Physics

Physics-I *Machine Learning in MRI: design, acquisition, and analysis*
(3 speakers, 90 min)

Physics-II *Chemical Exchange Saturation Transfer: signal origin, animal model, and human applications*
(3 speakers, 90 min)

Physics-III ***Diffusion MRI: from basic principles to advanced applications***
(3 speakers, 90 min)

Physics-IV *Quantitative MRI: from parametric mapping to multi-parametric application*
(2 speakers, 60 min)

Physics-V *Novel MRI modalities*
(2 speakers, 60 min)

Ching-Po Lin, PhD
林慶波 教授

Time Table

Saturday, May 21, 2022
Room 205

Time	Topics	Speakers	Moderators
15:30-16:00 (30mins)	What You Need to Know about Diffusion MRI	Hiroyuki Kabasawa	Ching-Po Lin Li-Wei Kuo
16:00-16:30 (30mins)	Advances in quantitative diffusion MRI of white matter microstructure and connections	Chun-Hung Yeh	Ching-Po Lin Li-Wei Kuo
16:30-17:00 (30mins)	Processing Algorithms for Diffusion MRI	Yung-Chin Eric Hsu	Ching-Po Lin Li-Wei Kuo

Diffusion MRI: from basic principles to advanced applications

Organizer:Hsiao-Wen Chung

Overview:

Diffusion MRI noninvasively probes the random motion of water molecules. In the presence of diffusion barriers, the anisotropy of diffusion MRI becomes an important tool visualizing the microstructural integrity of biological tissues, the most successful one being the myelinated white matter. In this session, a first education lecture providing the necessary background about diffusion MRI will be given, followed by research achievements related to quantification of brain white matter microstructure, as well as technical issues associated with post-processing of diffusion MRI including artifact correction and spatial registration.

What You Need to Know about Diffusion MRI

Hiroyuki Kabasawa, Ph.D., Japan

- Professor of Radiological Sciences, International University of Health and Welfare
- Board of Director, Asian Society for Magnetic Resonance in Medicine
- Developing acquisition and image processing techniques for diffusion and perfusion magnetic resonance imaging

What You Need to Know about Diffusion MRI

- **Synopsis:**
- Diffusion MRI is a noninvasive imaging tool that could probe the random motion of water molecules, which in turn provides valuable information regarding pathological alterations of microstructural integrity. Acquisition of diffusion MRI is accomplished by adding a pair of motion sensitizing gradients to an imaging sequence, echo planar imaging (EPI) being the most commonly used one. The combination of EPI with diffusion gradients results in unique image behavior. In this educational lecture, issues related to diffusion MRI will be discussed to help investigators understand the proper usage as well as limitations of this important imaging tool.
- **Key Reference:**

- Yoon JH, Lee JM, Lee KB, Kim D, Kabasawa H, Han JK. Comparison of monoexponential, intravoxel incoherent motion diffusion-weighted imaging and diffusion kurtosis imaging for assessment of hepatic fibrosis. Acta Radiol. 2019;60:1593-1601.
- Takao H, Hayashi N, Kabasawa H, Ohtomo K. Effect of scanner in longitudinal diffusion tensor imaging studies. Hum Brain Mapp. 2012;33:466-477.
- Kabasawa H, Masutani Y, Aoki S, Abe O, Masumoto T, Hayashi N, Ohtomo K. 3T PROPELLER diffusion tensor fiber tractography: a feasibility study for cranial nerve fiber tracking. Radiat Med. 2007;25:462-466.

Advances in quantitative diffusion MRI of white matter microstructure and connections

Chun-Hung Yeh, PhD, Taiwan

- Assistant Research Fellow of Radiological Research, Chang Gung University
- Software analysis tools for human and animal structural connectome using advanced high angular resolution diffusion magnetic resonance imaging and tractography

Advances in quantitative diffusion MRI of white matter microstructure and connections

- **Synopsis:**

- Diffusion MRI (dMRI) enables the non-invasive acquisition of in vivo image data for probing microstructural features and connections of white matter (WM) fibers in the brain. Fixel-based analysis or FBA is an emerging analysis framework that can provide quantitative metrics specific to individual fiber populations within a voxel from diffusion MRI data. It has been shown to increase the specificity, sensitivity, and interpretability over voxel-averaged measures obtained in the conventional voxel-based morphometry approach. This presentation will cover the main concept and methods of FBA, with a demonstration of its potential in clinical neuroscience research via a range of studies.

- **Key Reference:**

- Liang X, Yeh CH, Domínguez D JF, Poudel G, Swinnen SP, Caeyenberghs K. Longitudinal fixel-based analysis reveals restoration of white matter alterations following balance training in young brain-injured patients. Neuroimage Clin. 2021;30:102621.
- Yeh CH, Jones DK, Liang X, Descoteaux M, Connelly A. Mapping Structural Connectivity Using Diffusion MRI: Challenges and Opportunities. J Magn Reson Imaging. 2021;53:1666-1682.

Processing Algorithms for Diffusion MRI

- Chief Technology Officer, AcroViz Inc.
- Post-processing algorithms for the analysis of diffusion MRI data, such as artifact correction, diffusion model reconstruction, and spatial registration, with applications to brain age estimation

Yung-Chin Eric Hsu, PhD, Taiwan

Processing Algorithms for Diffusion MRI

- ## Synopsis:

- We developed a set of preprocessing algorithms for diffusion MRI (dMRI) data. DACO (distortion/artefact correction) makes use of anatomical images (T1w or T2w) to correct the susceptibility-induced distortions, eddy current-induced distortions, head motions, and the misregistration between the dMRI data and the anatomical image. ReMAP (regularized MAP-MRI) improves the estimation of MAP-MRI by penalizing the unsmoothness of the estimated diffusion model. NTU-DSI-122 is a diffusion template with high anatomical consistency to the ICBM-152 space. A set of 76 fiber tracts was derived from NTU-DSI-122. Finally, we developed a brain age model to investigate dementia.

- ## Key Reference:

- Tsai TH, Su HT, Hsu YC, Shih YC, Chen CC, Hu FR, Tseng WI. White matter microstructural alterations in amblyopic adults revealed by diffusion spectrum imaging with systematic tract-based automatic analysis. Br J Ophthalmol. 2019;103:511-516.
- Tseng WI, Hsu YC, Kao TW. Brain Age Difference at Baseline Predicts Clinical Dementia Rating Change in Approximately Two Years. J Alzheimers Dis. 2022. doi: 10.3233/JAD-215380.