety standards, and compatibility with emerging technologies make it an encouraging remedy for the upcoming mobile device charging. This paper aims to investigate the technological facets of the Magnetic Inductance-Based Wireless Mobile Charger System, comprising the integration of resonant coils, power management circuits, and communication interfaces. Additionally, experimental analyses will be carried out to evaluate the power transfer efficiency of the system, charging speed, and overall reliability. As the world moves towards a more wirelessly connected and mobile-centric future, the execution of this Magnetic Inductance-Based Wireless Mobile Charger System represents a significant step forward in providing users with a seamless, efficient, and cable-free charging solution, contributing to the evolution of wireless charging technologies**.**

II. LITERATURE SURVEY:

Shivam Mishra and Anubhav Srivastava et. al explains that **[1]** The abstract presents a project on efficient wireless phone charging using mutual induction. The focus is on addressing the complications and issues related to recharging mobile phone batteries.

The project employs wireless charging based on inductive coupling, employing a transmitter and a receiver coil. The DC energy is converted to AC energy through an oscillation circuit, transmitted via a transmitter coil, and received by a coil for receiving, ultimately charging the mobile device battery. The foundation of the system is mutual induction, having a high efficiency in charging. The abstract outlines the functioning concept, circuit information, and block diagram for both transmitter and receiver sections, and the experimental setup. Future development suggestions include using high-standard components and exploring alternative methods to increase efficiency. The paper concludes with the successful demonstration of inductive coupling for wireless energy transmission.

Omkar Singh et.al explains that **[2]** The presented research focuses about the creation of a wireless charging system for efficiently charging mobile batteries without requiring tangible cables. The system utilizes inductive coupling, where DC energy is transformed into AC energy using an oscillation circuit in the transmitter coil, creating a field of magnetism that causes the receiver coil to become current-rich. The project involves the use of Ampere's law, Biot-Savart's law, and Faraday's law the inductive coupling calculation and ensure safe and efficient power transfer. The system for wireless charging is designed with a transmitter component and a receiver part, emphasizing safety for users as well as nearby electrical equipment. The study includes a literature review exploring uses of wireless power transfer in the present and future, considering aspects such as routing, optimization, and adaptive decision-making systems, scalability, energy transmission by wireless and wireless sensor networks.

Abishek Gupta et.al explains that **[3]** The paper proposes a wireless mobile phone charging system using a microcontroller circuit with a timer to prevent overcharging. The system comprises two circuits, a transmitter, and a receiver. The transmitter involves an AC to DC rectifier, pulse width modulator circuit, and a step-down transformer. The recipient comes with a resonant magnetic coupling setup with three coils tuned on the same frequency. A microcontroller with timer coding prevents overcharging. The paper discusses the principles of coupling inductive, coupling magnetic resonant, resonant frequency, and quality factor. The experimental setup demonstrates LED illumination at various distances. The application scenarios include stationary high-altitude relay platforms, electric vehicle charging, and electronic portable devices. The advantages encompass safety, simplicity, high charging efficiency, user-friendliness, flexibility, and durability. The conclusion emphasizes the successful implementation of wireless power transmission via magnetic resonant coupling, with future scopes including wireless charger networks, green energy provisioning, and addressing technical issues pertaining to power density increase.

M Fareq et. al explains that **[4]** The paper investigates Using inductive coupling, wireless power transfer (WPT) allows mobile phone charging. The study explores the result of distance on WPT functionality as well as assesses the system's resilience to obstacles like hands, books, and plastics. Three main components are identified: the device used to transmit power, inductive coils acting as antennas, as well as the rectifier converting Alternate Current to Direct Current. The methodology involves simulation using Multisim software and experimental setups to analyze WPT efficiency. The results indicate that WPT With regard to mobile phone chargers, inductive coupling works well, with distance affecting transmission efficiency. The study also demonstrates the system's robustness against obstacles, paving the way for practical implementations in charging electronic devices wirelessly.

