Heinz-Nixdorf-Lehrstuhl für Biomedizinische Elektronik
TUM School of Computation, Information and Technology, TranslaTUM
Campus Klinikum rechts der Isar, Technische Universität München

Tuesday, June 27th, 3:00 PM
Johannes B. Ortner Forum (Auditorium right part)

Prof. Natan T. Shaked

Seeing the unseen: Rapid label-free 3D cell imaging by interferometry for cancer diagnosis in liquid biopsies and for in-vitro fertilization

I will review our latest advances in the field of cancer detection and monitoring in liquid biopsies, via interferometric phase microscopy (IPM) during cell flow, as well as label-free sperm selection for in vitro fertilization. Although exogenous markers can provide biological cell assays with a high degree of specificity, using these markers might cause cytotoxicity by perturbing the cell environment, by influencing its behavior over time and its viability, preventing further clinical use. This gives rise to label-free imaging methods. The intrinsic refractive index of cell can indicate abnormal cell morphology and physiology. These cellular changes be detected by label-free IPM, which uses interference between a beam interacting with the sample and a reference beam to record the cell refractive index map. This can be done even for cells using flow, in throughput of up to thousands of cells per second, as well as be used to track the internal morphology and rapid 3D movement of sperm cells during in vitro fertilization. For the first field, we have developed label-free imaging flow cytometry systems for real-time visualization and automatic processing for detection and classification of untreated cancer cells in blood during label-free imaging flow cytometry. Deep learning is used to classify the cells to non-cancer/cancer cells during flow, and track cancer cell metastatic potential during cancer progression. These new platforms are expected to bring to the foundation of robust clinical tools for detection and monitoring of cancer and identifying different stages of oncogenesis by using liquid biopsies obtained in routine blood tests. For the second field, we have integrated IPM with deep-learning-based virtual staining that can take images of sperm cells acquired without chemical staining and make them look as if they have been chemically stained, allowing analysis of the internal morphological structures of the cells as well as analysis of DNA fragmentation level for individual sperm cells swimming freely in a dish. I will also review our new approach for ultra-rapid 3D refractive-index imaging, providing high-resolution interferometric tomography for acquisition of the entire sperm cell (head with organelles and tail) during free swim and without staining. These novel tools are now becoming available for direct clinical use, giving rise to new and exciting opportunities for cancer detection and in vitro fertilization.

Natan T. Shaked is a Professor and the Chair of the Department of Biomedical Engineering at Tel Aviv University, Israel. He directs a large experimental group dealing with label-free biomedical imaging with focus on phase imaging. He is the author >100 refereed journal papers and >170 conference papers, as well as a book on biomedical phase microscopy and nanoscopy. He is the Founder and co-Chair of the SPIE Label-Free Imaging and Sensing (LBIS) annual conference in SPIE Photonics West, San Francisco, CA, USA (founded in 2019). He is a Fellow in the Optica Society (previously OSA) and a Fellow in the SPIE.