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Benchmark Head Phantoms for Microwave Imaging of Brain Strokes

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Abstract— This work is devoted to the development and realization of a benchmark head phantom to test microwave imaging prototypes dedicated to cerebrovascular diseases monitoring [1], as microwave technology offers a low-cost, mobile and non-ionizing alternative modality for such an application. The 3D realistic head phantom realized by additive manufacturing contains 3 cavities and a stroke mimicking anomaly (Figure 1(a)). The cavities are filled up with liquid mixtures based upon Triton X-100 and salted water. The composition of these mixtures can be predetermined as a function of the operating frequency range [2] and the numerical version of the phantom (the STL file) can be used to perform simulations. The resulting phantom is easy to produce, realistic concerning its shape and dielectric properties, stable over time, reproducible, and adaptable to different configurations, thus it can be used as a standard realistic model to test inversion algorithms as well as experimental configurations. This work is carried out in the framework of the National research project "MiBraScan — Microwave Brain Scanner for Cerebrovascular Diseases Monitoring [3]". Figure 1(b) displays the phantom and the conformal antenna array based on the MiBraScan system. The electromagnetic field distributions inside the phantom, in the presence and in the absence of the stroke mimicking anomaly, are computed by means of CST Microwave-Studio, and the differential field is then obtained by subtracting the latter from the former. The influence of several parameters such as the constitutive material (ABS) is studied herein. Figures 1(c)–(d) display the magnitude of the electric field (in dB) inside the phantom with the anomaly and the differential field, when the phantom is illuminated at 1 GHz by antenna #1 of the 24 conformal antenna array.

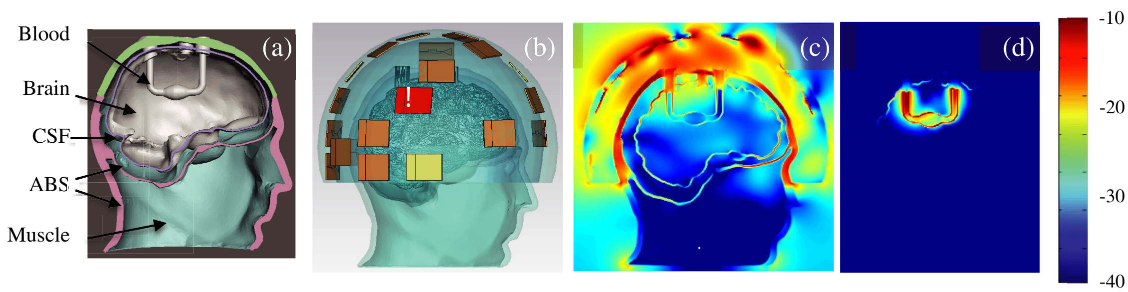

Figure 1: (a) 3D printed phantom with the anomaly (blood), (b) antenna array and magnitude of (c) the electric field in the presence of the anomaly, and of (d) the differential field.

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