Real Time Smart Wireless Power Transfer System for Small Scale Applications using Aerial Projector

S. Christo Jain
Asst.Professor,Dept of ECE,
KS Institute of Technology
Bangalore-62,India

Manju, PhD
Professor,Dept of Telecom,
KS Institute of Technology,
Bangalore-62,India

P. N. Sudha, PhD
Professor & HOD,Dept of ECE,
KS Institute of Technology,
Bangalore-62,India

ABSTRACT
The excessive usage of portable devices is driving the need of development of wireless transfer technology So we are motivate to develop and design Real time smart power transfer system using an Aerial projector. In this system, Wireless power transfer system has been intended by means of a Radio wave basis which hand on the electrical energy as of a power source to a load using the advantage of free space. The homeward bound voltage can be improved to drive the right and proper load. This mode is instigated for short and mid-range application rather than long distance application. The proficiency of power transfer can be enhanced to a prodigious degree along with the difficulties of numerous types of drops that incur in inductive coils (Non-Radiative methods of WPT) are used can be overcome, thus improving the overall efficiency of the system. Friss Transmission Formula is applied to calculate the gain and operating frequency of System. The Omni-directional nature of the radiative power emission used in this model support to improve the overall efficiency and load capacity. The system proves to be maintenance free, cost effective and hassle free.

Keywords
Aerial, Radio wave , Friss Transmission Formula

1. INTRODUCTION
With the growing demand for charging of wearable devices and Internet of Things devices anywhere without wires, wireless power transfer (WPT) technologies are being studied intensively around the world. Therefore, in recent years, most research in this area has focused on high efficiency and long charging distance. Many industrial commercial applications must be able to provide precise voltage with highest possible efficiency. But in most of the cases output voltage varies with coupling co-efficient and load conditions. In the case of inductive power transfer (using resonators) which works by creating an alternating magnetic field (flux) in a transmitter coil and converting that flux into an electrical current in the receiver coil.

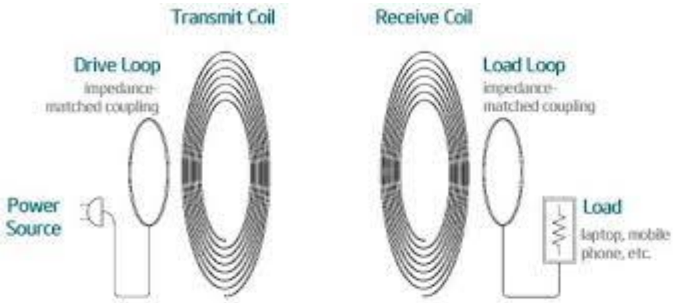

Fig.1. WPT using Inductive Power Transfer

Depending on the distance between the transmit and receive coils, only a fraction of flux generated penetrates into the receiver coil, more the flux reaches the receiver better will be coils coupled. However such a very high coupling factor improves transfer efficiency but there might loses due to heating. In order to overcome these problems we go for Wireless Power Transfer using Radiative Technology. Here the radiative power generated from a microwave source can be can be transmitted with the help of antenna which propagates through the medium in the form of electromagnetic wave, the receiving antenna captures the received power which could be utilized by the load. Generally such radiative power transfer methods are preferred for long distances, but due to omni-directional nature of the radiative power emission, the energy efficiency of power transmission is low. Thus if the same method is implemented for short and mid-range application instead of long distance application the efficiency of power transfer can be improved to a very large extent as well as the problems of various kinds of loses that incur if inductive coils (Non-Radiative methods of WPT) are used can be overcome, thus improving the overall efficiency of the system.

