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THE DEPARTMENT OF COMPUTER SCIENCE & THE COMPUTER SCIENCE GRADUATE STUDENT ORGANIZATION (GSOCS) PRESENT

INVITED SPEAKER SERIES

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Distinguished Professor Yi Wang
Cornell University

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Quantitative susceptibility mapping (QSM): physics, algorithm and applications

Abstract: Tissue magnetism refers to the electron–proton interaction, which is macroscopic and long range with its effects on MRI being treated as static dephasing. In contrast, traditional tissue relaxation refers to the proton–proton (commonly known as spin-spin) interaction, which is microenvironment-sensitive and short range with its effect on MRI being treated quantum-mechanically. The long-range magnetism implies nonlocal blooming artifacts in both T2* hypointensity and phase of MRI signal. Quantitative susceptibility mapping (QSM) is to study magnetism by deconvolving the blooming artifacts. The Bayesian approach has been established to address the main QSM challenge, which is the ill posedness of the magnetic field to susceptibility source inverse problem.

QSM has become sufficiently accurate and robust for routine applications. QSM is advancing MRI study of tissue magnetic susceptibility from simple qualitative detection of its hypointense blooming artifacts to precise measurement of its biodistributions. Tissue susceptibility contains rich functional and structural information pertinent to molecular electron cloud properties. The dominant susceptibility sources in tissue are biometals, which are vital participants in cellular functions and pathologies. QSM can be useful for diseases that involve neurodegeneration, inflammation, hemorrhage, abnormal oxygen consumption, substantial alterations in highly paramagnetic cellular iron, bone mineralization, or pathologic calcification; and for all MRI with contrast agent injection. Clinicians should consider integrating QSM into their routine imaging practices by including susceptibility-sensitive gradient echo sequences in all relevant MRI protocols.

Bio: Yi Wang (PhD 1994, University of Wisconsin-Madison) is the Faculty Distinguished Professor of Radiology and professor of Biomedical Engineering at Cornell University. He is a Fellow of AIMBE, IEEE, and ISMRM, and have received the Distinguished Investigator Award from The Academy for Radiological & Biomedical Imaging Research. He has published more than 217 papers in peer-reviewed scientific journals, authored a textbook “Principles of Magnetic Resonance Imaging” and a monograph book “Quantitative Susceptibility Mapping”, co-authored a book “Electro-Magnetic Tissue Properties MRI” and edited a book “Introduction to Medicine for Engineers”. Prof. Wang is interested in developing biomedical imaging methods, particularly MRI, using tools from computer science, electronic engineering, mathematics, and physics and using knowledge in biology, chemistry, life science and medicine. He has made significant contributions to MRI development including: 1) navigator motion compensation for cardiac MRI that has become widely adapted in cardiac MRI community, 2) time resolved imaging of transport processes, including MR digital subtraction angiography that has become a major method for MRA and vector field perfusion, 3) multi-station stepping-table platform with local coils for fast imaging of large FOV that has become a standard feature of modern MRI system, such as the platform for Siemens’ TIM MRI product, and 4) recently, the Bayesian approach to the field source inverse problem for quantitative susceptibility mapping (QSM) of tissue magnetism (including iron, calcification and myelin).