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VISION focus

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Image courtesy of NASA / Zeiss.

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Embedded vision – from cars to Mars

Welcome to the latest issue of VISION Focus, the quarterly magazine *(and free download from optics.org)* that covers all aspects of vision and imaging, produced by the team that brings you optics.org. The editorial focus of this issue is Embedded Vision Europe, which runs at the iCS Exhibition Center in Stuttgart, Germany, between 24-25 October.

The second edition of Embedded Vision, which is positioned between the now biannual VISION expo, takes a closer look at the capabilities of hardware and software platforms that extend the reach and capabilities of vision systems.

Researchers at Harvard's School of Engineering & Applied Sciences have developed metasurface gratings that offer new route to polarization imaging. Their compact camera platform promises new applications machine vision and elsewhere *(page 4)*.

The UTOFIA European vision project has developed a sub-sea 3D laser camera, which is being prepared for commercial introduction later this year. It operates in murky waters to depths of hundreds of meters to map the seabed, monitor fish stocks, and detect pollution *(page 6)*.

Based on an intelligent vision system, Hyundai Mobis has developed a Driver State Warning system. The system uses eye tracking and facial recognition and it will be applied to commercial vehicles in Korea. It is expected to contribute to preventing big traffic accidents caused by careless driving *(page 7)*.

This year marks the 50th anniversary of the first moonwalk. Optics and camera tech pioneer Zeiss recalls developing its bespoke camera lenses that recorded the first human visit to earth's satellite. The unmistakable images, which have been widely republished around the world, have lost none of their power to fascinate *(page 8)*.

Mixed business news from vision players Stemmer Imaging and Cognex. The former has reported strong Q4 and full year as expansion continues (page 10), while the latter's sales are down as key markets have slumped *(page 11)*.

Another vision-focused European development project – TULIPP – is working to develop more energy-efficient, less costly embedded image processing systems for monitoring and medical applications *(page 12)*.

Considering the growing global problem of opioid addiction, a hyperspectral analytical vision system has been short-listed in the US Department of Homeland Security's $1 million Opioid Detection Challenge. Headwall Photonics' approach is one of eight technologies being evaluated for detecting illicit drugs in mail packages *(page 14)*.

Ahead of next year's Mars 2020 mission, NASA optometrists have verified the accompanying rover's "20/20" vision systems; MV calibration of the forward-facing cameras on the rover has now been completed *(page 16)*.

Plus we showcase the latest product launches from across the industry, including LMI Technologies' plugin, enabling interfacing of its Gocator 3D sensors with robots from Universal Robots *(page 18)*, and Sony Semiconductors' SED-100A holographic waveguide *(page 19)*, and many more that will be on show in Stuttgart.

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This Issue

Publication and Editorial Schedule 2020

Winter Issue 2020 *(January/February 2020)*

- Bonus Distribution: **SPIE BiOS, Photonics West, SPIE Medical Imaging**
- **Editorial Focus:** industrial applications, sensing, biomedical analysis and treatments.
- Published in advance of BiOS, 2nd - 3rd Feb, Photonics West, 4th Feb - 6th Feb, SPIE Medical Imaging, February 2020

Spring Issue 2020 *(April/May 2020)*

- Bonus Distribution: **SPIE Defense+Commercial Sensing, CONTROL, Stuttgart**
- **Editorial Focus:** aerospace and defense applications, associated research and development
- Published in advance of DCS 2020 *(Defence & Commercial Sensing)*, 28th – 30th April 2020

Summer Issue 2020 *(July/August 2020)*

- Bonus Distribution: **Astronomical Telescopes + Instrumentation**
- **Editorial Focus:** optical components, academic research, software applications.
- Published in advance of Astronomical Telescopes + Instrumentation, 14th – 19th June 2020

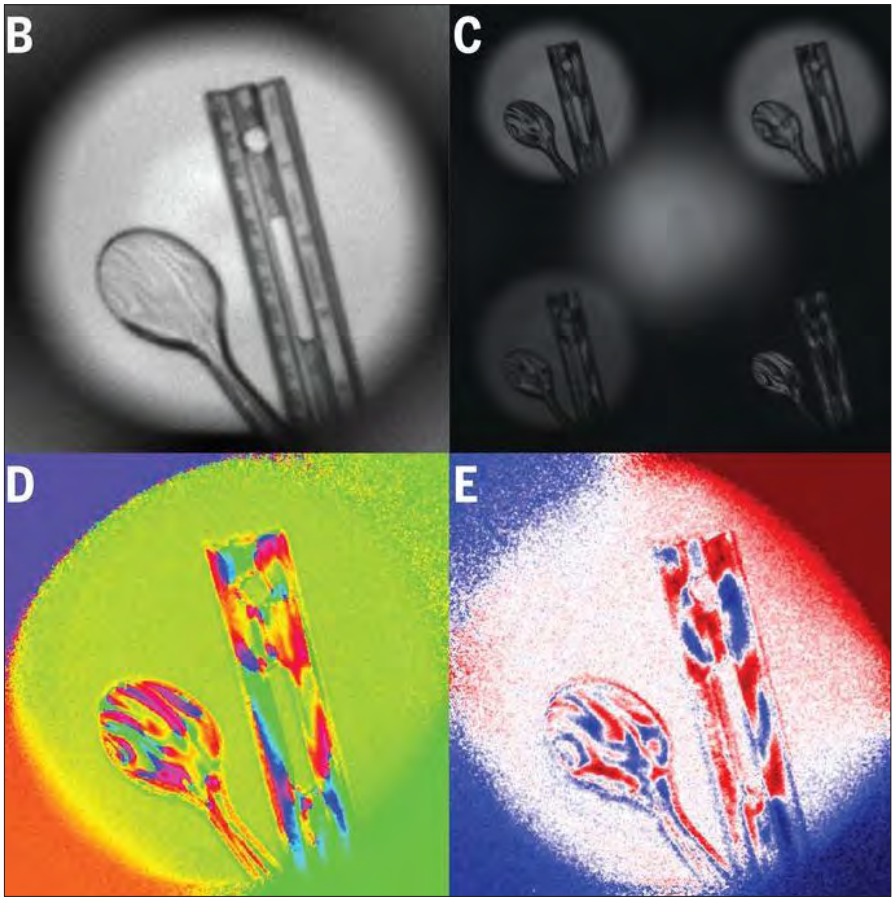
Autumn Issue 2020 *(October/November 2020)*

- Bonus Distribution: **EMVA Embedded Vision Forum Europe,**
- **Editorial Focus:** opto-electronic systems, applications in sensing and manufacturing.
- Published in advance of EMVA Embedded Vision Europe, October 2020

Metasurface gratings offer new route to polarization imaging

Harvard SEAS develops compact camera platform for machine vision and other uses.

Polarization of light can reveal otherwise invisible information about natural materials and the condition of man-made structures, but the cameras used to detect it are often bulky, expensive, and rely on moving parts.



Credit: Harvard SEAS.

A plastic ruler and spoon are photographed with the new camera, revealing internal stresses.

A project in Federico Capasso's lab at Harvard School of Engineering and Applied Sciences (Harvard SEAS) has developed a device that could make polarization imaging simpler and less expensive, potentially making the technique more readily accessible to applications such as autonomous vehicles or atmosphere science. The results were published in Science.

"This research is game-changing for imaging," said Capasso. "Most cameras can typically only detect the intensity and color of light but can't see polarization. This camera is a new eye on reality, allowing us to reveal how light is reflected and transmitted by the world around us."

The breakthrough involves the use of metamaterials, which have been a focus of research at Capasso's lab for some time. In this case, they can allow all the optics needed for polarization imaging to be integrated into a single simple device, as an alternative to the more complex devices or non-standard patterned image sensors that have been required until now.

