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Digital imaging pioneer Eric Fossum says future sensors could revolutionize biometrics, and urges caution

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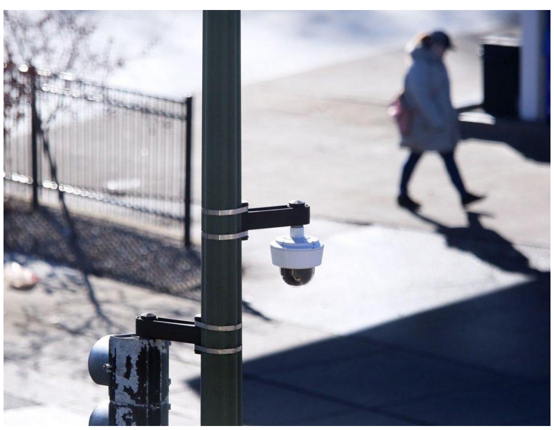

Professor Eric Fossum is concerned about the double-edged sword that powerful technologies, like those behind biometrics, represent. Connecting with Fossum for a chat over the internet, the webcams we are using are based on digital image capturing technology that he pioneered, which is also behind many biometric sensors.

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Fossum was awarded the Queen Elizabeth Prize for Engineering, along with colleagues in the field Dr. George Smith, Dr. Michael Tompsett, and Professor Nobukazu Teranishi, for their revolutionary innovation of digital imaging sensors. The complementary metal oxide semiconductor (CMOS) image sensor was invented by Fossum.

The Queen Elizabeth Prize for Engineering is the world's number one engineering accolade. The £1 million (US$1.3 million) prize celebrates engineering visionaries from a wider variety of sectors, inspiring young minds to consider engineering as a career choice and to help to solve the challenges of today and tomorrow.

The future of imaging sensors remains bright, according to Fossum, with solutions to several of the more significant challenges in the field currently development.

"We still have a ways to go in low-light sensitivity, which is problem we're currently working on in research," he explains. "We've made good progress on that, but in terms of commercial off-the-shelf technology, improving the low-light sensitivity is important."

Dynamic range, which is the ability to capture shadowy parts and high-light parts of the image well at the same time, also needs work, Fossum says, and improvement in that area could help a lot of different use cases.

Photon-counting image sensors are the next-generation technology with the promise of handling challenging lighting conditions more effectively.

"Intensity in light is just the number of photons that arrive in a certain interval," Fossum observes. "If you can count them, you'll have a very accurate measure of the light intensity."

One of the ways of doing this is a single photon avalanche detector (SPAD), which measures when each unit (or 'particle') of light returns to the sensor. Fossum is now working on more traditional kind of sensor, more like a CMOS sensor. This "quanta image sensor" (QIS) is sensitive enough to detect a single photon.

SPAD engineers have found they can also use their technology to builds QIS as well, which is called SPAD-QIS to distinguish it from the CMOS image sensor QIS, or "CIS-QIS" sensor type.

"For very low light, you can't do anything better than count every photon that comes in," Fossum notes.

CIS-QIS development seems to Fossum be advancing more quickly, but a relatively recent increase in funding for SPAD investment because of established commercial applications could level the playing field.

SPAD-QIS is effective for precise timing information, Fossum says, but is lower-resolution "and probably more expensive as well because they have to make bigger pixels compared to what we can do with the CIS-QIS. But either way, this is where it's going, is photon-counting imaging, and I think it will be very useful also to the biometric community to have this capability."

A similar method is used to improve the capture of items in motion.

With a computational approach to image capturing based on the measurement of discrete photons, "people have shown very recently a very good job of removing motion artifacts from images even under low light conditions where you'd normally have the shutter open for a long time," according to Fossum. "It gets rid of blur and that sort of thing using the single photon QIS approach."

Economies of scale will eventually drive down the cost of these technologies, but ultimately the size of the pixels, and the related materials, are what is important.

“That’s what drives the cost,” Fossum points out. “It’s not the cleverness factor or anything. It’s just the amount of silicon that the pixels take. So SPADs have this problem that they need relatively large pixels, and they’re working very hard to make tiny pixels. But for now, compared to what’s in your smartphone, which probably has, let’s call it around 1-micron pixel size, SPADs are enormous, they might be a hundred times more in area per pixel compared to that.”

For biometric product makers, these kinds of sensors may represent the future, but not the particularly near future, Fossum cautions, as research and development are still ongoing on this generation of digital imaging sensors.

Noting that the better technical approach does not always win, as with the format battle between Beta and VHS for the home video market, Fossum says quanta image sensors “within five years will perhaps be commercial, off the shelf technology.”

Sensor technology continues to evolve, and in the long run is moving gradually towards being able to detect changes in blood flow to the face, and perform subdermal imaging, like for veins. But the amazing power of such futuristic sensors also holds risk.

“Those things are becoming closer and closer to reality, kind of a do-all biometric sensor, but personally I’m just nervous from let’s call it an ethical point of view how the systems are going to be used in the future,” Fossum states. “I do not like the idea of tracking everybody all the time, which has now become a real possibility, and can of course be used for nefarious reasons as well.”

To biometrics developers, Fossum says, "Better technology is on the way, please use it wisely, and justly."

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