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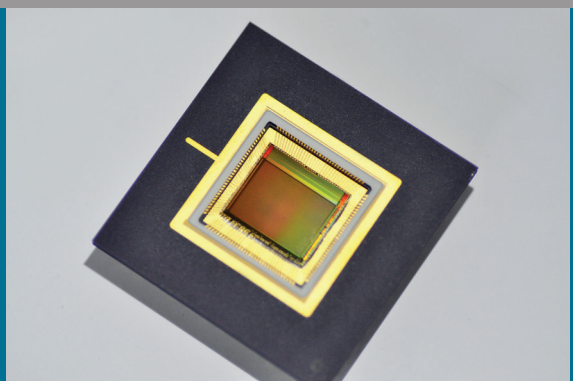

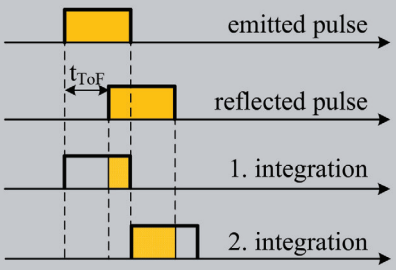

1 *Photograph of chip in PGA132 package*
2 *Indirect ToF principle*

QVGA PHOTO-DETECTOR FOR INDIRECT ToF-IMAGING

Next generation of lateral drift-field photodetectors

For many years Fraunhofer IMS is developing time-of-flight (ToF) image sensors based on the patented lateral drift field photodetector (LDPD) technology. This newly designed image sensor merges these experiences in order to combine the advantages of the fast charge transfer in the LDPD with a high lateral resolution of 320 x 240 individual pixels (QVGA).

Indirect ToF measurements

In ToF applications the distance from the camera to an object is measured by illuminating it with a pulsed light source and detecting the reflected light. From the time delay of the reflected pulse the distance can be evaluated.
The applied ToF principle is a scanner-less LiDAR (Light Detection and Ranging) which means the complete scene is illuminated and recorded with every light pulse.

In indirect ToF measurements the time is not determined by any kind of stopwatch. Instead of that the signal of the reflected pulse is collected on two individual integration nodes (Fig. 2). The signal is separated into two timing windows. The fraction of signal in the second timing window is proportional to the time delay and thus the distance. By performing this evaluation for each individual pixel the 3D depth image is reconstructed.
The advantage of this approach is the robustness against background light. In direct measurements the parasitic signal from e.g. the sun could trigger the timer to stop. By performing a separate measurement of the backlight itself the indirect ToF principle has an inherent mechanism to correct for this effect.

Need for speed

The measurement principle requires a very fast photodetector to achieve a clear separation on the integration nodes. For this purpose Fraunhofer IMS has developed the

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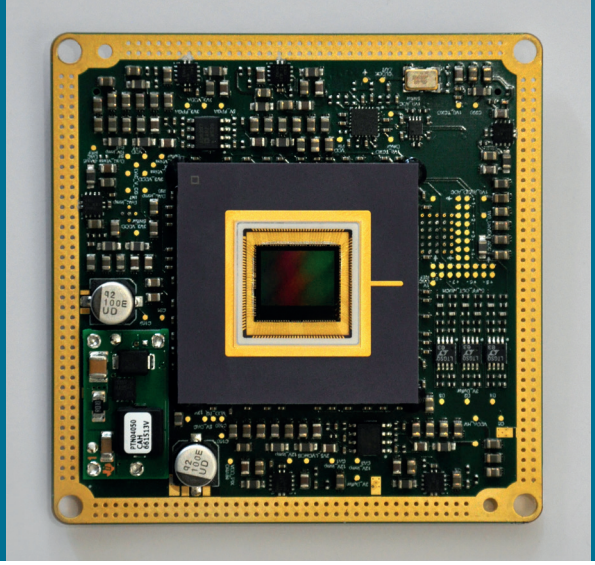

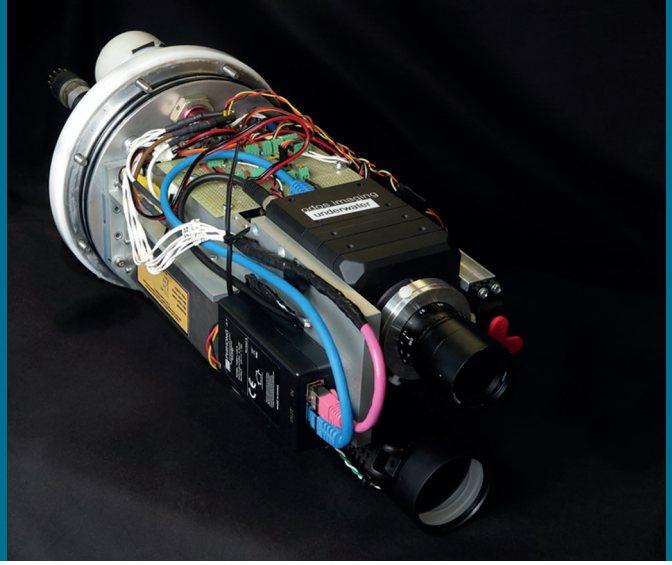

LDPD. The core feature is an inhomogeneous doping within the photoactive area which shapes an electric field and thus accelerates charges to the integration node. The ability of in-pixel accumulation of an arbitrary amount of light pulses allows to apply dim and thus cheap and eye-safe illumination sources.

Camera integration for evaluation

The sensor is integrated into the camera StarForm manufactured by Odos Imaging Ltd via a carrier PCB (printed circuit board). This camera platform is able to operate the sensor and fulfills its need for fast control signals as well as high speed image readout.

Applications

The sensor was originally developed in the project UTOFIA within the Horizon 2020 framework (grant agreement No. 633098). UTOFIA aims to deliver an underwater ToF image acquisition system where the sensor plays a key role on the route to high contrast 3D videos.

Due to the general purpose approach the sensor can easily adapted to a large variety of applications such as:

- **Automotive:**
  indoor and outdoor usage for e.g. control of car entertainment or pre-crash detection
- **Human-machine interface:**
  Intuitive gesture recognition
- **Machine vision:**
  Efficient inspection of goods in the production line
- **Robotics:**
  Easy coordination by acquisition of real-time depth maps

Specifications

QVGA ToF image sensor:	
Lateral resolution	320 x 240
Pixel pitch	34 µm
Pixel type	Lateral drift field photodetector
Independent nodes per pixel	2
Readout time (full frame)	< 4 ms
Output format	8 parallel analog channels
Image capture method	Global shutter
Technology	Fraunhofer IMS 0.35 µm standard CMOS certified for automotive applications
Sensor dimension	12.66 x 11.35 mm²
QVGA evaluation camera:	
Illumination	Pulsed laser diodes, 905 nm, class 1
Lens	C-mount, f/1.8, 50 mm
Platform	Odos Imaging StarForm
Interface	GigEVision and GenICam compatible

3 *Chip module including the interface board*
4 *UTOFIA system (without outer cover)*