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A Review on Emerging Revolution of Witricity

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ABSTRACT: Witricity or wireless electricity is an emerging technology which is used to transfer electric power over a distance without using wires. This technology was advented by Dr. Nickolas Tesla in 1899 but has founded its grip in the recent years with numerous gadgets and there snacking cables around us. Further it was explored by Professor Marin Soljacic and a team of MIT researchers, Massachussets who are refining its range and amount of power transfer capability. This technology will free us from power cords and would expel E-waste. Witricity depends upon strong coupled resonance between transmitter and receiver coils. The transmitter emits a non-radiative magnetic field resonating at MHz frequencies and the receiving unit load resonates in that field. Witricity is an efficient, reliable and environment friendly method of transferring power and nowadays used in many applications like automobile, wireless charging for implantable medical devices in biomedical fields, military field etc.

KEYWORDS: Witricity; resonance coupling; rectenna; inductive coupling; evanescent waves.

I. INTRODUCTION

Nickolas Tesla demonstrated transmission of electrical energy without wires in early 19th century. Tesla used electromagnetic induction systems. William C Brown demonstrated a micro wave powered model helicopter in 1964. This receives all the power needed for flight from a micro wave beam. In 1975 Bill Brown transmitted 30kW power over a distance of 1 mile at 84% efficiency without using cables. Researchers developed several techniques for moving electricity over long distance without wires. Some exist only as theories or prototypes, but others are already in use. Most approaches to wireless power transfer use an electromagnetic (EM) field of some frequency as the means by which the energy is sent. At the high frequency end of the spectrum are optical techniques that use lasers to send power via a collimated beam of light to a remote detector where the received photons are converted to electrical energy. Efficient transmission over large distances is possible with this approach; however, complicated pointing and tracking mechanisms are needed to maintain proper alignment between moving transmitters and/or receivers. It is also possible to transmit power using non-radiative fields. As an example, the operation of a transformer can be considered a form of wireless power transfer since it uses the principle of magnetic induction to transfer energy from a primary coil to a secondary coil without a direct electrical connection. MIT team explored many techniques for transmitting power over "mid-range" distances and arrived at a non-radiative approach. Further, demonstrated the highly resonant technique using a magnetic field to transfer energy over a mid-range distance of 2 meters, and an industry was born. In some instances, this technology is also referred to as "magnetic resonance", and it is often contrasted to "induction" for its ability to efficiently transfer power over a range of distances and with positional and orientational offsets. Since that initial demonstration, the use of HR-WPT, or magnetic resonance, has enabled efficient wireless energy transfer in a wide range of applications that was not possible before.

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II. WITRICITY MECHANISMS

The technology of transferring electricity wirelessly i.e witricity is as shown in fig 1below:

Fig1. Witricity

The different mechanisms of transferring wireless electricity are classified as:

A. Non-Radiative: These are wireless transmission techniques over distances comparable to, or a few times the diameter of the device(s).

(i) Inductive Coupling: Inductive coupling is the action of electrical transformer is the simplest instance of wireless energy transfer. The primary and secondary circuits of a transformer are not directly connected. The transfer of energy takes place by electromagnetic coupling through a process known as mutual induction. The receiver must be very close to the transmitter or induction unit in order to inductively couple with it.

(ii) Resonance Coupling: The idea of such mid-range induction was given by Marin Soljacic for efficient wireless transfer. The reason behind it is that, if two such resonant objects are brought in mid-range proximity, their near fields (consisting of so-called 'evanescent waves') and can allow the energy to transfer from one object to the other within times much shorter than all loss times, which were designed to be long, and thus with the maximum possible energy- transfer efficiency. Electromagnetic resonance induction works on the principle of a primary coil generating a predominantly magnetic field and a secondary coil being within that field so a current is induced within its coils, when both of these are made to resonate at same frequency they become much efficient.

B. Radiative: Radiative refers to methods achieving longer range transfers, often multiple kilometre ranges, where the distance is much greater than the diameter of the device(s).

Laser/Microwave Transmission: Such power transmissions can be made effective at long range power beaming, with shorter wavelengths of electromagnetic radiation, typically in the microwave range. A rectenna may be used to convert the microwave energy back into electricity. These provide 95% efficiency. A new company, Powercast introduced wireless power transfer technology using RF energy this system is applicable for a number of devices with low power requirements. Currently, it achieves a maximum output of 6 volts for a little over one meter. Energy Transmission via laser is an efficient way for long range, except for it requires a proper line of sight for power beaming. In the case of light, power can be transmitted by converting electricity into a laser beam that is then fired at

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a solar cell receiver. With such laser beam efficiencies it is planned to build a solar panel grid in space & transferring the solar energy to earth receivers via laser methods.

