Inverse Problems Network Meeting 3

Thursday, 26th April 2018 - Friday, 27th April 2018

Centre for Inverse Problems, UCL

Abstract of Talk

TOWARDS IMPROVED METAL DETECTION USING (GENERALISED) MAGNETIC POLARIZABILITY TENSORS

Paul Ledger

Swansea University

Locating and identifying hidden conducting objects has a range of important applications including searching for buried treasure, identifying landmines and in the early detection of concealed terrorist threats. Traditional approaches to the metal detection problem involve determining the conductivity and permeability distributions in the eddy current approximation of Maxwell's equations and lead to an ill-posed inverse problem. On the other hand, practical engineering solutions in hand held metal detectors use simple thresholding and are not able to discriminate between small objects close to the surface and larger objects buried deeper underground.

In this talk, an alternative approach in which prior information about the form of the conducting object has been introduced will be discussed. This allows the perturbed magnetic field, due to the presence of a conducting (permeable) object, to be described in the form of an asymptotic expansion as the object size tends to zero. The asymptotic expansion separates the object's position from its shape and material description offering considerable advantages in case of isolated objects. Our previous result focused on the leading order term and described the object using a rank 2 magnetic polarizability tensor (MPT). The coefficients of the MPT can be computed by solving a vector valued transmission problem numerically using finite elements. Recently, we have extended this result by providing a new complete asymptotic expansion of the perturbed magnetic field as the object size goes to zero. In this expansion, the object is described in terms of a new class of generalised MPTs (GMPTs), which can also be computed by solving vector valued transmission problems. We believe that our new result will have important implications for metal detectors since it will improve small object discrimination and, for situations where the background field varies over the object, this information will useable, and indeed useful, in characterising objects.

The talk will explore the interesting properties exhibited by (G)MPT, which characterise conducting objects. It will describe how the eigenvalues of the MPTs for candidate target objects can form a dictionary for object classification in an off-line stage. Initial investigations using a machine-learning approach to object classification, using the aforementioned dictionary, will also be included.