Semi-sesquicentennial of mecheng@IISc Distinguished Seminar Series

Patient-specific modeling of blood flow in arteries - from the academy to the clinic

Dr. Charles A. Taylor
Founder, Chief Technology Officer, Heartflow Inc.

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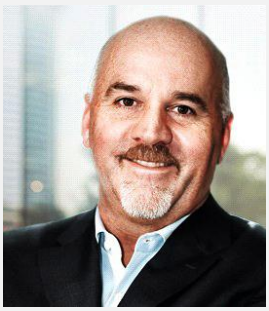
Meeting link: https://bit.ly/3tgkVlR (MS Teams)

ABSTRACT

Patient-specific models of blood flow constructed from coronary CT angiography (cCTA) images and using computational fluid dynamics are transforming the diagnosis of heart disease by providing a safer, cheaper and more efficient procedure as compared to the standard of care that often involves nuclear imaging and invasive diagnostic cardiac catheterizations. Such image-based computations require an accurate segmentation of the coronary artery lumen from cCTA images and employ biologic principles relating form (anatomy) to function (physiology). Leveraging research originally performed at Stanford University, HeartFlow has developed a non-invasive test, FFRCT, based on computing flow and pressure in the coronary arteries. FFRCT has been validated against invasive pressure measurements in more than 1000 patients and demonstrated to improve care in numerous clinical studies in more than 6000 patients to date. At present, FFRCT has been used for more than 100,000 patients in routine practice for clinical decision making in the United States, Canada, Europe, and Japan. The National Health Services in England, the Ministry of Health and Welfare in Japan, and Medicare and the majority of private insurance companies in the U.S. reimburse physicians for using FFRCT.

Patient data is uploaded to the HeartFlow application running on Amazon Web Services and then image quality analysis is performed to determine suitability of CT data for quantitative. Image analysis methods leveraging deep learning are used to create an initial patient-specific geometric model, and then a trained analyst inspects and corrects the patient-specific geometric model. Next fully-automated mesh generation techniques including anisotropic and boundary layer elements are used to discretize the model and computational fluid dynamic analysis is performed on AWS to compute the blood flow solution. Results are returned to the physicians through a web interface or mobile application. New developments including planning treatments and evaluating risk of rupture of coronary plaques will be discussed.

ABOUT THE SPEAKER



Charles is co-founder, Chief Technology Officer (CTO), and member of the Board of Directors of HearFlow Inc. Previously, he was an Associate Professor in the Departments of Bioengineering and Surgery at Stanford University with courtesy faculty appointments in the Departments of Mechanical Engineering and Radiology. He is also currently a Consulting Professor of Bioengineering at Stanford University and a part-time Professor of Biomedical Engineering at the Technical University of Eindhoven. He is internationally recognized for his pioneering work in combining computer simulation methods with medical imaging data for patient-specific modeling of blood flow to aid in the diagnosis and treatment of cardiovascular disease. Charles has published over 350 peer-reviewed journal and conference papers and has over 220 issued or pending patents worldwide.

He received his B.S. degree in Mechanical Engineering, M.S. degree in Mechanical Engineering and M.S. degree in Mathematics from Rensselaer Polytechnic Institute and a Ph.D in Mechanical Engineering from Stanford University.

Session chair: Prof. Namrata Gundiah, mecheng@IISc