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Smart Approach of Power Transfer (WiTricity)

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Abstract: *When your mobile shows low battery indication and you are on the way. Will younotdesirethat mobile's battery will get 'chargedwithself'? of course it will be! "WiTricity" the technique which we proposed in this paper is Transfer of power through air as a medium. We explain the background, basic idea, estimation and comprehensive study of WiTricity, we also demonstrate outcomes obtained by wireless power transmission, Through this technique the electronic devices can be powered efficiently over a limited distance. We lived in the modern world where approx. Everythingdepends on power. In this scenario, wireless power transfer will be very beneficial to us and it can be used for plenty of applications. In resonant circuits, two magnetically coupled coils resonate at similar frequencies, then power is transferred that depends on oscillating magnetic field. This is the basic concept of transmission of power wirelessly.*

Keywords: *WiTricity, Resonate, Magnetic field.*

1. INTRODUCTION

Now a day we are wasting electricity about half of its resource during its transmission and distribution to the power plants and further losses occur during providing to the customers. Energy has been the driving force to enable rapid societal development as well as to improve the quality of life [10].As these losses depending on type of conductor ,current flowing,voltage and length of transmission line.But now phenomenon is changed and fabulous research is going on the wireless power transmission .This technology become popular day by day because of less power losses and this is the best alternate of wired power transmission .This approach was firstly given by TESLA who demonstrate the transmission of power wirelessly in 1899 .Now today world adopted his approach and researched it further and WiTricityis introduced in the market.WiTricity is entirely a unique era of technology. The main modes of wireless power transmission are (1). Resonance (2).Inductive coupling (3).Microwave transmission and (4).Laser technology. This paper presents work on microwave based wireless power transmission. Microwave based Wireless Power Transmission System (WPTS) is a long range power transmission from one end to another without using wire in between [11].

In communication systems, multiple frequencies are used to transmit information independently within a medium among several senders and receivers. Recently, multi-frequency approaches emerge to transfer power in the kilowatt range [12].

Transmission of power from one place to another place with the help of resonant frequency through medium as an air is known as WITRICITY.In which no power losses because of source and load are in varying magnetic field.It eliminates the need to plug in power cables, it gives opportunity to every electronic device to charge on their own.There are two techniques are used of wireless power transmission one is

Near Field Technique (Radioactive)

This technique with the help of magnetic field using inductive coupling power is transferred over small distances.

Far Field Technique (Non-Radioactive)

In this technique power is transmitted with the help of electromagnetic radiation beams over a long distance.

2. HISTORY

The idea behind transmission of electrical energy or power from one point to another wirelessly or without any physical contact is not new, it has been there for about a century. The Ampere's circuital law 1826, Faraday's law of induction 1831, Maxwell's equations all provides thebasis for the concept of wireless transmission of electricity. In 1880's Nikola Tesla and Heinrich Hertz theorized the concept of transfer of electricity wirelessly. In May, 1899 Tesla arrived at Colorado Springs, Tesla conducted a series of experiments to achieve wireless power transmission.

Tesla turned the theoretical concept into practical demonstration of lighting bulbs in the field wirelessly from 25 miles.

He applied high radio frequency oscillating voltage by using a Tesla coil to which two metal sheets were connected. A vacuumed glass tube was placed between the two sheets, which resulted in glowing of the tube, although there was no physical contact; the sheets were at a distance from the tube.

Nikola Tesla wanted to build a wireless power transmission system for large distances, for this purpose construction at Shoreham, Long Island, New York began in 1901. He intended to build a high voltage coil facility to transmit electrical power to the whole world without using wires, the station was known as Wardenclyffe Tower it was also called Tesla Tower, and the tower was 57m tall and 21m in diameter. However, regardless of Tesla's endeavor to make wireless power transmission to the whole globe a reality, but by the end of 1904 he ends up with the shortage of funds because at that time it was less expensive to lay down copper wire for transmission of electricity. The Wardenclyffe Tower was demolished in 1971.

