Available online www.jsaer.com

***Journal of Scientific and Engineering Research*, 2018, 5(1):46-49**

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Wireless Power Transfer

M. N. O. Sadiku[1], S. R. Nelatury[2], S.M. Musa[1]

[1]College of Engineering, Prairie View A&M University, Prairie View, TX 77446
[2]School of Engineering and Engineering Technology, Pennsylvania State University, Erie, PA 16563-1701

Abstract As portable mobile devices become pervasive, charging their batteries has become a critical problem. The wireless power transfer (WPT) is emerging as a promising technology for wirelessly charging electronic devices. WPT has been an exciting emerging technology in consumer electronics, replacing wired chargers and eliminating the need of power cords and chargers. WPT is capable of completely disrupting the way that mobile devices, cars, and aerial vehicles, operate and obtain energy. This paper provides a brief introduction to WPT.

Keywords Wireless power transfer, wireless power transmission, wireless charger, wireless energy transmission, mobile charger

Introduction

The transfer of power from source to receiver is a technology that has been with us for over a century. This transfer of energy has traditionally necessitated the use of a physical connection such as power cords. Rapid growth in the area of high-speed wireless data transfer has resulted in the proliferation of cell-phones and various mobile devices that include even biomedical implants. Charging mobile devices through wireless power transfer (WPT) has become the preferred choice [1].

Wireless power transfer (WPT) (also known as wireless power transmission or wireless energy transmission) is the transmission of electrical energy without wires. WPT frees us from the tyranny of annoying power cords. The idea of WPT was realized by Nikola Tesla around the turn of the 20th century. Recently, there has been much interest into the area of wireless power transfer (WPT) [2].

Overview of WPT

The block diagram of a wireless energy transfer system is shown in Figure 1 [3]. Basically, a wireless power system consists of a "transmitter" connected to a source of power. The technique involves using two coils that are physically separated. When one coil is excited by a time-varying current, it creates a magnetic field which couples the other coil and transfers power. The power transfer is made possible if both transmitter and receiver achieve magnetic resonance.

As shown in Table 1 and Figure 2 [4], these are different kinds of wireless power technologies. Most approaches to WPT apply an electromagnetic (EM) field of some frequency as the means by where power transfer takes place. They fall into two broad categories: non-radiative and radiative. Because users are not bound by the limits of the cable, WPT can be used within a certain distance of approximately 10 meters.

Table 1: WPT Technologies [4]

Technology	Energy Transfer	Enabling the Power Transfer
Inductive coupling	Magnetic fields	Coils of wire
Resonant inductive coupling	Magnetic fields	Resonant circuits

Capacitive coupling	Electric fields	Conductive coupling plates
Magnetodynamic coupling	Magnetic fields	Rotating permanent magnets
Microwave radiation	Microwaves	Phased arrays/dishes
Optical radiation	Light/infrared/ultraviolet	Lasers/photocells

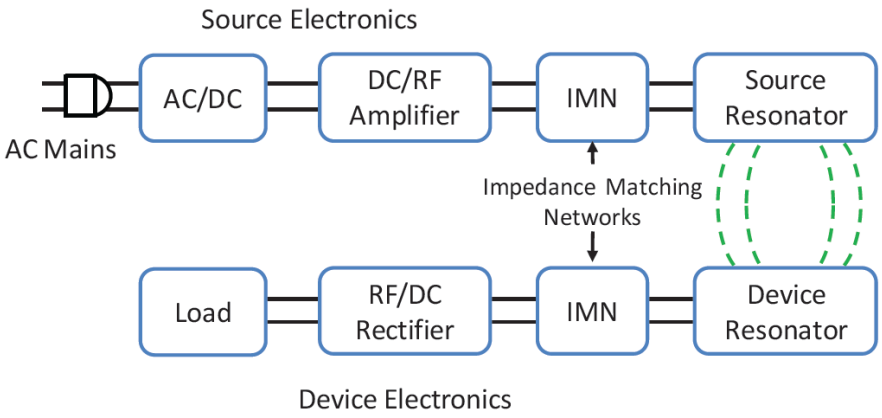

Figure 1: The block diagram of a wireless energy transfer system [3]

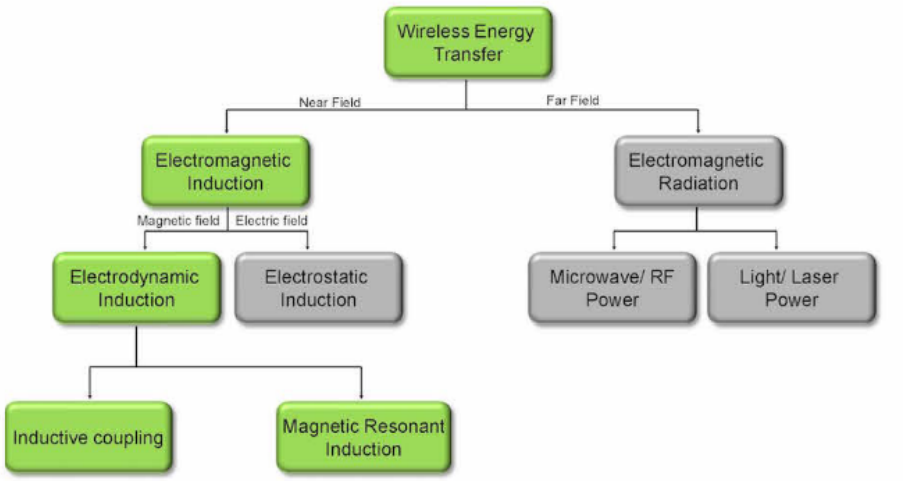

Figure 2: An overview of wireless energy transfer [4]

