Department of Instrumentation & Applied Physics

DEPARTMENT OF INSTRUMENTATION AND APPLIED PHYSICS ALUMNI SEMINAR SERIES

Least-Squares Amplitude Detection for High-Speed Atomic Force Microscopy

SPEAKER : DR.LAVANYA S.B

High-speed atomic force microscopy (HS-AFM) enables real-time visualization of dynamic biomolecular processes at nanometer spatial resolution and millisecond temporal resolution. This is made possible by maintaining a constant tip-sample interaction force in tapping mode (amplitude-modulation mode). Hence, this mode requires an amplitude detector that is not only fast but also robust to noise in the measured tip-displacement signal. To address this, we developed a least-squares (LSQ) sine-fitting amplitude detector for HS-AFM operation. This detector has an adjustable window length that provides a tunable delay–noise trade-off, a feature unavailable in current state-of-the-art detectors used in HS-AFM.

In this talk, I will first discuss the implementation of LSQ on field-programmable gate array (FPGA) hardware. Subsequently, demonstrate the improvements of LSQ by comparing the delay and noise performance of LSQ with the sample-and-hold (SHB) amplitude detector, which is the conventional detector used in HS-AFM. Then show that LSQ achieves approximately 2× lower amplitude fluctuations compared to SHB. Finally, I will show the HS-AFM imaging of annexin-V lattices on supported lipid bilayers and structural dynamics of nanodiscs on mica. These results establish LSQ as an amplitude detector for HS-AFM, particularly useful for applications involving noisy tip-displacement signals where a tunable response time is desired.

WEDNESDAY
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TIME
03:00 PM

SVN AUDITORIUM
IAP

ABOUT THE SPEAKER

Dr. Lavanya S. B. is a researcher specializing in instrumentation and precision mechanical engineering for atomic force microscopy. She received her B.E. degree in Electrical and Electronics Engineering from University Visvesvaraya College of Engineering (UVCE), Bangalore, in 2016, and earned her Ph.D. from the Department of Instrumentation and Applied Physics at the Indian Institute of Science (IISc), Bangalore, in 2024, where her doctoral research focused on the design of linear Nano positioning systems employing compliant mechanisms. Following her graduate studies, she completed two years of postdoctoral research at the University of Texas at Austin, focusing on fast amplitude detection for high-speed atomic force microscopy (HS-AFM) and quantitative mechanical mapping using HS-AFM. Apart from the technical side, she is passionate about STEM outreach and volunteer initiatives.

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