Printed Conformal Series-Fed Patch Array for Radar Sensing Applications

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This report presents a conformal array of series-fed patch subarrays printed using additive manufacturing techniques as transmitter or receiver antennas for automobile radar applications. Current commercial radars mostly utilize microstrip patches etched on rigid PCB boards that result in high fabrication costs and extended lead time. Here, direct ink printing is explored to reduce the fabrication cost and speed up prototyping and mass production. Moreover, since radiation elements are usually located on an RF frontend board separate from DSP board, they could be potentially fabricated on a flexible substrate to allow a conformal form factor.

A planar antenna array comprising four corporate-fed subarrays of 9 series-fed patches with half power beamwidth of 10°×20° was designed, simulated, fabricated and tested for near range sensing. The initial prototype was designed for 10GHz to be scaled down for 76.5GHz in subsequent designs. To achieve a sidelobe suppression of at least 15dB, the aperture distribution was tapered based on a Taylor line-source distribution that was achieved by varying the patch width along the axis of subarray. An equivalent circuit model of the series-fed patch subarray was used to match the voltage distribution in the patches (by varying the width and length sizes) to the amplitude distribution of Taylor line-source distribution. The patch array as well as the corporate feed were printed using a 2.5D aerosol jet printer with a conductive nano-silver ink on a flexible substrate. Radiation and VSWR measurements in anechoic chamber showed a good match compared to the simulated results.

Next, distributed analog phase shifters comprised of analog varactors integrated with printed periodically loaded transmission lines were incorporated to the feed lines of series-fed patch subarrays. The phase shifters were used to steer the main beam to positive and negative angles using applied bias voltage.

Future work involves integrating such additively manufactured series-fed patch array to an FMCW radar evaluation platform in order to perform radar radiation and sensing measurements. This work presents the possibility of leveraging additive manufacturing technologies to reduce the cost, lead time and weight of commercial radars, and introduce new form factors.