2. RELATED WORK
Horn antenna fed by a linear array of 4 H-plane coupled rectangular waveguides instead of a single horn antenna. As a result of this the gain is increased by around 3-dB. This type of antennas can be used as high gain, high power, but restricted to radar based application only. The waveguide array can be chosen as a linear or two- dimensional array, hence a great advantage here is the flexibility in the dimensions of the antenna[1]. Wireless power transmission system for a Micro Aerial Vehicle using microwave beam. It is basically a tracking system, which receives the pilot signal of microwave sent from the MAV and analyzes its current position using the phase difference. The transmitter system uses a microwave beam from five horn antennas formed by using a phased array system. On the receiver end eight rectennas were arrayed and connected in parallel minimizing the array pitch to drive the required load[2]. Wireless power transfer system using a microwave active phased array developed to transmit electrical energy from a power source to an electrical load without artificial interconnecting conductors. A horn antenna of 2.45 GHz is designed and simulated in this paper. The results show that the horn antenna has a high gain and suitable in the field of high power microwave applications. In this proposed system a transmitter beam is formed to increase the conversion efficiency, as for the purpose of long distances a single microwave power source will not be sufficient. The formation of the transmitter beam will increase the overall efficiency of the system and makes it more suitable for long distance communication.[3] . Basic corrugated structure is simulated to reduce back and side lobe before designing an array synthesis horn antenna.

The proposed model uses array synthesis horn antenna for high power microwave applications. Four horn antennas are arrayed in this proposed model to divide this high power and the array is extended on an aperture, in this case there is suppression of split mode by controlling the vertical junction as a result minor lobe is decreased. And therefore the proposed antenna structure would be appropriate for high power microwave applications.[5]. Magneto-inductive research activities being conducted on wireless power transfer and mainly focuses on maximum power transfer and maximum efficiency principles as the two main operating principles. The differences of these two approaches are described in terms of energy efficiency and transmission distance capabilities. It also uses maximum energy efficiency principle in 2-coil system and they are more suitable for short and mid range applications and the use of maximum power transfer principle for 4-coil system for the purpose of increasing the transmission distance. The article also deals with the various drawbacks and trade-offs that come into picture when wireless power transfer occurs using inductive coils.[15]. Control scheme for a closed-loop wirele WPC system for wireless charging of mobile devices. Generally, WCS need precise output voltage and current with the highest possible efficiency. proposed WPC implemented at 6.78 MHz using loosely coupled series-series resonant coils.[17].A WCS contains a high frequency power source, a wireless transformer/coupler, a rectifier and the load. The wireless transformer/coupler is the main element of the WCS, and the power source and rectifier design are all dependent on its design. For a two coil type wireless transformer, the maximum efficiency is limited by the coupling coefficient which rapidly decreases with increasing distance between the primary and secondary coils.[18].

As per the literature survey the newest technologies rely on inductive coupling techniques to transmit power between transmitting and receiving coils. The frequency at which the device transfers power between the transmitter and receiver is dependent on the size of the coils. The small transmitting and receiving coils able to transfer high frequency signal and also used Wireless Power Transfer using Radiative Technology. In this radiative method power generated from a microwave source can be transmitted with the help of antenna which propagates through the medium in the form of electromagnetic wave, the receiving antenna captures the received power which could be utilized by the load. Generally such radiative power transfer methods are preferred for long distances, but due to omni-directional nature of the radiative power emission, the energy efficiency of power transmission is low. Thus if the same method is implemented for short and mid range application instead of long distance application the efficiency of power transfer can be improved to a very large extent as well as the problems of various kinds of loses that incur if inductive coils (Non-Radiative methods of WPT) are used can be overcome, this wil improve the overall efficiency of the system.

3. PROPOSED SYSTEM

The excessive usage of portable devices is driving the need of development of wireless transfer technology and this WPT eliminates the need for wired devices to be tethered to wall plugs during charging. The proposed system uses the radio waves for the purpose of wireless power transfer. The radio waves are more preferred in this proposal for short and mid range purposes.The major highlight in the proposed system is the use of free space for the transmission of radio wave. The advantage of this system is radio wave will not strongly absorbed by the free space, as a result the loads better equipped with sufficient power with reduced attenuation and power losses.

Wireless Short and Mid-range System

In this scheme, wireless power transfer system has been designed using a Radio wave source which transmits the electrical energy from a power source to a load without artificial interconnecting conductors. The block diagram of the proposed system is shown below in Fig.2. On the transmitting end the electrical signals generated from the RF source is transmitted with the help of Transmitting Antenna. The transmitted electrical signals on the receiving end is captured using Receiving Antenna and is de-modulated to tune to required frequency as required by the load. The received voltage can be amplified to drive the suitable load.

