Efficient Microwave Biomedical Imaging through Sparse Reconstruction of Frequency Independent Parameters

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Microwave tomographic imaging (MTI) has been considered as a viable imaging technique in the past. As a portable imaging method, though electrical impedance and capacitance tomography (EIT & ECT) have emerged with high-speed capabilities, they have several limitations including low spatial resolution and a requirement to be in direct contact with the medium.

To this end, in this work, we address three long lasting issues in microwave imaging. Firstly, we propose a modification to the conventional Gauss-Newton (GN) algorithm to enable high-speed imaging. This modification significantly speeds up imaging to enable real-time (~0.25 sec) solutions. Specifically, we employ a Taylor series approximation for the forward solution of the GN algorithm. Notably, earlier microwave imaging Gauss-Newton algorithms typically require more than 60 sec.

Secondly, we note that regular MTI methods reconstruct the permittivity of the imaging domain which is itself a function of frequency. So, there is no direct way of incorporating multifrequency data into the reconstruction process. In this work, we propose a set of frequency independent parameters and show their reconstruction by employing multifrequency measurements. This makes the associated matrix system more stable.

Thirdly, we observe that most of the MTI works solve a quadratic objective function to reconstruct the image. As this types of functions deal with L_2 norms, the solution loses its capability to resolve closely spaced anomalies. In this work, we present an algorithm based on minimization of the L_1 norm which increases the spatial resolution considerably.

Simulation and experimental results will be presented at the conference to validate the concepts.