III. ECONOMIC ASPECTS OF WITRICITY

In terms of economic theory, many countries will benefit from this service of wireless power transmission. Only private, dispersed receiving stations will be needed. A single resonant energy receiver is required, which may eventually be built into appliances, so no power cord will be necessary. Monthly electric utility bills from old-fashioned, fossil-fuelled, loss prone electrified wire-grid delivery services will be optional.

IV. APPLICATIONS OF WITRICITY

WiTricity or wireless power transfer technology can be applied in a wide variety of applications and environments. The ability of our technology to transfer power safely, efficiently, and over distance can improve products by making them more convenient, reliable, and environmentally friendly. WiTricity technology can be used to provide:

1) Automatic Wireless Power Charging: When all the power a device needs is provided wirelessly, and no batteries are required. This mode is for a device that is always used within range of its WiTricity power source. When a device with rechargeable batteries charges itself while still in use or at rest, without requiring a power cord or battery replacement. This mode is for a mobile device that may be used both in and out of range of its WiTricity power source.

2) Consumer Electronics:
a) Automatic wireless charging of mobile electronics (phones, laptops, game controllers, etc.) in home, car, office, Wi- Fi hotspots while devices are in use and mobile.
b) Direct wireless powering of stationary devices (flat screen TV‘s, digital picture frames, home theatre accessories, wireless loud speakers, etc.) eliminating expensive custom wiring, unsightly cables and wall-wart power supplies.
c) Direct wireless powering of desktop PC peripherals:wireless mouse, keyboard, printer, speakers, display, etc.eliminating disposable batteries and awkward cabling.
3) Industrial
a) Direct wireless power and communication interconnections across rotating and moving joints (robots, packaging machinery, assembly machinery, machine tools) eliminating costly and failure-prone wiring.
b) Direct wireless power for wireless sensors and actuators, eliminating the need for expensive power wiring or battery replacement and disposal.
4) Transportation
a) Automatic wireless charging for existing electric vehicle classes: golf carts, industrial vehicles.
b) Automatic wireless charging for future hybrid and all electric passenger and commercial vehicles, at home, in parking garages, at fleet depots, and at remote kiosks.
c) Direct wireless power interconnections to replace costly vehicle wiring harnesses and slip rings.
5) Medical Application:
Wireless charging systems are being developed for implanted medical devices including Left ventricular assist device (LVAD) heart assist pumps, pacemakers, and infusion pumps. Using highly resonant wireless power transfer, such devices can be efficiently powered through the skin and over distances much greater than the thickness of the skin, so that power can be supplied to devices deeply implanted within the human body. The HRWPT technique eliminates the need for drive lines that penetrate the human body, and for surgical replacement of primary batteries.

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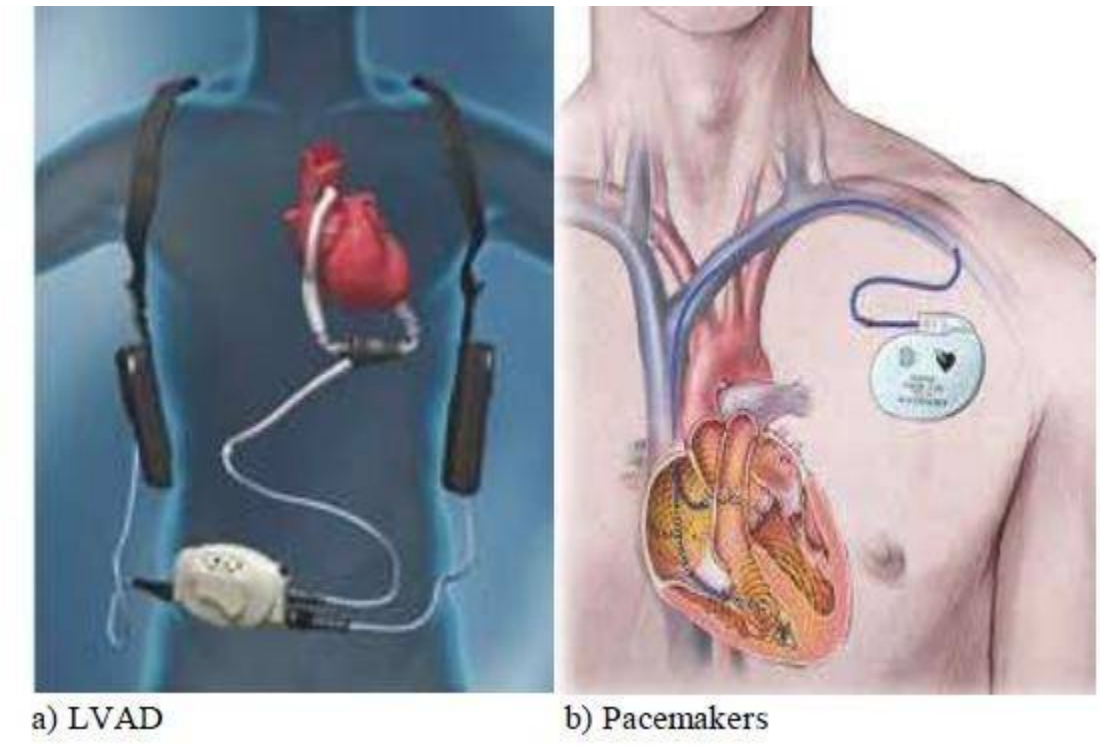