Puranam Revanth Kumar et. al explains that **[5]** The paper introduces a novel concept for a mobile device protection and wireless charging using inductive coupling. Inductive plates are used to wirelessly charge mobile phones, highlighting security and convenience. The system involves KEIL software, AT89S52 Microcontroller, induction coils, and a buzzer. The literature survey discusses various wireless charging techniques and applications, including microwaves, magnetic resonance coupling, as well as wireless power transfer mechanisms for mobile devices. The hardware implementation includes components like transformers, rectifiers, filters, regulators, LED-LDR setups, and a microcontroller for effective wireless charging and anti-theft measures. The system demonstrates potential uses in various fields, such as biomedical devices.

Otchere Peter Kweku et. al explains that **[6]** This system presents a wireless charging for smartphones concept based on inductive coupling, enabling users to charge their phones without using adaptor plugs. A charging pad, utilizing advanced power transfer, provides electricity to the user-placed adapter circuit wirelessly. The system incorporates a high-frequency transformer to convert mains input to 12V DC, allowing inductive coupling to facilitate wireless power flow to the mobile device. Nikola Tesla's contributions to wireless power transmission are acknowledged. The study lists issues related to wired charging, emphasizing safety concerns and inconvenience. The methodology involves circuit design using livewire simulation software, testing, and troubleshooting. The wireless mobile charger demonstrates successful wireless charging, converting 12V DC to 5V DC for mobile phones. Experimental results align with theoretical models, indicating the viability of inductive coupling for efficient wireless charging.

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III. METHODOLOGY:

Modern technology called wireless power transmission (WPT) was created to make it easier to move electrical energy from a power source to a load—like a mobile device—without requiring physical connections. The primary goal of this technology is to eliminate the dependency on traditional wired charging methods, providing a more convenient and flexible approach to powering electronic devices.

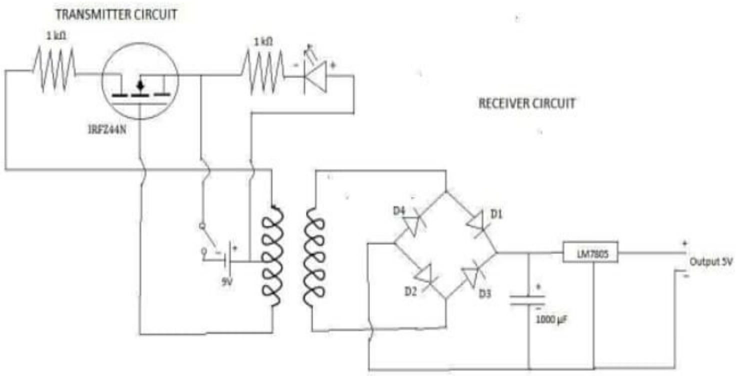

Fig-1. Circuit Diagram of WPT [7]

Wireless Power Transmission Principle: The transmitter and receiver coils of the device transfer energy wirelessly through a process known as inductive coupling or resonance. As power is applied to the transmitter coil, it generates an electromagnetic field, creating a current in the coil of the receiver, subsequently charging the mobile device.
The primary objective of the system for wireless power transmission is to provide a cable-free and user-friendly solution for charging mobile devices. By doing away with the necessity of physical links, the technology aims to enhance convenience, reduce clutter, and contribute to the development of ecosystems for wireless charging. This innovative approach reflects a shift towards a more accessible and seamless power transfer experience for users of electronic devices.

WORKING:

Current Amplifier: Begin the assembly of the system of wireless power transmission by fastening the transmitter and reception coils using 25-gauge copper wire. Wind the wire uniformly around selected cylindrical forms, ensuring a seamless coil without overlaps or gaps. Connect one end of each coil to the corresponding terminals of the IRFZ44N MOSFET, serving as an amplifier for current and controlling power flow in the circuit.
Transmitter Setup: Include necessary parts on the transmitter side, such as the IC4007 diode, 1000 µF capacitor, and 9-volt battery. Consider the polarity of these components to ensure proper functionality. Include the Voltage regulator LM7805 on the transmitter side, connecting its input and ground pins appropriately.
Integrate the 1 KΩ resistor and LED for voltage regulation and feedback. Incorporate a user-controlled switch into the circuit for efficient management of the power transmission process.