In World War II, progresses were made in the field of microwave technology. William C. Brown gave rise to microwave power transmission in 1960's and by using far field technique; he got successful to achieve power transmission to a wide range of first time. He designed retina in 1964 to transform microwaves to DC power which he used to energize a helicopter by microwaves without using any wire. In 1982, Brown (Raytheon) and James F. Trimmer (NASA) announced the development of a thin-film plastic retina using printed-circuit technology that weighed only one-tenth as much as any previous retina [1].This providesa basis to develop SHARP (Stationary High Altitude Relay Platform). SHARP was a prototype of an aircraft without pilot intended for the communication between two points.

The MIT team headed by Prof. Soljačić took Tesla's work in the field of wireless power transmission to another level even after a century. In 2007, the team led by Marin Soljačić at MIT used to couple tunes circuits made of a 25 cm resonant coil at 10 MHz to transfer 60 W of power over a distance of 2 meters (6.6 ft.) (8 times the coil diameter) at around 40% efficiency [2]. Prof. Soljačićlaid the foundation of WiTricity.

3. MAJOR METHODS OF WIRELESS TRANSMISSION

Nowadays power is transmitted wirelessly in three following methods, which are:

- Laser
- Microwaves and Radio waves
- Electromagnetic Resonance

Thirdmethodeasier, less injurious, for human being hence it is the most suitable method of transmission.

3.1. Laser

The first method of transmission using a beam of laser which behaves as a source.In this technology, high intensity beam is transmitted through source to the load under a specific distance. The first experiment on WPT through laser is conducted by NASA "Marshall Space Flight Center" in which aircraft is powered by a laser beam.

This is very related to photovoltaic cell which used to convert solar energy into electricity when laser beam or sunlight strike the photovoltaic cell, then these cells convert it into electrical energy. Power can be transmitted through long distance, but losses occur due to scattering of light, it is also harmful to human being.

It needs straight line of sight, if in any case line of sight is not met, then a lot of power losses occur atthe receiver side. Recent experiments using commercially obtainable laser sources have generated over 7.2 watts of photovoltaic output from a 70 watt laser beam [3]. In Washington State company trying to transmit electricity using a laser beam. Laser Motive is a Seattle-based company developing wireless power delivery systems using laser beams to transmit electricity without wires [4]. WPT using laser has many uses in today's world such as underwater, space, ground vehicles, quad copters, UAVs anddrones, etc.Laser beam also known as power beam because in which power is transmitted to the receiver and where it can be transformed into electrical energy.

3.2. Microwaves and Radio Waves

The Second method of Transmission of power usingradio waves having small value is also known as microwaves. In this method, microwave is sent to the long distances and can be received through the retina, whichextract, microwave energy back to electrical energy [5].

Microwave power transmission (MPT) Retina is used which consist of the rectifier and antenna. It can convert transmitted radio waves into electricity with high efficiency about 95-96 %. Two antennas are used for radio wave transmission; one is on the source side which transmits high frequency radio wave range 1GHz to 1TeraHz. The high efficiency slotted waveguide antenna is perfect for radio waveand the other is on the receiving side through which load is connected. The radio waves received by receiving antenna are converted into DC power. MPT is very helpful for long distance power transmission. This technique is safe for human because it is proven that power is slightly higher emission of power from the cell phone.

3.3. Electromagnetic Resonance

The Third method is the most common method of transmission. It is the transmission of power using electromagnetic resonance having two coils, one is primary coil which is used for power transmission and other is secondary coil which receives power at the receiver end, both resonate at the same resonant frequency. The frequencies at which the response amplitude is a relative maximum are known as resonance frequency [6]. Condition to produce resonance is that capacitive reactance and inductive reactance must be same,

XC = XL

$$\frac{1}{2\pi fC} = 2\pi fL$$

In this regard, we perform experiments to transfer wireless power ,first we design transmitter which resonate at frequency ranges from 0-160 kHz .The coils we used are of 15 gauge ,10 feet long circular in shape with 8 turns. Secondly, receiver circuit having same no of coilto receive the electromagnetic waves.