Achieving a complete description of light's polarization involves the values called Stokes parameters, the assessment of which has traditionally required at least four individual measurements to be made. The new platform uses a method based on matrix Fourier optics, described by the project as a "powerful generalization of a large body of past work on optical elements in which polarization may vary spatially." This approach allowed the team to envisage ways of effectively deploying many polarization devices in parallel using just a single optical element.

"We can design diffraction gratings whose orders behave as polarizers for an arbitrarily selected set of polarization states, creating a new class of optical element," noted the team in its Science paper. "The intensity of light on a set of diffraction orders is then dictated by the polarization of the illuminating light, making these gratings immediately applicable to full-Stokes polarization imaging."

Designing these gratings was where the lab's work on matasurfaces came in. Capasso has previously described how metasurfaces may replace complex cascades of polarization optics based on bulk birefringent crystals with a single, flat optical element.

In a 2018 review of the topic for an issue of Nanophotonics honoring his work, Capasso wrote that "Polarization can be used in a unique way to access two different functionalities built into a metasurface. Two completely independent phase profiles can be encoded in a metasurface and subsequently accessed with perpendicular polarizations, to create corresponding unrelated images in the far field."

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Metasurface gratings offer new route to polarization imaging

New direction for camera technology

The Harvard SEAS lab has also previously demonstrated how metasurfaces can convert left- and right-circular polarizations into states with independent values of orbital angular momentum, findings with potential significance in structured light, singular optics and quantum optics.

Capasso and three colleagues founded Metalenz in 2017, a spin-out intended to develop CMOS-compatible flat optics platforms for high volume markets such as cameras, displays, and wearable optics.

In the new polarization research, the team designed diffraction gratings with dielectric metasurfaces in which sub-wavelength, anisotropic structures allowed tunable polarization control at visible frequencies. Notably, "an arbitrary set of polarizations may be analyzed by a single unit cell, in contrast to past approaches that relied on interlacing of several individually designed diffraction gratings," commented the project.

Harvard SEAS video.

A compact camera device was then designed around the new approach, with the key optical element said to be about two centimeters in length and no more complicated than a camera on a smartphone. With an attached lens and protective case, the device is about the size of a small lunch box.

"Polarized light from a photographic scene is incident on the grating inside of a camera," explains Capasso in the project's paper. "The polarization is 'sorted' by the sub-wavelength metasurface grating. When combined with a lens and a conventional CMOS sensor, four copies of the image corresponding to four diffraction orders are formed on the imaging sensor. These copies have each, effectively, passed through a different polarizer whose functions are embedded in the metasurface."

Trials using the device to image at 532 nanometers showed that it could reveal the in-built stresses in a pair of injection molded plastic pieces, when illuminated by a linearly polarized backlight. It was also used to film the polarization effects of car windscreens, and visualize the 3D contours of a human face.

"This research opens an exciting new direction for camera technology with unprecedented compactness, allowing us to envision applications in atmospheric science, remote sensing, facial recognition, machine vision and more," said Capasso.

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https://optics.org/news/10/7/19

Sub-sea 3D laser camera readied for commercial introduction

System developed under the 'UTOFIA' European project works in murky waters to depths of hundreds of meters.

An underwater 3D laser camera intended to map the sea bed, help monitor fish stocks, and detect marine pollution is expected to launch commercially this year.

Developed under the €5.7 million "UTOFIA" project, part of Europe's Horizon 2020 innovation program, the camera is being described as a "game-changer" for maritime applications.

After three iterations during the course of the project – reducing system size by a factor of six while quadrupling laser power - it will now be commercialized by Marseille-based Subsea Tech, one of seven partners that took part in the three-year effort that officially ended in April 2018.

Low-cost time-of-flight

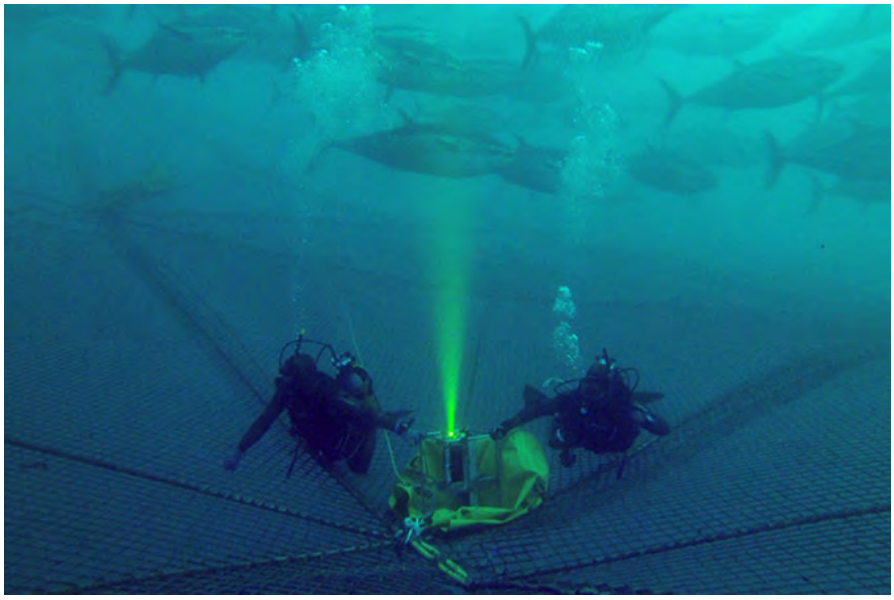
The system is said to use a combination of innovative technologies to obtain clear images in low-visibility environments, overcoming the problem of back-scatter caused by light reflecting off particles suspended in the water.

Instead of using a continuous-wave source of light, the UTOFIA system emits nanosecond laser pulses that are range-gated by an optical shutter and simple camera sensor to yield time-of-flight data, enhanced by software capable of distinguishing any back-scattered noise.

"The use of range-gating to reduce back-scatter was previously limited to very high-cost, highly complex systems," says the team, which last year tested the system at a tuna farm off the Spanish coast. "UTOFIA is the first system to achieve range-gating using a CMOS sensor, common to most digital cameras, enabling a much more cost-effective and compact system."

The aquaculture tests carried out during the project are said to have showed "highly promising" results both monitoring fish stocks and as part of a navigation system for autonomous underwater vehicles.

In its final newsletter report for the project, the UTOFIA team described the tuna farm test as "very successful", with the system able to size tuna at different distances - something that is not possible with a stereoscopic camera. Other tests took place in Norwegian and Danish waters.



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The 3D laser camera developed during the 'UTOFIA' Horizon 2020 project is said to provide an unprecedented combination of field of view and range in murky waters. It can operate to depths of hundreds of meters, using a gate-ranged time-of-flight detection scheme.

Full-field, real-time imagery

According to a European Commission report on the effort, those applications and others are being explored further in a number of follow-up projects. These include "BIOSYS", which will use the system to monitor stocks at salmon farms, and "SMARTISH", which will develop an automated version to reduce the amount of fish discarded by trawlers.

Other plans include developing applications for fishing tuna, and exploring other potential uses, perhaps even for space exploration.

Among the partners to provide photonics expertise in the UTOFIA project were the Italian laser developer Bright Solutions, and UK-based Rockwell Automation subsidiary Odos Imaging.

In a detailed report on the second prototype system deployed during the project, the team wrote that the 200 picosecond timing jitter of the diode-pumped green Q-switched source - mostly caused by noise in the trigger circuit rather than the laser itself - was sufficiently low for effective operation, although it could still be improved.

