ABSTRACTS (MASTER THESIS)

Study on Transmitting Antennas in Microwave Wireless Power Supply System to Vehicle Roof

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The thesis presents microwave wireless power supply systems for electric vehicles using a new charging method unlike the conventional methods adopted in our previous studies. In the new method, receiving antennas are mounted on the roof of vehicles, and they receive microwave power radiated downward from transmitting antennas, which are located at several meters in height. Three requirements have to be met when we apply this method to the charging system: (i) the transmission efficiency should be high, (ii) the undesired radiation should be well suppressed under 1 mW/cm^2, and (iii) flat-topped uniform power distribution should be on the surface of receiving antennas. In this thesis, transmitting antennas are studied by computer experiments in order to meet these three requirements. First, electromagnetic analyses of six kinds of single element antennas and a two-dimensional array antenna comprising 169 horn elements were conducted at the 5.8 GHz ISM band by using HFSS. Single element antennas were unable to meet any of those requirements; on the other hand, a two-dimensional array antenna with the tapered amplitude excitation showed good results in achieving high transmission efficiency of around 99% and lowering side lobe levels. Then, we designed one/two dimensional transmitting array antennas comprising patch elements at the 2.45 GHz/5.8 GHz ISM bands. The excitation phases and amplitudes were optimized by using genetic algorithm (GA) in order to find out their optimum combination that yields flat-topped radiation patterns. The numerical results indicate that the optimized phases and amplitudes can form flat-topped patterns. To validate the practicability of flat-topped patterns, we also conducted beam-forming experiments using a phased array antenna at 5.8 GHz. We successfully demonstrated that the measured radiation pattern was consistent fully with that of simulation results. Three-dimensional simulations using finite-difference time-domain (FDTD) method were also executed to clarify the propagation and scattering behavior of electromagnetic waves, as shown in Figure 1.

References

[1] Y. Kubo, N. Shinohara, and T. Mitani, “Development of a kW Class Microwave Wireless Power Supply System to a Vehicle Roof”, IEEE MTT-S International Microwave Workshop Series on Innovative Wireless Power Transmission: Technologies, Systems, and Applications (IMWS-IWPT 2012), FRI-G-1, Proceedings pp.205-208, Kyoto, Japan, May 10-11, 2012.

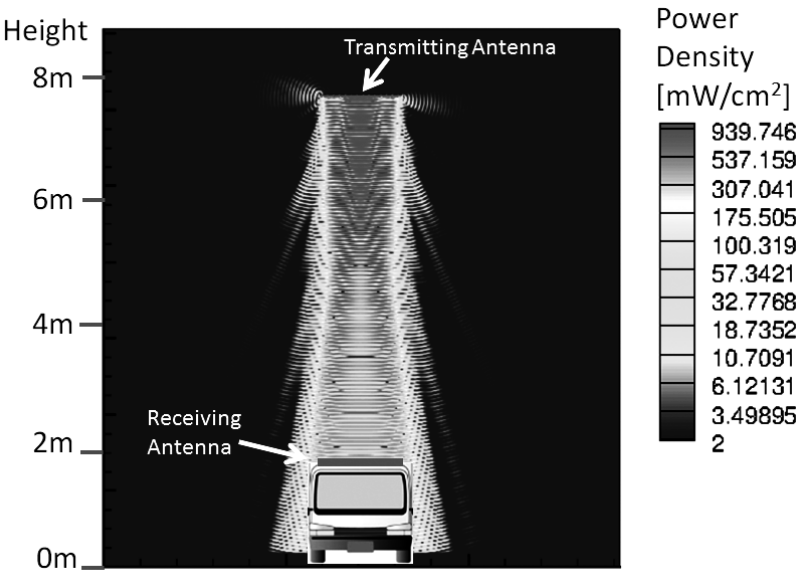

Figure 1. Three-dimensional electromagnetic simulation from the transmitting array antenna to the vehicle roof.