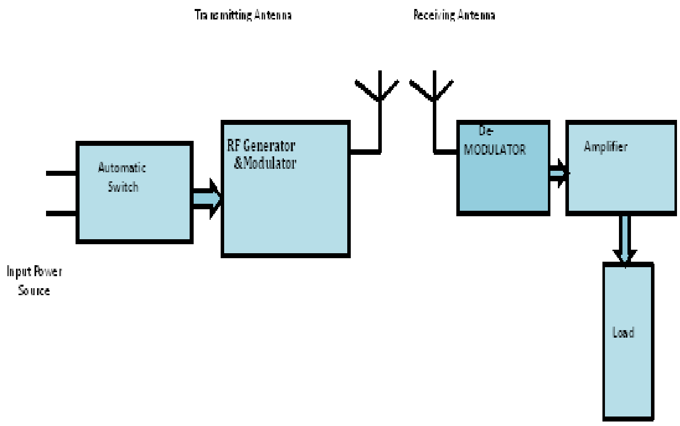

Fig.2. Block diagram of the proposed System

4. EXPERIMENTAL RESULTS AND DISCUSSIONS

After the set up was made as shown in the block diagram, analysis was made regarding the amount of power that got transmitted and received. The experimental set up is as shown in the figure below (Fig.3 and Fig.4). Two case study was made by using different antennas at transmitting and receiving end, in order to check if the power got transferred onto the receiving end without the use of wires. The two cases are:

i. Wireless power transfer that was achieved by using Yagi-Uda Antenna on both transmitting as well as receiving end.

ii. Wireless power transfer that was achieved by using Yagi-Uda Antenna on Transmitting end and monopole Antenna on receiving end.

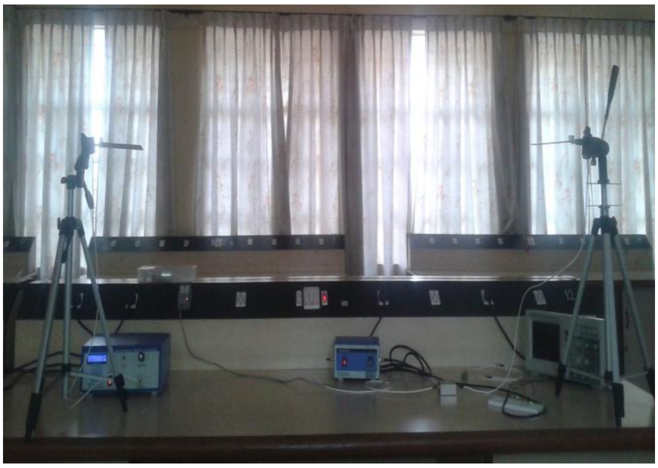

Fig.3. Experimental setup that depicts WPT using Yagi-Uda Antenna on both Transmitter and Receiver end.

Fig.4. Experimental setup that depicts WPT using Yagi-Uda Antenna on Transmitter end and Monopole Antenna on Receiver end

The power from the source about 1.2 V is transmitted for the purpose of analysis using Yagi-Uda Antenna in the first case and on the receiving end after amplification about 13 V was received by another Yagi-Uda Antenna. From the figure.3. it is evident that a load like LED was driven using received voltage. The same process was repeated with Monopole Antenna on the receiving end and voltage that was received after amplification was around 9 V.

The experimental details are tabulated in the table below :

Tx Antenna	Rx Antenna	Tx Voltage	Rx Voltage	Amplifier o/p	TxFrequency
Yagi Uda	Yagi Uda	1.2 V	1 V	13V	2.2 G Hz
Yagi Uda	Monopole	1.2V	.75 V	9V	2.2 G Hz

The gain, operating frequency can be calculated using the Friss Transmission Formula which is given below

