

# Hybrid Neural Network and Particle Swarm Optimization Approach for Frequency Tuning of Square Sierpinski Carpet Fractal Antennas

Nasakolthana Sombattheera and Chanchai Thaijiam\*

*Department of Electrical Engineering, Faculty of Engineering, Srinakharinwirot University, Ongkharak Campus, Nakhon-Nayok, 26120, Thailand*

\*Email: [chanchait@g.swu.ac.th](mailto:chanchait@g.swu.ac.th) (C. Thaijiam)

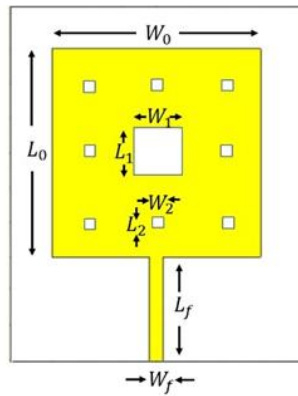
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## Abstract

This paper discusses the design of a square Sierpinski carpet fractal microstrip antenna using artificial intelligence techniques, including a neural network (NN) and particle swarm optimization (PSO), to tune the operating resonance and transformation frequencies. The objective is to enhance antenna configurations based on the desired operating frequencies by utilizing NN's radial basis function (RBF) networks as a fitness evaluator for optimizing by PSO. The patch of a square shape emphasizes geometric symmetry in each plane. The resonance and transformation frequencies were established by optimizing the antenna configurations and aligning a microstrip feedline to minimize return loss. MATLAB and CST programming tools were utilized to train the NN, which predicted the resonance and transformation frequencies. The parameters of the PSO were updated based on the fitness function evaluated by the NN, thereby moving toward the optimal antenna design. Results indicate that the optimized configurations of the square Sierpinski carpet fractal microstrip antenna can achieve the resonance and transformation frequencies with return losses of less than -10 dB. This paper summarizes the essential requirements and the proposed methods for antenna design, enabling reliable frequency tuning with fewer full-wave electromagnetic (EM) simulations.

## Table of Contents



Hybrid Neural Network and Particle Swarm Optimization  
Approach for Tuning the Operating Frequencies of Square  
Sierpinski Carpet Fractal Antennas

*Innovative Description:* This study presents an innovative hybrid approach that combines Neural Networks (NN) and Particle Swarm Optimization (PSO) to achieve accurate frequency tuning in square Sierpinski carpet fractal antennas.