A Working Model for Mobile Charging using Wireless Power Transmission

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***Abstract* - Portable electronic devices are very popular nowadays. Almost all portable devices are battery powered, meaning that eventually, they all must be recharged–using the wired chargers currently being used. As the usage of these portable electronic devices is increasing, the demands for longer battery life are also increasing. These batteries need to be recharged or replaced periodically. It is a hassle to charge or change the battery after a while, especially when there is no power outlet around. Now instead of plugging in a cell phone, Personal Digital Assistant (PDA), digital camera, voice recorder, mp3 player or laptop to recharge it, it could receive its power wirelessly. The technology for Wireless Power Transmission or Wireless Power Transfer or Transmission (WPT) is in the forefront of electronic development. WPT systems are designed to transmit power without using wires more efficient than transmitting it while using wires. There could be large number of applications for wireless power systems. Hence, in this work, a wireless battery charger has been proposed for mobile phone charging which is expected to eliminate all the hassles with today's battery technology. The advantage of this device is that it can wirelessly charge up the batteries which can save time and money in a long run for the general public.**

1.INTRODUCTION

Today, electricity plays a vital role in our modern-day life. As we are using many numbers of appliances using electricity, it is quite difficult to live without electricity. Traditionally wires or cables are used to carry the electrical power from one place to another. However, Wireless Power Transmission (WPT) has emerged as the technology in the recent days, where the electrical power is transmitted from one place to another without the use of wires. The main theme behind WPT is to get rid of the risky usage of the wires at the same time to eliminate the difficulty in organizing the power. Cords. For an example, the portable electronic devices including mobile phones, tablets, laptops, household robots, drones and etc. normally relies upon the battery power. Due to the rapid development and tremendous applications, these portable devices are becoming part of our day-to-day activities. In addition to that, there is always an increasing demand of smart gadgets to say goodbye to wires, making capable of charging without being plugged in. Hence, there is a necessity for finding a new technology to be free of from the clumsy cables or the chargers [1]-[3].

Hence, the researchers at MIT coined the term WiTricity as the part of their project work, where WiTricity is nothing but the Wireless Electricity offering the transmission of electrical power to a remote place without using wires. Basically, WiTricity eliminates the need for having a different charger for each device we use. This is the fundamental advantage we can get it from this technology. It is enough to identify a location where we can put the portable devices which is getting automatically charged. WiTricity ensures that the power-hungry devices can charge by their own without the need for plugging in into to power cords using the chargers.

Apart from safety (as there is no need of cables), WiTricity provides more convenient in the sense that there is no need for manual recharging or changing the batteries and seems to be more reliable as the devices will never run out of the battery power. Moreover, WiTricity can make the environment as more eco-friendly as it reduces the use of disposable batteries. Even though WiTricity provides automatic wireless charging, mainly requires short distances to charge. Hence, WiTricity is still under development where lots of research works are going on to improve its potential applications to even charge the larger vehicles or equipment's and also being operated over a longer distance. Hence, this work aims to propose a novel method of using WiTricity to charge the mobile phones without the use of wired chargers. The significance of this work is to make an efficient power transfer of low voltage over a shorter distance. The proposed work promises that the mobile users can carry their phones anywhere even if the place is devoid of charging facilities [4]-[6].

2. RELATED WORKS

Whenever we use the devices in our day-to-day activities and whatever may be the devices we use, it becomes essential to recharge the devices regularly with the help of wired chargers. But there may be a situation that there may be no power supply due to some natural hazards may include cyclone, earthquake and etc. In that case, is there any possibility to transfer the power from one mobile phone to another mobile phone wirelessly? Keerthana and Pragadeshwar addressed this issue in their work by eliminating the need of physical power supply to the portable devices where the easy transfer of power from one mobile phone to another mobile phone can be done using inductive coupling [7]. This might be very useful in emergency condition.

There may be certain places where the wired systems can be unreachable or impossible. Hence, without using wires, there should be way for finding the effective methods to transfer the power between two pints is the need of the hour. Sharma et al addressed this issue in their work [8]. The power can be transferred by any one of the following three methods namely inductive coupling (for short-range), resonant induction (for midrange) and electromagnetic wave transmission (for long-range). The objective of this work was to charge a low power device using inductive coupling by quickly and efficiently [9].

Likewise, it may not be always possible to carry the mobile phone chargers wherever we go. It is quite hard to carry the mobile phone chargers at all times at all places. Vithyaa and Marthandan attempted to address the implementation issues of WPT usage for mobile phones and vehicles in their work [10].

