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ADAPTIVE MESHING APPROACH TO LOCATING INTERNAL METALS WITH ELECTRICAL RESISTANCE TOMOGRAPHY

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ABSTRACT

In this paper we propose a new computational approach to Electrical Resistance Tomography (ERT) imaging of targets including metallic internal structures. We model the internal metals as electrodes and use adaptive meshing in estimation of metal locations. The approach is tested with simulation studies (Figures 1 and 2).

In ERT the target is monitored with electrical boundary measurements. Electric current is injected to the target through electrodes attached to the target boundary and the resulting voltages between a set of electrode pairs are measurement. The boundary voltage data corresponding to multiple current patterns is used for reconstructing the internal (3D) conductivity distribution. The most accurate model for ERT measurements is the *complete electrode model*, which takes into account the size of the boundary electrodes and the contact impedances between the electrodes and the target. Reconstructing the conductivity distribution on the basis of boundary voltages is an ill-posed inverse problem - this is a result of the diffusive nature of the modality. The presence of internal metallic structures causes an additional challenge for reconstruction, because the mechanisms of the electric charge transfer are different in metallic objects than in the surrounding material: the metals are perfect conductors, and hence the electric potential is constant on all the connected metal surfaces.

In paper [1] the problem of internal metals was considered in the case of industrial process tomography application. An internal metallic structure was modeled as an internal electrode with the complete electrode model. In the cited paper the location of the internal metal was known. In this paper we extend the approach to cases of internal metals with unknown locations. The resulting reconstruction algorithm uses adaptive meshing in inferring the metal location on the basis of ERT measurements.

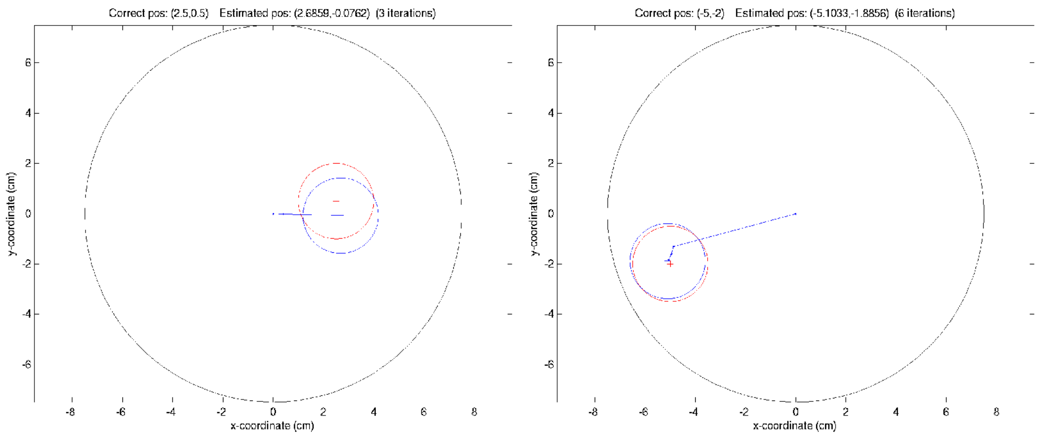

Figure 1: Estimation of internal electrode location. The red circles indicate the true locations of the internal electrodes in two different simulations, and the blue circles represent the corresponding estimates. The blue line segments illustrate the transition of the electrode center in iteration. In both simulations the initial guess for the center of internal electrode was the Origin. As expected, the estimated location of the internal metal is more accurate in the case that the metal is close to the boundary, because the ERT measurements are more sensitive to deformations of the electric field near to boundary than in the center.

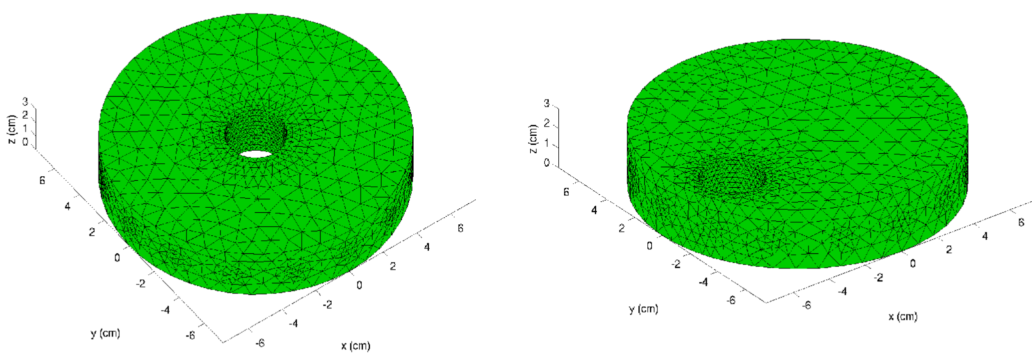

Figure 2: The Finite element meshes corresponding to initial guess for the internal electrode location (left), and the final estimate for the electrode location; second simulation (Figure 1, Right)

We expect that the proposed approach is applicable for non-destructive testing (NDT) of reinforced concrete. In the case of imaging reinforced concrete we often have reliable prior information on the size and shape of reinforcement bars, but their orientation and distance from the concrete surface are unknown. Indeed, one important application in NDT of concrete is detecting the thickness of the protective concrete layer on top of reinforcement bars; if the protective layer is too thin, the corrosion risk is high. In addition, in cases that the purpose in ERT imaging of concrete is other than locating the reinforcement bars - e.g. detection of cracks, moisture or chloride distribution - it still may be necessary to estimate the location of the reinforcement bars because they have a significant effect on the electrical measurements.

REFERENCES

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