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המחלקה להנדסה ביורפואית
הפקולטה למדעי ההנדסה

סמינר מחלקתי מיוחד – הנדסה ביורפואית
יום שלישי 6.11.2012 בשעה 14:00 בנין 30 חדר 300
BME Seminar, Tuesday 14:00, Building 30, room 300

Seeing transparent biology in sub-nanometer accuracy

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Live biological specimens, such as cells, tissues, or microorganisms, are microscopic dynamic objects, continuously responding to their environments and performing multiple processes by adjusting their three-dimensional sizes, shapes, and other biophysical features. Microscopy and nanoscopy of living specimens can provide a powerful tool for basic biological and biophysical studies, and for medical diagnosis and monitoring of disease progression. However, many live biological specimens such as cells in-vitro are transparent or semi-transparent objects, and imaging them with conventional bright-field light microscopy fails to provide adequate contrast in the microscope image. For this reason, exogenous contrast agents such as fluorescent labels are widely used in biomedical microscopy. However, these exogenous agents are often cytotoxic and may influence the specimen behavior, especially in the long run. Additionally, fluorescent agents tend to photobleach which might limit imaging time and make signal quantification hard to obtain.

Phase microscopy proposes a unique solution to the contrast problem. Phase is proportional to optical path delays of the light passing through the sample, and thus it captures information on the specimen structure and dynamics without using exogenous labeling. Traditional phase microscopy methods, such as phase contrast and differential interference contrast (DIC) microscopy, are widely used today. However, these common approaches present distinctive imaging artifacts, especially near the cell edges. In addition, a significant problem with these approaches is that they are not inherently quantitative methods, meaning that they do not enable interpretation of the resulting phase images in terms of quantitative optical path delays since they do not give the phase profile of all points across the cell viewable area. In contrast, interferometric phase microscopy enables to obtain the quantitative optical thickness profiles of live cells and track them in time with sub-nanometer accuracy.

In this lecture, I will present new optical interferometric and spectroscopic microscopy and nanoscopy techniques that enable accurate and quantitative measurements and visualization of biological cell structure, organization, and dynamics by recording the cell temporal, spatial, and refractive-index structures on sub-nanometer and sub-millihertz scales. These techniques include tracking the changes occurring in the texture, shape, size, and mechanical properties of cells using hybrid interferometric approaches. The unprecedented spatial and temporal resolutions obtained by the proposed methods will enable not only basic research applications but also carry a great potential for clinical and in-vivo applications.

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About the Lecturer

Natan T. Shaked is a senior lecturer in the Department of Biomedical Engineering, Tel Aviv University, Israel, starting from April 2011, where he heads the Biomedical Optical Microscopy, Nanoscopy, and Interferometry Research Laboratory. Previously, Shaked was a Visiting Assistant Professor in the Department of Biomedical Engineering in Duke University. He has coauthored more than 30 refereed journal papers, more than 35 conference papers, several patents and book chapters and edited a book on biomedical phase microscopy and nanoscopy.