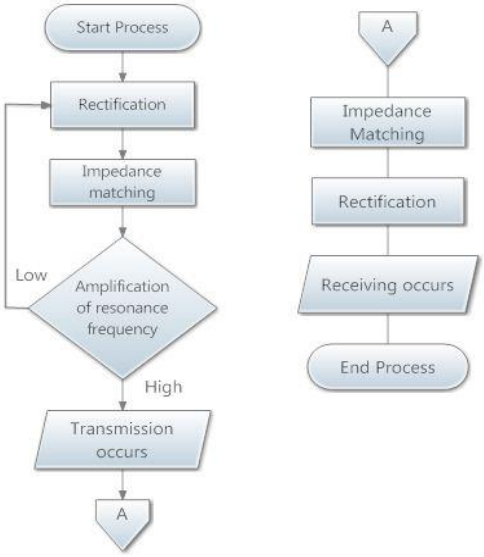

Fig1. *Flow Diagram of WPT system via Electromagnetic radiation*

DC converted into AC having high frequency using inverter circuit.Frequency may be in hundred or thousand Hz and it must fulfill the resonance condition using impedance matching network then it passed through primary coil, it produces varying magnetic field around itself, now when secondary coil is brought near to primary coil ,magnetic field interact with the secondary coil current is induced in secondary coil then this AC current is converted into DC using a rectifier and then transferred to the loads. Power transmission efficiency depends upon distance between two coils and oscillating magnetic field. Using this method, over several kilowatts of power can be transferred safely and efficiently over significantly larger distances irrespective of the alignment [7].

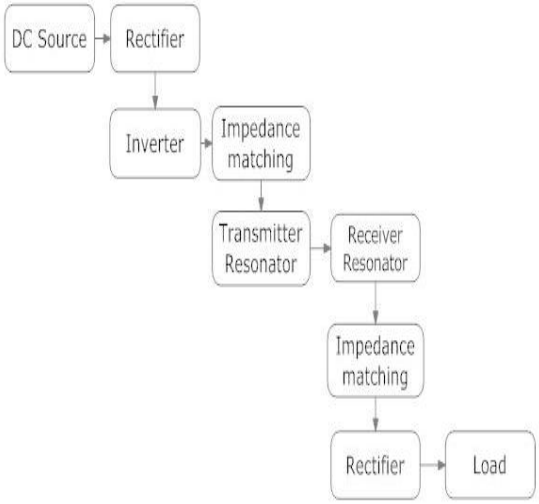

Fig2. *Block diagram of overall wireless power circuit*

The resonant frequency of the system will change as a function of the coupling, and hence on the distance as in case of the wireless power system, coupling is dependent on the distance between the transmit and receive coils. The number of turns in the coils, diameter, material, and resistance of wire also produce interference in mutual induction.

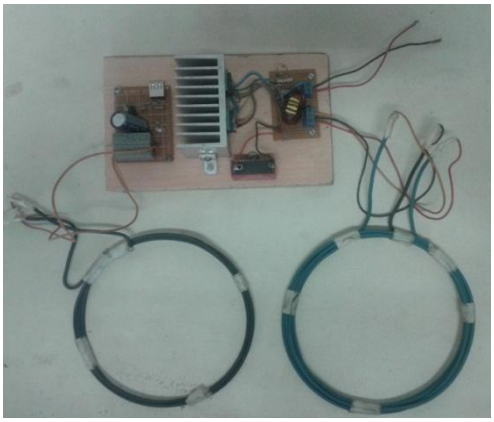

Fig3. *Electromagnetic induction circuit with coils*

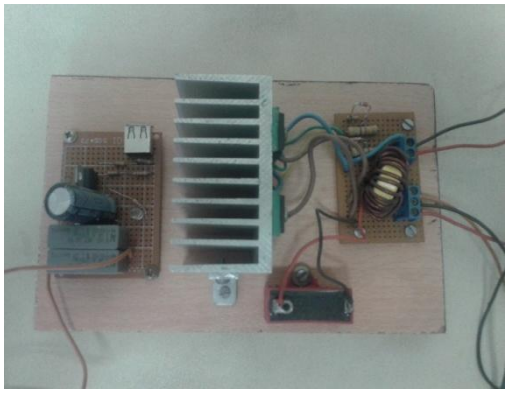

Fig4. *Transmitter and receiver circuit.*

We have some limitation of wireless transmission.