Zaman et al emphasized the need for designing a simplified model to transfer the electrical power from one mobile to another mobile phone using the series-series technology for charging inductively [11]. It is inferred that more development is required for designing a low cost, more efficient, simple WPT which can be compatible with any phone model.

Electric vehicles are getting more attention today rather than traditional counterparts (which rely on natural resources) due to its nature of environment friendly. On et al presented an experimental method of WPT for charging the electric vehicles using inductive coupling method [12].

In continuation to that, Sultana et al proposed the design of WPT based charging system for electric vehicles by placing the WPT circuitry into the electrical vehicles [13]. This circuitry was activated when the electrical vehicles reached the charging area mainly to overcome the battery related issues in electrical vehicles. The pros and cons of each WPT technologies, the research objectives of WPT such as improving the transmission efficiency and the distance, current state-of-art technologies of WPT, the open research challenges of WPT are discusses by Mou in his work. Even the possibility of charging multiple devices using WPT in the near future is also presented in [14].

3. CIRCUIT DIAGRAM

3.1Transmitter Section

Transmitter section consists of transmitter coil. Main voltage is converted into high frequency alternating current. The alternating current is sent to the transmitter coil by the transmitter circuit. The AC current then induces a time varying magnetic field. The AC current flowing within the transmitter coil creates magnetic field which extends to the receiver coil within specified distance.

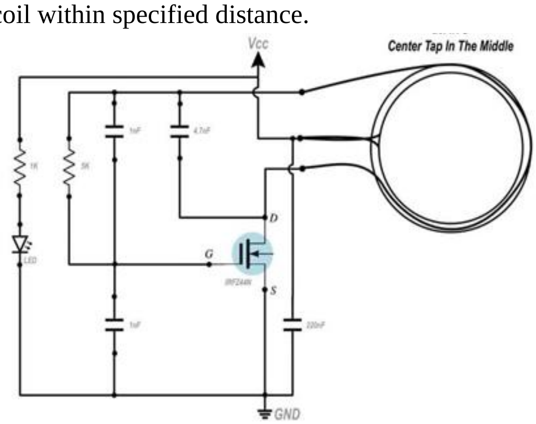


Fig. 1: Transmitter Circuit

3.2 Receiver Section

Receiver section consists of receiver coil. The AC current from the receiver coil is admitted for rectification and filters to convert AC into DC. Then, the DC supply is admitted to the DC regulator (7812) to change the DC supply to 12v DC. Next the 12v DC is applied as an input to the PIC 16F877A.Then the output is connected to the mobile adapter. Since we are obtaining very low DC supply, a mobile adapter is used. Using that adapter, mobile phone is admitted to the charging as shown in Fig.2.

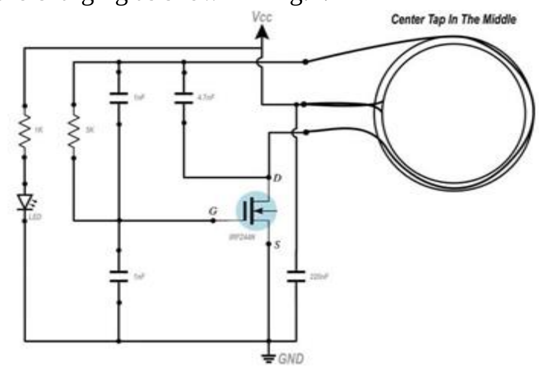


Fig. 2: Receiver Circuit

4. BLOCK DIAGRAM

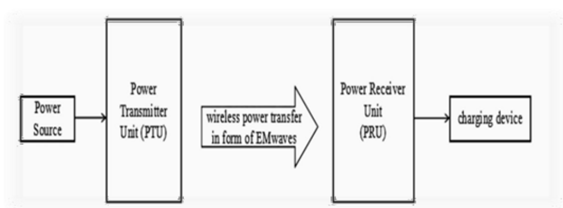


Fig. No .3 Block Diagram of wireless charging device

5. DESIGN PROCEDURE

1.We use DC supply instead of AC supply. Because, AC have 50Hz frequency. That means supply is fluctuate 50 times in one second. But for that WPT system we need continue supply. So, we are using DC supply instead of AC.

2.We calculate the number of turns of transmitting coil and receiving coil. The distance between the transmitting and receiving coil is depends upon following factors:

- No. of turns of coil.
- Frequency generated in the coil.
- Voltage generated by transmitting section.

