EMBC 2019 **Workshop**

Image-based estimation of cardiovascular tissue motion and elasticity

Type (Half day)

Organisers: Spyretta Golemati -IEEE/EMBS Member, **Elisa E. Konofagou** – IEEE/EMBS Member

Spyretta Golemati is Assistant Professor in Biomedical Engineering in the Medical School of the National and Kapodistrian University of Athens, Greece. She holds a Diploma in Mechanical Engineering from the National Technical University of Athens and M.Sc. and Ph.D. degrees in Bioengineering from Imperial College London. Her research interests include (a) vascular ultrasound image analysis, (b) biosignal processing, and (c) vascular physiology and pathophysiology. She has coauthored 32 papers published in international peer-reviewed journals (h-index: 21), 12 book chapters, and 44 papers published in international scientific peer-reviewed conference proceedings. She has been visiting research associate in Columbia University in the city of New York, USA (2013 and 2016) and in Ecole Centrale de Paris, France (2013). She is a member of the Institute of Electrical and Electronic Engineers [Engineering in Medicine and Biology Society (IEEE-EMBS), Ultrasonics, Ferroelectrics and Frequency Control (IEEE-UFFC)], the Technical Chamber of Greece, and the Hellenic Atherosclerosis Society.She is Associate Editor of Elsevier's Ultrasonics and alumna of the Fulbright Foundation-Greece (academic year 2016-2017).

Elisa Konofagou is the Robert and Margaret Hariri Professor of Biomedical Engineering and Professor of Radiology as well as Director of the Ultrasound and Elasticity Imaging Laboratory at Columbia University in New York City. Her main interests are in the development of novel elasticity imaging techniques and therapeutic ultrasound methods and more notably focused ultrasound in the brain for drug delivery and stimulation, myocardial elastography, electromechanical and pulse wave imaging, harmonic motion imaging with several clinical collaborations in the Columbia Presbyterian Medical Center and elsewhere. Elisa is an Elected Fellow of the American Institute of Biological and Medical Engineering and of the Acoustical Society of America, a member of the IEEE in Engineering in Medicine and Biology, IEEE in Ultrasonics, Ferroelectrics and Frequency Control Society, the Acoustical Society of America and the American Institute of Ultrasound in Medicine. She has co-authored over 180 published articles in the aforementioned fields. Prof. Konofagou has also served as a technical committee member of the Acoustical Society of America, the International Society of Therapeutic Ultrasound, the IEEE Engineering in Medicine and Biology conference (EMBC), the IEEE International Ultrasonics Symposium and the American Association of Physicists in Medicine (AAPM). Elisa serves as Associate Editor in the journals of IEEE Transactions in Ultrasonics, Ferroelectrics and Frequency Control, Ultrasonic Imaging and Medical Physics, and is recipient of awards such as the CAREER award by the National Science Foundation (NSF) and the Nagy award by the National Institutes of Health (NIH) as well as others by the American Heart Association, the Acoustical Society of America, the American Institute of Ultrasound in Medicine, the Wallace H. Coulter foundation, the Bodossaki foundation, the Society of Photo-optical Instrumentation Engineers (SPIE) and the Radiological Society of North America (RSNA).

Image-Based Estimation of Cardiovascular Tissue Motion and Elasticity

Theme: <u>**02. Biomedical Imaging and Image Processing**</u>

Keywords: motion, elasticity, ultrasound, MRI, heart, vessels

Abstract

The estimation of tissue motion and elasticity in the heart and vessels is valuable for characterising cardiovascular status in health and disease. Following the periodic movement of the heart and the resulting blood pressure variations during the cardiac cycle, the cardiovascular tissue performs a complex three-dimensional motion. Motion can be quantified through the calculation of a number of kinematic parameters, including displacements, velocities, and accelerations, as well as strain, which has gained attention for characterising tissue function. Tissue elasticity characterises its mechanical properties and can be assessed through estimations of displacements/strains in combination with pressure indices. To estimate motion from images, different imaging modalities can be used, including ultrasound, magnetic resonance imaging (MRI) and computed tomography (CT). Among these, ultrasound imaging is the most widely used technique for cardiovascular motion estimation, due to its wide availability, easy use, high temporal resolution, and possibility to access various central and peripheral vessels. This workshop aims to present the state-of-the art in image-based estimation of motion and elasticity of the cardiovascular tissue and to highlight novel directions and challenges toward identifying non-invasive markers of cardiovascular risk.

LIST of Speakers

A. *Spyretta Golemati, National and Kapodistrian University of Athens, sgolemati@med.uoa.gr*

Ultrasound-image-based estimation of motion and strain of the carotid artery wall in health and disease

Spyretta Golemati is Assistant Professor in Biomedical Engineering in the Medical School of the National and Kapodistrian University of Athens, Greece. She holds a Diploma in Mechanical Engineering from the National Technical University of Athens and M.Sc. and Ph.D. degrees in Bioengineering from Imperial College London. Her research interests include (a) vascular ultrasound image analysis, (b) biosignal processing, and (c) vascular physiology and pathophysiology. She has coauthored 32 papers published in international peer-reviewed journals (h-index: 21), 12 book chapters, and 44 papers published in international scientific peer-reviewed conference proceedings. She has been visiting research associate in Columbia University in the city of New York, USA (2013 and 2016) and in Ecole Centrale de Paris, France (2013). She is a member of the Institute of Electrical and Electronic Engineers [Engineering in Medicine and Biology Society (IEEE-EMBS), Ultrasonics, Ferroelectrics and Frequency Control (IEEE-UFFC)], the Technical Chamber of Greece, and the Hellenic Atherosclerosis Society. She is Associate Editor of Elsevier's Ultrasonics and alumna of the Fulbright Foundation-Greece (academic year 2016-2017).

