MARKET & TECHNOLOGY TRENDS

Israeli Startup Democratizes Hyperspectral Imaging

By Anne-Françoise Pelé

Cameras are critical components of the drive to enable the autonomy and increase the safety of vehicles, drones, and robots. Near-infrared (NIR) cameras are rapidly enhancing machine-vision capabilities and are essential to a range of inspection applications. Israeli startup Unispectral says it has developed a solution that includes a miniature tunable NIR filter and image-processing software to turn any low-cost IR camera into a hyperspectral camera.

Promising startups pop up every day, and it is not always easy to spot them, especially when they emerge several thousand kilometers away. Alissa Fitzgerald, founder of microelectromechanical-system design and development house A.M. Fitzgerald and Associates, brought Unispectral (Tel Aviv) to EE Times Europe's attention. The startup was noteworthy, Fitzgerald said, because it had "released a spectral camera suitable for the mass market, and the MEMS technology makes this product smartphone-sized instead of a tabletop instrument." An interview with Ariel Raz, Unispectral co-founder and CEO, soon followed.

Admittedly, there are plenty of spectral cameras today, but they are large, complex, expensive and suitable for high-end equipment in labs. Unispectral's goal has been to develop high-end spectral cameras accessible for the mass market.

HIGHER-DIMENSIONAL COLOR SPACE

Human color vision is trichromatic. Every color we see is the product of signals generated by solely three types of photoreceptor cells in the retina. Our vision is thus organized into — and limited to — a three-dimensional color space.

Now imagine a device, such as a smartphone, that could extend human vision into a high-dimensional color space. Think of all the hidden information that could surface and play a critical role in our daily lives. One way of doing that is hyperspectral imaging.

Unispectral says it has developed a new concept of a tunable Fabry–Pérot NIR filter. Its design mounts an array of vapor-coated mirrors on a MEMS assembly. With controlled changes of the voltage applied on the upper mirror holder, the optical cavity changes to allow only a desired IR wavelength to pass.

Israeli startup Unispectral says it has developed a solution to turn any low-cost IR camera into a hyperspectral camera.

Peleg Levin, CTO of Unispectral, explained the concept at an IEEE MEMS Conference. "In our design, we have a movable mirror that has one set of electrodes and another set of electrodes that are exterior to the optical gap," said Levin. "When we apply the actuation voltage, the optical gap increases instead of decreasing, and since we can design this electrostatic gap to be much greater than the optical gap, we can allow a very large tunable range of the optical gap itself."

The filter is manufactured on a full wafer-level technology to provide a component ready for mounting and integrating with the camera assembly and device controllers, according to the company.

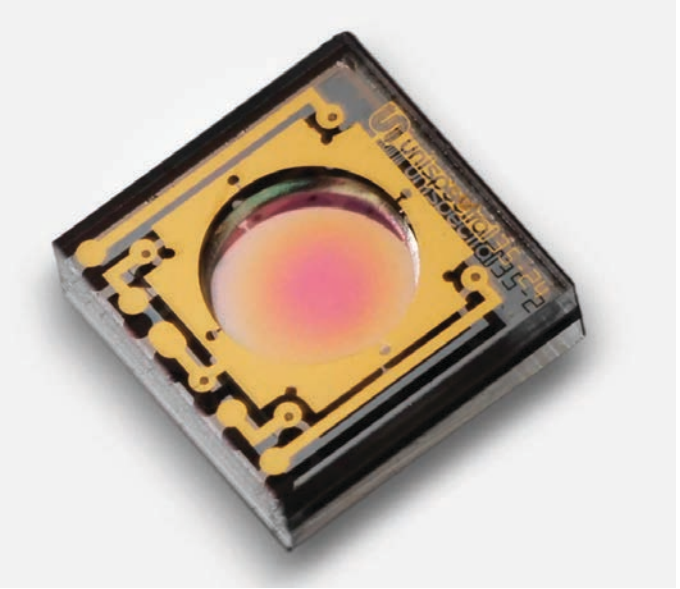
FROM SEEING TO SENSING

As the camera megapixel race was nearing its end, Tel Aviv University EE professor David Mendlovic and Raz, who was then his doctoral student, realized that the combination of spectral analysis and imaging would "create something very powerful," Raz told EE Times Europe.

In 2016, the researchers patented an optical component based on existing MEMS technology and established Unispectral. Four years later, the company announced the availability of an evaluation kit for its tunable NIR filter, now named ColorIR, which turns low-cost IR cameras into 700- to 950-nm spectral cameras, according to the startup.

