BREAST CANCER IMAGING BY MICROWAVE TOMOGRAPHY

（課程博士・様式７）（Doctoral qualification by coursework,Form 7）

学 位 論 文 要 旨

Abstract of Doctoral Thesis

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Abstract：

Breast cancer is one of the most widespread types of cancer in the world. The key factor in treatment is to reliably diagnose the cancer in the early stages. Moreover, currently used clinical diagnostic modalities, such as X-ray mammography, MRI, and ultra-sound are limited by cost and reliability issues. These limitations have motivated researchers to develop a more effective, low-cost diagnostic method and involving lower ionization for cancer detection. Recently, studies on the early detection of breast cancer by microwave imaging have attracted significant interest among researchers over the last decade, due to the high dielectric properties contrast between the cancerous and the normal tissue. In this thesis, tomography based microwave imaging is proposed as a method for early breast cancer detection. This imaging system has advantages such as low cost, being non-invasive and easy to use, with quantitative images which provides information directly correlated to the composition of the examined object, thus has a good potential in early cancer detection.

Microwave tomography is an inverse scattering problem which is formalized by determine the position and complex permittivity distribution of the unknown object from the measured scattered field. The image reconstruction process in microwave tomography involves forward problem and inverse problem. For the forward problem, Method of Moment (MoM) is used to obtain the measurement scattering data. For the inverse problem, two approaches were

proposed to solve the non-linear inverse scattering method, i.e., Newton-Kantorovich and Distorted Born Iterative Method (DBIM). In addition, three types of solving techniques to reduce the ill-posedness and perform more stable solution were also introduced. The ill-posed of non-linear problem can be avoided by choosing appropriate solving techniques, considerable number of unknowns used in the analysis region, and the use of a *priori* information.

In microwave tomography, it is necessary to increase the amount of diverse observation data to obtain accurate image reconstruction of the complex permittivity distribution of the imaging area. Several methods were considered, such as increase the number of antennas, use multi-frequency method and implement the multi-polarization method. In this thesis, the multi-polarization approach has been proposed as a suitable technique for the acquisition of a variety of observation data. A compact-sized imaging sensor using multi-polarization approach for accurate image reconstruction is presented. While the effectiveness of employing multi-polarization has been confirmed, the physical considerations related to image reconstruction have not been investigated. An analysis of the correlation coefficient of the received data of adjacent antennas was performed to interpret the imaging results. Numerical simulation results demonstrated that multi-polarization can reconstruct images better compared to single polarizations owing to its low correlation coefficient. For this reason, the correlation coefficient may represent a viable parameter for image reconstruction in microwave tomography aimed at breast cancer detection.