論文の内容の要旨

A Study on Safe Power Transmission Using Two-Dimensional Waveguide

（二次元導波路を用いた安全な電力伝送の研究）

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This thesis reports on a research project that aims to develop a safe, up to 10-watt available, and tabletop-size wireless power transmission system based on two-dimensional waveguide power transmission (2DWPT) technology. Portable electronic devices having a special receiver coupler can be charged by just putting them on the 2-D waveguide surface. The tabletop-size interface is significantly larger than typical wireless charger pads for mobile phones, which have recently become commercially available.

If the whole surface of a table is covered with the 2DWPT system, electronic devices just placed wherever on the table surface can be charged and users do not have to be aware of where the charging spot is. Moreover, any items usually placed on the table can be electronized. For example, if a coffee cup had a small display and a receiver coupler, it could tell today's weather to the user.

In 2DWPT system, microwave is confined in the waveguide sheet and generates evanescent field around the sheet surface. Special receiver couplers put on the sheet

surface can extract the microwave across the sheet surface. This scheme was originally proposed by Yamahira et al. in 2006.

In this work, a trade-off relationship between selectivity and efficiency of the scheme is pointed out, and a 2DWPT system is designed to achieve high selectivity while the efficiency remains practically high. The term "selectivity" expresses the contrast between the power extracted by a special coupler and the power unintentionally extracted by other general objects. The most important contribution of this work is to improve the selectivity by modifying the waveguide sheet to have a thick surface insulator layer and developing a high-quality-factor (high-Q) resonant coupler.

As an experimental result, power transmission to a 6.5×3.7-cm^2 coupler at 40% efficiency on a 56×39-cm^2 sheet was achieved. The efficiency was defined as the ratio of dc output power of coupler to the microwave input into the sheet.

The safety was also confirmed by measuring specific absorption rate (SAR), the power absorption per unit mass of human tissue. The maximum localized SAR was less than 2 W/kg, the limit provided in the guideline by The International Commission on Non-Ionizing Radiation Protection (ICNIRP).

This thesis also presents a complete 2DWPT system development including designs of phased array microwave source, waveguide sheet, receiver coupler, and microwave-to-dc converter circuit. The phased array microwave source enables controlling standing wave in the sheet and stable power transmission independent of the receiver position.

The results presented in this thesis indicate the feasibility of the large-area 2DWPT system as above mentioned.