Project coordinator Jens Thielemann from Norway's SINTEF summed up the progress made under the project, saying: "Before UTOFIA there was no real full-field, real-time 3D technology available on the market with a range of several meters. Existing approaches either provided an incomplete image, or had a limited 3D viewing range.

"UTOFIA has opened up a new underwater imaging approach that will expand the market for underwater surveillance in areas such as marine science, public sector environmental monitoring, commercial fisheries, underwater archaeology, and all kinds of sub-sea technologies - including autonomous vehicles."

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https://optics.org/news/10/7/15

Hyundai Mobis develops Driver State Warning technology

Eye tracking, facial recognition system to be applied to commercial vehicles in Korea to boost safety.

Hyundai Mobis, which supplies parts to 57 million Hyundai and Kia Motors vehicles worldwide, has developed an optical driver state warning system that recognizes a driver's face and can track their eyes. The system is expected to contribute to preventing big traffic accidents caused by careless driving.

The developer says that the new DSW system is "the most advanced-in-class product that offers a new level of careless driving detection accuracy through driver identification based on facial feature points such as eyes, nose, mouth and ears as well as eye tracking through pupil recognition."

Image: Hyundai Mobis.

DSW recognizes a driver's face and tracks eye movements, for both security and safety purposes.

The so-called Driver State Warning (DSW) system, which accurately analyzes the driver's facial biometric data and warns about careless driving situations, will be supplied to mid- and full-sized commercial vehicles for the first time in Korea by 2021, says Hyundai, which is the third largest vehicle manufacturer in the world.

Existing driver state warning systems, which have already been applied on a limited basis to certain premium sedans and commercial vehicles, have been restricted to recognizing the orientation of the driver's face and whether the eyes are open or closed.

The new driver identification feature supports registration of multiple drivers. With this system, Hyundai Mobis is considering connecting it with personalization features such as automatic adjustment of seats and mirrors.

Infrared camera

Globally, says Hyundai, systems of this level have hardly yet been applied to sedans and not mass-produced for commercial vehicles. The new system combines driver state data captured from an indoor camera with chassis data such as speed, transmission and handling for analysis, offering what the company calls "a higher level of reliability."

The launch announcement states, "This is state-of-the-art technology that recognizes the driver's face with an infrared camera installed in the vehicle and detects careless driving caused by drowsy driving, distraction and fatigue.

"To prevent traffic accidents, the system detects lane departure and lane crossing caused by careless driving and alerts the driver with cluster indication, alarm sound and vibration."

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https://optics.org/news/10/7/25

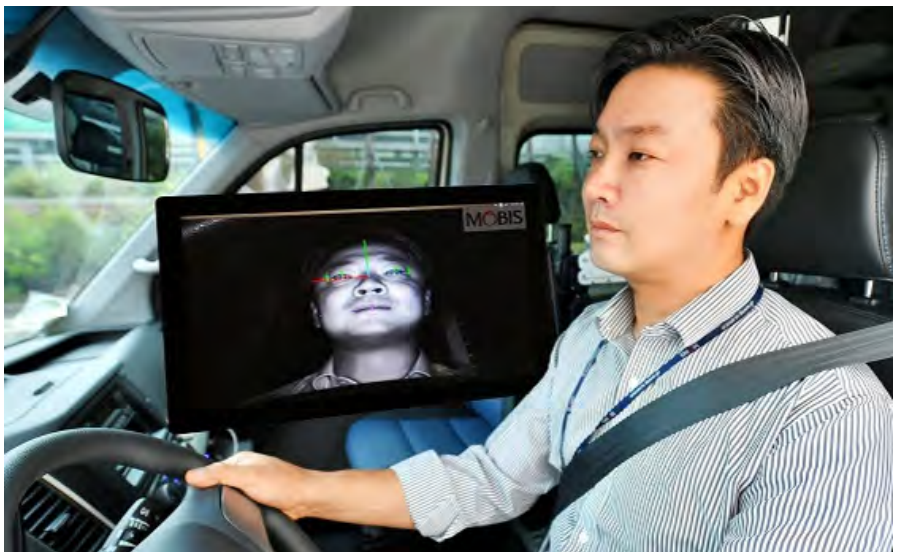

Image: Hyundai Mobis.

DSW analyzes a driver's facial biometric data and warns about careless driving.

Image: courtesy of NASA / Zeiss.

Man in the Moon: Neil Armstrong's classic photograph of Buzz Aldrin.

One small camera click by a man, one giant photo album for mankind

Zeiss recalls developing its bespoke camera lenses that recorded first visit to the Moon, 50 years ago.

Fifty years may have passed since the first Moon landing, on 20 July 1969, but the unmistakable images, which have been widely republished around the world, have lost none of their power to fascinate. In fact, the main reason this event become so firmly entrenched in our collective memory is that it gave us the iconic images captured during the Apollo missions.

These were not only the first photographs ever taken of the Moon's surface, the image of the Earth as seen from the Moon also continues to inspire people of all generations to this day. And all the images from these missions originated in cameras using lenses developed by optics pioneer Zeiss.

The first Moon landing was also the first global media event. Audience ratings typically amounted to 50 per cent of populations, across the world, which means that an estimated 500 million people followed the event live on television. Many observers still remember exactly where they were when the Moon landing took place.

The history of photography in space took off with the Mercury (1962) and Gemini (1964) programs, which preceded the Apollo missions. Increasingly, camera lenses were bring used in the Earth's orbit. During these years, explained the company in a release published this week, "Zeiss laboratories further refined the technology and designed camera lenses ready to meet the challenges posed by space."

Custom lens, made for the Moon

In October 1968, Zeiss received the order for a camera lens to be used during the Moon landing, which was scheduled to take place a mere nine months later as part of the Apollo 11 mission.

"The time for this development was extremely brief," commented Dr. Vladan Blahnik, who works in research and development at the company. The optical data for the preceding model, the Biogon 4.5 / 38 (f 4.5 / 38mm focal length) still needed to be calculated manually, which was an extremely time-consuming process.

However, a mainframe computer helped to determine the mathematical parameters for the subsequent Zeiss Biogon 5.6 / 60, the camera lens designed for the Moon landing, in just a couple of weeks. Dr. Erhard Glatzel (1925-2002), a leading mathematician from the optical design department at Zeiss, ultimately received the Apollo Achievement Award for this and the development of other special lenses for space photography.

Bespoke 'Moon lens'

The customized Zeiss Biogon 5.6 / 60 "Moon lens" had to meet a number of requirements. While it was supposed to work within an easy-to-use camera, it also had to precisely map the lunar surface around the landing site.

Blahnik explained, "They decided on a camera fitted with a Reseau plate, which created a grid of cross-marks on the

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One small camera click by a man, one giant photo album for mankind

images. These made it possible to calculate the distances between individual objects on the Moon."

Image: courtesy NASA / Zeiss.

One small step for a man...

"The special symmetric design of the camera lens provided an excellent correction for distortions and all other image errors." A straight line remains a straight line. Furthermore, the images have great definition and edge-to-edge contrast.

Research inspires the present

Apart from the Zeiss Biogon used on the surface of the Moon, the company designed a number of other special camera lenses for space photography in the 1960s, among them lenses that could transmit UV-waves or extremely fast lenses such as the Zeiss Planar 0.7 / 50.

The company added that it continues to benefit from this research into the present day. Some examples are in the development of faster lenses for professional movie cameras, lenses for aerial photography used in surveying the Earth's surface, and lithographic lenses employed in the production of microchips.

Image: Zeiss.

The customized Zeiss Biogon 5.6/60 "Moon lens".

The camera lens made a significant contribution to the Apollo 11 lunar mission. But, interestingly, the cameras with the Zeiss lenses are still up there on the Moon, because to make the return journey, the astronauts needed to save every gram in order to take back as many samples of Moon rocks as possible; so only the valuable exposed film made it back to Earth.

