Design of a C-band Conformal Series-Fed Phased-Array Antenna for Airborne Synthetic Aperture Radar

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The Applied Physics Laboratory at the University of Washington (APL-UW) has developed a miniaturized along-track interferometry synthetic aperture radar for remote sensing of nearshore ocean and river surface current velocities. The system, which is operated on a Cessna 172 aircraft, consists of two radar transceivers, an inertial navigation system (INS), and six antennas. The antennas are mounted on the outside of the aircraft underneath the fuselage. They are regular flat-panel broadside antennas, and as such they are mechanically oriented in the proper directions. This introduces aerodynamic drag resulting in reduced fuel economy of the aircraft. In addition, the antennas and the related mounting structure weigh two thirds of the entire radar system. Substantial savings in operating costs could be achieved if the antennas were reduced in size and weight and mounted parallel to the fuselage. In addition, this would make it possible to move the entire radar system onto an Unmanned Aerial Vehicle (UAV) resulting in further cost savings.

The required antenna characteristics include a 5-degree azimuthal beam width with a 25-degree beam direction. The elevation requirements are 40 degrees beam width and 60 degrees beam direction. The beam is to be fixed, and proper elevation beam direction is to be achieved by the positioning of the antenna along the aircraft fuselage. The operating frequency range of the antenna is 5.33 GHz - 5.53 GHz.

The design process of a conformal series-fed phased-array antenna is presented along with a comparison of its simulated and measured radiation characteristics. The antenna is an aperture-coupled rectangular patch array with a serpentine line feeding network. It contains an antenna cover and a stripline feeding architecture to ensure grounding of the back plate which is to be attached to the side of the aircraft. Using a dielectric with low tensile modulus and keeping the overall thickness under 112 mil (3.1 mm) it is possible to bend the antenna onto a cylindrical surface with curvatures up to 0.2 m. The array consists of two rows of 15 radiating elements which are manufactured on a 4 in x 22 in PCB.

Preliminary results indicate that the design meets the antenna requirements with an acceptable margin of error. The antennas are currently being manufactured, upon completion of which anechoic chamber measurements will test the simulation data. The radiation characteristics will also be parameterized as the curvature of the antenna is changed.