Also the design of primary and secondary that is the number of turns depends upon the following formula, the inductance is depends upon the number of turns of coil:

$$L=\frac{N^2uA}{I}$$

Where,

- L= inductance of coil in henry
- N= no. of turns in wire coil
- u= permeability of core material
- u0=1.26*10^-6T–m/At permeability of free space
- A= area of coil in square meter
- I= Average length of coil in meter.

3.Distance between transmitting and receiving coil is maximum 3 cm.

6. CONSTRUCTION

- Supply is connected with 1st terminal of transmitting coil. LED is, used to detect supply is on or off.
- Then we take MOSFET and 1st terminal of MOSFET is gain connected with 5k resistor in series with 1st terminal of transmitting coil.
- And then the 1k ceramic capacitator is connected in parallel with 5k resistor Also gain terminal connected to ground with 1k ceramic capacitor.
- Then 2nd terminal of MOSFET which is drain is connected with 1st and 2nd terminal of transmitting coil. And 4.7k ceramic capacitor is connected between these 2 terminals of transmitting coil.
- Then 3rd terminal of MOSFET which is source is connected to ground and center tap of transmitting coil. In between them 220k ceramic capacitor is connected in series.
- For the receiving side 23 guage copper conductor used to make coil and we take 30 turns then these coils connected with full wave bridge rectifier as input. Terminal connected to input of regulating IC .2nd terminal is connected to ground.
- 10k ceramic capacitor and 100micro farad c
- Another two terminal which is output 1st +ve apacitor connected parallel in between these two terminals.
- Middle terminal of regulating IC which is ground,it is connected to ground.output terminal of IC which is ground connected to device.
- These output terminal short by 10 micro farad capacitor

7. WORKING

- Wireless charging is based on principle of magnetic resonance or Inductive Power Transfer (IPT). Wireless charging also known as inductive charging uses an electromagnetic field to transfer energy between two objects through electromagnetic induction.
- This is conventionally done with a charging pad also called charging station. Energy is sent through an inductive coupling to an electronic device, which can then use that energy to charge batteries of electronic devices.
- Induction chargers use an induction coil to create an alternating electromagnetic field from within a charging station, and a second induction coil in the portable device takes power from electromagnetic field and converts it back into electric current to charge the battery.
- The two induction coils in proximity combine to form an electrical transformer. Most wireless chargers only operate over a short distance, however, and while physical contact between a electronic device and its charging station isn't necessary for induction to work but the field generated is very weak and device must be in direct contact of charging station.

8. CLASSIFICATION OF THE WIRELESS CHARGING TECHNOLOGIES

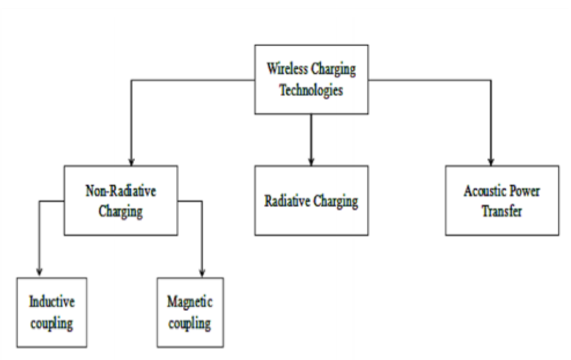


Fig. No. 4 Classification of the Wireless Charging technologies

As illustrated in the above fig. no. 10 the wireless charging is extensively characterized into 3 types. They are non-radiative coupling-based charging, radiative RF based charging and Acoustic ultrasonic based charging.

8.1 Non-Radiative Charging

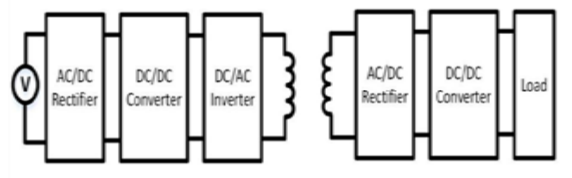


Fig. No. 5 Non-Radiative Charging

The block diagram of the general non-radiative charging is given in figure3demonstratesa block diagram of a general non- radiative wireless charging system. The transmitter side consists of

i) an AC/DC rectifier, which converts alternating current (AC) to direct current (DC); ii) a DC/DC converter, which alters the voltage of a source of DC from one level to another; and iii) a DC/AC inverter, which changes DC to AC. The receiver side is composed of i) an AC/DC rectifier, which converts high frequency AC into DC, ii) a DC/DC converter, which tunes the voltage of the DC, and iii) a load for charging applications.

