A Minature Nullsteering GPS Antenna

Yue Zheng,Yikun Huang, and Yunxuan E. Wang
Department of Electrical and Engineering
University of California, Los Angeles, CA 90095-1594

Global positioning system (GPS) is a popular tool for outdoor localization. Being open signal transmitted from distant GPS satellites allows it to be easily accessed worldwide, which also means that it is easy to be jammed. GPS antenna arrays or RF/IF based signal processing techniques have been proposed to supress jamming signals. But, these methods usually have complicated and bulky RF architectures. In (Y. Chen, et al., *IONITM* 2017), a single element, dual feed antenna was designed for spoof detection as well as interference mitigation. The basic concept for null-steering technique is to combine two type of signals received from the antenna using a phase-shifter and a combiner. A deep null is formed when combine the LHCP (from the GPS satelite) and RHCP (from the ground) signal components provided they have 1) similar magnitude and 2) out-of-phase or 180 degree phase difference. However the assupmtion of similar magnitude of the RHCP and LHCP may not be realiztic in most applications.

We propose to use the Spatial Multiplexing of Local Elements (SMILE) technique developped at UCLA for reduced RF footprint GPS nullsteering antenna system (D. S. Goshi, et al., *IEEE Trans. on Microwave Theory and Techniques*, vol. 52, no. 12, pp. 2732-2738, 2004). SMILE array uses a switch network to combine the multiple data streams from the different antenna elements into one data stream, which requires only one RF receiver. A 4 element uniform circular array (UCA) is designed for demo. The inter-element spacing is 0.4λ. A miniature strip-loaded annular-ring microstrip patch antenna for L1 band (f = 1575.42 MHz) is chosen for testing (X. L. Bao & M. J. Ammann, *Journal of Electromagnetic Waves and Applications*, 20:11, pp. 1427-1438, 2006). The antenna size is 49.6mm ×49.6mm ×1.52 mm. CST simulations were performed and antenna fabrication was done at the UCLA High frequency Electronics Lab. Dielectric substrate FR4 of 1.6mm thickness, with relative permittivity of 4.3, and dielectric loss tangent of 0.025 was used. The lab tested mutual coupling between the UCA elements is below -25dB. An arbitrary waveform generator (Tektronic AWG520) was used to generate digital sequence to control a 4-channel switch network in the analog multiplexer (MUX). The 4-channel RF switch multiplexer is realized with three high speed ZFSW-2-46 SPDT switches that connect different RF channels to the receiver sequentially in real-time. The multiplexed signal was sent to a single RF channel with a LNA and mixer for down-conversion. This RF channel is followed by a high speed Gage CSE8482 digitizer sampled at 25MS/s. The digital demultiplexing and nullsteering were processed for the filtered and digitized baseband multi-channel signals. Nullsteering can be achieved below -10dB. Both simulation and lab testing results will be presented.