Quantum Particle Swarm Optimization for Electromagnetic Applications

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Abstract - Recently, the evolutionary particle swarm optimization (PSO) technique has attracted the attention of many engineering researchers. Several modifications to the PSO have been suggested since its discovery in 1995. The method found its way to the electromagnetic community because of its simplicity and high capability of searching for the global optimum of hard optimization problems.

In this project, we propose a new PSO version for electromagnetic applications. The method is based on quantum mechanics rather than the Newtonian rules assumed in all previous versions, which we refer to as *classical* PSO. A general procedure is suggested to enable the researcher to derive many different versions of the quantum algorithm.

The new quantum PSO (QPSO) is applied to linear array antenna synthesis. Specifically, it is required to control the side-lobe and main beam region of the resulted pattern of the array. This problem has many applications in modern smart antenna and Multi-Input Multi-Output (MIMO) systems, where it is desirable to force the array pattern to follow a specific performance in order to increase the signal-to-noise-ratio (SNR) of the communication/radar system.

The performance of the QPSO is compared against an improved version of the classical PSO. The new algorithm outperforms the classical one most of the time in convergence speed and achieves better levels for the cost function. The QPSO contains only one control parameter that can be tuned easily by trial and error or by suggested simple linear variation. Based on our understanding of the physical background of the method, various explanations of the theoretical aspects of the algorithm are presented.