8.1.1 Inductive coupling

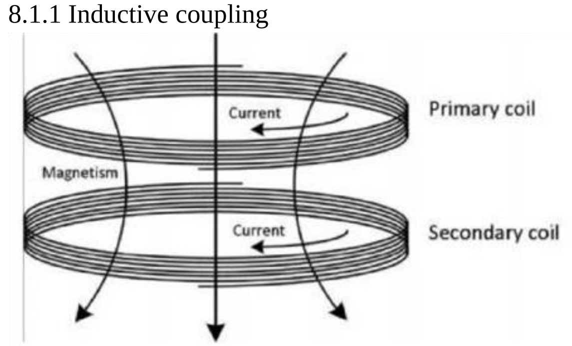


Fig. No. 6 Inductive coupling

In this technique the electrical energy is transferred between two coils based on the magnetic field induction.

8.1.2 Magnetic resonance coupling

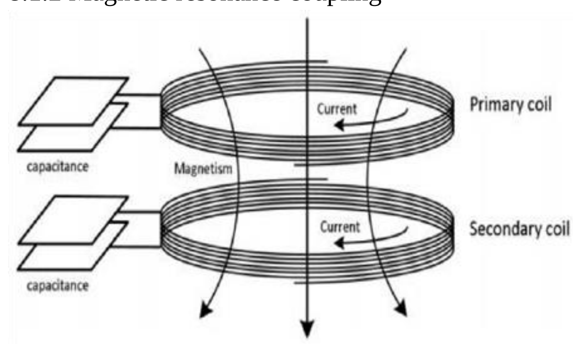
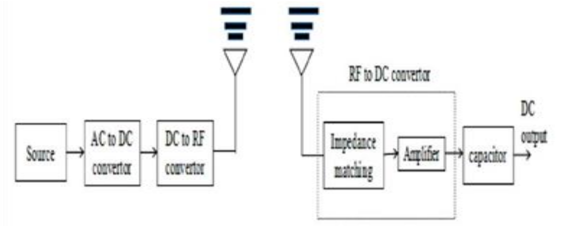


Fig. No. 7 Magnetic resonance coupling

In this technique the coupling based evanescent wave coupling which generates and transfers the electrical energy between the resonant coils through fluctuating magnetic fields.

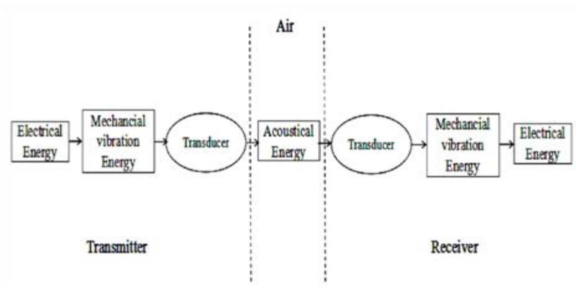
8.2 Radiative Charging-



Fig, No. 8 Radiative Charging

In this technology the RF radiation utilizes diffused RF/microwave as the medium to carry the radiant energy.

8.3 Acoustic Power Transfer-



Fig, No. 9 Flow of Energy Conversion during acoustic power transfer

In this technology, ultrasonic which are sound waves used to transmit the power through the dielectric air media. This technology is a newly evolved one to have biocompatible wireless power transfer technique in bio-medical implantation.

9. HARDWARE IMPLEMENTATION

Blinking of the LED light is found by loading the program into the PIC microcontroller and connecting LED light into one of its port to get the output as shown in Fig. 10.

Fig. No. 10 LED Blinking on PCB Board.

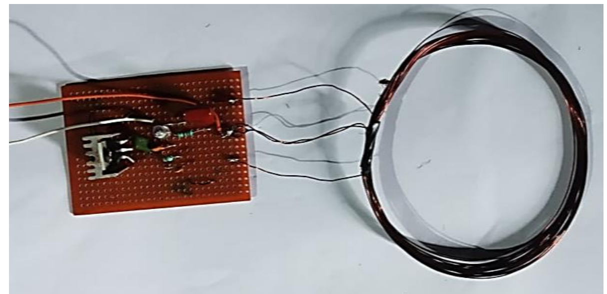


Fig. No. 11 Transmitter Section.

After finishing the LED blinking, the transmitter section is constructed. Fig.11 shows the detailed view of transmitter. Here, the components like transformer, bridge rectifier, regulator and a transmitter coil are used.

