A "Simple" Solution to a Common Situation

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Most people recognize “K.I.S.S.” as an acronym for “Keep it simple, silly” – a warning about the cost of sophistication with origins in military hardware. Department of Electrical Engineering graduate student, Yide Zhang, has found it’s a practice that has served his research as well.

EE graduate student Yide Zhang working with FLIM Microscope. Photo Credit: Leslie Lestinsky

Zhang works with Scott Howard, associate professor of electrical engineering, on problems in super-resolution microscopy, an important tool in biomedical research that allows scientists to see past the limits of conventional microscopy. Its high cost means that it’s not always a viable option, but Zhang has discovered a simple and inexpensive way to overcome resolution limits using basic fluorescence microscopes that do not require any additional hardware. Biologists can use the conventional equipment they already have to work on complex problems. “Physics places limits on how small of a thing we can see. Zhang used a physics trick to break those limits.” said Howard.

The method Zhang discovered is based on the principle of stepwise optical saturation (SOS). By linearly combining two images that were obtained at regular powers, the resolution is extended beyond the diffraction limit. SOS microscopy provides super-resolution imaging deep in scattering samples. Zhang also collaborated on this project with Research Assistant Professor Prakash Nallathamby and Professor Ryan Roeder in the Department of Aerospace and Mechanical Engineering (AME) and Assistant Professor Joel Boerckel, a former AME faculty member who now serves as an assistant professor of orthopaedic surgery in the Perelman School of Medicine at the University of Pennsylvania.

The group’s discovery was a necessity-is-the-mother-of-invention event that came about as a result of an all-too-common situation, too many people trying to use the same equipment. Zhang recalls, “Another graduate student in our group was occupying our custom-built microscope, preparing for her Ph.D. defense. I thought maybe I should do some theoretical work instead, to give her time to finish her experiments. That led me to discovering the theoretical basis of this SOS technique. I thought, great, now I can use any microscope on campus to implement super-resolution!”

The SOS method has been shared with Cody Smith, the Elizabeth and Michael Gallagher Assistant Professor, in the Department of Biological Sciences and his students. They are using it in brain imaging to study neurons in zebrafish and how those neurons make connections, using 3-D super-resolution.

— Leslie Lestinsky, Department of Electrical Engineering

FEATURED PEOPLE

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