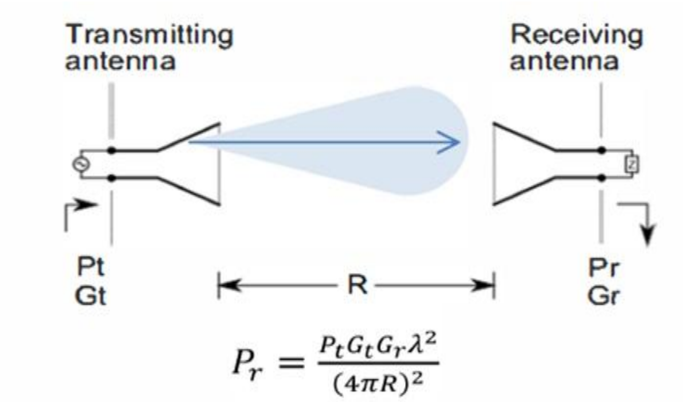

Fig.5. Friss Transmission Formula

where, Pt is the transmitting power, G is the antenna gain and R is the distance between the two antenna.

The radiation pattern for case (i) is as shown in Fig.6.

5. CONCLUSION

To conclude, the proliferation of portable wireless communication devices such as mobile phones, tablets and other devices in the recent decades is currently driving the development of wireless powering and charging technology to eliminate the need for these devices to be tethered to wall plugs during charging. Using a far field method for shorter distances as the directivity is more the overall efficiency with respect to power transmission is enhanced.

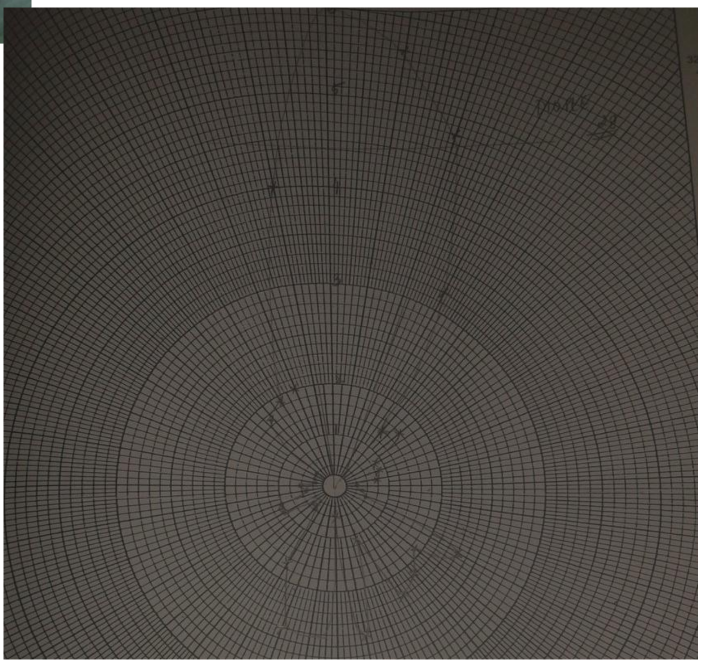

Fig.6. Radiation Pattern for case (i)

The concept of wireless power transfer can be used to power various devices at home as, it can be used as a part of home automation as well as shown in Fig.7. One clear advantage of home automation is the unmatched potential for energy savings, and therefore cost savings. Cell phones, laptops and other mobile devices could function without ever having to be plugged in. We can also say that wireless power even has the potential to solve much of the renewable energy issues we face. Higher level applications could be the use of this concept to charge the EV's that is the Electric Vehicles and also WPT could be used to drive the street lights, traffic signal lights as well. To conclude The future of energy is the untethering of devices from a power cord to realize the freedom of mobile technologies.

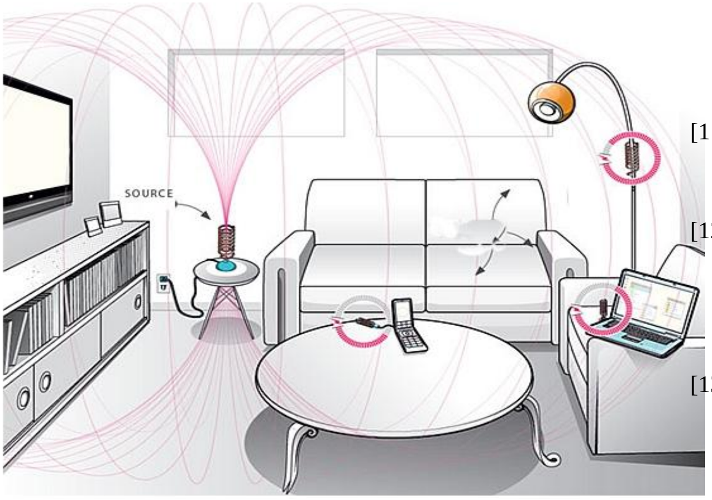

Fig.7. Figure that illustrates the use of WPT at home

6. REFERENCES

[I] R.Marino, R.Mashiah, H.Matzner, E.Levine, "Investigation of a MultiWaveguide Fed Horn Antenna", Journal of Wireless Networking and Communications, 2012.