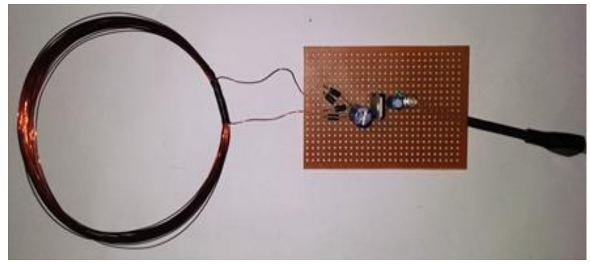


Fig. 12: Receiver Section

After completing the transmitter section, the receiver section is added which in turn connected to the PCB board and tried to blink the LED. Since, the constant voltage is not obtained; the relay switch is used to charge the phone.

Fig. 13: Charging Phone using WPT

From Fig. 13, it is observed that the mobile device is getting charged. But the problem with this model is that it produces low output voltage. Since the output voltage is low, the charging rate of the mobile device is less. Increasing the dimension of the coil and bringing them in close proximity would form a sufficing solution to the above. Instead of using a single pair of inductor coils, multiple pairs connected in parallel could be used to enhance the production of output voltage.

10. APPLICATIONS

- Smart Phones, Portable Media Players, Digital Cameras, and Tablets and Wearable – Consumers are asking for easy-to-use solutions, increased freedom of positioning, and shorter charging times. These applications typically require 2 W to 15 W of power. Multistranded interoperability is preferred. Wireless charging can coexist with NFC (Near Field Communication) and Bluetooth, allowing for very creative solutions. For example, paired phones can charge each other up when placed back-to-back, after they negotiate the appropriate host and client.
- Accessories – Headsets, wireless speakers, mice, keyboards and many other applications can benefit from wireless power transmission. Plugging charging cables into the tiny connectors of ever shrinking devices is an impediment to robust design. For example, Bluetooth headsets need to be sweat proof to survive in a gym environment. Only wireless charging can enable that possibility.
- Public Access Charging Terminal –
  Deployment of charging pads (transmitters) in the public domain requires systems to be safe and secure. But smart charging systems can go well beyond stand-alone charging solutions. They can enable quick network-connectivity and create billable charging stations if desired. Many coffee shops, airport kiosks and hotels support these scenarios. Furniture manufacturers also design-in discreet wireless power transmitters into their end and side tables.
- Computer Systems –
  Laptops, notebooks, ultra-books and tablet PCs are all candidates for wireless charging as either hosts or clients. The possibilities are endless.
- In-Cabin Automotive Applications –
  A wireless charger is ideal for charging mobile phones and key fobs by placing them either on the dash or the centre console of the car, without inconvenient wires going to the cigarette lighter socket. Moreover, since Bluetooth and Wi-fi require authentication to connect phones to car electronics, combining NFC with wireless charging can enable the user to not only charge the phone, but to automatically connect it to the car's Wi-fi and Bluetooth networks without going through any specific setup process.
- Electric Vehicles –
  Smart charging stations for EVs (electric vehicles) are also coming up but require much higher powers. Standards are under development.
- Miscellaneous –
  Wireless chargers are finding its way into anything with a battery inside it. This includes game and TV remotes, cordless power tools, cordless vacuum cleaners, soap dispensers, hearing aids and even cardiac pacemakers. Wireless chargers are also capable of charging super capacitors (super caps), or any device that is traditionally powered by a low-voltage power cable.
- Low power applications are generally supportive of small consumer electronic devices such as cell phones, handheld devices, some computers, and similar devices which normally charge at power levels below 100 watts.
- High power inductive charging generally refers to inductive charging of batteries at power levels above 1 kilowatt. The most prominent application area for high power inductive charging is in support of electric vehicles, where inductive charging provides an automated and cordless alternative to plug-in charging. Power levels of these devices can range from approximately 1 kilowatt to 300 kilowatts or higher. All high-power inductive charging systems use resonated primary and secondary coils.

11. CONCLUSION

As for safety, there's really nothing to worry about. The average wireless charging system creates a field no more dangerous than radio waves, and waves are not strong enough to have any effect on human body.

Wireless battery charging has many advantages in terms of convenience because users simply need to place the device requiring power onto a mat or other surface to allow the wireless charging to take place. We believe that our contribution in this work will successfully benefit society in terms of convenience, reduced wear of plugs and sockets, and application in medical environments. Reduced efficiency is one of the key challenges in wireless battery charging system due to resistive losses on the coil, stray coupling and etc.

12. FUTURE WORK

The future studies mainly concentrate on reducing physical size of antenna and embed it in mobile itself to give high efficiency and less loss. And designing high level power transmission system for charging laptops. We can increase the range between mobile & wireless charger. Also, we improve charging time have good scope of work.

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