3D experimental detection and discrimination of malignant and benign breast tumor using NN-based UWB imaging system

ABSTRACT

This paper presents both simulation and experimental study to detect and locate breast tumors along with their classification as malignant and/or benign in three dimensional (3D) breast model. The contrast between the dielectric properties of these two tumor types is the main key. These dielectric properties are mainly controlled by the water and blood content of tumors. For simulation, electromagnetic simulator software is used. The experiment is conducted using commercial Ultrawide-Band (UWB) transceivers, Neural Network (NN) based Pattern Recognition (PR) software for imaging and homogenous breast phantom. The 3D homogeneous breast phantom and tumors are fabricated using pure petroleum jelly and a mixture of wheat flour and water respectively. The simulation and experimental setups are performed by transmitting the UWB signals from one side of the breast model and receiving from opposite side diagonally. Using discrete cosine transform (DCT) of received signals, we have trained and tested the developed experimental Neural Network model. In 3D breast model, the achieved detection accuracy of tumor existence is around 100%, while the locating accuracy in terms of (x, y, z) position of a tumor within the breast reached approximately 89.2% and 86.6% in simulation and experimental works respectively. For classification, the permittivity and conductivity detection accuracy are 98.0% and 99.1% in simulation, and 98.6% and 99.5% in experimental works respectively. Tumor detection and type specification 3D may lead to successful clinical implementation followed by saving of precious human lives in the near future.

Keyword: Breast phantom; Breast tumor; Conductivity detection; Detection accuracy