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http://optics.org/news/10/7/28

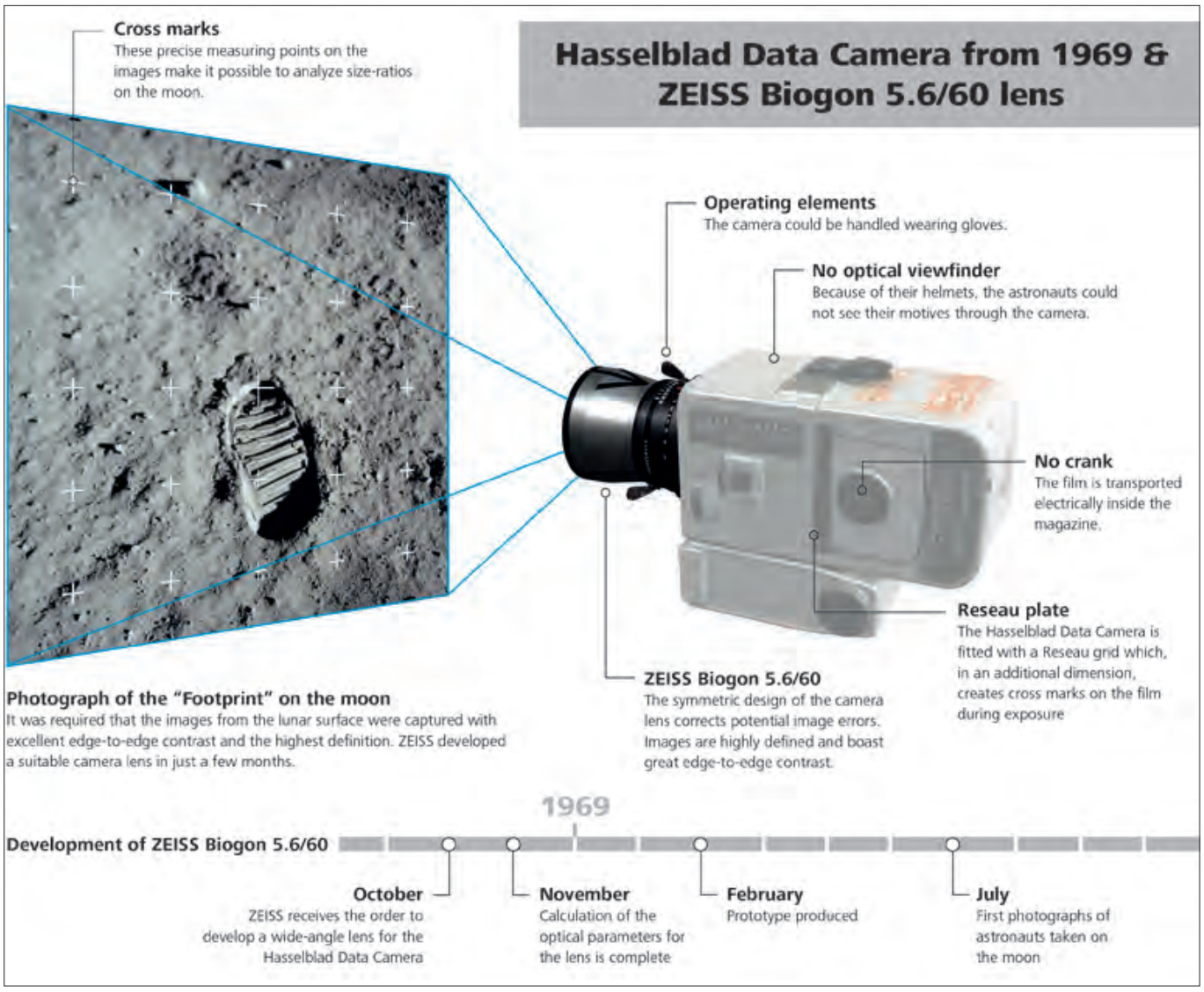

Image: Zeiss.

How Zeiss did it: the specification, operation and development timeline of the special Moon lens.

Stemmer Imaging announces 'strong' Q4 and 2019 as expansion continues

Q4 sales up 14.7% thanks to strong project business; annual revenue up by 8.3% to €109 million.

Machine vision and camera giant Stemmer Imaging has published preliminary figures for its 2018/2019 financial year. The company generated an increase in revenues of 8.3% to €109.0 million in the year to 30 June 2019. Pre-tax earnings totaled €10.0 million (€10.6 million in prior year).

In what the company described as "a challenging market environment," Stemmer achieved its revenue guidance of €108 to €111 million. Its results statement said, "Our broad diversification across all major European markets and low dependence on specific end markets contributed to this result."

This past year, the company has also restructured its sales organization and expanded its range of products and services. In the past year, order intake rose by 5.6% to €112.9 million. Stemmer has also made several acquisitions, notably French company Elvitec, in July 2018, Spanish firm Infaimon, in May 2019, and investment in Austrian Perception Park/

By these acquisitions, Stemmer's overall sales network was significantly extended and product range supplemented by applications such as hyperspectral imaging and robot-bin-picking systems. The company says it is now represented in all major European markets with its own locations and staff.

German market dependence cut

Stemmer's recent financial statement also noted, "Dependence on the German sales market was also reduced due to significant increases in sales in regions such as Scandinavia and France; the share of sales in Germany is below 50% for the first time." However, integration costs had a "negative impact" on earnings in the first half of the year 2018/2019, but in the second half of the financial year, synergy effects, such as

Lars Böhrnsen, Stemmer's CFO.

purchasing advantages and the reduction of redundant structures had a "positive impact on profitability."

In May, 2019, Stemmer announced that it had successfully started to trade on the Prime Standard of the Frankfurt Stock Exchange.

Lars Böhrnsen, CFO, commented, "We are satisfied with the development in the latest financial year. Our acquisitions complement each other both geographically and in terms of technologies. We are optimistic about tasks ahead and intend to keep on pursuing our growth path vigorously. The move to the Prime Standard increases our attractiveness for further investors."

The company advised that this week's figures are provisional and that it will publish the final figures for the 2018/2019 financial year on 26 September 2019.

Stemmer launches Optronis CamRecord Sprinter/CR

Newly-launched by Stemmer, the Optronis CamRecord is an MV camera specified where "fast-moving production processes need to be analysed or high-speed events need to be captured." Suggested application areas range from the laboratory to crash tests.

The CamRecord is available in four models, offering varying resolutions and frame rates, along with numerous event trigger modes including gated recording or pre-event recording. Stemmer comments, "The optical trigger which uses changes in the image to act as a start signal obsoletes a physical trigger input."

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https://optics.org/news/10/8/26

Versatile: the Optronis CamRecord.

Photo: Stemmer Imaging.

Cognex sales down as key markets slump

Simultaneous slowdown in automotive and consumer electronics sectors hits machine vision firm's financial results.

Weak demand across its two most significant markets will continue to hit the sales of machine vision market leader Cognex in the third quarter of the year.

Announcing the Natick, Massachusetts, firm's financial results for the three months ending June 30, company founder and chairman Bob Shillman told investors that it was "frustrating" to report year-on-year declines in both sales and profits.

Attributing the decline to the twin downturns impacting the automotive and consumer electronics sectors - and smart phone manufacturing in particular - Shillman and Cognex' CEO Rob Willett said that the impact had been mostly felt in Europe and China.

"[The] factory automation market in Europe was considerably softer than we anticipated in Q2, and the impact of this will be more noticeable in our Q3 results," Willett said. "Demand for many end markets is declining, notably in automotive, which is one of our largest markets in Europe."

