Fraunhofer Institut
Mikroelektronische
Schaltungen und Systeme

Low Power CMOS Image Sensor

Features

The IMS CIF-Camera is a versatile CMOS image sensor (fig. 1 for the chip photomicrograph). It features on-chip fixed-pattern-noise (FPN) cancellation, random pixel access, subregion readout, multiple integration, and low power dissipation (fig. 3 for reproduced images).

Fixed Pattern Noise Cancellation

The on-chip correlated-double-sampling (CDS) eliminates the superimposed fixed pattern noise (FPN) of the pixel array. Because of the advanced circuitry of the imager the FPN has been reduced to less than 2 mV or 60 dB below the maximum signal level. In addition, the CDS reduces offsets and low-frequency random noise.

Region Readout

Many applications, e.g. in automotive or machine vision, need only a small portion of the whole image to be read out. The IMS CIF-Camera is capable of multiple subregion readout. In full frame mode the regions of interest can be set. After this the subregions can be captured at a high frame rate. Because of this feature the image processing systems based on IMS CIF-Camera can operate at a higher speed than as systems processing full frames. The imager can capture up to 1000 frames/s at a resolution of 64 by 64 pixels. The size of the subregion window can be adjusted by a single pixel increment. Fig. 4 shows an image sequence of a rotating fan captured at 1000 frames/s.

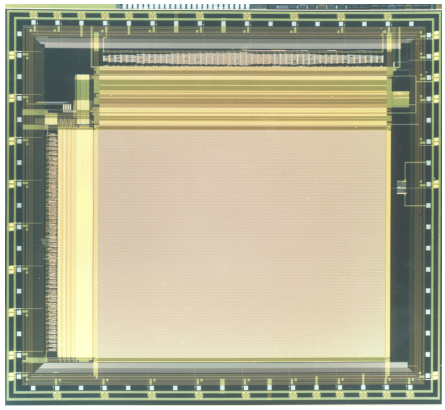

Fig. 1: Photomicrograph of the CIF format CMOS imager

Fraunhofer-Institut für Mikroelektronische Schaltungen und Systeme

Finkenstr. 61
D – 47057 Duisburg
Phone: +49 (0) 2 03 / 37 83-0
Fax: +49 (0) 2 03 / 37 83 23-266
Internet: http://www.ims.fhg.de

Contact:
Michael Bollerott
Phone: +49 (0) 2 03 / 37 83-227
E-Mail: bollerot@ims.fhg.de

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High Dynamic Range

Numerous imager applications require a dynamic range of more than 60 – 70 dB due to nonuniform illumination or reflection of the objects. Camera systems that feature only a single exposure time can not capture the whole scene, because part of the image may be under- or overexposed. The IMS CIF-Camera is capable of carrying out multiple exposures at different exposure times defined by the user. This feature makes it feasible to take images with a dynamic range of more than 100 dB.

Low Power Dissipation

The IMS CIF-Camera has been fabricated in standard 1 µm CMOS technology. It is well suited for mobile and low power applications. It dissipates only 35 mW at 5 V power supply and 100 frames/s. CCD based imagers need at least 500 mW.

Summary

The IMS CIF-Camera is a versatile imager suitable for many applications. It features subregion readout, multiple exposure, and low power consumption.

For evaluation a demonstrator system is available. The camera system uses a RS422 interface compatible to the Matrox Pulsar Frame Grabber Board. Software for Windows NT for use with the demonstrator is also available.

Readout:	progressive, rolling shutter
Total pixel count:	380 x 300 pixel
Readout pixels:	max. 360 x 288 pixel (CIF-Format)
Fill factor:	30 %
Pixel size:	17 x 17 μm^2
Chip area:	88 mm^2 in 1 µm CMOS
Supply voltage:	5 V $\pm$ 0.1 V
Power dissipation:	35 mW
Typical pixel rate:	13.5 MHz
Maximum pixel rate:	20 MHz
Typical frame rate:	100 Hz
Maximum frame rate:	140 Hz
Max. frame rate for 64 x 64 pixel subregion readout:	1000 Hz
Dynamic range @ 30 ms integration time	60 dB
Max. signal-noise-ratio	52 dB
Fixed-pattern-noise	<2 mV
Minimum detectable Illumination @ 30 ms integration time:	$5 \cdot 10^{-5}$ W/m²

Fig. 2: Technical Data

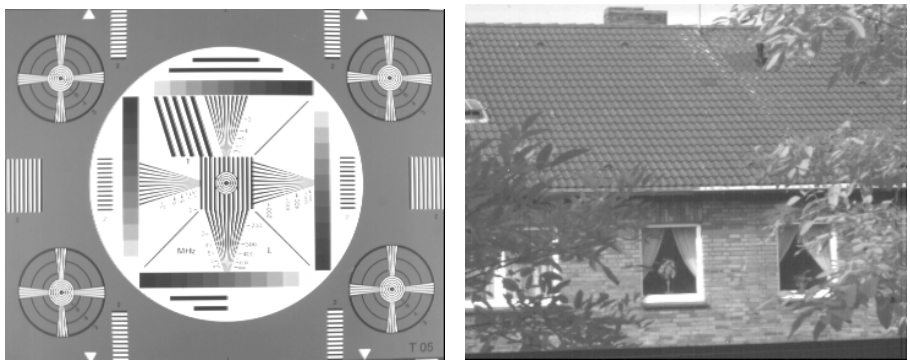

Fig. 3: Reproduced images from the CIF-Camera

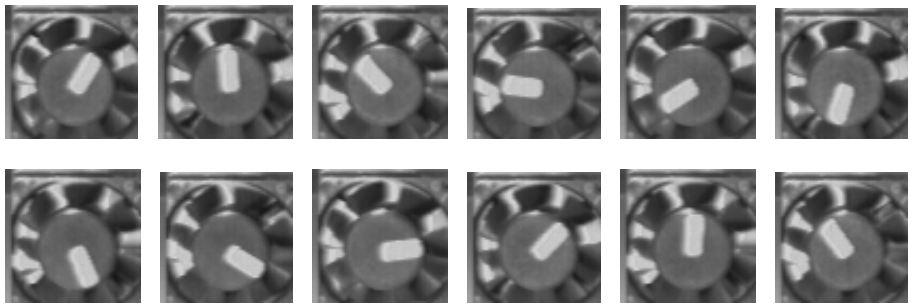

Fig. 4: High speed image sequence of a rotating fan