High Fidelity Modelling of a Microwave Imaging Device for Brain Stroke Monitoring

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Abstract— Supporting clinicians and therapists to perform an early diagnosis and a constant post-event monitoring of the onset of a brain stroke, one of the significant causes of death and permanent disability worldwide, highly increase the effectiveness of the treatment and the recovery of patients. Traditionally, physicians support their diagnosis based on well-established imaging techniques such as computed tomography (CT) and magnetic resonance imaging (MRI), which are shown to be convenient in terms of spatial resolution but resulted expensive, bulky and harmful for operators. Then, recently, microwave tomography (MWT) has appeared as an alternative diagnostic tool for medical imaging that allows decreasing the cost, the size of the equipment and guarantees low intensity and non-ionizing radiations [1].

In this paper, we present the validation of novel microwave imaging device able to monitor cerebrovascular diseases through a 3-D anatomically realistic full-wave simulation and a reconstruction algorithm based on Truncated Singular Value Decomposition (TSVD).

The system consists of a set of 24 realistic antennas immersed individually on solid blocks of coupling medium and conformal placed around of the head. The coupling blocks are filled with a mixture of urethane rubber and graphite powder [2], while the antennas are wideband monopoles printed on a standard FR4 substrate and their coaxial feeding. The 3-D antenna layout follows the procedure as in [3], considering the spatial resolution, information into the brain region, reconstruction capabilities and dynamics under different levels of Signal to Noise Ratio. The head is a standard adult man one that represents the different head tissues as electrically-uniform-material structures, and the strokes are modelled as sphere filled with blood.

In this work we perform full-wave simulations of the cerebrovascular diseases monitoring device showing its promising capabilities. The simulation is a complementary tool of analysis for the realization and real-life validation of the system.

ACKNOWLEDGMENT

This work was supported by the EMERALD project funded from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 764479.

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