Research of a power transmitting and receiving system on microwave wireless charging for an electric vehicle

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Our research group has been studying on wireless power transmission systems by microwave for electric vehicle charging. In these systems, microwave power is transmitted from slot antennas on the ground to rectennas on the bottom of the vehicle. The rectenna is composed of a patch antenna and a rectifying circuit. The rectennas receive microwave and rectify it to DC power, and DC power is supplied to capacitors. The objective of the present study is to improve charging efficiency.

We found out if enough antennas covered the slot antenna's radiation area, the transmitting efficiency remained only 50% in simulation. Then, we tried to improve transmitting efficiency among transmission and receiving antennas. We used slot antennas of 45cm long and a miniature car, to simplify the experimental system. We designed a slot antenna and a patch antenna having high performance under proximally location. Antennas' performance gets worse other antennas' influence in proximally location. It caused by change of impedance of the transmitting space. So, we changed the antennas' input impedance and output impedance by shifting slot position and feeding position. According to this improve, transmitting efficiency improved to 53.7% from 47.4% in simulation.

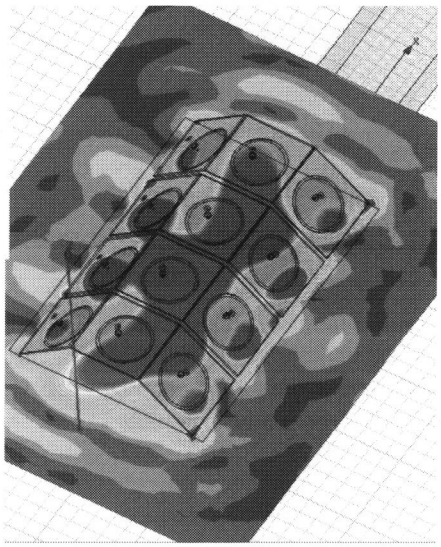

Figure 2. Simulation result of microwave propagation between transmitting and receiving antenna.

Next, we invented receiving unit with obliquely placed patch antennas (Fig.1). The microwave from the slot antenna expands in a radial fashion in near field, and enters the side of patch antennas obliquely. But it can't be received well, because of patch antennas' directivity. Therefore, we set antennas of side part at an angle to match the receiving directivity of patch antennas and radiation directivity of a slot antenna. Using this receiving unit, transmitting efficiency goes up to 84.4% in simulation (Fig.2).

Based on the simulation, we carried out an experiment, and get 76.0% of transmitting efficiency. As a result, the overall charging efficiency from waveguide to capacitor improved to 33%, 12% higher than that of the last experiments.

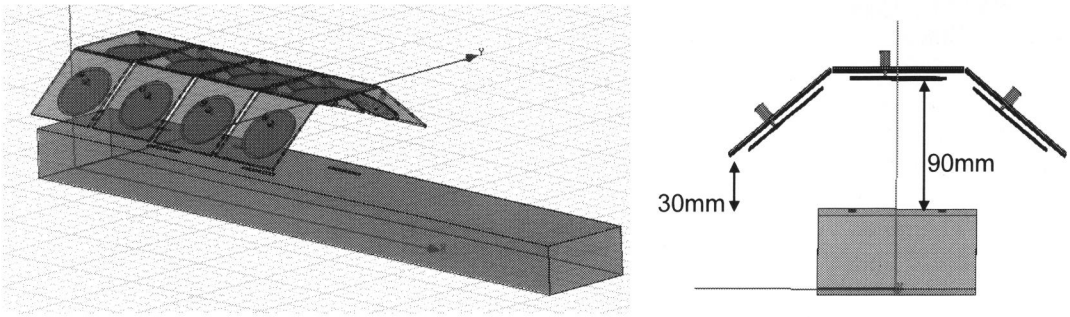

Figure 1. Oblique receiving unit (rectenna) which increases the transmitting efficiency of 84.4%