Design of 3D Printed Slotted Waveguide Array Antenna Using Neural Network Optimization

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Slotted waveguide array antennas are highly directive antennas usually used for microwave radar applications due to its special properties including high gain, radiation efficiency and power capability. Slotted waveguide arrays are usually made from brazed, machined plates and sheets via precision machining process. However, for millimeter wave systems, typical machining process has insufficient precision and high manufacturing cost. An efficient way to reduce manufacturing complexity and cost is 3D printing technology. In this work, 3D printing technology with a novel conductor coating technique is employed to implement a slotted waveguide array antenna in W-band (75 – 110 GHz) range. Since the slotted waveguide array has relatively complex structure, it involves large number of design parameters. Hence, a neural network algorithm is applied to optimize the overall design.

The design, optimization as well as fabrication of the proposed monolithic W-band slotted waveguide array antenna are discussed. The array consists of 10 slotted waveguides and each waveguide has 10 radiating slots. Center fed coupling waveguide is designed to excite the array. Radiating and coupling slots are optimized to have low side lobe level. The standard W-band waveguide with a flange is added as a feeder to complete the monolithic structure. In order to metalize the inner and outer surface of the waveguide array, non-radiating slots are added on top and bottom surface of the array. The optimization is done using neural network algorithm which optimizes the value of seven design parameters in order to achieve low side lobe level, low back lobe level as well low reflection coefficient value at 78 GHz. The antenna is printed using stereolithography (SLA) and polymer jetting techniques. Room temperature conductor coating is done by Jet Metals' metallization technology. The proposed antenna has 27dB gain and -22dB side lobe level at 78 GHz in the simulation. The effective aperture efficiency is roughly 60%. More details regarding design, optimization and manufacturing will also be presented.