A Multifrequency Imaging Method for Microwave-Based Stroke Diagnostics

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Brain stroke is known as one of the leading causes of permanent disability and death, at a worldwide level. It is clear that a fast diagnostic process is extremely helpful to limit the negative effects of such a disease on patient's brain. Therefore, to complement and improve the standard diagnostic protocols, novel techniques are emerging as potentially useful. Among them, in the framework of biomedical applications of microwave imaging [1], [2], several approaches have been devised to achieve a first stroke diagnosis before hospitalization, or an efficient monitoring of the progression of the disease during treatment [3], [4].

One of the key issues is to identify the stroke type, i.e., whether it is hemorrhagic or ischemic. In this respect, an important role can be played by the dielectric characterization of the involved brain tissues, since these properties exhibit changes based on the stroke nature [5]. Such a quantitative characterization of stroke-affected tissues is possible resorting to nonlinear inversion strategies. However, the problem at hand is very challenging and it is crucial to properly use all the available information, including that coming from frequency diversity.

In this work, an improved nonlinear technique capable of retrieving the dielectric properties of stroke by simultaneously exploiting multifrequency data is introduced. The inversion method belongs to the class of inexact-Newton algorithms and features an automatic definition of the main parameters of the inner regularization loop, which is formulated in $L^{p(\cdot)}$ spaces with nonconstant exponent functions. Numerical experiments are presented and discussed to assess the performance of the proposed method and explore its behavior in a simulated environment.

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