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Brain Stroke Imaging by Means of Microwave Tomography: Quantitative Inversion Procedure, Configuration Set Up, and Preliminary Experimental Results

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In the last years, there has been a growing interest in applying microwave techniques to brain imaging. Several research teams around the world are currently involved in developing imaging systems, with different specific final objectives and considered modalities. Although excellent results have been reported in the scientific literature (see, for example, [1], [2], and the references therein), there are theoretical and practical difficulties that still make these techniques a challenge. The former are related to the processing of data (limited amount of information, low signal-to-noise ratios, ill-posedness, etc.), whereas the latter are essentially related to the effective realization and use of the system. In this paper, we discuss some recent results related to a tomographic system which is currently under development. In particular, a new reconstruction procedure based on a conjugate gradient approach, directly implemented in the framework of the L^p Banach spaces, is presented. This inversion procedure, preliminary discussed in [3], seems to be particularly suitable for obtaining a regularized solution of the inverse scattering problem, with less artefacts and noise (on the final image) due to a reduction of the usually encountered over-smoothing effects. The effectiveness of the approach is evaluated, even with three-dimensional data, by means of numerical simulations involving an accurate model of the human head.

Moreover, a preliminary experimental set up is proposed, which represents the basis for the development of a low-cost and portable imaging system in the form of a "helmet". Frequency range and other configuration parameters have been selected on the basis of the analysis reported in [4]. The proposed procedure has been tested with experimental data obtained by using this set up in the case in which a simplified phantom is considered. The phantom is filled with a water/glycerin mixture and is aimed at simulating the dielectric properties of the human head. Although preliminary, the results seems to indicate the validity of the considered approach, and, in particular, the reconstruction capabilities of the developed inversion procedure.

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