

apply a Minimum Energy Flow (MEF) method which is capable of estimating both incompressible and compressible flows from time-varying density images. Both the MEF and force-estimation techniques are applied to experimentally obtained density images, spanning spatial scales from micrometers to several kilometers. Using density image sequences describing cell splitting, for example, we show that cell division is driven by gradients in

apparent pressure within a cell. Using density image sequences of fish shoals, we also quantify 1) intershoal dynamics such as coalescence of fish groups over tens of kilometers, 2) fish mass flow between different parts of a large shoal, and 3) the stresses acting on large fish shoals. *IEEE Transactions on Pattern Analysis and Machine Intelligence* 33(6), pp. 1132-1146 (2011)

TUESDAY MORNING, 15 MAY 2012

S224 + S225, 9:20 A.M. TO 12:40 P.M.

Session 2aBA

Biomedical Acoustics: Biomedical Ultrasound Imaging Instrumentation

Lei Sun, Cochair

sun.lei@inet.polyu.edu.hk

Qifa Zhou, Cochair

qifazhou@usc.edu

Invited Papers

9:20

2aBA1. High frame rate velocity-coded speckle imaging platform for coherent blood flow visualization. Alfred C. H. Yu and Billy Y. S. Yiu (Medical Engineering Program, The University of Hong Kong, *alfred.yu@hku.hk*)

Non-invasive imaging of blood flow at over 100 fps (i.e. beyond video display range) is known to be of clinical interest given that such a high frame rate is essential for coherent visualization of complex hemodynamic events like flow turbulence. From a technical standpoint, getting into this frame rate range has become possible with the advent of broad-view ultrasound imaging paradigms that can track motion over an entire field-of-view using few pulse-echo firings. Leveraging on an imaging paradigm known as plane wave excitation, a novel high-frame-rate flow visualization technique has been developed to depict both blood speckle motion (using B-flow imaging principles) and flow velocities (using conventional color flow imaging principles). Experimental demonstration of this method has been carried out using a channel-domain research platform that supports real-time pre-beamformed data acquisition (SonixDAQ) and a high-throughput processing engine that is based upon graphical processing unit technology (developed in-house by the authors). In a case with a 417 fps frame rate (based on 5000 Hz pulse repetition frequency and slow-time ensemble size of 12), results show that high-frame-rate velocity-coded speckle imaging can more coherently trace fast-moving blood flow than conventional color flow imaging. Acknowledgement: Research Grants Council of Hong Kong (GRF 785811M)

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2aBA2. An open system for intravascular ultrasound imaging. Weibao Qiu, Yan Chen, Wang Fai Cheng, Yanyan Yu, Fu Keung Tsang, Jiyan Dai (The Hong Kong Polytechnic University, *qiu.weibao@connect.polyu.hk*), Qifa Zhou (University of Southern California), and Lei Sun (The Hong Kong Polytechnic University)

Cardiovascular disease is the main causes of morbidity and mortality due to lumen stenosis and atherosclerosis. Intravascular ultrasound (IVUS) is able to delineate internal structures of vessel wall with fine spatial resolution. However, IVUS is insufficient to identify the fibrous cap thickness and tissue composition of atherosclerotic lesions, the key factors to stage atherosclerosis and determine appropriate treatment strategies. Currently, novel techniques have been developed to determine tissue composition, which require an open IVUS system to accommodate these techniques for comprehensive plaque characterization. This paper presents the development of such an IVUS system with reconfigurable hardware implementation, programmable image processing algorithms, and flexible imaging control to support an easy fusion with other techniques to improve the diagnostic capabilities for cardiovascular diseases. In addition, this IVUS utilized a miniaturized ultrasound transducer constructed by PMN-PT single crystal for better piezoelectric constant and electromechanical coupling coefficient than traditional PZT ceramics. Testing results showed that the IVUS system could offer a minimum detectable signal of $25\mu\text{V}$, allowing a 51dB dynamic range at 47dB gain, with a frequency range from 20MHz to 80MHz. Finally, phantom imaging and in vitro vessel imaging were conducted to demonstrate the performance of the open system for IVUS applications.