

ABSTRACTS (MASTER THESIS)

Study on a harmonic-based retrodirective system for microwave power transfer

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Introduction

Recently, wireless power transfer (WPT) techniques has attracted much attention. Microwave power transfer, one of the type of WPT, has some feature that is able to transfer with a long distance. Some applications such as a small airplane or smartphone have been proposed and developed. A Retrodirective system can be used for beam steering in a microwave power transfer system. The target sends a pilot signal, and microwaves are radiated from the direction of arrival (DOA). In this paper, we proposed a harmonics-based retrodirective system (HBRS). Reradiation harmonics from rectennas are adopted for the pilot signal in the HBRS. As such, it is not necessary to prepare the pilot signal source. In this paper, we constructed an HBRS which consist from a rectenna, a DOA estimating system, and a transmitting system.

The system configuration and the experimental results

At first, the harmonic re-radiation characteristics of a $\lambda/2$ dipole rectenna was measured. Based on the re-radiation characteristics, we constructed an interferometry estimation system of second-harmonic DOA. The phase difference between two antennas were detected by phase comparator. Experimental results revealed that the detected directions of second-harmonic DOA were almost similar to a pilot signal DOA. The measurement errors of DOA were analyzed by electromagnetic simulation and were found to be caused by mutual coupling of the harmonic receiving antennas. In order to decrease these errors, correction function was introduced to the system. As a transmitter, a phased array antenna with 2 thin horn antennas was designed. The beam steering range of this phased array antenna was 25° . From the rectenna, the DOA estimating system, and the phased array antenna, integrated experiments was conducted. Figure 1 shows the picture. The results are showed in Figure 2 and Figure 3. Compared to the results without tracking, the rectenna was powered in a wide range with the HBRS tracking. Compared to the results with hand tracking, the results of the HBRS were almost similar. In addition, this paper proposed the method for estimating the initial direction of a target. In this method, initial power is transmitted in wider directivity by using one element of array antenna. This method was verified by experiments. Finally, the HBRS system adopted for experiments of powering a small airplane. However, The error of the DOA estimation differed from the previous experimental results with one rectenna because of the obscurity of re-radiation characteristics. In order to construct an HBRS, it is necessary to design the system entirely including rectennas.

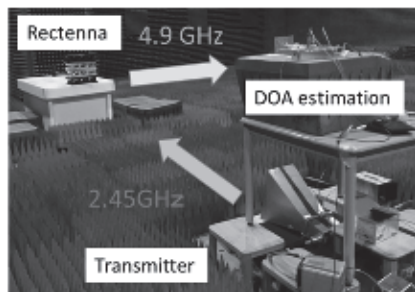


Figure 1.
The experimental system of HBRS.

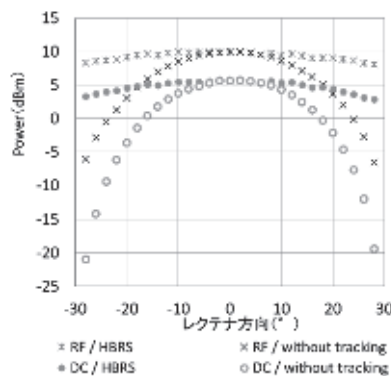


Figure 2. Experimental results without tracking and with HBRS.

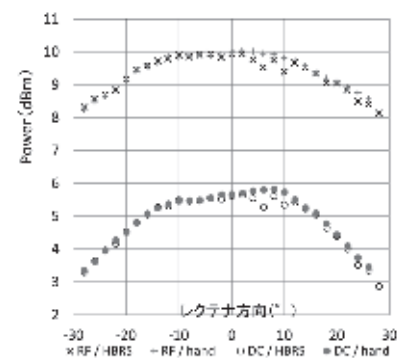


Figure 3. Experimental results with HBRS and with hand tracking.