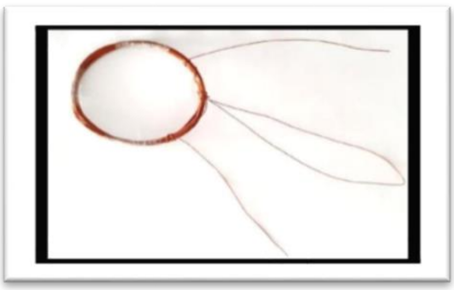

Fig-2. Transmitter coil [7]

Receiver Coil Setup: To make the reception coil, duplicate the primary coil's design. Ensure that the secondary operates at the same resonant frequency as the primary for optimal energy absorption. Connect one end connecting the receiver coil to the matching IRFZ44 MOSFET terminals on the receiving side.

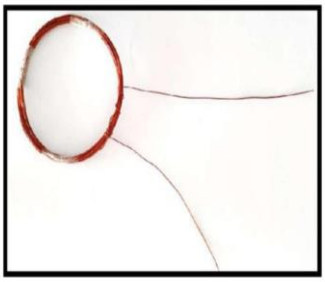

Fig-3. Receiver coil [7]

Rectification Process: Utilize a full-wave rectifier with four diodes on the receiving end to transform AC into smooth DC. D1 and D2 conduct during the positive half of the AC cycle, whereas D3 and D4 conduct during the negative half. Pure DC is produced by this bridge rectifier, which permits both sides of the AC sine wave to pass through.
LC Oscillator Circuit: Implement a circuit of LC oscillator on the receiver side to elicit LC oscillations electrically in the current and capacitor charge. This component is crucial for selecting or generating a particular frequency signal. The LC circuit, lacking resistance, sustains oscillations indefinitely.
Voltage Regulation: Employ an IC 7805 as a receiver-side positive voltage regulator, delivering a consistent 5V output. This component ensures a stable and regulated power supply for the system of wireless power transmission, contributing to its overall efficiency.

IV. IMPLEMENTATION:

Steps to implement wireless power transmission:
1.To assemble the system of wireless power transmission on a breadboard, begin by securing the 25-gauge copper wire for coils for both the transmitter and the receiver. Wind the wire uniformly around chosen cylindrical forms, ensuring no overlaps or gaps. Connect one end of each coil to the corresponding terminals of the IRFZ44N MOSFET, which controls power flow in the circuit.
2.Integrate the 9-volt battery, IC4007 diode, and 1000 µF capacitor, considering their polarity. Include the LM7805 voltage regulator, connecting its input and ground pins appropriately. Integrate the 1 KΩ resistor and LED for voltage regulation and feedback. Include a user-controlled switch in the circuit. Place the components on the breadboard with care, adhering to the circuit diagram.
3.Precautions during prototyping include double-checking connections, ensuring correct component placement, and verifying the polarity of the diode and capacitor. Regularly assess for short circuits and heat generation, making adjustments as needed. With careful assembly and thorough testing, the breadboard prototype can open doors for an optimized system of wireless power transmission.
4.To assemble the system for wireless power transmission on a breadboard, begin by securing the 25-gauge copper wire for coils used in transmitters and receivers. Wind the wire uniformly around chosen cylindrical forms, ensuring no overlaps or gaps.
5. Connect one end of each coil to the corresponding terminals of the IRFZ44N MOSFET, which controls power flow in the circuit. Integrate the 9-volt battery, IC4007 diode, and 1000 µF capacitor, considering their polarity.

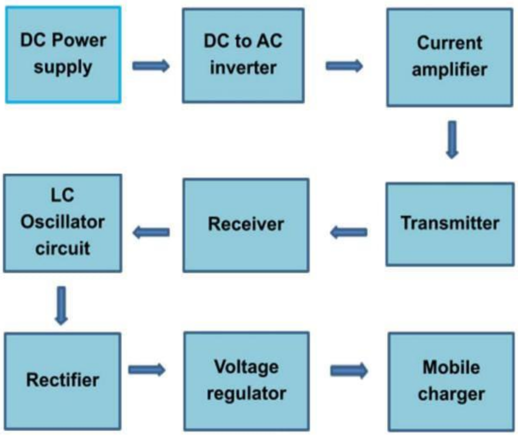

Fig.3 Block Diagram of Transmission [7]

In our system for wireless charging, two circuits play crucial roles: the circuits for the transmitter and receiver. The transmitter circuit features a IRFZ44 MOSFET, converting the DC power supply to AC. Using a transmitting coil, the wireless power is transmitted to the receiver circuit. The receiver circuit, in turn, receives the power through the receiving coil. The received AC current undergoes conversion into DC through a rectifier circuit, consisting of diodes and a capacitor.
The AC to DC conversion is further refined using a bridge rectifier. Ripples are filtered using a 1000 µF capacitor to provide a smooth DC output. The purified DC power then passes through a voltage regulator, ensuring a steady 5V output. Finally, the regulated DC is provided through a cable, facilitating mobile charging.

