ABSTRACT

The thesis entitled as “Development and Optimization of Fractal Patch Antennas for Medical and Communication Applications” is based on research works to provide low cost feasible solutions in terms of optimized fractal antennas in order to meet the challenging requirements of wireless and healthcare industries in the area of communications. The objectives of this research work are framed on the development and optimization of fractal antennas’ low power applications such as Bluetooth, Wi-Fi, WLAN, RFID, ISM band etc. The research work is carried out according to the approved objectives.

The demand of the compact antennas is increasing continuously due to the requirement of reduced size wireless communication devices. The use of fractal geometry for the design of small size antennas is a modern trend. As the closed form expressions do not exist for fractal antennas so there is a need for alternative methods of designing fractal antennas. The use of bio-inspired computing techniques like ANN, GA, PSO, and BFO are very appropriate in such cases. In the presented research work, these techniques have been used for parameter estimation and design optimization of fractal patch antennas. Therefore, the presented research works confines to the fractal antennas & bio-inspired computing techniques to provide the cost effective & efficient solutions.

An extensive literature survey is carried out to understand the concept of fractal antennas, their features and design approaches. Also a number of research papers are reviewed on the applications of bio-inspired computing techniques for antenna design, especially, fractal antenna design. The extracts of literature survey presented in the thesis highlight these important issues.

Many fractal antenna geometries suitable for medical and communication applications have been proposed in the presented research work. The IE3D software has been used to simulate various fractal antennas and the simulation results are obtained to analyze
the performance of the selected antennas. The desired features are assessed from the $S_{11}$ plots, gain plots, and radiation patterns which are validated with experimental and analytical findings.

The multilayer perceptron neural network, radial basis function neural network, and generalized regression neural network models are developed to estimate various parameters of the proposed fractal antennas. The performance of various ANN models has also been compared in order to find the optimally suitable models. The use of ANN ensemble models for the design of fractal antennas is also explored for the first time and it is found that the ANN ensemble approach is better than the traditional ANN model approach. The different methods of developing ANN ensemble models are also presented. The bio-inspired computing techniques based on GA, PSO and BFO are developed to find the optimal design of the proposed fractal antennas for the desired applications. The performance comparison of the various bio-inspired computing techniques is also carried out for selecting the best algorithm. The use of ANN models as objective function of optimization algorithms is also enumerated to design the presented fractal antennas. It has been observed that the developed bio-inspired computing techniques provide accurate solutions with a very small computational cost.

The performance of the designed antennas is validated by fabricating prototypes and then performing experimental testing. The simulated results are compared with the experimental results and good matching of simulated and experimental results is observed in almost all cases. The obtained results are also compared with the previously published results to validate the presented designs. The research work has resulted in the design of the fractal antennas having many desirable features like size reduction characteristics, multiband performance, enhanced gain, and improved bandwidths.

The outcomes of the research work have been published in various journals and conferences of repute.