He continued: "Customers, particularly those that are exposed to the slowdown in Greater China, are reducing and deferring large projects. Asia has also weakened. This is due to a continuation of the challenges that we have been experiencing broadly across China, and to softness observed in the industrial markets elsewhere in Asia."

$50M consumer electronics hit

At $199 million, sales in the second quarter of 2019 were down 6 per cent from the same period in 2018, although Cognex remains highly profitable - it posted a net income of $48.7 million for the latest period, down from $56.2 million a year ago.

But those numbers are likely to slide further in the September quarter. Willett told investors that Q3 sales should come in at around $180 million, compared with $232 million last year, and the record-breaking figure of $260 million posted in Q3 of 2017.

"The decline is due almost entirely to substantially lower revenue from consumer electronics," Willett explained, adding that the projected figures anticipate a $50 million year-on-year decline that is largely attributable to the smart phone slump.

The market dynamics have prompted Cognex to re-allocate resources to other areas, notably logistics and e-commerce, where Willett believes that annual growth will remain very strong.

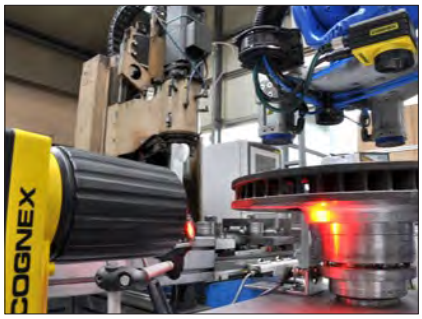

Image: Cognex.

The automotive sector, a key market for Cognex' wide variety of machine vision products, is currently in the midst of a major slump. Cognex' management team is confident of a strong rebound as and when production of electric vehicles ramps to large volumes - but exactly when that will come to pass is difficult to predict.

"If there is a silver lining to this very disappointing market situation we're seeing in automotive and electronics, it's that we're able to re-allocate those Cognoids [i.e. Cognex employees] to some very exciting growth opportunities, notably logistics and deep learning," said the CEO.

The machine vision company does appear to have been affected by the ongoing trade dispute between the US and China, including the blacklisting of Huawei - now ranked by analysts at IDC as second only to Samsung in terms of global smart phone market share.

"Cognex does supply all of the major manufacturers of smart phones, whether directly or indirectly, through contract manufacturers," said Willett, adding that the current market and trade conditions make it more difficult to work with some manufacturers than others.

"That's a challenge for us, certainly," added the CEO. "Our guidance contemplates that situation, and I think we will [just] have to see how it's going to play out from a government and trade talk point of view."

Automotive in transition

While the consumer electronics sector has the potential for a rapid rebound at some point, any such turnaround in automotive is likely to take much longer.

As evidenced by several of the world's largest car makers re-trenching, Willett said that the automotive industry remained in a state of over-supply with conventional combustion-powered vehicles - while the switch to electric vehicles was not yet at the point requiring a major investment in automation technologies like machine vision.

"I'm very optimistic about the long term, but much less optimistic about this year," said Willett of the automotive market, adding that there was "very significant" momentum and investment around electric and hybrid electric vehicles, as well as new autonomous driving features, that should see lots of new designs come to market in around 3-5 years' time.

"At some point, I think there's going to be a race to get those products to market and to gear up in automation," said the CEO. "But I think we have to see more of those products, [as] those new cars come into production - and I think we'll probably have a better view of that as we exit the year."

• Cognex' stock price dropped in value by around 6 per cent in pre-market trading July 30. At just under $40 on the Nasdaq, the company commands a market capitalization of close to $7 billion.

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https://optics.org/news/10/7/46

TULIPP platform blooms for enhancing image processors

European development project leads to more energy-efficient, less costly embedded image processing systems for monitoring, medicine and more.

Whether it is designed for the car or the drone, developing image processing software for embedded systems is time-consuming and therefore very expensive.

Now the newly-developed TULIPP platform is making it possible to develop energy-efficient, embedded image processing systems more quickly and less expensively. The Fraunhofer Institute for Optronics, System Technologies and Image Exploitation (IOSB) is a key member of the EU consortium, which has simplified this process.

Image: Fraunhofer IOSB.

Drone with stereo camera. The small white box holds the embedded system, which evaluates the slightly offset images from the two cameras in real time in order to detect obstacles.

At first glance drones, driver assistance systems and mobile medical diagnostic equipment don't appear to have much in common. But in reality they do: both technologies make increasing use of image processing, for example for detecting pedestrians and obstacles. Image processing can also be used with mobile X-ray equipment to ensure adequate image quality at reduced radiation levels, thus considerably reducing radioactive exposure.

Applications such as these require small, lightweight, energy-efficient image processing components that need to be real-time capable. This is why embedded systems using field-programmable gate arrays are often used.

Field-programmable gate arrays (FPGAs) are logic components the circuit structure of which can be configured by programming using a language such as VHDL. However, the majority of image processing applications are written in higher-level programming languages such as C/C++, and migrating these to embedded systems is highly complex, says the IOSB.

Starter kit

"The TULIPP consortium of eight partners from six countries has created a development platform consisting of design guidelines, a configurable hardware platform and a real-time-capable operating system that supports multicore processors, and a programing tool chain," says Dr.-Ing. Igor Tchouchenkov, group manager at Fraunhofer IOSB.

"A starter kit put on the market by one of our partners in TULIPP provides additional support. The starter kit makes developing such applications much faster and easier. Porting C++ programs to FPGA, which frequently means several months of work for the developer, can be handled within only a few weeks using the TULIPP starter kit."

This means the developer first has to consider, based on the software programmed in C++, which code elements should be distributed to which hardware components and which program steps could be optimized or parallelized. The formulated design guidelines provide help with this task.

Then the starter kit comes into play. It contains the configurable hardware to which the necessary sensors and output devices can be connected, the multiprocessor-capable real-time operating system, and what is called the STHEM toolchain.

The applications in the toolchain make it possible to optimize the C++ program in such a way that it can be ported to the FPGA as easily and quickly as possible. "One special focus of the toolchain is on energy optimization: after all, the aim is to design image processing systems that can be powered by a small battery whenever possible," said Tchouchenkov. "The toolchain makes it possible to individually display and optimize energy consumption for each code function."

Stereo camera

The consortium worked through three specific use cases in order to develop and test the TULIPP platform: the IOSB research team addressed stereo camera based obstacle detection for drones, while other project partners worked on

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TULIPP platform blooms for enhancing image processors

pedestrian detection in the vicinity of a car, and on live quality enhancement of X-ray images taken by mobile C-Arms during surgical operations.

In TULIPP, they ported the corresponding image processing software from C++ to FPGA.

The development team says the results are "impressive". The processing, which originally took several seconds to analyze a single image on a high-end PC, can now run on the drone in real time, so now approximately 30 images are analyzed per second.

"The speed of pedestrian detection algorithm could be increased by a factor of 100: Now the system can analyze 14 images per second compared to one image every seven seconds," added Tchouchenkov.

Image: Fraunhofer IOSB.

Stereo camera and the embedded system installed on the drone.

Enhancement of X-ray image quality by applying noise-removing image filters enables the intensity of radiation to be reduced during surgical operations to one quarter of the previous level. At the same time energy consumption could be significantly reduced for all three applications.

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https://optics.org/news/10/9/14

Hyperspectral system short-listed for drug detection contest

Headwall Photonics technology one of eight technologies that will be evaluated for detecting opioids in mail packages.

Hyperspectral imaging technology developed by Massachusetts-based Headwall Photonics has been short-listed for the US Department of Homeland Security's (DHS's) "Opioid Detection Challenge".

