From SPADs to Quantum Computers

CMOS SPADs have appeared in 2003 and soon have risen to the status of image sensors with the creation of deep-submicron SPAD technology. The format of these image sensors has expanded from 8x4 pixels of our first LIDAR in 2004 to 512x512 pixels of recent time-resolved cameras, and the applications have literally exploded in the last three years, with the introduction of proximity sensing and portable telemeters. The current promise is that SPAD based sensors will be in every smartphone by 2018 and in every car by 2022. But SPAD technology was born for scientific applications and in scientific applications it will continue to innovate. For instance, super-resolution microscopy has already benefitted from SPAD imagers and this trend is expected to continue well in the next decade. In addition, other time-resolved techniques, such as time-of-flight PET, NIROT, FLIM, FRET, useful in many biomedical imaging modalities, will become more and more accurate and less and less expensive thanks to the scalability of CMOS technologies. With the introduction of SPADs in 3D CMOS IC technologies in 2014, SPAD based imagers will be more compact, while at the same time more advanced techniques and functionalities will be available. Very recently, SPADs have been proposed as an interface to quantum processors, due to their sensitivity and the capability of operating normally at cryogenic temperatures. The talk will conclude with a technical and economic perspective on SPADs and SPAD imagers, and a vision for SPADs and other cryo-CMOS circuits in quantum computing.