Principle and Application of Electrical Impedance Tomography

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It is well known that the electrical resistance R between cross sections of a columnar conductor of length d and cross-sectional area S can be expressed as $R=\rho d/S$ where the proportional constant ρ is the resistivity. Its reciprocal, $\sigma=1/\rho$, is called conductivity and expresses how readily electricity flows. Conductivity is a material constant that is independent of the shape and size of the conductor and varies with the type and state of the material (temperature, pressure, water content, etc.). Therefore, by measuring the conductivity, information about the type and state of the substance can be obtained.

Electrical Impedance Tomography (EIT) is a measurement technology in which a large number of electrodes are placed in contact with the surface of the object under measurement, weak currents are applied from the electrodes, and the distribution of electrical conductivity inside the object is estimated and imaged from the measured electrode potential data.

In this talk, the history and current status of EIT will be summarized with a focus on its application to medical imaging, followed by an explanation of its principle in the following order: formulation of the forward problem, finite element method for discretizing and treating continuously distributed potentials and currents in the object, electrode model as an interface to measurement, and algorithm for reconstructing conductivity distribution.

An application to the measurement of body fat distribution, which we are currently developing, will also be introduced.