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DISCRETE COIL INDUCED CURRENT IMPEDANCE TOMOGRAPHY

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Abstract— A discrete coil induced current imaging system is proposed. The solution methodology of the forward problem of this system is explained. For concentric inhomogeneity problem, optimum coil currents that maximize the distinguishability are obtained.

I. INTRODUCTION

Electrical Impedance Tomography (EIT) is an imaging technique, which distinguishes the conductivity differences of tissues [1]. In EIT, current is injected throug 16-32 electrodes and measurement of voltage along the boundary of the object helps determine the image. Induced current EIT works with the same principles, the main difference being the induction of the current using a coil located outside the object. In this work, a discrete coil induced current system is proposed and analyzed. Optimum currents for best distinguishability [3] are also reported.

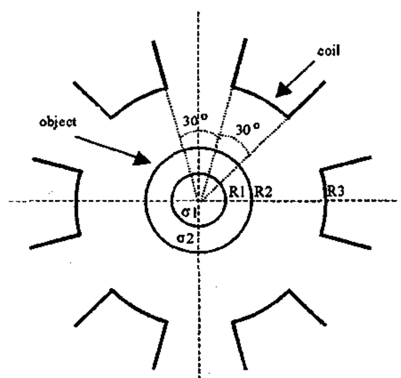


Fig.1. Discrete Coil EIT Configuration

II. DISCRETE COIL INDUCED CURRENT EIT

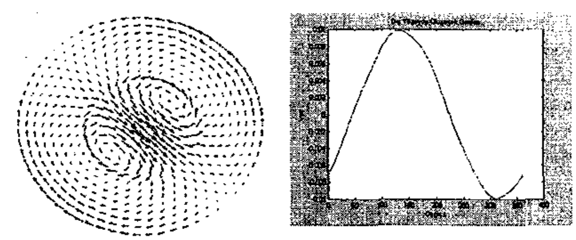
In EIT, independent measurements are obtained by changing the positions of the injection electrodes or by changing the location of the coil [1,2]. Induced current in the object can be controlled efficiently using the discrete coil configuration shown in Fig.1 and by changing the individual coil currents.

III. METHOD OF ANALYSIS

The problem of Fig.1 can be solved easily using quasi-static assumption and neglecting the displacement field in the object. As a result, electric potential can be found using only the Fourier coefficients of the normal component of the magnetic vector potential along the boundary of the object. Each coil current is assumed unity and the solution is expressed as a matrix equation using Fourier coefficients. Forward problem solution for any coil current and distinguishability optimization is handled using matrix operations.

IV. RESULTS

The six coil system of Fig.1 is used for the examples given and concentric inhomogeneity case is investigated. Operating frequency of the system is assumed as f=50 kHz. In all the cases investigated, it is found that 5 Fourier coefficients are sufficient to represent the normal components of the magnetic vector potential. The current distribution in Fig. 2(a) is obtained for R1=0.5, R2=1, $\sigma 1=10$ and $\sigma 2=1$ when the optimal currents are applied. Optimum currents are obtained under norm(I)=1 constraint, and are I=[0.41 0.56 0.15 –0.41 –0.56 –0.15]. Best currents are localized on the object as can be seen from Fig.2 (a).



(a) (b)

Fig. 2. (a) Current distribution in the object when optimum coil currents are applied. (b) Potential calculated at the boundary of the object.

V. CONCLUSION

In this work, a discrete coil induced current EIT system is analyzed. The purpose of new configuration was to control the current distribution inside the object without moving coils. It was shown through examples that this has been successfully achieved. The currents that maximize the distinguishability are obtained for two different constraints. Further research will focus on obtaining the optimum currents for eccentric inhomogeneities and on determining minimum detectable object radius for both cases.

REFERENCES

[1] K. Boone, D. Barber, B. Brown, 'Review Imaging with Electricity: Report of the European Concerted Action on Impedance Tomography ', *Journal of Medical Engineering & Technology,* vol:21, pp:201-232, 1997.
[2] I.L. Freeston, R.C. Tozer, 'Impedance Imaging Using Induced Currents', *Physiological Measurement,* vol:16, supp3A, pp:257-266, 1995.
[3] A. Köksal, B.M. Eyüboğlu, 'Determination of Optimum Injected Current Patterns in Electrical Impedance Tomography', *Physiological Measurement,* vol:16, supp3A, pp:99-109, 1995.