International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Wireless Energy Bridge [Web]

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ABSTRACT

Wireless Energy Bridge (WEB) is an advanced technology that facilitates the transmission of electrical power from a energy source to a consuming device without requiring physical connectors or conductive wires. The core principle of WEB relies on electromagnetic fields, utilizing methods such as magnetic induction, resonant inductive coupling, and microwave/radio frequency (RF) radiation.

The benefits of wireless power transfer include the elimination of physical connectors, enhanced user convenience, improved safety in environments where wiring poses risks, and the potential for uninterrupted charging. However, challenges such as efficiency losses, alignment sensitivity, limited power transfer distance, regulatory constraints, and potential health concerns must be addressed for wider adoption.

Key Words: *Wireless energy transfer, inductive coupling, resonant power transfer, RF power transmission, wireless charging.*

I. INTRODUCTION

A Wireless Energy Bridge (WEB) enables the transmission of electrical energy from a power source to a device without the need for physical wires or connectors. This technology leverages electromagnetic fields for energy transfer, primarily using inductive coupling, resonant inductive coupling, or radio frequency (RF) transmission.

Applications of Wireless Energy Bridge

WEB technology is widely used for charging various electronic devices, including:

- **Smartphones and wearables** – Wireless charging pads allow seamless power transfer.
- **Electric vehicles (EVs)** – Advanced wireless charging systems enhance efficiency and convenience.
- **Medical implants** – Pacemakers and other implants benefit from safe, contactless charging.
- **Industrial automation** – WEB can power autonomous robots and sensors in factories.

Key Technologies in Wireless Energy Bridge

1. **Inductive Coupling**

- The most commonly used method in wireless charging pads for smartphones and other small devices.
- A transmitter coil generates an alternating magnetic field, inducing a current in a receiver coil within the device, which is converted into usable electrical energy.

2. **Resonant Inductive Coupling**

- An extension of inductive coupling that improves efficiency and range.
- Uses resonant circuits tuned to the same frequency to enable energy transfer over longer distances.
- Applied in EV charging and industrial power solutions.

3. **Radio Frequency (RF) Transfer**

- Utilizes electromagnetic waves, typically microwaves, for wireless power transmission.

- Less efficient for high-power applications but effective for low-power devices like sensors and medical implants.

4. **Magnetic Resonance**

- A resonant transmitter and receiver operate at the same frequency, allowing for efficient power transfer over moderate distances.
- Useful in smart home automation and industrial applications where wired solutions are impractical.

II. RELATED WORKS

Several WEB techniques are applicable to mobile devices, including inductive coupling, resonant inductive coupling, and radio frequency (RF) power transfer. Inductive coupling, the most common method, uses magnetic fields to transfer power over short distances. Resonant inductive coupling, an extension of this concept, allows for greater distances and efficiency by tuning both the transmitter and receiver to resonate at the same frequency. RF-based techniques use radio waves to transfer power over longer distances but are generally less efficient due to significant power losses in free space.

Research on wireless energy bridges for mobile phones has primarily focused on developing protocols and standards that enable efficient power sharing. The Qi standard, developed by the Wireless Power Consortium (WPC), is the most widely adopted standard for wireless charging of mobile phones. Recent studies explore enhancements to the Qi standard to support device-to-device (D2D) charging, which enables one mobile phone to wirelessly transfer power to another. In 2018, the introduction of reverse wireless charging by Huawei and later Samsung's "PowerShare" highlighted the growing interest in this capability. These technologies allow a mobile phone to act as both a power source and a power receiver, expanding the utility of WEB in everyday scenarios.

III. PROBLEM STATEMENT

Mobile devices often run out of charge when a charging port or charger is unavailable. While power banks provide a solution, they too can run out of charge or be forgotten. This issue has inspired the concept of wireless power transfer between mobile devices, eliminating dependence on wired charging. Scenarios where this technology is beneficial:

1. Unavailability of a charger or power bank during travel.
2. Depleted power banks, leaving no option to charge mobile devices.
3. Disaster scenarios where chargers are unavailable or broken.
4. Lack of electricity to connect a USB cable for recharging.

IV. PROPOSED SOLUTION

The concentrated aim of our project is to develop a wireless power transfer mechanism that enables mobile phone users to send and receive battery power from each other. This will be achieved through a hardware chip designed for this purpose.

Initially, the solution will involve a hardware device that connects to the charging ports of two mobile devices: a sender and a receiver. Over time, this technology can be integrated directly into mobile phones, connecting to the battery and eliminating the need for additional hardware.

Additionally, a software application will be developed to allow users to control the transmission process, ensuring security and ease of use.

V. RESULT ANALYSIS

Hardware Development: An electrical expert will design and configure the necessary hardware components into two distinct chips: "Sender" and "Receiver." These chips will connect to mobile device charging ports, enabling wireless energy transfer.

Software Development: The project team will develop a user-friendly interface to manage hardware operations, allowing users to monitor and control the amount of energy being transmitted.

Integration and Testing: The appointed engineer and project team will integrate and test both hardware and software to ensure seamless operation, optimizing user control and reliability.

VI. CONCLUSION

Wireless power transmission has the potential to eliminate the need for wires and batteries, significantly enhancing mobility, convenience, and safety for users.

The Wireless Energy Bridge (WEB) enables energy transfer through air gaps without the need for interconnecting cables. By removing ports and cables, this technology makes electronic devices less obtrusive while enhancing the user experience with seamless recharging and power-sharing capabilities.

This type of technology represents a significant step toward a future where mobile devices can dynamically share power, offering an efficient and flexible alternative to traditional charging methods.

VII. REFERENCES

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Dispersive_gains_enhance_wireless_power_transfer_with_asymmetric_resonance