Development of highly-efficient microwave wireless charging system for electric vehicle

Junichiro Kojima
Laboratory of Space Radio Science, RISH, Kyoto University

Our research group has been studying on wireless power transmission system and applying this system for charging an electric vehicle these days. To charge an electric vehicle, microwave power is transmitted from the slot antennas on the ground to the antennas called rectennas on the bottom of the vehicle. Rectennas receive microwave and rectify it to DC power and this DC power is stored in capacitors. The objective of the present study is to improve charging efficiency. We introduced following three new devices.

First, we improve slot antennas. Characteristics of slot antennas get worse near some substances such as metal. In the conventional study, slot antennas used to be designed in free space, in this study, designed under rectennas instead so that slot antennas would be optimized in this charging environment and radiation efficiency goes up to 99.8%, 5.4% higher than that designed in free space.

Second, we downsize rectifiers of rectennas and improve their efficiencies. Rectifiers are composed of diodes, λ/4length microstriplines, output stubs and Wilkinson dividers. According to the results of experiments, longer output stubs make these rectifiers run with high efficiency even if microstriplines are shorter than λ/4. Owing to this characteristic, we succeed in downsizing rectifiers. Besides, last year our research group found that appropriate output phases of Wilkinson dividers result in higher efficiencies of rectifiers. Taking advantage of this, rectifiers come to run with higher efficiency up to 58% at 20W input.

Third, we introduce DC-DC converter. Input impedance of capacitors changes associated with their voltages, on the other hand, output impedance of rectennas should be stable to make them run with high efficiency. DC-DC converter between rectennas and capacitors keep output impedance of rectennas stable.

These three devices lead to the improvement of charging efficiency. As a result, charging efficiency from waveguide to capacitor goes up to 22%, 6% higher than that of last experiment.

REFERENCES

[1] Tetsuya Miyagawa, Development of a small and high power rectenna for a wireless power distribution system in a building (in Japanese), Master thesis of Kyoto University, 2006