Quadrifilar Helix Antenna for Enhanced Air-to-Ground Communications

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Communications systems for air-to-ground channels and airborne ground-to-ground relays are often hindered by polarization losses between the airborne antenna and the terrestrial antenna. For man-personal terrestrial communications via a handheld radio, the linear (vertical) polarized whip or flexible stub antenna is traditionally used for its simplicity, ruggedness and size. For airborne platforms that provide hemispherical coverage to a terrestrial region, typical antennas include bent monopole and blade antennas, which also exhibit linear (vertical) polarization. Significant RF losses of over 20 dB can occur due to polarization misalignment when the terrestrial radio antenna is tilted off-axis to the vertical position or when the aircraft in the communications link banks in a "racetrack" flight path in order to provide radio coverage to a desired terrestrial region. In order to ensure a stable communications link, it is critical that these polarization losses be minimized. One method for ensuring this is to replace the vertically polarized antenna on the airborne platform with a low-profile circularly polarized antenna. The uniform 3 dB polarization losses that will occur at all tilt angles due to the vertical-to-circular polarization link can be compensated for in the rest of the communication system design much more easily than the intermittent >20 dB polarization losses that might occur in the vertical-to-vertical polarization link.

A quadrifilar helix antenna is an excellent candidate antenna for the airborne link in such a system, providing hemispherical coverage of ~ 100°, 5 dBi realized gain and adequate bandwidth of ~3-4%. For this study, a compact, self-phased quadrifilar helix antenna will be designed, simulated, fabricated and measured. The effect of the metallic ground plane provided by the aircraft fuselage will be explored through simulation and the ideal standoff distance from this ground plane to ensure maximum realized gain will be determined. The simulation results for this design will be compared with measured prototype data. The details of these simulations and measurements will be presented in full at the 2015 USNC/URSI National Radio Science Meeting.