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Research Article

Breast Tumor Simulation and Parameters Estimation Using Evolutionary Algorithms

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Abstract

An estimation methodology is presented to determine the breast tumor parameters using the surface temperature profile that may be obtained by infrared thermography. The estimation methodology involves evolutionary algorithms using artificial neural network (ANN) and genetic algorithm (GA). The ANN is used to map the relationship of tumor parameters (depth, size, and heat generation) to the temperature profile over the idealized breast model. The relationship obtained from ANN is compared to that obtained by finite element software. Results from ANN training/testing were in good agreement with those obtained from finite element model. After ANN validation, GA is used to estimate tumor parameters by minimizing a fitness function involving comparing the temperature profiles from simulated or clinical data to those obtained by ANN. Results show that it is possible to determine the depth, diameter, and heat generation rate from the surface temperature data (with 5% random noise) with good accuracy for the 2D model. With 10% noise, the accuracy of estimation deteriorates for deep-seated tumors with low heat generation. In order to further develop this methodology for use in a clinical scenario, several aspects such as 3D breast geometry and the effects of nonuniform cooling should be considered in future investigations.