ABSTRACTS (MASTER THESIS)

Fundamental Study of a Small-Size and Large-Effective-Aperture Antenna by using Spherical Dielectric Resonator

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Recently, another type of the Solar Power Satellite (SPS) system, "ubiquitous SPS system" has been proposed. In this system, microwave energy from the space is distributively received and directly supplied for social infrastructures, such as street lights and base stations of mobiles. In the ubiquitous SPS system, power density is restricted to 10 W/m^2 for human safety. Limited power density requires antennas with large directional gain to receive enough power for devices. It causes problem of the miniaturization of antennas, because the directional gain is proportional to the physical size in the case of aperture antennas. To solve this problem, this research focuses on spherical wave expansion of a plane wave as a new method of realizing compact high-gain antennas. Spherical wave expansion is used for the analysis method of small antennas, directional antennas and antenna measurement, but it is not used for the design method of antennas yet. Therefore, in this paper, the design method of compact high-gain antenna based on the principle of spherical wave synthesis is investigated for the efficient microwave power transmission. First, in the present research, we have analyzed the directivity of the synthesized spherical wave, which is obtained by synthesizing a set of spherical waves with the expansion coefficient of a plane wave. The electromagnetic field of each order of spherical wave is given by corresponding order of the spherical Bessel function and the spherical harmonics. Figure 1 indicates calculation results on the directivity of the synthesized spherical wave. Next, we have investigated the structure of a radiation element of synthesized spherical wave. Since wave sources of the synthesized spherical wave are multi-poles, which are put at the same one point, radiation elements with finite size are required in order to realize a practical antenna. For this problem, we have revealed that a spherical dielectric resonator can work as the accurate wave source of a spherical wave with any order mode. Then, we have proposed the multilayered spherical dielectric resonators as a radiation element of the synthesized spherical wave. Synthesized spherical waves are composed of the orthogonal set of the several modes of spherical wave. In order to synthesize these modes, the resonant frequencies of the corresponding modes of the radiation element should be degenerated. For this problem, a prospect of degeneracy is given by the multilayered spherical dielectric resonators. Finally, we have made a homogeneous spherical dielectric resonator and have experimentally measured its resonance characteristics with rectangular waveguide.

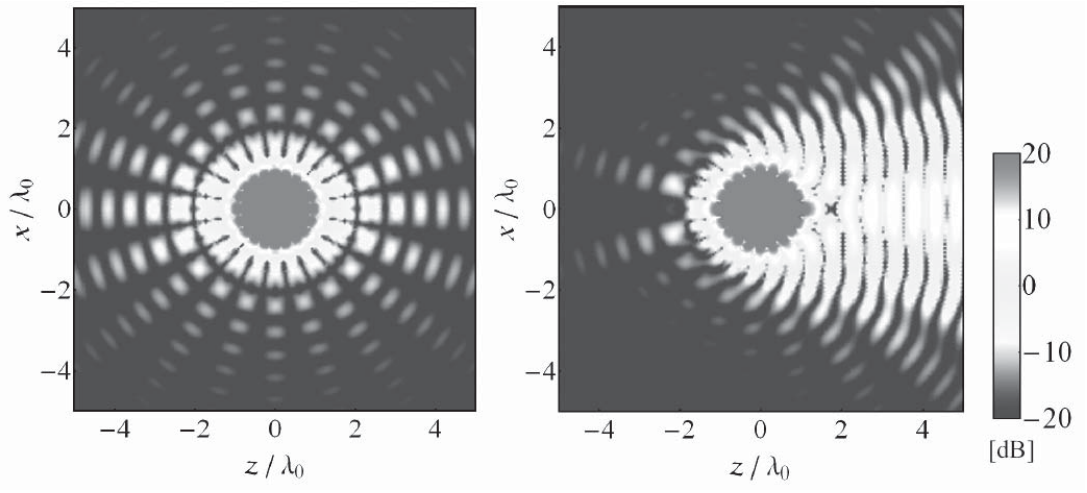

Figure 1. Calculation results on the directivity of the synthesized spherical wave.