Efficiency Assessment for Indoor Microwave Wireless Power Transmission Systems

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Abstract

Keeping the power hungry, smart wireless communication devices up and running became a challenging issue due to the need for continuous supply of battery power required for fulfilling all the functions. Since the battery capacity is limited, it needs to be recharged as often as possible. Hence, rather than spreading wires all around, it could be a promising solution to cover the medium with electricity wirelessly or create charging points around residential premises based on Wireless Power Transmission technology.

The work presented here involves investigation of the possibility of providing wireless charging points within a room and analyzing the choice of best frequency and best pulse shape for transmitting power wirelessly within a distance smaller than 10m in order to charge batteries of such devices as smart phones. The parameters that can be adjusted to maximize efficiency of wireless power transmission and the relationship between the choice of frequency, pulse shape and distance will also be investigated. Antenna design will be left as a subject for future study.

1. INTRODUCTION

Wireless Power Transmission (WPT) was first introduced by Nikola Tesla in the early 19th century [1]. His experiments were a great step toward a new generation of electricity transmission. Although his works didn't achieve an appropriate result because of low efficiency, it was a beginning for scientists and researchers to find a more efficient way for WPT. There are three different types of WPT techniques in the technological literature, namely, Laser Beam Wireless Power Transmission (LB-WPT), Near Field Wireless Power Transmission (NF-WPT) and Far Field Wireless Power Transmission (FF-WPT).

Due to the characteristics of the laser beam, the LB-WPT method needs a line of sight (LOS) between the transmitter and the receiver in order to enable the laser beam produce electricity at the photocell receiver. National Aeronautics and Space Administration (NASA) has done an experiment to energize an unmanned aircraft by lighting a laser beam to a photocell plate installed on the aircraft in 2003 [2]. NASA is currently working on the project of energizing satellites from earth using any suitable WPT technology.

In this work we are concentrating on improving efficiency and coverage flexibility of MWPT method with reference to the block diagram presented in Fig. 1.

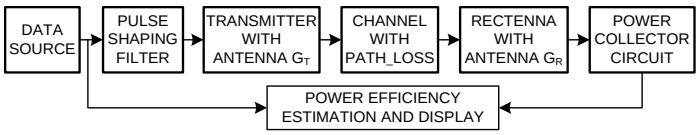

Fig. 1: Test-Bed for MWPT over indoor transmission medium.

1. MWPT SYSTEM MODELLING AND SIMULATION

System modelling and simulations using SIMULINK will be performed in order to validate the MWPT in an indoor transmission medium and assess transmission efficiency.

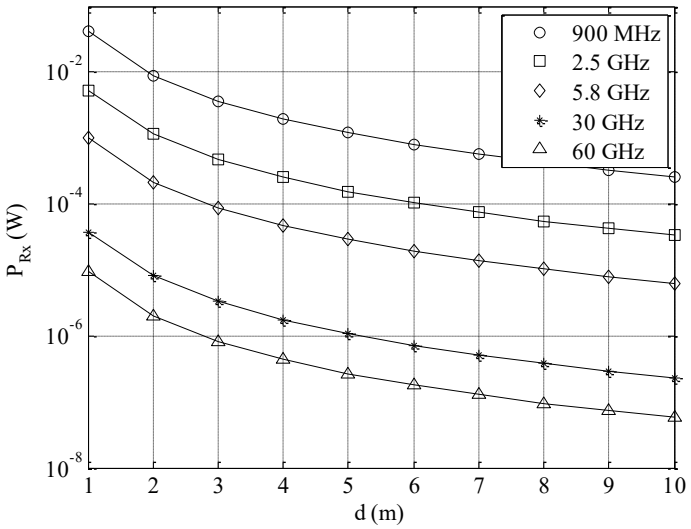

Fig. 2: P_{Rx} versus distance (d) graph for different frequencies of operation for rectangular pulse shape with [-0.5,0.5] amplitudes.

5. CONCLUSIONS

Due to the need to supply increasing amounts of power in order to implement sophisticated functions such as video processing and rendering and wideband data communication, there is an urgent need to charge batteries of electronics communication devices such as smart phone very often. Therefore, providing wireless charging points suitable for all sorts of electronics device batteries can be a smart solution. This work has been done in order to prove by simulations that design and implementation of such a system is possible. The simulation results have shown that, rectangular pulses can carry more power than raised-cosine pulses. It was also concluded that duty cycle of the rectangular pulses has no effect on transmission efficiency. It was also clear from the results that, without using highly directional antennae, the received signal power will not be sufficient to charge a typical smart phone battery. The availability of a strong LOS has been shown to improve system efficiency significantly.

6. REFERENCES

[1] Nikola Tesla, "Apparatus for transmitting electrical energy," USA Patent 1119732 (1914).

[2] NASA, "Beamed laser power for UAVs," Dryden Flight Research Center (2003).