Neural Network Reconstruction of Functional 2D Permittivity Profiles from Waveguide *S*-Parameters

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A new microwave imaging technique is proposed for reconstruction of two-dimensional complex permittivity profiles in dielectric samples located in a waveguide system. The spatial distributions of the dielectric constant and the loss factor are approximated by continuous functions whose functional parameters are determined using a neural network technique backed by full-wave finite-difference time-domain analysis. The profiles are reconstructed from measurements of reflection and transmission characteristics obtained with the tested sample at different locations. Operational capabilities of the technique are illustrated through a series of computational experiments for rectangular and cylindrical samples at two (original and 90°-rotated) positions. The results demonstrate excellent agreement between the reconstructed and actual profiles approximated by linear (Fig. 1a), quadratic (Fig. 1b) and Gaussian functions (Fig. 1c-e): the average relative errors do not exceed 0.4, 2.2, and 4.8%, respectively.

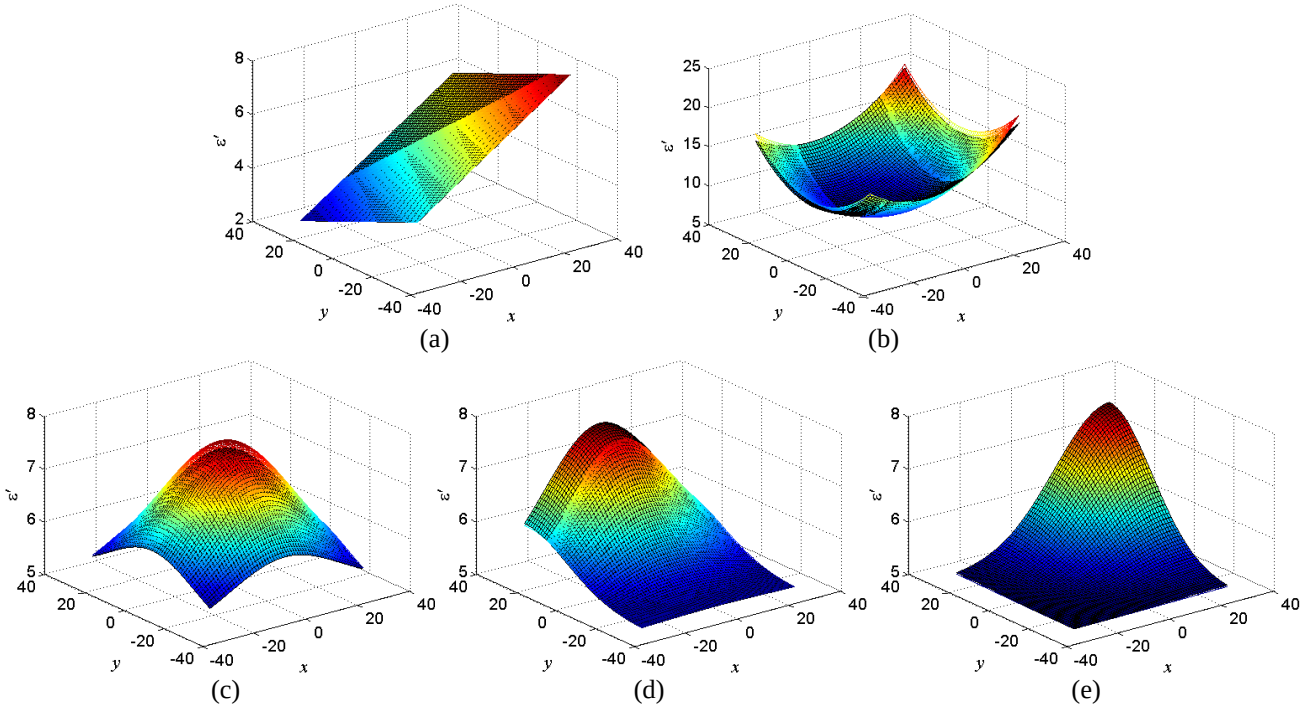

Fig. 1. Actual (transparent surfaces) and reconstructed (solid surfaces) 2D profiles of dielectric constant: linear (a), quadratic (b) and Gaussian (c-e) profiles reconstructed from 2 positions of a rectangular (60 x 60 x 20 mm) sample in a 2-port system based on a 612 mm section of WR975 (248 x 124 mm).