The automated multimodal opioid detection system from Headwall's partner Battelle uses the imaging sensors in combination with dual-energy radiography and machine-learning algorithms.

Aimed at non-invasive detection of opioids in packages without disrupting the flow of mail, the technique is one of eight finalists - selected from 83 submissions - in the $1.55 million competition that will now proceed to the prototyping stage.

Opioid crisis

The technology challenge is one of the responses from the US government in a bid to address a public health crisis in the country that saw nearly 50,000 people die from opioid overdoses in 2017. Deaths attributed to the potent opioid fentanyl are responsible for a huge recent increase in fatal overdoses.

Figures from the US National Institute on Drug Abuse show that total deaths from overdoses in the US jumped from around 17,000 in 1999 to more than 70,000 in 2017 – roughly doubling every decade. Fentanyl is seen as particularly dangerous because only a tiny amount is needed to overdose, with musician Prince among those thought to have died accidentally after taking the drug.

"International mail has been identified as a route for illicit opioids entering the US, commonly transported in nearly pure, powdered form," explains the DHS. "Consequently, large-scale drug trafficking can occur via small packages sent in the mail."

As a result, the DHS and US Customs and Border Protection are looking for automated, user-friendly technologies that might be suitable for inspecting large numbers of packages without disrupting or opening mail.

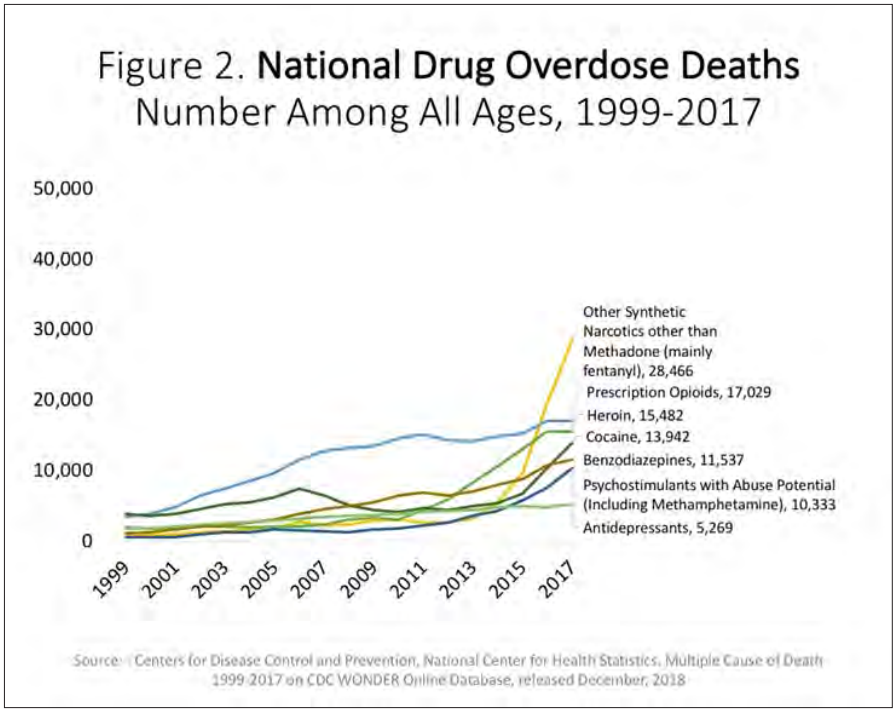

Image: NIH.

The number of fatalities per year in the US from drug overdoses has more than quadrupled in the past two decades. Much of the recent, sharp increase has been attributed to misuse of the opioid fentanyl. Musicians Prince and Tom Petty were among the fentanyl-related fatalities.

Headwall's CEO David Bannon said in a company announcement: "Our hyperspectral sensors offer a powerful combination of machine vision sensing, real-time processing capability, and a ruggedized design that already benefits thousands of customers around the world with instruments on the process line, on farms, in the air, and even in space.

"Helping to reduce the human cost of addiction by automated interdiction has great social impact and means a great deal to us and our community."

On-site testing

The Battelle/Headwall system now moves on to a 14-week accelerator stage, during which a deployable prototype will be developed.

Other technologies to have made the short-list include a variety of X-ray, ultrasound, and high-frequency radio wave methodologies.

Once the prototypes have been built, they will be deployed across international mail and express consignment facilities, and similar environments across the US.

The testing stage culminates in a mandatory live event, with the finalists set to convene at a government-selected facility for on-site testing of their prototypes.

This fall the judging panel, which comprises several senior personnel from the likes of the US Postal Inspection Service and US Customs and Border Protection, will select a winner and runner-up sharing a prize pool worth $750,000.

Author:
Mike Hatcher, Contributing Editor, optics.org
https://optics.org/news/10/9/17

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NASA 'optometrists' verify Mars 2020 rover's 20/20 vision

Machine-vision calibration of the forward-facing cameras on the rover has been completed, ahead of next year's mission to the Red Planet.

Equipped with visionary science instruments, the Mars 2020 rover has just undergone an "eye test" after several cameras were installed on it. The rover contains a diverse range of imaging capabilities, from wide-angle landscape cameras to narrow-angle high-resolution zoom lens cameras. Before it blasts off to Mars next year, its development team needs to ensure that the vision systems will work perfectly – because there will be no opportunity to send a mechanic to Mars.

"We completed the machine-vision calibration of the forward-facing cameras on the rover," said Justin Maki, chief engineer for imaging and the imaging scientist for Mars 2020 at NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California. "This measurement is critical for accurate stereo vision, which is an important capability of the vehicle."

To perform the calibration, the 2020 team imaged target boards that feature grids of dots, placed at distances ranging from 1 to 40 meters (44 yards) away. The target boards were used to confirm that the cameras meet the project's requirements for resolution and geometric accuracy. The cameras tested included two Navcams, four Hazcams, the SuperCam and the two Mastcam-Z cameras.

"We tested every camera on the front of the rover chassis and also those mounted on the mast," said Maki. "Characterizing the geometric alignment of all these imagers is important for driving the vehicle on Mars, operating the robotic arm and accurately targeting the rover's laser."

Credit: NASA/JPL-Caltech.

Engineers test cameras on the top of the Mars 2020 rover's mast and front chassis. The location is the Spacecraft Assembly Facility's High Bay 1 at NASA's Jet Propulsion Laboratory in Pasadena, California.

Credit: NASA/JPL-Caltech.

Engineer Chris Chatellier stands next to a target board with 1,600 dots. The board was one of several used on July 23, 2019, in the Spacecraft Assembly Facility's High Bay 1 at NASA's Jet Propulsion Laboratory in Pasadena, California, to calibrate the forward-facing cameras on the Mars 2020 rover.

In the coming weeks, towards the end of 2019, the imagers on the back of the rover body and on the turret at the end of the rover's arm will undergo similar calibration. Mounted on the rover's remote sensing mast, the Navcams (navigation cameras) will acquire panoramic 3-D image data that will support route planning, robotic-arm operations, drilling and sample acquisition.

The Navcams can work in tandem with the Hazcams (hazard-avoidance cameras) mounted on the lower portion of the rover chassis to provide complementary views of the terrain to safeguard the rover against getting lost or crashing into unexpected obstacles. They will be used by software enabling the Mars 2020 rover to perform self-driving over the Martian terrain.

Along with its laser and spectrometers, SuperCam's imager will examine Martian rocks and soil, seeking organic compounds that could be related to past life on Mars. The rover's two Mastcam-Z high-resolution cameras will work together as a multispectral, stereoscopic imaging instrument to enhance the Mars 2020 rover's driving and core-sampling capabilities.

