Theoretical and Practical Aspects of Diffusion MRI and MR Compatible Robotics

Asst. Prof. Dr. Alpay Özcan
Research Assistant Professor
Biomedical MR Laboratory, Mallinckrodt Institute of Radiology
Washington University, USA

Abstract

A new, geometric and sample independent optimization problem is defined based on minimizing the difference between the eigenvalues calculated with and without including the imaging gradients in the estimation equations. The optimization generates new diffusion gradient vector schemes that define the Diffusion Tensor Imaging (DTI) experiments. Aside reaching from the optimization goal defined above, the optimally conducted experiments also possess smaller model matching errors, thus the model fits better the data obtained with the optimal experiments. This result has significant effects on the DTI's applications. For example, the performance of the multimodal MR classifier is improved thanks to these more accurate results. These advantages play an important role for pre-, during and post-operational assessment for interventions executed using the MR compatible robotic device that is described here. On the theoretical side, the rigorous analysis of the DTI model exhibits deficiencies for incorporating the imaging gradients in order to obtain a complete model of diffusion weighted imaging. When a more careful analysis is carried out, it is shown that the diffusion weighted MR signal is in fact the Fourier transform of the joint distribution of the proton density and the displacement integral values. The application of this brand new high dimensional method, Complete Fourier Direct MRI, is demonstrated on an ex-vivo baboon brain sample. The method does not possess the symmetry constraints of any of the existing methods and thus provides a higher level of microstructural information.

Biography

EDUCATION
Doctor of Science, Systems Science and Mathematics (Feb . 2000)
Master of Science, Systems Science and Mathematics (May 1996)
1994-2000 Dept. of Systems Science and Mathematics, Sever School of Engineering and Applied Science, Washington University in Saint Louis
Diploma of Imperial College and Master of Science, Electrical Engineering
1992-1993 Dept. of Electrical Engineering (Control Systems Section), Imperial College, University of London
Honours of Distinction, Department of Electrical Engineering
Bachelor of Science, Electrical and Electronics Engineering,
Bachelor of Science, Mathematics
1988-1992 Dept. of Electrical and Electronics Engineering and Dept .of Mathematics, Boğaziçi University
Honors Student, Department of Electrical and Electronics Engineering
Honors Student, (2nd in Rank) Department of Mathematics

EXPERIENCE
Research Assistant Professor, Biomedical MR Laboratory, Mallinckrodt Institute of

Radiology, Washington University School of Medicine (Mar. 2007-present).
Senior Scientist Biomedical MR Laboratory, Mallinckrodt Institute of Radiology, Washington University School of Medicine (Jan. 2005- Feb. 2007)
Research Associate Biomedical MR Laboratory, Mallinckrodt Institute of Radiology, Washington University School of Medicine (Jan. 2001- Dec. 2004)
Research Associate DARPA-JFACC Project, Dept. of Systems Science and Mathematics, Washington University (Jan. 2000- Jan. 2001);
Instructor Mobile Robotics Course (Fall 2000)
Research Assistant Dept. of Systems Science and Mathematics, Washington University (Sep. 1994-Jan. 2000)
Systems Administrator Dept. of Systems Science and Mathematics, Washington University (Sep. 1996-Jan. 2000)
Research Assistant Dept. of Electrical and Electronics Engineering, Boğaziçi University, Istanbul, (Sep.1993-June 1994)