

Abstract

This thesis studies the two-dimensional (2-D) microwave imaging of dielectric and conducting objects under transverse magnetic (TM) polarization. The presented work is focused on the reconstruction of permittivity profile of dielectric objects and geometric estimation of both dielectrics and conducting objects.

To estimate the permittivity profile of dielectric objects in the experimental setup, an equivalent source is modeled. This source effectively considers the directivity characteristics of transmitting antenna thereby the incident fields in the investigating domain are calculated. From the knowledge of these incident fields and the measured scattered fields, the permittivity profile is estimated with the contrast source inverse (CSI) algorithm.

To determine the geometric features of dielectric and conducting objects, linear sampling method (LSM) is employed. The behavior and limitations of LSM are analyzed for reconstructing these objects. The study is based on the representation of scattered fields as a multipole expansion. The remaining part of the thesis is focused on the applications of LSM. In the first application, the LSM is applied to mixed boundary problems (both dielectric and PEC objects). The imaging capabilities of LSM are studied in terms of frequency of operation and permittivity of dielectric objects. To overcome the drawbacks of standard LSM indicator, a modified LSM indicator based on a multi-frequency approach is introduced. Next, the LSM is applied to the case of half space domain and the estimates of LSM are evaluated in a mixed boundary problem scenario. In another application, LSM is utilized to estimate the shapes and locations of small dielectric objects that improves the accuracy as well as the efficiency of CSI method.

Keywords: Conducting objects, contrast source inversion method (CSI), dielectrics, equivalent source, geometric features, linear sampling method (LSM), microwave imaging, mixed boundary problem, permittivity estimation, transverse magnetic polarization (TM), two-dimensional (2-D).