Imaging Behind Obstacles Using Only Diffracted Fields

Tadahiro Negishi*[1], Vittorio Picco[1], Douglas Spitzer[1], Danilo Erricolo[1], and Lorenzo Lo Monte[2]

[1] (1) Department of Electrical and Computer Engineering, University of Illinois at Chicago, Chicago, IL

[2] (2) Sensor Systems Division, University of Dayton Research Institute, Dayton OH

We consider the problem of reconstructing the image of an object that is illuminated only by diffracted fields, i.e., there is no line-of-sight between the object and the source of illumination. The geometry of the problem consists of a partial metallic enclosure, i.e., an open metallic box, containing an object. The illumination is provided by a system of multiple transmitting and receiving antennas, which belong to an RF Tomography system (L. Lo Monte, D. Erricolo, F. Soldovieri, M.C. Wicks, "Radio Frequency Tomography for Tunnel Detection," IEEE Trans. Geoscience and Remote Sensing, Vol. 48, No. 3, Mar. 2010, pp. 1128-1137).

Radio frequency tomography is an imaging technology first proposed for underground applications. This technique is based on multiple, inexpensive, distributed sensors used to reconstruct the contrast dielectric permittivity distribution of the volume under investigation. The goal of RF Tomography is to detect the presence of a target, which could be a tunnel in the case of underground investigations. This technique was conceived to produce images when monochromatic signals are used; therefore, an extremely narrow-band electrically small antenna should be employed in Radio Frequency Tomography. Free space scenarios have been experimentally validated (V. Picco, T. Negishi, M. Stephens, S. Nishikata, and D. Erricolo, "Experiments for RF Tomography," National Radio Science Meeting, Boulder, CO, Jan. 2012). Usually, RF Tomography considers objects that are directly illuminated by the transmitting antennas. However, in this work we focus on the exploitation of diffracted fields to produce an image of an object inside an open metallic box. Accordingly, the transmitting antennas are positioned so that they are located on a plane that is below the rim of the open box. The presence of the box is accounted for by introducing a numerical Greens function (T. Negishi, V. Picco, S. Nishikata, D. Erricolo, "Numerical Greens Function for Radio Frequency Tomography with Complex Geometry," International Union of Radio Science Commission B Electromagnetic Theory Symposium, Hiroshima, Japan, May 20-24, 2013) in the forward model of RF Tomography.

Preliminary simulation results obtained by computing the diffracted fields with FEKO indicate that it is possible to reconstruct an image. The goal of this work is to compare the reconstructed image obtained using the numerical computed diffracted fields with the image reconstructed using measured fields in the anechoic room of the University of Illinois at Chicago.