- As operating frequency increases, the diameter of the coil should be rising.
- As the distance between coils increases, no of turns should be increased.
- Presence of opaque object between the coils can behave as a barrier and decreases the transmitting efficiency.
- The cost of developing and implementing wireless energy network means that it would be too expensive for the end-user to afford at this point [8].

4. STATICTICS

According to statistics collected form experiment results ,maximum 5 v is achieved when both coils are overlaps and give maximum 85 % efficiency.

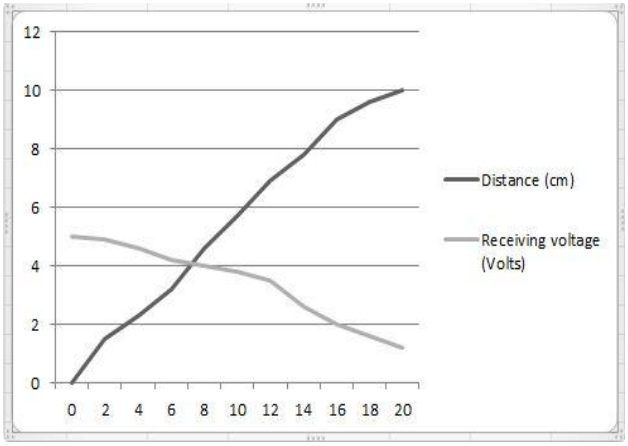

Fig5. *Graph between distance vs voltage.*

5. MERITS &DEMERITS

5.1. Merits

- The Wireless Power, Transmission systemwould completely eliminate the existing high-tension power transmission line cables, towers and substations between the generating station and consumers and facilitates the interconnection of electrical generation plants on a global scale [9].
- Since there is no rigid path for electrical energy means electricity can be transmitted in any direction.
- It will be cheaper for both distributors and consumers because the components used in the receiver and transmitter are less costly than the power cables, transmission grid etc.
- It is more efficient since it does not travel on any resistive wired path so there is no energy dissipation or absorption. Hence the loss of energy is almost negligible.
- There will be no power failure due to power cables or short circuit and power theft in this system is not possible.
- Power transmission will be possible even in those areas of the world where it is not possible to deliver it through wires.
- It is an environment friendly method of power transmission since the usage of materials which can harm our environment is completely eliminated.
- WiTricity is more appropriate and reliable method.

5.2. Demerits

- Currently the practical implementation of wireless transmission is very expensive.
- Up till now the range of WiTricity only by a few feet, which is a hindrance in the path to commercialize it.

- Its efficiency is a big question since the method is still in early stages of its development so the efficiency is less than the wired transmission.
- The possibility of its interference with the current communication system is possible.
- Presently, this technology is only limited to the household.
- The use of microwave will put negative effects on our environment and health.

6. APPLICATIONS OF WPT

Wireless power transmission has multiple fascinating applications. Some of them are:

- **Transportation:** Movingobjects likevehicles, fuel, lessplanes, quad copters, UAVs, rockets, industrial vehicles, golf carts etc.
- **Post-PC Era:** No batteries are needed to charge mobile phones, tablets, laptops within range of power source.
- **Industrial:** Wireless power transfer in cruelatmosphere, e.g.Underwater, cosmic rays, mining, drilling etc.
- **Electronics, Appliances:** Electronic devices such as TV, home theater accessories, speakers, home appliances, desktop PCs, batteries, etc.It also eliminates electric wiring and switch boards
- **Solar Power Satellite**: Satellite having solar panels convertsolar energy into electrical then into electromagnetic waves and transferred wirelessly to earth where these waves then converted to electrical power.

7. CONCLUSION

Wireless power transmission is entirely a unique and outstanding innovation of the modern world. In this paper, weexplain basic idea, historical background andmajor methods of wireless power transmission. It also gives information about designing and working on wireless power oscillating circuit. Power can be economically transmitted wirelessly over a short or long distances safely. This technology eliminates transmission wires, towers, power cords and heavy wirings. It achievesefficiency in reducing dependency of humans on fuel or petroleum. Each technique has its own pros and cons hence it depends on the requirements like (cost, distance, power, etc.) to choose an appropriate technique.Research is continuing to remove transmission losses and make it commercial, efficient, cost effective and reliable.Future possibilities are there that new generation will see the implementation of this technology in every field of life.

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