B. *Elisa E. Konofagou, Columbia University, ek2191@columbia.edu*

Intrinsic Wave Imaging for Assessment of Cardiovascular Mechanics

Elisa Konofagou is the Robert and Margaret Hariri Professor of Biomedical Engineering and Professor of Radiology as well as Director of the Ultrasound and Elasticity Imaging Laboratory at Columbia University in New York City. Her main interests are in the development of novel elasticity imaging techniques and therapeutic ultrasound methods and more notably focused ultrasound in the brain for drug delivery and stimulation, myocardial elastography, electromechanical and pulse wave imaging, harmonic motion imaging with several clinical collaborations in the Columbia Presbyterian Medical Center and elsewhere. Elisa is an Elected Fellow of the American Institute of Biological and Medical Engineering and of the Acoustical Society of America, a member of the IEEE in Engineering in Medicine and Biology, IEEE in Ultrasonics, Ferroelectrics and Frequency Control Society, the Acoustical Society of America and the American Institute of Ultrasound in Medicine. She has co-authored over 180 published articles in the aforementioned fields. Prof. Konofagou has also served as a technical committee member of the Acoustical Society of America, the International Society of Therapeutic Ultrasound, the IEEE Engineering in Medicine and Biology conference (EMBC), the IEEE International Ultrasonics Symposium and the American Association of Physicists in Medicine (AAPM). Elisa serves as Associate Editor in the journals of IEEE Transactions in Ultrasonics, Ferroelectrics and Frequency Control, Ultrasonic Imaging and Medical Physics, and is recipient of awards such as the CAREER award by the National Science Foundation (NSF) and the Nagy award by the National Institutes of Health (NIH) as well as others by the American Heart Association, the Acoustical Society of America, the American Institute of Ultrasound in Medicine, the Wallace H. Coulter foundation, the Bodossaki foundation, the Society of Photo-optical Instrumentation Engineers (SPIE) and the Radiological Society of North America (RSNA).

C. Andreas Wittek, Frankfurt University of Applied Sciences, <u>wittek@bio.uni-frankfurt.de</u>

In vivo assessment of the heterogeneity of the human aortic wall's local elastic properties and its changes with age and disease based on 4D ultrasound.

Andreas Wittek is founding member of the Personalized Biomedical Engineering Laboratory at the Frankfurt University of Applied Sciences. Holding a degree in Mechanical Engineering (Dipl.-Ing. (FH)) he is currently finishing his PhD in Mechanical Engineering at the University of Siegen. In his thesis work, that was conducted in an interdisciplinary project with the Departments of Biology and Medicine of the Goethe University Frankfurt, he has pioneered noninvasive full field displacement and strain measurement of the human aorta by time-resolved 3D ultrasonography. Based on these novel in vivo data, he has developed innovative approaches to the biomechanical and pathophysiological characterization of the individual aortic and aneurysmal wall.

D. Magnus Cinthio, Lund University, magnus.cinthio@bme.lth.se

Longitudinal movement of the arterial wall - recent developments

Magnus Cinthio was born in Klippan, Sweden, in 1969. He received the M.Sc. degree in biomedical engineering and the Ph.D. degree in electrical measurements in 1999 and 2004, respectively, from Lund University, Lund, Sweden. In 2010, he became Associate Professor in the Faculty of Engineering, Lund University, Lund. He has been visiting researcher at Tohoku University, Sendai, Japan, in 2007, and at Florence University, Florence, Italy, in 2012. He obtained a University Lecturer position in 2013 at the Department of Biomedical Engineering, Lund University, Lund, Sweden. His research interests include the longitudinal movement and the resulting intramural shearing of the arterial wall, ultrasonic tissue motion measurements, photoacoustic imaging, as well as arterial, cerebral, and intestinal characterization. He has produced 34 original publications in journals, 35 conference proceedings and 108 abstracts, 2 patents and 2 technical reports.

E. Anja Hennemuth, Universitätsmedizin Berlin, anja.hennemuth@mevis.fraunhofer.de

Image-based assessment of the interplay of blood flow and tissue motion for surgery planning
Prof. Anja Hennemuth studied Computer Science with Medicine as second subject. During her education with focus on Medical Image Processing she worked on Cardiac Image Analysis at Philips Research, Siemens and Hamburg University. She has been head of cardiovascular research and development at the Fraunhofer Institute for Medical Imaging since 2009. Since 2017, Prof. Hennemuth has held a bridge professorship at the Technical University and the newly founded Institute for Cardiovascular Computer-Assisted Medicine at Charité - Universitätsmedizin Berlin.

F. Nadja Kachenoura, INSERM-France, nadjia.kachenoura@inserm.fr

Myocardial tracking for multi-chamber strain estimation in cardiac magnetic resonance imaging
N Kachenoura had her PhD in Paris in 2007, a post-doc at University of Chicago, and Inserm research associate position in 2011. She is now the head of the cardiovascular imaging (LIB-ICV) team at Sorbonne Université/INSERM/CNRS. She is focusing on basic and applied research of morphological, functional & hemodynamic cardiovascular imaging methods. Research interests include: cardiovascular MRI & computed tomography, population/cohort imaging & clinical research, biomedical image processing, imaging biomarkers. She is currently the principal investigator of 3 national projects and 2 international projects (USA, Argentina). She has over 115 web of science publications (h-index=16) as well as several invited talks, and awards at international meetings. Her ICV team has just been

renewed for the 2019-2023 period with 16 team members and she currently supervises 3 PhD students (2 with an engineering and 1 with a medical background), and a post-doctoral fellow.