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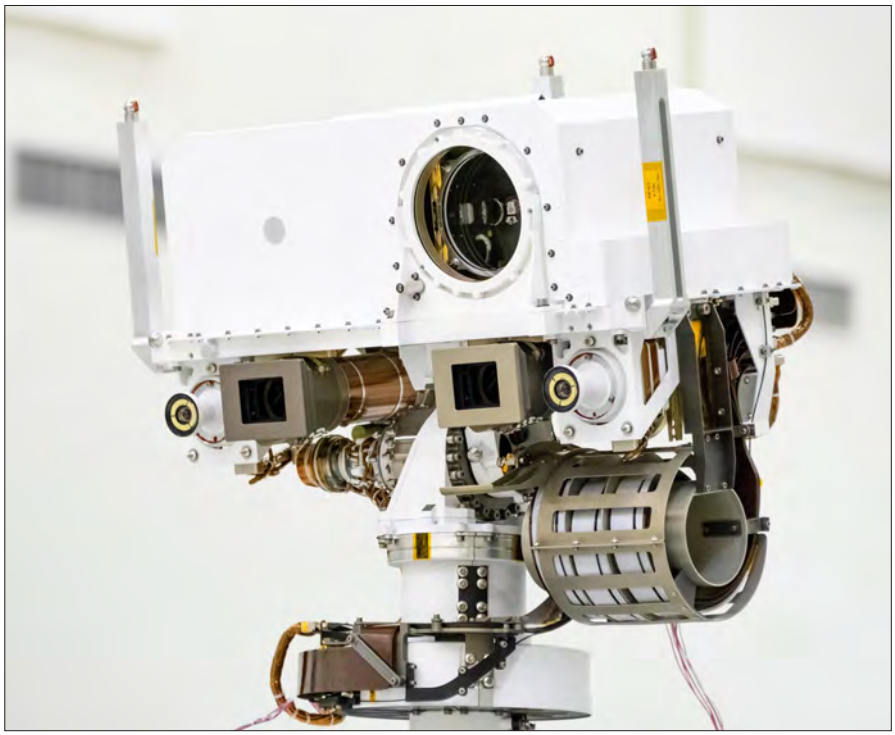
NASA 'optometrists' verify Mars 2020 rover's 20/20 vision

The Mastcam-Z cameras will also enable science team members to observe details in rocks and sediment at any location within the rover's field of view, helping them piece together the planet's geologic history.



Credit: NASA/JPL-Caltech.

Head of Mars 2020's remote sensing mast. The mast head contains the SuperCam instrument (its lens is in the large circular opening).

JPL is building and will manage operations of the Mars 2020 rover for the NASA Science Mission Directorate at the agency's headquarters in Washington. NASA will use Mars 2020 and other missions, including to the Moon, to prepare for human exploration of the Red Planet. The agency intends to establish a sustained human presence on and around the Moon by 2028 through NASA's Artemis lunar exploration plans.

Mars 2020 gets HD eyes

One of the first operations the Mars 2020 rover will perform after touching down on the Red Planet's Jezero Crater on Feb. 18, 2021, will be to raise its remote sensing mast (RSM), which carries important optics and instrumentation.

Its Mastcam-Z is a multispectral, stereoscopic imaging instrument that will enhance the Mars 2020 rover's driving and core-sampling capabilities. It will also enable science team members to observe textural, mineralogical, structural and morphologic details in rocks and sediment at any location within the rover's field of view, helping them piece together the planet's geologic history.

"Mastcam-Z will be the first Mars color camera that can zoom, enabling 3-D images at unprecedented resolution," said Mastcam-Z Principal Investigator Jim Bell of Arizona State University in Tempe. "With a resolution of 0.8 mm in front of the rover and less than 38 mm from over 100 meters away — Mastcam-Z images will play a key role in selecting the best possible samples to return from Jezero Crater."

Mastcam Z's capabilities are not the only firsts of the mission. Mars 2020 will be the first spacecraft in the history of planetary exploration with the ability to accurately retarget its point of touchdown during the landing sequence. And the rover carries a sample-caching system that will collect Martian rock and soil samples and store them on the planet's surface for retrieval and return to Earth by subsequent missions.

Mars 2020 will launch from Cape Canaveral Air Force Station in Florida in July of 2020. JPL is building and will manage operations of the Mars 2020 rover for the NASA Science Mission Directorate at the agency's headquarters in Washington.

Author:
Matthew Peach, Contributing Editor, optics.org

Credit: NASA/JPL-Caltech.

In the Spacecraft Assembly Facility's High Bay 1 clean room at the Jet Propulsion Laboratory in Pasadena, California, engineers re-install the cover to the remote sensing mast (RSM) head after integration of two Mastcam-Z high-definition cameras that will go on the Mars 2020 rover.

Direct interfacing of smart 3D vision system with robots

The use of small to medium-sized collaborative robots for factory automation applications is growing at a rapid rate.

Many of these applications are pick-and-place, so the robots require machine vision to visualize the scene, process information to make control decisions and execute precision-based mechanical movements.

2D or 3D vision systems are used to provide these critical functions, but integrating the vision system and robot can be demanding. LMI Technologies have developed a plugin, which allows direct interfacing of its Gocator 3D snapshot sensors with robots from Universal Robots.

The 3D snapshot sensor can be mounted connected directly to the robot over Ethernet using the Gocator URCap plugin. The 3D coordinate system of the Gocator is mapped directly into the robots coordinate system resulting 3D vision-guided robotic system is simple and highly efficient. No additional software or PC is required.

Benefits of 3D vision

2D-driven systems can only locate parts on a flat plane relative to the robot. Robotic systems equipped with 3D vision, on the other hand, can identify parts randomly posed in three dimensions (i.e., X-Y-Z), and accurately discover each part's 3D orientation. This is a key capability for effective robotic pick-and-place.

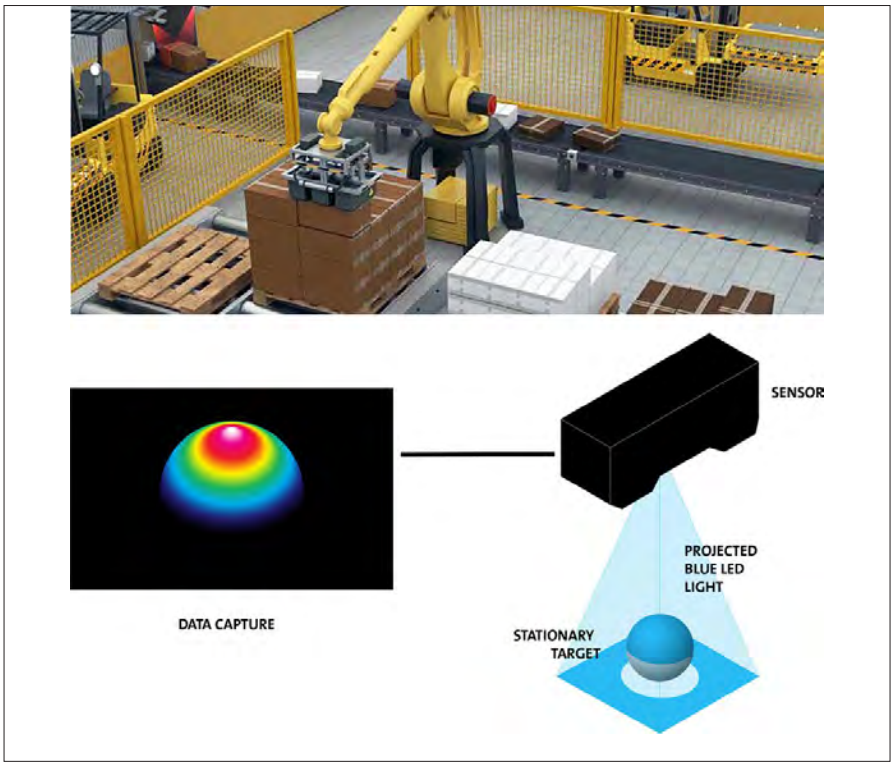


Image: LMI Technologies

Gocator Pick And Place Factory: Picking and placing packages onto pallets using 3D information.