More recently, Unispectral introduced the Monarch spectral IR camera, which integrates its tunable Fabry–Pérot filter with a miniature IR camera module in a 60 × 40 × 14.5-mm, 30-gram camera. The unit connects via a USB cable to an Android smartphone, a PC, or the main processor of an OEM platform.

IMAGE: SHUTTERSTOCK



The ColorIR filter (Source: Unispectral)

"Developers in many industries can integrate Monarch in their products because it is already a spectral camera with some on-board processing, easy connectivity, and an easy-to-use API," said Raz. "It can fit many platforms without going through the very tedious development cycle of the camera."

Raz said spectral imaging drives better AI. The optical MEMS component acts as a tunable filter, and the software — an image-fusion library — supports the component and extracts all the relevant information from the image. "By combining our optical MEMS component and algorithms, the camera makes the transition from seeing to sensing," he said.

Customers are currently evaluating Monarch in different industries and geographic regions, said Raz, adding that Unispectral has manufacturing partners to "support scale."

DATA IN THE PALM OF THE HAND

Unispectral claims its technology can be applied in any area of human activity, from agricultural inspection to industrial quality control, facial authentication, computer vision, vehicle safety, and health monitoring. With its NIR tunable filter and NIR spectral camera, Unispectral aims to lower the barrier to entry for camera-based applications and use cases.

"It can be integrated in any platform that needs to address the question, 'What do I see?' and act on the answer," said Raz.

One initial target has been smartphone front-camera facial authentication. Because of the limited space on the surface of a smartphone, sensors cannot be indefinitely added. A spectral camera can perform eye recognition, eye scanning, and face mapping all in the same unit, according to Unispectral. The company says that NIR facial authentication guarantees a higher level of security and robustness than visible spectrum authentication and 3D solutions.

In the medical domain, the integration of Unispectral's NIR filter can help monitor vital signs, perform vein detection, and support contactless examination and diagnosis. A diabetic patient with an open wound, for example, could send a photo of the wound and a current blood-oxygenation reading to a doctor for remote evaluation and advice on treatment.

Precision agriculture is another potential application. A raft of sensors are already being used to measure soil humidity/moisture levels and soil/air temperatures, but Unispectral says its Monarch NIR portable camera promises a simpler way to monitor plant health and nutrients, detect pests and pesticide residues, and diagnose plant diseases. Monarch captures detailed frames in the 700- to 950-nm NIR spectral range and measures large samples to provide context.

Asked whether Unispectral's camera could help farmers transition from curative to preventive agriculture, Raz said the company has recently completed a proof of concept for the early detection of contamination in plants before the damage is perceptible to the human eye. In a greenhouse, such early detection would allow the farmer to remove the affected plant and prevent contamination of the whole crop. Unispectral has also developed a proof of concept for the detection of insufficient fertilizer application, which would give farmers an early indication of a mechanical malfunction or other problem.

Farming is a 24/7 job, and it's critical to make timely decisions. If farmers miss the perfect planting window in their geographic area, the result is a lower crop yield. When farmers must send samples to external labs and then wait days to get the results, as is generally the case today, precious time is lost. "By the time they get [the information back], there is nothing they can do; it's too late," said Raz. Having the lab "in the palm of your hand is a game changer," letting farmers instantly access meaningful insights and make real-time decisions in the field.

The Monarch camera (Source: Unispectral)

CAPTURING OPPORTUNITIES

At the time of its inception, Unispectral raised US$7.5 million in a round led by Jerusalem Venture Partners, Robert Bosch Venture Capital, Samsung Catalyst Fund, and the Tel Aviv University Technology Innovation Momentum Fund. "We established the company, built a team, and it took us years to develop a new type of MEMS component," said Raz. "It's not like we took it off the shelf and optimized it. We overcame a lot of technical challenges. It was a long and complicated journey.

"The fun part starts now," he continued. "We have developed the technology in the lab and now [can] start seeing how it really improves day-to-day life and how customers can integrate it into their products and gain a competitive edge."

Unispectral, which employed 15 people when this article was written, is expanding into international markets. In addition to its Tel Aviv headquarters, it has established a subsidiary in China. It also has sales representatives in Germany, South Korea, and Hong Kong, and discussions are under way with distributors in the U.S. and U.K. ■

Anne-Françoise Pelé *is editor-in-chief of EE Times Europe.*