2021 CMBEC44

CMBES/SCGB

Virtual Conference
May 11-13, 2021

Frequency Model Filtering for Microwave Imaging in Breast Cancer Applications

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I. Introduction

In Canada, it is estimated that breast cancer will affect the lives of 27,400 women in 2020 [1]. Microwave (MW) imaging distinguishes between healthy and non-healthy tissue using MW frequency properties (permittivity and conductivity) and has the potential to be a fast and inexpensive scan for treatment monitoring at point-of-care. An area of improvement for ultra-wideband MW imaging is filtering in the frequency domain to improve the sensitivity of permittivity calculations. Most current filtering models lack adaptability to different signal variation and a quantitative measure to determine the best fit; therefore, global interpolation and statistical methods are proposed.

II. Methodology

Interpolation Model Fitting: The MW transmission system (MITS) at the University of Calgary has two fixed antenna arrays with five antennas on opposing plates [2]. Each antenna transmits a series of frequencies to the receiving antennas on the opposite array through the breast tissue. The measured signal is referred to as S_{12}, and 25 S_{12} measurements are provided for each scan. The transmission signals require adaptive filtering measures to decrease the measurement uncertainty in resulting images.

Interpolation Development: Using terrain modeling algorithms [3], an adaptive least squares interpolation was used to calculate polynomial coefficients up to the fifteenth order for each frequency signal. The algorithm found the highest amplitude in the signal and isolated the largest curve using thresholds of tangential line slope and maximum amplitude. This curve was extracted into a matrix, normalized to reduce matrix singularities, and tested for significance.

III. Discussion

Patient datasets (study REB15-3246, Conjoint Heath Research Ethics Board) were used to test the interpolation models. Figure 1 shows the results of a ninth order model for a signal with low levels of high frequency noise. The model closely follows the data compared to lower order models and captures the complexity of the shape in the higher frequencies with a cutoff frequency at 6 GHz. The adjusted R squared value was calculated to be 0.9978 and f-statistic is significant to a 95% level.

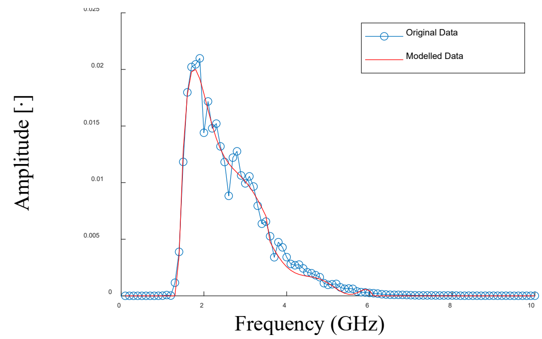

Fig. 1 Ninth order interpolation modelling of a healthy breast in the frequency domain

The global interpolation method is an effective, adaptive model that was used on signals with different characteristics to calculate MW transmission data filter parameters in the frequency domain. After optimizing the modeling approach, integration with the imaging algorithm will be explored.

Acknowledgements

We would like to acknowledge the Alberta Innovates, Natural Sciences and Engineering Research Council of Canada, and Alberta Cancer Foundation for funding.

References

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