Fig. 2 Wireless charging system for implantable biomedical devices.

6) Military Application:

Designers of defence systems are able to utilize wireless charging to improve the reliability, ergonomics, and safety of electronic devices. The Talon Teleoperated robot shown in Fig 3 is being equipped with wireless charging so that it can be recharged while it is being transported by truck from site to site. Helmet mounted electronics, including night vision and radio devices can be powered wirelessly from a battery pack carried in the soldier's vest, eliminating the need for disposable batteries or a power cord connecting the helmet to the vest mounted battery pack.

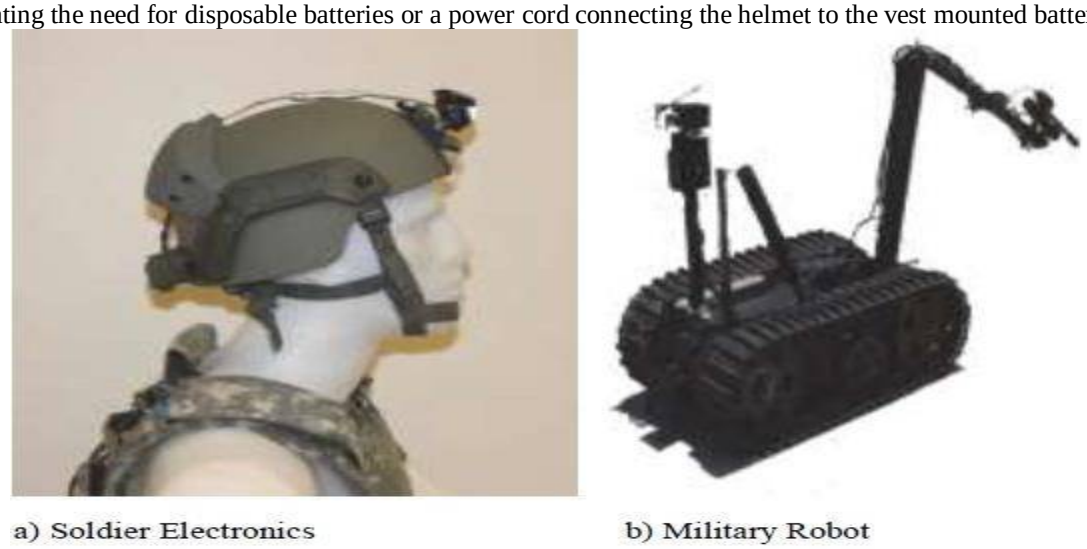

Fig.3 Highly resonant wireless charging system for Military applications.

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V. ADVANTAGES AND LIMITATIONS OF WITRICITY

A. Benefits of Design
1) More Convenient
a) No manual recharging or changing batteries.
b) Unaffected by the day night cycle, weather or seasons.
c) Eliminate unsightly, unwieldy and costly power cords.
2) More Reliable
a) Never run out of battery power.
b) Reduce product failure rates by fixing the weakest link: flexing wiring and mechanical interconnects.
3) More Eco Friendly
a) Reduce use of disposable batteries.
b) Use efficient electric grid power directly instead of inefficient battery charging.
B. Limitations of Design
1) The resonance condition should be satisfied and if any error exists, there is no possibility of power transfer.
2) If there is any possibility of Very Strong ferromagnetic material presence, then there may be a possibility of low power transfer due to radiation.

VI. CONCLUSION AND FUTURE WORK

This provides mid-range non-radiative energy transfer scheme based on strongly-coupled resonances. Even very simple design has promising performance and provides better efficiency with respect to distance. As a powerful concept, it could enable a wide range of applications. We can call WiTricity as future technology of Electricity transmission for power consumer. MIT's WiTricity is only 40 to 45% efficient and according to Soljacic, they have to be twice as efficient to compete with the traditional chemical batteries. The team's next aim is to get a robotic vacuum or a laptop working, charging devices placed anywhere in the room and even robots on factory floors.

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