Gocator snapshot sensors combine fringe projection using blue-LED structured light with a rich array of built-in 3D measurement tools and decision-making logic to scan and inspect any part feature with stop/go motion at speeds up to 6 kHz. The blue LED projects one or more high-contrast light patterns onto the object to allow full-field 3D point cloud acquisition by the stereo cameras, providing excellent ambient light immunity, even in challenging conditions. The combination of these metrology-grade snapshot sensors with UR devices gives a complete robotic solution that delivers high-performance 3D results in robot vision-guidance, quality control inspection, and automated assembly with smart pick and place.

The 3D vision-guided robots are generally equipped with a vacuum- or pneumatic-based grip that allows the robot to contact the part on a variety of surfaces and effectively transport the part while avoiding collisions to a target destination. Parts can be positioned systematically or randomly on moving conveyors, stacked bins, or pallets.

Image: LMI Technologies

LMI GoCator: The Gocator camera system that enables "intelligent" pick-and-place with a 3D vision-guided robot.

Typical applications

- Pick-and-place of incoming raw materials or subassemblies travelling on a transport system (e.g., conveyor, pallets). Gocator scans the target part/assembly, reports its position in global coordinates, and places it randomly or directly on a conveyor/pallet.
- Random placement and picking up off of a conveyor. Gocator scans a part as it travels down a conveyor, and directs the robot to pick up the part and place into the appropriate bin.
- Placing finished products/assemblies into structured bins according to the height of the parts. The Gocator sensor uses 3D information to place the parts in the appropriate bin and set them at the appropriate clock angle.

All three of these applications can be performed using just the Bounding Box, Height and Part Matching tools from the 140+ that are provided. This simplicity, with no need for additional programming, makes it easy to set up, run, and to achieve the desired results from the system.

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Sony's holographic waveguide display designed for custom AR wearables

Sony Semiconductor Solutions' new SED-100A holographic waveguide display is designed to enhance customized hardware AR developments for industrial applications with high precision and quality.

The developer says, "the display aids in industrial AR glasses development and provides new opportunities for industrial companies to facilitate tasks, and create safer and faster workflows." The display is available from global vision partner FRAMOS.

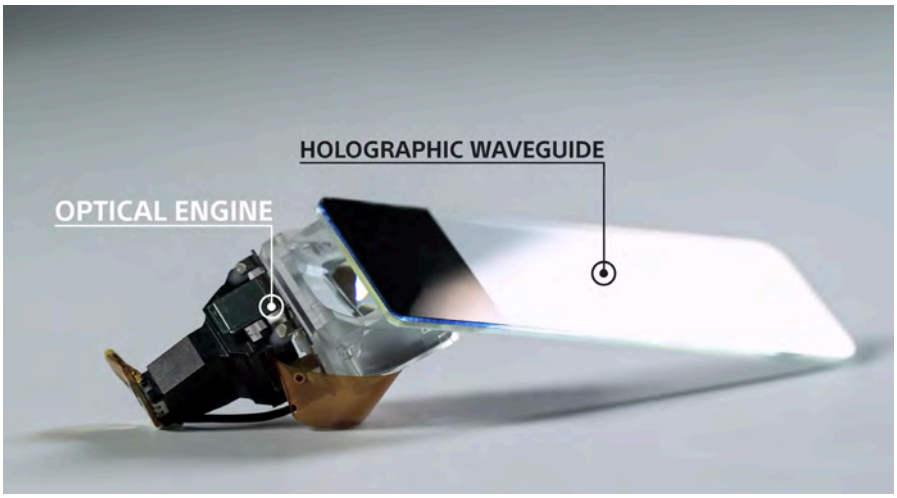
Applications for the display range from entertainment, production, inspection and maintenance, to real-time translation and logistics. These applications benefit from users (wearers of the smart glasses) that are supported by hands-free guidance, support, and task management, by adding digital information to custom smart eyewear.

Sibel Yorulmaz-Cokugur, a Display Expert at FRAMOS, commented, "The Sony SED-100A smart glasses display provides seamless AR communication for industrial environments. It facilitates the development of intelligent data glasses, which overlay real existing objects with digital information.

"Wearers can see the environment directly through the glasses and get supplemental text and pictures in their field of vision. This display is Sony's ready-to-integrate solution with its convincing slim profile of 1mm, a brightness of up to 2000 nit for great readability, and a transmittance over 85% for a very clear view of the real-world."

The SED-100A is based on Sony's proprietary hologram optics technology, and consists of two components. An optical engine uses micro display ("µdisplay") to project images and text to a holographic waveguide. Secondly, a waveguide made of an extremely thin transparent glass plate takes the light created in the optical engine, and projects a virtual image through holographic optical elements to the eyes of the wearer.

This technology enables an external light transmittance of more than 85%. The lenses, together with a protective plating, comprise a total width of only 3.14mm for a slim industrial AR solution to provide both convenience and wearing comfort.



Source: Sony

Profile of the Sony SED 100A system, showing its optical engine and holographic waveguide.

The kit is optimized for what Sony calls "instant integration and quick series production," and includes the optical display component and the driver chip. The additional development kit is available for prototyping on reference designs, and for the easy evaluation of custom hardware and software development for augmented reality (AR) solutions.

The development kit contains a monocular display and a controller puck as evaluation hardware. It provides a multitude of development resources like 3D model files, design guidelines, bill of materials, controller circuit board design, firmware source code, code samples for Android and Linux, and many more.

FRAMOS is ready to support customers with the integration of these new displays into their applications and projects. The distributor also provides a broad range of support services for development, customization, and logistics.

Author:
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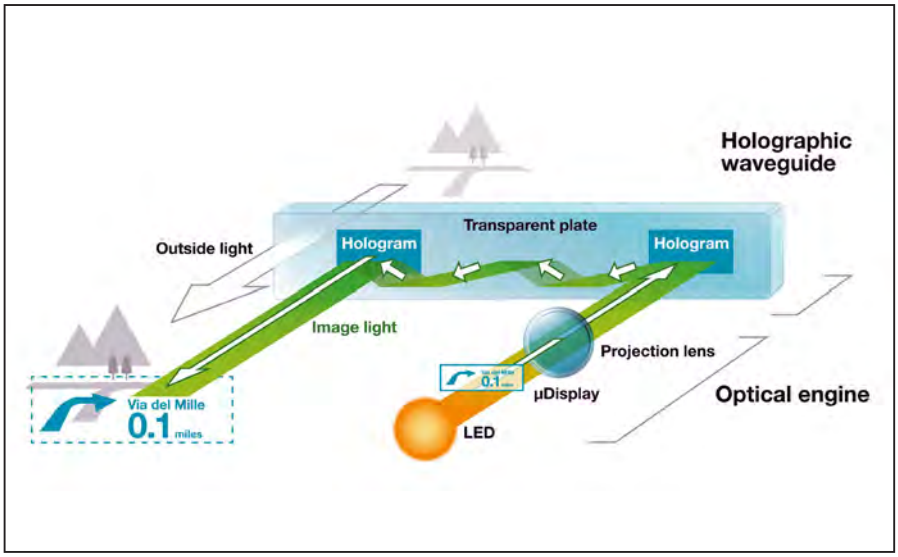

Source: Sony

The Sony SED 100A system design and principles of operation.

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