Design of Dual-band GPS Antennas for Small Controlled Reception Pattern Antenna Applications

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In current warfare, the global positioning system (GPS) has become essential in various applications to navigate accurate locations of moving objects, such as vehicles and ships, using GPS satellites. This system, however, fails to recognize GPS signals when the power of multi-path interferences is stronger than that of the line-of-sight signals. Thus, great efforts have been made to increase the multi-path rejection capabilities of the system using controlled reception pattern antenna (CRPA) that consists of an array of multiple antenna elements. In the CRPA application, received signals on each element are weighted and then combined together as a single port signal to produce an adaptive gain pattern in order to place a null direction to an undesired interference. However, most of the size constraints for CRPA arrays are previously determined as only a few centimeters in diameter for the array's circular ground plate; as a result, the performance of the system may be significantly degraded by pattern distortions and strong mutual coupling among antenna elements. To overcome this performance degradation, a high-dielectric substrate has been applied to many researches to reduce the size of each antenna elements, so that the electrical distance between the elements is maximized in the given constraint. These researches, however, are generally focused on single frequency applications, thus more research is required for multi-band CRPA applications.

In this paper, we propose the design of dual-band antennas operating in GPS L1 and L2 bands for CRPA applications. The proposed structure of each element will consist of two microstrip patches having different resonant frequencies with a coaxial feed structure. Thick ceramic substrates with a high dielectric constant will be inserted between the patches to reduce the antenna size and minimize the mutual coupling between the antennas. Optimum dielectric constant of the substrate will be carefully determined by considering reflection coefficient, mutual coupling, and radiation gain. Then the five identical antenna elements will be installed on the circular ground plate with a 15-cm diameter. To improve the antenna's radiation gain while achieving circular polarization in the desired matching bandwidth, detailed parameters will be optimized by using a genetic algorithm (GA) in conjunction with the FEKO EM simulator developed by EM Software and Systems. To verify the suitability for small CRPA applications, we will observe and present the average radiation gain (from θ = -60° to θ = +60°), axial ratio (from θ = -45° to θ = +45°), reflection coefficient (24MHz each, VSWR<2), and the mutual coupling between elements.