ABSTRACT

The use of antennas for vehicle applications is growing very rapidly due to the development of modern wireless communication technology and service. The need for a computational tool to design and optimize new automobile antennas more simply and easily has been increasing.

Currently, an automobile antenna design using the Simple Genetic Algorithm (SGA) has been introduced. In this model, the SGA computation tool attempts to obtain the best design based on a single cost function. The automobile antenna design is a multi-objective problem. The different objectives are combined into a single cost function, each with a weight value. The results of the optimization procedure depend strongly on these weights, and thus, the designer must properly choose each weight value to get the desired optimum. Also, all the weight values must then be changed, and the entire optimization procedure must be repeated whenever the designer wants to change any single objective goal. In addition, a single optimum solution obtained by the SGA can be unrealizable due to various limitations. Present SGA research has focused on antennas with limited geometric flexibility, such as simple wire antenna geometry.

This dissertation presents the development and application of the Nondominated Sorting Genetic Algorithm (NSGA) to design new automobile conformal antennas. The

NSGA can find a set of Pareto-optimal solutions, instead of finding a single optimal solution. In multi-objective optimization problems, one may not find a single best solution. There may be many solutions, which are considered better with respect to all objectives. The Pareto-optimum solutions are a set of compromise solutions based on a comparison with each objective. The NSGA searches the Pareto-optimal solutions by using a fitness assignment process and a sharing process. The use of a sharing process ensures diversity of the solution space.

A set of Pareto-Optimum automobile conformal antenna geometries for FM radio and GPS/SDARS systems using the NSGA is produced. The design requirements for automobile antennas are combined into multiple objective goals, such as simplicity of the antenna geometry, gain pattern, VSWR and polarizations. The NSGA generates a set of feasible antenna geometries satisfying desirable goals. The antenna designer can choose realizable and simpler antenna geometries from among the set of Pareto-optimum solutions. The electromagnetic numerical tool used for the analysis in this research is the Method of Moments (MoM).

The automated and integrated computational code has been developed for automobile antenna design by combining of the NSGA process which is programmed in MATLAB and the ESP5 theoretical tool which is based on the MoM. The results of this computational code to design and optimize automobile antennas for FM/GPS/SDARS are provided as well as the comparisons results with experimental measurements.