Image Sensors

Image sensors will further impact the consumer, automotive, and other industries.
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Innovations in Imaging
Various types of three-dimensional (3D) imaging sensors are available in the market. In such sensors, very few light pulses are emitted by the imaging system before the emitted pulse is measured and received. Such sensors can have limitations in measurement distance and acquisition speed. In particular, for objects at a distance, the acquisition speed can be limited.

Fastree3D aims at addressing the growing global market needs for 3D imaging applications. This focus has helped the company in tracking the needs of its customers, thereby addressing the issues faced by the clients.

Fastree3D has developed a laser-based 3D vision system based on a unique photo sensor platform that uses a single photon detector. Data is derived from both hardware and software to provide the unambiguous and precise identification of a objects moving at a very high speed at a long distance.

The main features of Fastree3D vision system are high frame rate, low light imaging, programmable region of interest, flexible pixel binning with individual pixel readout, programmable control of gain, frame rate and exposure, and selective exclusion of hot pixels.

Fastree3D SA, Switzerland
The measurement of the phase difference between outgoing and incoming light requires multiple pixel detectors. This further leads to slower analog readout and digital conversion. In addition, transit time through the detectors is such that modulations higher than 50 MHz are not possible.

**CMOSIS** has developed the CSI2100 2 M Pixel CMOS image sensor and displayed the sensor in the 2015 International Technical Show in Yokohama, Japan under the medical imaging category. The hardware kit of the sensor is co-developed with Pleora Technologies. The sensor employs Pleora’s iPORT NTx-U3 Embedded Video Interface.

The CMOS image sensor can operate in a 10 bit mode and come with 12 micrometer-sized black and white global shutter pixels.

At a high speed, the sensor works with full capacity to detect small variations in signal.

The efficient global shutter has low spatial and temporal noise. In single exposure, it has high linear dynamic range.

**Potential Applications**
- Machine vision
- High frame rate image capture
- Inspection systems
- Endoscopy
- X-ray imaging
- Scientific instruments
- Smart sensors and system on chip (SoC) imagers

**Technology Profile**

**CMOSIS** is headquartered in Belgium and has offices in USA, Portugal, and Germany.

**Who**
CMOSIS develops customized and standard CMOS image sensor. The company provides global and rolling shutter image sensors.

**Where**
CMOSIS has been acquired by AMS and is a member of the AMS group. The acquisition helps AMS to expand its optical sensor portfolio in machine vision, medical, photographic, and scientific imaging and many more applications.

**Potential Applications**
- Machine vision
- High frame rate image capture
- Inspection systems
- Endoscopy
- X-ray imaging
- Scientific instruments
- Smart sensors and system on chip (SoC) imagers

**Commercialization Strategy**

The CSI2100 2 M Pixel CMOS image sensor is expected to be commercialized by one to two years. CMOSIS improved the CMOS image sensor technology, including its performance in low light conditions and enhanced sensitivity of very small pixels.

**Participation**
CMOSIS has been one of the participants in European Commission FP7 CARIoCA project started around 2012 and completed in 2015. The project focuses on full-field optical coherence tomography to provide fast cancer assessment at cellular scale with the help of novel non-invasive optical imaging. In addition, CMOSIS is also one of the participants in European Commission’s Horizon 2020 (H2020) program, Eyes of Things project to develop a computer vision platform for complex artifacts and applications such as wearables, robotics, home products, and surveillance.
Global Shutter CMOS Image Sensor  
*On Semiconductor, USA*

**Technology Profile**

On Semiconductor is one of the leading suppliers for semiconductor-based solutions. The company’s product portfolio comprises SoCs, sensors, power management devices, analog devices, logic devices, and connectivity devices.

**Who**

- Automotive imaging
- High speed barcode scanning
- Virtual reality
- 3D depth sensing

**Where**

On Semiconductor has its headquarters in USA and has offices across the globe.

