North American BioAFM User Meeting

In-vivo AFM: Using AFM on Live Human Subjects to Extract the Elasticity of the Skin Using Viscoelastic Models and Plans for Using Poroelastic Models in Frequency Domain

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Detecting mechanical properties of the intact skin in-vivo leads to a novel quantitative method to diagnose skin diseases and to monitor skin conditions in clinical settings. Current research and clinical methods that detect skin mechanics have major limitations. The in-vitro experiments are done in non-physiological conditions and in-vivo clinical methods measurer unwanted mechanics of underneath fat and muscle tissues but report the measurement as skin mechanics. An ideal skin mechanics should be captured at skin scale (i.e., micron-scale) and in-vivo. However, extreme challenges of capturing the in-vivo skin mechanics in micron-scale including skin motion due to heart beep, breathing and movement of the subject, has hindered measurement of skin mechanics in-vivo. This study for the first time captures micro-scale mechanics (elasticity and viscoelasticity) of top layers of skin (i.e., the stratum corneum (SC) and stratum granulosum (SG)) in-vivo using Atomic Force Microscopy. In this study, Atomic Force Microscopy (AFM) was used to capture force-indentation curves on the fingertip skin of four human subjects at a high indentation speed of 40 um/s: The skin of the same subject was tested in-vitro at 10 different indentation speeds ranging from 0.125 to 40 um/s by AFM. This study extracts the in-vivo elasticity of SC and SG by detecting time-dependency of tested tissue using a fractional viscoelastic standard linear model developed for indentation. The talk will end by discussing the steps toward using poroelastic models in the frequency domain to extract indentation data.

Dr. Azadi holds a Ph.D. from the University of Alberta in Canada. He completed his master and undergraduate studies at Sharif University of Technology and Tehran universities in Iran.

He is an Associate Professor at the School of Engineering at San Francisco State University (SFSU) since August 2015. The primary goal of Dr. Azadi's lab is developing sensitive and quantitative biomechanical assessment tools to detect subtle changes in soft biological materials caused by biological factors, medications, and medical interventions.

Prior to joining SFSU, he worked for four years on numbers of collaborative projects around Biomimetics, Bioinstrumentation, Mechanobiology and Rehabilitation Robotics at the Biological and Mechanical Engineering Departments at MIT and Faculty of Rehabilitation Medicine at University of Alberta. These projects include designing a Bio-tensegrity leg for a robotic cheetah, measuring mechanics of soft tissues such as skin, Fallopian tube, cartilage, Tectorial membrane, and different cell layers in micro and nano scales.