TWO-DIMENSIONAL MICROWAVE TOMOGRAPHIC IMAGING OF BIOLOGICAL OBJECTS

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Microwave tomographic imaging is one of the emerging technologies with potential applications in the field of geosciences, medicine, industry etc., using non-ionizing electromagnetic waves. When exposed to microwaves, biological objects exhibits electrical property variations that depend on the bound water content. Microwave tomographically reconstructed images can potentially provide information about the physiological state as well as the anatomical structure of the object. A prototype of 2-D microwave tomographic imaging set up is presented in this paper. The sample is mounted on a circular platform capable of circular motion in the horizontal plane. The platform along with samples is kept inside a tomographic chamber of radius 12 cm. and height 30 cm, coated inside with suitable absorbing material. Suspended bow-tie antennas are used for both transmission and reception of microwave energy. All measurements are done using HP 8714 ET network analyzer; interfaced with Compaq work station SP 750 using GPIB bus. The sample is illuminated at the frequency of 3000 MHz. The transmitting antenna is placed at a fixed position on the circular rail, while the receiving antenna is rotated with an arm around the vertical cylindrical target. The platform upon which the sample is mounted is rotated from 0^o to 360^o in steps of 10^o and the receiving antenna is rotated from 30^o to 330^o in steps of 10^o. For every 10^o rotation of the platform, the receiving antenna makes the measurement in steps of 10^o. The samples considered are, freshly excised thigh bone of cow without any flesh, freshly excised thigh of chicken having flesh and bone, freshly cut branch of rubber tree having uniform cross section. Due to the contrast in the dielectric properties of the object, the wave undergoes multiple scattering within the object. This poses a non linear inverse scattering problem that is formulated in terms of Fredholm integral equation of second kind. The cylindrical medium is considered inhomogeneous in the x y plane but homogeneous in the z direction. The problem is linearized using distorted Born approximation and then seek progressively better estimates of the total field inside the object. The discretization of the integral equation in the inverse scattering problem yields vector representations of the scattered field and the object profile. As the inverse problem is ill-posed, a regularization procedure is employed where an optimization technique is adopted to minimize the error by minimizing a cost functional. Thus the non uniqueness and instability of the problem is circumvented and an adequate solution is provided. The iteration is continued until convergence is reached. Due to computational complexity, the imaging area is restricted to 16 x 16 pixels. The sampling rate considered is 0.1λ. The reconstructed 2 – D images and dielectric permittivity profiles of the samples are in good agreement with the available literature data of bone and wood samples.