Hybrid Methods for Anomaly Imaging

Hyeonbae Kang

The presence of inclusion or excitation of local area of tissue cause perturbation of fields. This perturbation of fields an be measured on the surface or inside of the body. In these lectures we will discuss various modalities using these measurements of perturbation of fields for imaging inclusions and tissues.

In the first lecture, we discuss the mathematical theory which provides the basic background for designing imaging algorithms. We explain the asymptotic formula, under the assumption that the size of the inclusion is small, for the perturbation of the field far away from the inclusion (outer expansion) and near the inclusion (inner expansion). We then explain some simple methods to image the inclusion. This method can be used for imaging the cluster of inclusions.

The asymptotic expansion, especially the inner expansion can be used for imaging the material property of the inclusion in case when the perturbation can be measured inside the tissue. For example the Magnetic Resonance Elastography provides us with the interior information of the displacement vectors. We use this interior information and inner expansion of the perturbation to effectively imaging the stiffness parameter of the inclusion (cancer). The stiffness is an important parameter to distinguish the benign cancers from malign ones. This will be the content of the second lecture.

Ultrasonic beam can be used to excite local area of tissues and this excitation causes perturbation of electric field or produces acoustic waves. We can measure the perturbation or the acoustic wave on the surface of the body and use this measurement to image the conductivity distribution. These method of imaging are called the Vibration Potential Tomography (or Hall Effect Tomography) and Magneto-Acoustic Tomography (with Magnetic Induction). In the third lecture we discuss new mathematical analysis based on asymptotic expansions and algorithms for imaging.