Diffusion Tensor MRI Predictors of Cognitive Impairment in Confluent White Matter Lesion

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Although age-related white matter lesion (WML) is an important substrate for cognitive impairment in the elderly, the mechanisms whereby WML induces cognitive impairment are uncertain. Our findings in this project suggested that diffusion tensor imaging (DTI) measures might be the most sensitive imaging predictors in patients with WML. Understanding the imaging predictors for such disease will be useful in monitoring disease progression and in devising surrogate marker for treatment trials.

In this project, we developed computing algorithms of successfully reconstructing neural fibers from DTI, automatically grouping neural fibers into anatomical structures, and computing a set of new DTI measurements from the grouped neural fibers. Clinical studies showed that the proposed DTI measurements have much stronger correlations with cognitive impairments than conventional MRI measurements. Our structure-wise measurements provide more precise ways of looking into region-specific neurological functions than existing full brain statistics.

This project is an collaboration among Department of Electronic Engineering, Department of Medicine & Therapeutics, and Department of Imaging & Interventional Radiology. It is funded by Shun Hing Institute of Advanced Engineering. Prof. Xiaogang Wang from the Department of Electronic Engineering is the principal investigator of this project. Some results of this project have been published on *NeuroImage*, which has the highest impact factor (IF = 5.739, 5-year IF = 7.168) among all the medical imaging journals. More journal submissions are under preparation.

Publications:

[1] X. Wang, E. Grimson, and C. Westin, "Tractography Segmentation Using a Hierarchical Dirichlet Processes Mixture Model," *NeuroImage*, pp. 290-302, Vol. 54, 2011.

[2] C. Li, X. He, V. Mok, W. Chu, J. Yuan, and X. Wang, "Free-Form Fibers: A Whole Brain Fiber-to-DTI Registration Method," *Workshop on Computational Diffusion MRI*, 2011.

利用彌散張量核磁共振成像預測由於合流腦白質病變引起的認知障礙

醫學研究表明腦白質病變是導致老年人認知障礙的重要基質，但其具體機制依然未知。本項目中的研究發現彌散張量核磁共振影像對於腦白質病變更加敏感。研究通過醫學影像對這類疾病作出預測，不但可以更加準確地監控病情的發展，還可以用於設計治療試驗中的替代指標，對於臨床研究有著重要的價值。

在本項目中，我們的研究成果可以成功地通過計算機模擬從彌散張量核磁共振影像數據中重構人腦的神經纖維，自動將神經纖維分組，形成對應人腦不同解剖結構的神經纖維束，併計算得到一組新的基於神經纖維束的彌散張量核磁共振影像度量。臨床研究表明，與傳統的核磁共振影像度量相比，我們提出的彌散張量核磁共振影像度量與認知障礙具有更強的相關性。傳統的度量是基於全腦的統計量，我們的度量與人腦的特定結構相關，因而能更好的反映人腦不同結構和不同區域的神經功能。

這是香港中文大學電子工程系、內科及藥物治療系、影像學及介入放射學系的合作項目，由訊興先進工程學院資助，由電子工程系的王曉剛教授擔任項目的主要負責人。本項目的部分研究成果發表在神經影像期刊(NeuroImage)。該期刊在所有的醫學影像期刊中具有最高的影響因子(5.739). 更多的成果將陸續發表。

發表論文

[1] X. Wang, E. Grimson, and C. Westin, "Tractography Segmentation Using a Hierarchical Dirichlet Processes Mixture Model," *NeuroImage*, pp. 290-302, Vol. 54, 2011.

[2] C. Li, X. He, V. Mok, W. Chu, J. Yuan, and X. Wang, "Free-Form Fibers: A Whole Brain Fiber-to-DTI Registration Method," *Workshop on Computational Diffusion MRI*, 2011.

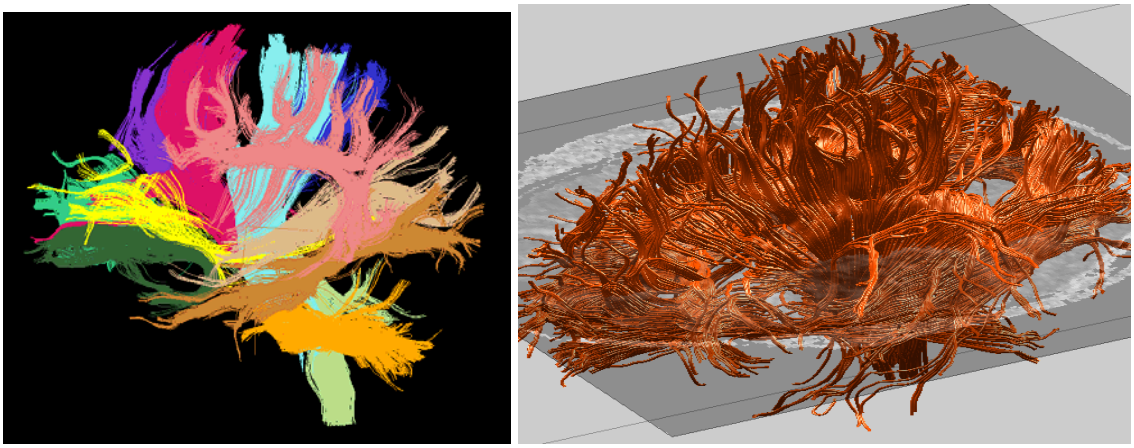

Figure 1. Reconstructed neural fibers from diffusion tensor MRI data. Colors indicate different anatomical structures of brain white matter

圖 1. 計算機從彌散張量核磁共振影響數據中構的大腦神經纖維。顏色代表大腦白質中不同的解剖結構。

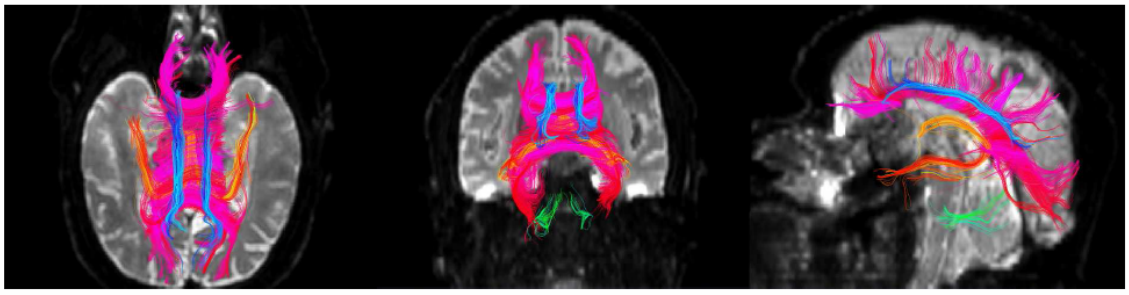

Figure 2. Reconstructed fibers of four anatomical structures: corpus callosum (magenta), superior cingulum (blue), fornix (orange), and inferior cerebellar peduncle (green)

圖 2. 四個對應個不同大腦白質解剖結構的神經纖維束：胼胝體(品紅)、前扣帶回 （藍）、穹窿（橙）、下小腦腳（綠）。