Guidelines for Student Reports

RADOME DESIGN WITH JOINT OPTIMIZATION OF MATERIALS AND PROFILE

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Abstract

Radomes are often used to cover the exposed parts of antennas in order to protect them from the deteriorations due to the environmental conditions (e.g. rain, wind, snow). An ideal radome should be radio "transparent" such to avoid/minimize the interactions with the electromagnetic field either generated or received by the antenna. However, real radomes impact on the antenna performances since they introduce boresight errors (BSEs), pattern sidelobe degradation, and increase the insertion loss.

The bottleneck in the design of radomes is the high computational effort required for the reliable testing of the trial solutions within the optimization loop. In order to overcome such drawback, the System-by-Design (SbD) strategy, introduced in literature, is here customized to the design of complex radome structures. According to the SbD paradigm, the problem of the radome design is decomposed into smaller elementary blocks performing simpler tasks. In this particular case two blocks have been defined:

1 - Synthesis Block - A global optimization method with the task of computing the geometrical quantities of interest in the design (e.g. the thickness profile of the radome);

2- Analysis Block - A fast forward solver used for the simulation of the 3D radome structure.

In this case, the Particle Swarm Optimization (PSO) and the Differential Evolution (DE) algorithms are adopted for the "Synthesis Block" because of their effectiveness in dealing with problems characterized by real-valued unknowns and multiple minima. In addition, an Electromagnetic Emulator (EmE) block is used as "Analysis Block" which is implemented by means of a Learning-by-Example regression strategy, more precisely a Gaussian Process (GP) regressor method, in order to predict the radome performances from its geometrical descriptors parameters. The EmE block is trained prior to the design step by exploiting a limited number of training samples obtained through accurate electromagnetic solvers.

The current version of the developed methodology deals with the optimization of the thickness profile of a 3D ogive-shaped radome without considering the properties of the radome material. Hence, the objective of this activity is the extension of the current methodology in order to include also the material properties into the design process.

Reference Bibliography: Evolutionary Optimization [1]; Metamaterial [2]-[8]; System-by-Design [9].

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