**What**

The AR0135 CMOS image sensor is developed with the global shutter pixel design and allows effective synchronization with pulsed light sources. This new design will help to provide clear images with low noise in environments such as high temperature, bright scenes, and low light.

**Innovation Attributes**

The AR0135 sensor comprises a dedicated trigger and flash pins, which are further used to synchronize multiple sensors for stereo camera applications and control external LED light source.

The AR0135 sensor is a 1280 x 960 resolution device with 720p at 60fps and 54fps per second at full resolution.

The AR0135 sensor with the innovative global shutter pixel design, operates with 10 times lower dark current and 4 times higher shutter efficiency than previous generations of product. In addition, this helps the sensor to improve the performance in gesture recognition and eye tracking functionality.

**Potential Applications**

- Automotive imaging
- High speed barcode scanning
- Virtual reality
- 3D depth sensing

**Market Opportunity**

The market has a need for clear, accurate, and high-speed imaging solutions. The global shutter pixels from On Semiconductor provide reliable operations in harsh environments and resolve the challenges in high speed barcode scanning and driver monitoring.

**Commercialization Strategy**

Engineering samples of the CMOS image sensor are available and such sensors are slated for production in the third quarter of 2016.
Unispectral is a startup company and a spin off from Tel Aviv University.

Unispectral has developed a compact image sensor based on hyperspectral imaging (which takes images at many close-interval wavelength bands to provide a more complete spectrum for each pixel). Unispectral is aiming to transform the standard of color sensing mechanisms in compact cameras and to provide high low-light sensitivity, rich color, better resolution.

**Innovation Attributes**

Researchers at the company are developing a small optical component with the help of MEMS (micro-electromechanical system) technology. The system will identify electromagnetic fingerprints and extract vital information from the images of various substances and processes. For instance, just by taking a picture of a structure, the chemical composition of the structure inside the picture can be studied by the user.

- Software will be employed to support the process in extracting the information from the image with the help of an image fusion library.
- The technology will enable capturing images with rich color and better resolution even in low light conditions.

**Potential Applications**

- Consumer electronics
- Wearable
- Medical imaging
- Industrial
- Agriculture
- Internet of Things

**Funding**

The company has raised $7.5 million through Series A funding led by Jerusalem Venture Partners, Robert Bosch Venture Capital, Samsung Catalyst Fund, and Tel Aviv University Innovation Momentum Fund.

**Commercialization Strategy**

The technology is currently under development by Tel Aviv University’s technology transfer company, Ramot. The technology is expected to be commercialized over the near-term.
Strategic Insights
• North America is a major market for image sensors, particularly for consumer electronics and defense applications.
• Research in the European region is mainly spearheaded by universities and research institutes.
• Technology development is high in the APAC region with major patent holders having their headquarters in Japan and South Korea.
• There is an increase in patent filings under image sensors for autonomous vehicles and unmanned aerial/ground vehicles for security and defense applications.
Strategic Insights (continued)

### Drivers
- Smartphones and tablets, as well as automotive, will continue to be major drivers for the growth of CMOS image sensors. Security is another key application for image sensors.
- Wider adoption in emerging applications such as healthcare (medical imaging), industrial automation is expected to drive growth in the medium- and long-term.

### Restraints
- The demands and requirements of the automotive industry (for driver assistance applications) put pressure on sensor suppliers.
- End-user consolidation restricts opportunities for image sensors.
- Competition leads to pricing pressures.

### Focus Areas
- Noncontact 3D laser scanners
- LIDAR
- Stereovision
- Interferometry
- Mapping large areas
- 3D machine vision
- 3D depth sensing

### The 2020 Scenario
- Image sensors with 3D vision will enable robots to have better perception of their surroundings. This will lead to humans and robots sharing the work floor and performing tasks in unstructured environments.
- The market share for image sensors in the automotive industry will increase as cameras become key components for increasing car safety, driving assistance, and driving comfort. Assistance in blind-spot viewing, lane-departure warning systems, and automatic headlight dimming are some of the applications for imaging in automobiles.
- 3D depth sensors based on time-of-flight will find opportunities in gesture control in consumer electronics, automotive, and so on.

