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THREE-DIMENSIONAL DESIGN OF A MIMO SYSTEM BASED ON SUPERSHAPE ANTENNA

by

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Abstract

In this thesis, a three-dimensional multiple-input-multiple-output (MIMO) antenna is designed for wireless applications. The MIMO consists of three antennas arranged around a triangular prismatic polystyrene foam that acts as a supporting block to form a tetrahedral configuration. This system has the capability of achieving multipath propagation; it also has the potential to improve the quality and reliability of radio signals, improve the channel capacity, and increase the communication speed and data rate. A circular microstrip patch antenna with regular spikes was designed based on the Superformula- a generic formula that describes naturally occurring shapes with six parameters. Afterward, bandwidth enhancement techniques were used to improve its performance over the ultra-wideband (UWB) frequency range. The antenna was then simulated, fabricated, and tested to ensure its performance conforms with the UWB requirements. Subsequently, three similar antennas were configured around a triangular prismatic polystyrene foam to realize the MIMO, and mutual coupling reduction was incorporated. The system was simulated, fabricated, and tested. For a unit antenna, the simulated and measured $|S_{11}(\text{dB})|$ is greater than 10dB across the FCC band, the antenna shows an acceptable gain, efficiency, group delay, and radiation characteristic fulfilling the UWB requirements. The MIMO has a simulated $|$ reflection coefficients(dB) $|$ greater than 10dB in the entire FCC band, the inter-element isolation is greater than $|15\text{dB}|$, the CCL, ECC, MEG, diversity gain, and TARC are acceptable for MIMO application.

Our design of a miniaturized UWB circular patch antenna, a compact three-dimensional MIMO with the least possible number of antennas for full 3D beam coverage that is 360 degrees in both the azimuth and the elevation, and the implementation of microstrip isolation and bandwidth enhancement techniques to boost the overall performance of the MIMO system are improvements to the state-of-the-art in antenna system design for wireless applications.

Keywords: ECC, FCC, MEG, MIMO, Supershape, Superformula, TARC, UWB.