New image-reconstruction method yields clear images of subsurface features

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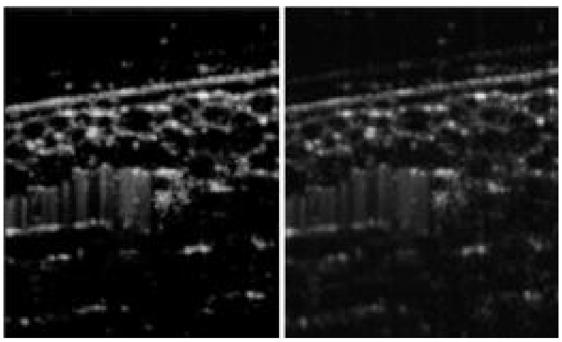

An optical-coherence tomogram of onion skin, reconstructed with the new method developed by Seck and his co-workers (left), shows sharper details than the original image (right). Reproduced, with permission, from Ref. 1 © 2012 SPIE

Optical coherence tomography (OCT) is a popular imaging modality for obtaining three-dimensional, micrometer-resolution pictures of structures that lie beneath the surface of, for example, the human eye or silicon wafers used in the computer industry. The technique could now become even more powerful, thanks to work led by Hon Luen Seck from the Singapore Institute of Manufacturing Technology at A*STAR. The team has found a way to eliminate one of the main noise sources that otherwise blur these images.

The OCT method works by splitting a light beam into two separate rays. One ray penetrates the sample and partially scatters from features beneath its surface. A fraction of the incident light therefore returns to its origin. This reflected light then interferes with the other ray—known as the 'reference beam'—that travelled entirely outside the sample and was reflected from a mirror. The position of the mirror determines which layer of the sample is imaged. By moving the mirror, researchers can obtain information about different parts of the sample.

The method has proved very successful for biological and technological applications. It is, however, plagued by one problem: light returning from the sample not only interferes with the reference beam, but also with other light fields reflected by the sample. "This adds ambiguities when interpreting the image," says Seck. The method developed by the researchers reliably removes this so-called 'autocorrelation noise'.

Seck and co-workers liken the process of light scattering from the sample to the passage of light through a particular kind of filter. There are physical constraints on how this filter may look. By putting this additional information into the reconstruction process, the researchers demonstrated that they could almost entirely delete autocorrelation noise from the images (see image). The technique has been developed for OCT, but is not limited to it. "The approach can be adapted to other image-formation processes," explains Seck.

The team's method works particularly well with sparse samples, which sport relatively few features. This is the case, for instance, in biological specimens and in layered electronics. "We plan to explore now the application of the technique to the imaging of printed electronics devices and micro-fluidics devices," says Seck. Moreover, the researchers are working to make the reconstruction algorithm faster: "At the moment, our method is not able to achieve instantaneous reconstruction as required for real-time applications where an area scan is required, but we expect that with ongoing research the computational demand will decrease."

More information: Seck, H. L., Zhang, Y. & Soh, Y. C. Autocorrelation noise removal for optical coherence tomography by sparse filter design. Journal of Biomedical Optics 17, 076029 (2012). biomedicaloptics.spiedigitalli … px?articleid=1352413

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