Fixed-Beam Sequentially Rotated Wideband Circularly Polarized Microstrip Patch Array Antenna on a 3D Printed Doubly Curved Surface

Azzam Tabbal, Ghanshyam Mishra and Satish K. Sharma
Department of Electrical and Computer Engineering
San Diego State University
5500 Campanile Drive, San Diego, CA, 92182-1309, USA
E-mail: atabbal91@gmail.com ghanshyam1606@gmail.com and ssharma@mail.sdsu.edu

The 3D printing technology is getting very popular for designing antennas in addition to other industrial applications (A. Castro, B. Babakhani, and S. K. Sharma, "Design and Development of a Multimode Waveguide Corrugated Horn Antenna Using 3D Printing Technology and its Comparison with Aluminum based Prototype", IET Microw. Antennas Propag., 2017, Vol. 11, Iss. 14, pp. 1977-1984). Wideband circular polarized high gain array antennas are highly desired for several wireless and satellite communications (A. Castro and S. K. Sharma, "Inkjet Printed Wideband Circularly Polarized Microstrip Patch Array Antenna on a PET Film Flexible Substrate Material" IEEE Antennas and Wireless Propagation Letters, Vol. 17, No. 1, January 2018).

In this abstract, a fixed-beam sequential rotated circular polarized 4x4 microstrip patch array antenna on a 3D printed doubly-curved surface is proposed for operation in the frequency range of 4.9 GHz to 6.0 GHz which covers 5G communication technology band. Right-hand circular polarization (RHCP) with an axial ratio (AR) less than 3 dB is targeted over the matching bandwidth. The double curved surface based 3D printed array antenna's performance is compared with that of a flat 3D printed surface array antenna. This 4x4 sequentially rotated circular polarized patch array antenna (Figure 1) is designed on both flat and doubly curved surface using 3D printed photopolymer (Verowhite+) substrate (60 mil thick, $\varepsilon_r = 2.86$ and loss tangent = 0.02). This material is used in many 3D printed manufacturing techniques, and allows for high reproducibility of the antenna design. Silver particle ink based conductive metallization will be performed. Two stages of 2x2 subarray is used to generate the 4x4 array antenna. An equal power division based feed network is implemented using 13 quarter wave matching transformers to match microstrip feed lines to the patch impedance, and to provide 90° phase increment as required for sequential rotation (R. R. George, A. T. Castro, and S. K. Sharma "Comparison of a Four Stage Sequentially Rotated Wideband Circularly Polarized High Gain Microstrip Patch Array Antennas at Ku-Band" 11th European Conference on Antennas and Propagation (EuCAP 2017), Paris, France, March 19-24, 2017, pp. 2307 - 2311). Both corporate feed and patch dimensions are optimized for satisfactory array antenna performance on the double curved surface.

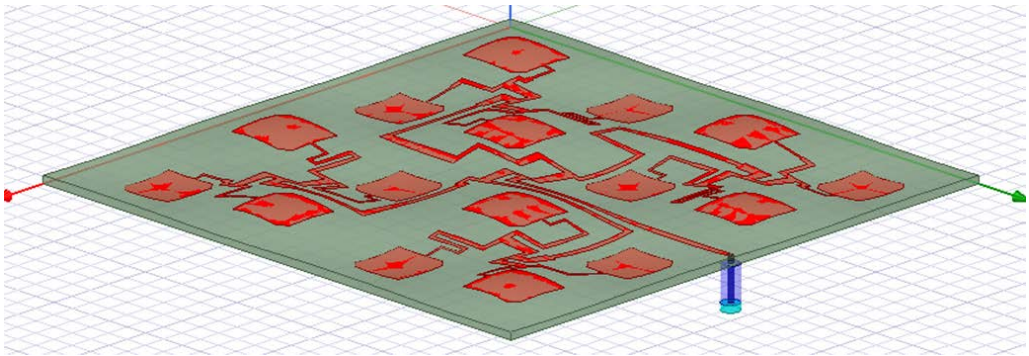

Figure 1: Proposed right hand circularly polarized (RHCP) 4x4 microstrip patch array antenna on doubly curved surface to be fabricated using 3D printing technology followed by silver ink based metallization.