### Funding
- Occipital (USA), a provider of the structure sensor and software for augmented reality, received funding of around $1.3 million on Kickstarter. The company has developed a 3D image sensor that can be used on mobile devices, such as iPads.
- Funding support by governments and venture capitalists is expected to accelerate the commercialization of devices in such areas as consumer electronics.
Key Patents
<table>
<thead>
<tr>
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<th>Publication Date</th>
<th>Title</th>
<th>Assignee</th>
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<tr>
<td>1</td>
<td>US20160092714</td>
<td>31.03.2016</td>
<td>Fully-addressable sensor array for acoustic imaging systems</td>
<td>Apple Inc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>An acoustic imaging system can contain a plurality of individual acoustic elements that each contain an acoustic transducer, drive circuitry, and low voltage sense and/or read circuitry. In many embodiments both the drive circuitry and the read circuitry can be independently addressable. For example, if the individual acoustic elements are arranged into rows and columns, each acoustic element can include row/column drive circuit enable switches and row/column read circuit enable switches.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>US20160093654</td>
<td>11.02.2016</td>
<td>Image sensor and method for operating the same</td>
<td>SK Hynix Inc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>An image sensor includes a photoelectric conversion element suitable for generating photocharges corresponding to incident light, a transfer transistor suitable for transferring the generated photocharges to a floating diffusion node based on a transfer signal, and a reset transistor suitable for resetting the floating diffusion node based on a reset signal and including a memory gate.</td>
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### Key Patents (continued)

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<tr>
<td>3</td>
<td>US20160093656</td>
<td>31.03.2016</td>
<td>Image sensor device and method of manufacturing the same</td>
<td>Semiconductor Manufacturing International (Shanghai) Corporation</td>
</tr>
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<td></td>
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<td></td>
<td>An image sensor device includes a top substrate and a subassembly. The top substrate includes a plurality of connection pillars, and the subassembly includes a plurality of connection pads. The connection pillars on the top substrate are bonded to the connection pads in the subassembly. The connection pillars are formed of a first metal and the connection pads are formed of a second metal.</td>
<td></td>
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<tr>
<td>4</td>
<td>US20160093658</td>
<td>31.03.2016</td>
<td>Image-sensor structures</td>
<td>VisEra Technologies Company Limited</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>An image-sensor structure is provided. The image-sensor structure includes a substrate, a plurality of photoelectric conversion units formed in the substrate, a plurality of separated color filters formed above the substrate and the photoelectric conversion units, a first light shielding layer surrounding the separated color filters, and a first conductive polymer element blended with a low-refractive-index component filled between the individual separated color filters and between the all separated color filters and the first light shielding layer, wherein the first conductive polymer element is electrically connected to a grounding pad.</td>
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### No. 5

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<th>Assignee</th>
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<tbody>
<tr>
<td>US20160093664</td>
<td>31.03.2016</td>
<td>Image sensor pixel cell with non-destructive readout</td>
<td>Omnivision Technologies Inc.</td>
</tr>
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</table>

A pixel cell includes a photodiode coupled to photogenerate image charge in response to incident light. A deep trench isolation structure is disposed proximate to the photodiode to provide a capacitive coupling to the photodiode through the deep trench isolation structure. An amplifier transistor is coupled to the deep trench isolation structure to generate amplified image data in response to the image charge read out from the photodiode through the capacitive coupling provided by the deep trench isolation structure. A row select transistor is coupled to an output of the amplifier transistor to selectively output the amplified image data to a column bitline coupled to the row select transistor.
Industry Contacts
<table>
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<tr>
<th>Contact Name and Designation</th>
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<td><a href="http://www.ramot.org">http://www.ramot.org</a></td>
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