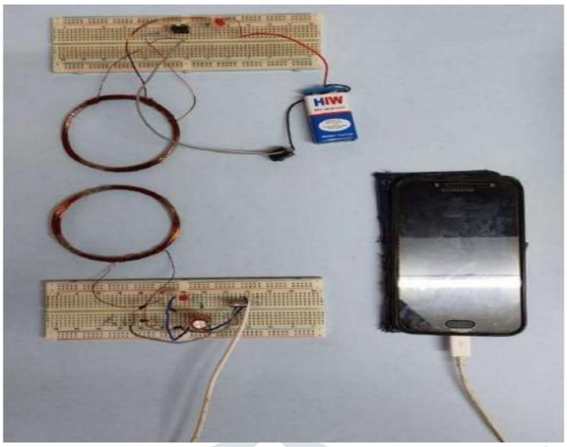

Fig.4 Circuit Connections [7]

V. RESULTS AND DISCUSSION:

The intended coils for the tr ansmitter and receiver, coupled with the IRFZ44N MOSFET shown how to transfer electricity wirelessly and effectively from the transmitter to the receiver circuit. The system's efficiency drops as the distance between the transmitter and reception coils grows, according to experiments with different coil spacing. This is consistent with theoretical forecasts. The effectiveness of the wireless charging system was positively impacted by increasing the number of turns in the coils, confirming the theoretical prediction. The integrated components, including the LM7805 voltage regulator and filtering capacitors, maintained a stable and regulated 5V DC output for charging mobile devices. The inclusion of a user-controlled switch, LED, and voltage regulation components provided manual control and visual feedback, enhancing the user experience.

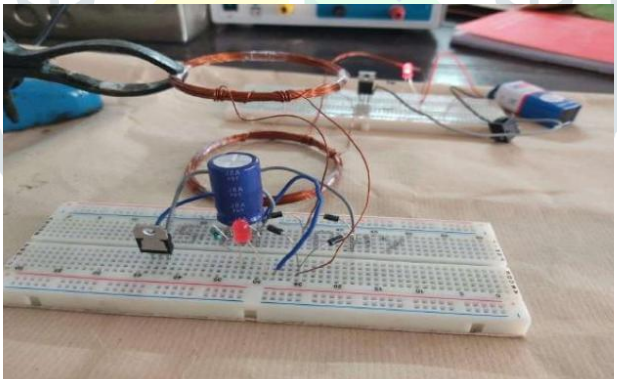

Fig.5 Final Connection of Circuit [7]

VI. FUTURESCOPE:

The future of wireless power transmission in mobile chargers holds promise for significant advancements, focusing on enhancing efficiency, convenience, and sustainability. Anticipated trends include improved charging efficiency through enhanced resonant inductive coupling, enabling faster and more effective charging. Furthermore, future chargers may support a multi-device charging ecosystem, accommodating smartphones, smartwatches, and other devices simultaneously on a single charging pad. Research efforts may also target long-range wireless charging technologies, potentially enabling charging from a distance, thereby eliminating the need for direct contact with charging pads. These developments represent innovative solutions poised to revolutionize user experiences and drive the evolution of wireless charging technology.

VII. CONCLUSION:

The transition from traditional wired chargers to wireless power transmission in mobile chargers represents a paradigm shift in device charging. This evolution has introduced unprecedented convenience, flexibility, and user-friendliness to the charging process, liberating users from the constraints of cables and enabling charging on the go. Wireless charging solutions have become integral to the dynamic landscape of mobile technology, fostering a more mobile lifestyle. Looking ahead, the future promises even greater advancements in efficiency, versatility, and sustainability in wireless charging technology, further enhancing the seamless integration of charging into our daily lives.

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