Optical coherence tomography: a $10 platform?

While advances in OCT expand the technique’s use in biomedicine, the prospect of new cost-effective approaches may herald a revolution outside the clinic.

The impact of optical coherence tomography (OCT) in ophthalmology is testament to the technique’s exceptional suitability for imaging below the surface of accessible tissues. And despite a quarter-century of productive deployment, it is evident – not least from this week’s BIOS conferences – that new ways to exploit OCT’s capabilities continue to be developed.

One current example is the extraction of useful information from the speckle patterns that appear in, and sometimes bedevil, many imaging methodologies when the light path interacts with biological materials in motion - blood cells, for instance.

“In the past the objective was to eliminate speckle, but there have now been several breakthroughs in understanding what can be learned from speckle across different imaging techniques,” commented Martin Leahy of the National University of Ireland, Galway, who chaired a panel discussion entitled Speckle In Biomedical Optics during this week’s symposium.

“In principle, the variation in speckle over time can give an indication of the speed of blood flow through vessels, helping to identify the locations where active blood flow is taking place and whether it is fast or slow,” he explained.

This general principle has spurred the gathering of data from speckle specifically seen by OCT when living tissues are imaged - the subject of another dedicated BIOS session. Topics included mapping transverse capillary flow speed using OCT speckle signals, and the factors influencing the creation of shadow-artefacts in microcirculation imaging.

A $10 OCT system

But alongside these clinical advances, a major development in the use of OCT in new and wider markets is taking shape, based on the prospect of workable instrumental platforms potentially priced at just a few dollars. “The starting point was the realization that the optical units in a DVD pick-up drive now cost very little money, but nonetheless share some core components with an OCT system,” said Leahy.

“We envisaged building OCT platforms exploiting these low-cost items.”

Compact Imaging, a California start-up with strong connections to Irish research centers including Leahy’s NUI Galway group, has developed a modified version of the architecture usually employed for time-domain OCT, intended to fit the bill. Christened multiple reference OCT (MR-OCT), Compact Imaging’s initial working model used a voice coil extracted from the optical pick-up head of a DVD player, and the company believes the heart of mass-produced MR-OCT units can be made with similarly convenient components. CTO and co-founder Josh Hogan brings expertise from that field, having previously developed low-cost DVD+RW optical storage technology for HP Labs.

“One factor in our favor is that the processing power in mobile platforms, such as smart-phones and tablets, is advancing so rapidly,” commented Leahy. “Given their abilities at computation and display, we are confident that those tasks can be separated from the optical systems of the OCT platform and handled elsewhere.”

The question of obtaining a light source suitable for such a low-cost unit does remain an issue, given that the broadband sources used in clinical OCT systems carry hefty price tags. Identifying the right markets should provide the answer. “Again, the parallel is with CD and DVD drives,” Leahy noted. “Once both the technology to build DVD drives around semiconductor lasers and suitable markets for those units numbering in the tens of millions were developed, the price dropped to single-digits.”

Biometric security

So where exactly might the markets for similarly large quantities of OCT systems actually emerge? Biometric security is one likely candidate. The traditional surface fingerprint used for identification purposes can be readily spoofed, but the “primary” fingerprint pattern – first created in the womb and lying just below the skin’s surface - provides a more cast-iron proof of identity. Examining that pattern could make banking and other financial systems more secure, or be used for identity checks on travelers. As Leahy noted, border security is unlikely to become a shrinking market any time soon.

That kind of business may prove crucial to a $10 OCT system in advanced economies, but the positive impact in more personal applications could be just as significant. Over six billion people have no access to the expensive healthcare technology available to many in the developed world, so reaching them with OCT would perform a clear global good.

OCT’s heartland of ophthalmology provides one possibility: a simple system designed to yield single significant measurements - perhaps the thickness of the retina - rather than the wider array of complex parameters or detailed images captured by full clinical systems, could help identify the symptoms of particular eye diseases at low cost.

“Age-related macular degeneration affects retinal thickness, and can do so very rapidly, potentially over a period of just a few days,” said Leahy. “A cost-effective way to assess at-risk individuals more regularly and with less inconvenience could spot the disease before it becomes irreparable, and allow prompt treatment.”

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