Challenges and Opportunities in Biological Imaging

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Abstract

While the major achievements in medical imaging can be traced back to the end the 20th century, there are strong indicators that we have recently entered the golden age of cellular/biological imaging. The enabling modality is fluorescence microscopy which results from the combination of highly specific fluorescent probes (Nobel Prize 2008) and sophisticated optical instrumentation (Nobel Prize 2014). Modern microscopy centers are providing biologists with unprecedented amounts of data in 3D + time.

To address the computational aspects, two nascent fields have emerged in which image processing is expected to play a significant role. The first is "digital optics" where the idea is to combine optics with advanced signal processing in order to increase spatial resolution while reducing acquisition time. The second area is "bioimage informatics" which is concerned with the development of image analysis software to make microscopy more quantitative. The key issue here is reliable image segmentation as well as the ability to track structures of interest over time. We shall discuss specific examples and describe state-of-the-art solutions for bioimage reconstruction and analysis. This will help us build a list of challenges and opportunities to guide further research in bioimaging.

Biography

Michael Unser is professor and director of EPFL's Biomedical Imaging Group, Lausanne, Switzerland. His primary area of investigation is biomedical image processing. He is internationally recognized for his research contributions to sampling theory, wavelets, the use of splines for image processing, stochastic processes, and computational bioimaging. He has published over 250 journal papers on those topics. He is the author with P. Tafti of the book "An introduction to sparse stochastic processes", Cambridge University Press 2014.

From 1985 to 1997, he was with the Biomedical Engineering and Instrumentation Program, National Institutes of Health, Bethesda USA, conducting research on bioimaging.

Dr. Unser has held the position of associate Editor-in-Chief (2003-2005) for the IEEE Transactions on Medical Imaging. He is currently member of the editorial boards of SIAM J. Imaging Sciences, IEEE J. Selected Topics in Signal Processing, and Foundations and Trends in Signal Processing. He is the founding chair of the technical committee on Bio Imaging and Signal Processing (BISP) of the IEEE Signal Processing Society.

Prof. Unser is a fellow of the IEEE (1999), an EURASIP fellow (2009), and a member of the Swiss Academy of Engineering Sciences. He is the recipient of several international prizes including three IEEE-SPS Best Paper Awards and two Technical Achievement Awards from the IEEE (2008 SPS and EMBS 2010).