[2] Eri Shimane, Alseny DiaIlo, Takashi Komaru, Kimiya Komurasak, Yoshihiro Arakawa, "Wireless Power Transmission system for a Micro Aerial Vehicle", 2012.

[3] S. Sheik Mohammed, K. Ramasamy, T. Shanmuganantham, "Wireless Power Transmission - A Next Generation Power Transmission System", Internatinal Journal of Computer Applications. Number 13 - Article 18,2010.

[4] V. Surducanl, E. Surducanl, R. Ciupa2 and C. Neamtul, "Microwave Generator For Scientific And Medical Applications", 2013.

[5] Jae-Min Lee, "Design of Array synthesis horn antenna for high power microwave applications", PIERS Proceedings, Russia, 2012 .

[6]http://www.rfcafe.comlreferences/electrical/waveguide.htm . accessed on Nov 10, 2015.

[7] D. V. Giri, "High-power Electromagnetic Radiators: Nonlethal Weapons and Other Applications" Harvard university press. England, 2004.

[8] C.A. Balanis, "Antenna Theory Analysis and Design, Second Edition", 1997, pp. 86.

[9]http://www.antennamagus.comlindex.php. accessed on Nov 10,20 15.

[10] [Ojha13] Ojha, Shailendra Singh; Singhal, P.K.; Agarawal, Anshul; Gupta, Akhilesh; 2-GHz Rectenna For Wireless Power Transmission, Current Research in Engineering, Science and Technology (CREST) Journals Vol 01 Issue 01 March 2013, http://www.crestjournals.com/CREST/issue-1/CREST-ENTC-RP-1.pdf

[11] [WikiWP] Wireless Power, http://en.wikipedia.org/wiki/Wireless_power Wikipedia overview of wireless power.

[12] [Choudhary11] Choudhary, Vikash; Singh, Satendar Pal; Kumar, Vikash; Prashar, Deepak, Wireless Power Transmission: An Innovative Idea, International Journal of Educational Planning & Administration. ISSN 2249-3093 Volume 1, Number 3.

[13] [Rault13] Rault, Tifenn; Bouabdallah, Abdelmadjid; Challal, Yacine; Multi-hop wireless charging optimization in Low-Power Networks, IEEE Global Communications Conference, 2013,http://hal.archives-ouvertes.fr/hal-00871198/

[14] C.-G. Kim, D.-H. Seo, J.-S. You, J.-H. Park, and B. H. Cho, "Design of a contactless battery charger for cellular phone," IEEE Transactions on Industrial Electronics., vol. 48, no. 6, pp. 1238–1247, Dec. 2001.

[15] S.Y.R. Hui, A Critical Review of Recent Progress in Mid-Range Wireless Power Transfer, 2013 IEEE. Personal use is permitted. For any other purposes, permission must be obtained from the IEEE by emailing pubs-permissions@ieee.org

[16] Warayut Samakkhee, Kittisak Phaebua and Titipong Lertwiriyaprapa, Design of a Low cost and Simple Wireless Battery Charging by using Repeater Antenna Technique, 978-1-4673-9149-8/15/ ©2015 IEEE

[17] Tae-Dong Yeo, DukSoo Kwon, Seung-Tae Khang and Jong-Won Yu, Design of Maximum Efficiency Tracking Control Scheme for Closed Loop Wireless Power Charging System Employing Series Resonant Tank., IEEE TRANSACTIONS ON POWER ELECTRONICS, VOL 00, NO 00, JULY 2015

[18] Shuo Wang1, *Student Member*, David G. Dorrell2, Inductive Charging Coupler with Assistive Coils, 0018-9464 (c) 2015 IEEE.