Robust Fast Jamming Signal Nulling Using Particle Swarm Optimization Algorithm Implemented on FPGAs

Nghia Tran[1]*, Farshid Tamjid[1], Farhan Quaiyum[1], Aly E. Fathy[1] and Ozlem Kilic[2],

[1]Department of Electrical Engineering and Computer Sciences
University of Tennessee at Knoxville, Knoxville, TN 37996, U.S.A.
[2]Department of Electrical Engineering and Computer Sciences
The Catholic University of America, Washington, DC 20064, U.S.A.
ntran8@utk.edu, fathy@utk.edu, kilic@cua.edu,

Services like GPS/GNS could be easily jammed caused by different types of strong intentional or unintentional signal interference. Here, we propose a power minimization algorithm to place a null in the direction of these relatively strong jamming signals without prior knowledge of their directions. The proposed power minimization scheme is bio-inspired optimization algorithm implemented on FPGA to anti-jam the receiver in near real time. One of these bio-inspired original algorithms is the Particle Swarm Optimization (PSO), which is based on the behaviour of bees in their search for the best food location in a field.

This bio-inspired optimization algorithm has significant advantages over its classical counterparts, such as its ability to recover from local minima, and simplicity particularly that it requires less numerically intensive computations. Given that the radiation pattern of an array consists of superposition of the individual antenna element's weighted radiation pattern, then we can control the overall radiation pattern by using programmable amplifiers/attenuators and phase shifters to adjust these complex weights. The sum of these weighted patterns is down-converted to a digital baseband stream, and is subsequently processed using the proposed PSO algorithm. Feedback is provided through a microcontroller to adjust the values of these complex weights in near real time.

Many authors have investigated a number of other methods to mitigate interference for various types of these receivers. However, most of them are based on simulated results, and only a few have investigated the use of experimental performance of various beaming forming techniques and did not discuss the speed of identifying the jammer location or placing a null along its direction. The solution in most of these cases, however, does not always converge, or it is relatively slow.

Results obtained from this bio-inspired PSO method have been obtained in few milliseconds and robust, and could be even accelerated in parallel processing is used. Proposed hardware and PSO algorithm implementation will be discussed in our presentation.