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Microwave Tomography Using Optimization Techniques

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ABSTRACT— In this paper, we apply the microwave tomography method combined with optimization techniques for reconstructing the 2-D image of dielectric properties of the breast and early detection of the tumor location. The finite difference time domain method is used to calculate the scattered electromagnetic fields in the forward solver. Furthermore, genetic algorithm (GA), Particle swarm optimization (PSO), and differential evolution algorithm (DE) have been used in the inverse solver to update the dielectric properties of the object.

A novel cost function is used to overcome the problems associated with the functions used in previous works. To speed up the solution convergence process, the dielectric parameters are divided among four intervals. In addition to the use of a new cost function, the novelty of this work also lies in its first-time use of the particle swarm and differential evolution algorithms in the inverse solver for determining the dielectric parameters of the object which, according to the best of our knowledge, have never been applied in this way before. The numerical results of the simulation experiments indicate that the proposed approach is superior to its rivals in terms of both the convergence speed and the accuracy of the solutions.

KEYWORDS: Breast Cancer, Dielectric Properties, Inverse Scattering Problem, Optimization, Tomography.

I. INTRODUCTION

The breast cancer is the second most common cancer among women behind skin cancer and is the second cause of cancer death among females in many countries. Since the early detection of this cancer greatly increase the chance of an effective treatment, the timely diagnosis of the cancer is of utmost importance to physicians. With the introduction of the new methods in the field of cancer diagnosis over the past few years, there has been significant improvement in the field of cancer treatment [1], [2]. Although, like many other academic and practical methods, these methods have their own merits and drawbacks as well.

One of the novel approaches in this field is the microwave method. The basic idea behind this method is to expose the suspected area to the low-powered electromagnetic fields and measuring the scattered fields. These electromagnetic waves generate different reflections due to the different dielectric properties of the tissue under exposure. The most important challenge in this method lies in the detection of the electromagnetic waves radiation reflected from the cancer tissues.