AI-Powered Microwave Imaging for Stroke Detection

Hannah Baum, Md. Asiful Islam, and Asimina Kiourti,
ElectroScience Laboratory, Dept. of Electrical and Computer Engineering, The Ohio State University,
Columbus, OH, USA; e-mail: baum.219@osu.edu

In the medical field, accurate stroke diagnoses and effective treatments depend upon rapid access to reliable imaging technology. To mitigate symptoms and increase the likelihood of recovery, diagnosis should occur as soon as possible to allow the correct treatment to be administered for the type of stroke present. Ischemic strokes, which are caused by clots in the brain, comprise 87% of all stroke diagnoses [1]. The remaining 13% of strokes are caused by bleeding in or around the brain, with 10% of all strokes classified as intracerebral hemorrhages (ICH) and 3% as subarachnoid hemorrhages (SAH) [2]. The treatment prescribed for an ischemic stroke may drastically worsen the condition of a patient with a hemorrhagic stroke, and vice versa. Current medical tools used in stroke diagnosis include Magnetic Resonance Imaging (MRI) and Computerized Tomography (CT) scans, which are bulky, costly, and limited to use in hospital environments. Microwave Tomography (MIT) is a promising imaging modality that can be made portable and low-cost, but exhibits poor resolution that restricts its clinical usage.

To overcome limitations in the state-of-the-art, we propose a MIT system that leverages the many advantages of novel, into-body Bio-Matched Antennas (BMAs) coupled with machine learning. BMAs mimic frequency-dependent tissue permittivities, eliminating the need for a matching medium, and have been shown to result in a 12-fold improvement in state-of-the-art transmission loss [3]. We combine these novel antennas with the use of machine learning to estimate imaging results for high frequencies at which microwave antennas experience significant transmission loss. Our goal is to artificially expand the usable frequency range for imaging applications using a Deep Neural Network (DNN). We are currently working to generate a large quantity of input and output data using 2D forward solvers with canonical models at low frequencies. With the resulting data, we can train a DNN to estimate high frequency data, thus extending the usable bandwidth. Increasing the highest usable frequency in this manner helps surpass image resolution of previous MIT approaches.

References

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