Applications of WPT

There are countless applications for wireless power transfer. Here are just a few popular examples [2]:

- *Electronic portable devices*: Handheld devices such like smartphones, tablets, drones, cars, etc. need to recharge their internal battery so that the device can be used while mobile. WPT has the potential to make portable devices more convenient by eliminating the need for a physical power supply.
- *Electric vehicles:* The emergence of electric vehicles, aimed at reducing environmental pollution, turned a greater impetus for more efficient ways of charging batteries. A major drawback of electric vehicles is the need to recharge their internal batteries which take many hours. WPT can be used for the charging of electric vehicles. Some advanced automotive technology, such as vehicles with driverless operation and autonomous navigation, will benefit from being able to charge without human intervention.
- *Medical devices:* The WPT technology has been used to power up healthcare devices, especially in implantable medical devices with higher power consumption. WPT can extend the lifetime of an

implant because its battery can be recharged [4]. It is also used in an artificial pacemaker, which is a small medical device that uses electrical impulses,

- *Sensor networks*: The Internet of Things (IoT) is currently used in various services. Wireless sensor networks which are employed in IoT are constrained by limited battery energy. For employing large IoT wireless sensor networks, powering the sensors by cabling is not feasible. Using PWT seems to be a possible alternative. WPT can be used to send power to sensor nodes which are not reachable.

Other applications include RFID tags, industrial robots, and cellular networks.

Challenges

WPT may cause electromagnetic interference with communication systems, which is not desirable. There is the common fear of the effect of EM radiation. Some of the existing implementations of WPT mainly focus on the power transfer efficiency but overlook the health impairments caused by RF exposure. The exposure assessment of human body to the stray electromagnetic fields emitted by WPT devices is a critical issue which can limit the wide adoption of this technology [6]. WPT devices must be designed to comply with the standards and they must not have hazardous effects on the human health.

Conclusion

With WPT, energy can be transferred wirelessly from an energy storage to consuming devices such as cell phones, laptops, vehicles, RFIDs, and sensors. WPT is still in developing stage and research is going in various countries to bring WPT into a practical environment. It can bring a revolution in energy resources and eliminate traditional charging systems in place today.

The Wireless Power Consortium (WPC) and the Alliance for Wireless Power (A4WP) aim at maximizing the use of WPT technologies. WPC was found in 2008 as cooperation between American, European, and Asia companies to develop global standard for the inductive charging technology. WPC now has a membership of over 220 companies worldwide. They introduced the Qi standard which has brought wireless charging technology for portable electronic devices to the commercialization stage. A4WP was formed in 2012 as an independent organization composed of global wireless power and technology industry leaders focusing on WPT technology [7].

More information about wireless power transfer can be found in *Wireless Power Transfer*, the first journal dedicated to publishing original research and developments on WPT, and several books on the topic available at Amazon.com.

REFERENCES

[1]. S. R. Nelatury, "Wireless power transfer," in M N. O. Sadiku, *Elements of Electromagnetics*. New York: Oxford University Press, 7th ed., 2018, Section 9.10, p 457.

[2]. R. Mehrotra, "Cut the cord: wireless power transfer, its applications, and its limits," http://www.cse.wustl.edu/~jain/cse574-14/ftp/power/index.html

[3]. M. Kesler, "Highly resonant wireless power transfer: safe, efficient, and over distance," http://witricity.com/wp-content/uploads/2016/12/White_Paper_20161218.pdf

[4]. M. Christiano, "Introduction to wireless power transfer," October, 2016, https://www.allaboutcircuits.com/ technical-articles/introduction-to-wireless-power-transfer-wpt/

[5]. C. H. Kwan, D. C. Yates, and P, D. Mitcheson, "Design objectives and power limitations of human implantable wireless power transfer systems," *Proceedings of the IEEE Wireless Power Transfer Conference (WPTC)*, 2016, pp. 1-4.

[6]. R. Pinto, V. Lopresto1, and A. Genovese, "Human exposure to wireless power transfer systems: a numerical dosimetric study," *Proceedings of the 11th European Conference on Antennas and Propagation*, 2017, pp. 988-990.

[7]. A. Madhja, S. Nikoletseas, and T. P. Raptis, "Distributed wireless power transfer in sensor networks with multiple mobile chargers," *Computer Networks*, vol. 80, 2015, pp. 89–108.

About the Authors

Matthew N.O. Sadiku (sadiku@iee.org) is a professor at Prairie View A&M University, Texas. He is the author of several books and papers. He is an IEEE fellow. His research interests include computational electromagnetics and computer networks.

Sudarshan R. Nelatury (srn3@psu.edu) is an associate professor at Penn State University, The Behrend College, Erie, Pennsylvania. His teaching and research interests lie in electromagnetics and signal processing.

Sarhan M. Musa (smmusa@pvamu.edu) is a professor in the Department of Engineering Technology at Prairie View A&M University, Texas. He has been the director of Prairie View Networking Academy, Texas, since 2004. He is an LTD Spring and Boeing Welliver Fellow.