A 0-Laplacian approach to impedance imaging

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Resumen

Electrical impedance tomography (EIT) technique has been an active research topic since the early 1980s. In EIT, one measures the boundary voltages due to multiple injection currents to reconstruct images of the conductivity distribution. However, these boundary voltages are insensitive to a local change of the conductivity distribution and the relation between them is highly nonlinear.

Medical imaging has been one of the important application areas of EIT. Indeed, biological tissues have different electrical properties that change with cell concentration, cellular structure, and molecular composition. Such changes of electrical properties are the manifestations of structural, functional, metabolic, and pathological conditions of tissues, and thus provide valuable diagnostic information. Since all the present EIT technologies are only practically applicable in feature extraction of anomalies, improving EIT calls for innovative measurement techniques that incorporate structural information.

The core idea of the approach presented in this talk is to extract more information about the conductivity from data that has been enriched by coupling the electric measurements to localized elastic perturbations. More precisely, we propose to perturb the medium during the electric measurements, by focusing ultrasonic waves on regions of small diameter inside the body. Using a simple model for the mechanical effects of the ultrasound waves, we show that the difference between the measurements in the unperturbed and perturbed configurations is asymptotically equal to the pointwise value of the energy density at the center of the perturbed zone. In practice, the ultrasounds impact a spherical or ellipsoidal zone, of a few millimeters in diameter. The perturbation should thus be sensitive to conductivity variations at the millimeter scale, which is the precision required for breast cancer diagnostic.

The material presented in this talk conerning the imaging by perturbation approach, is based on a joint work with Habib Ammari, Eric Bonnetier, Michael Tanter & Matthias Fink and on an ongoing collaboration with Frdric de Gournay, Otared Kavian and Jrme Fehrenbach. I will also discuss recent results concerning perturbation of asymptotically small volume fraction which are based on joint works with Michael Vogelius.