New miniaturized Thermopile IR Arrays with medium resolution

M. Schnorr [1], B. Forg [1], F. Herrmann[1], Dr. W. Leneke [1], Dr. M. Simon [1], Dr. J. Schieferdecker [1]

[1]: *Heimann Sensor GmbH, Maria-Reiche-Str. 1, D-01109 Dresden, Tel. 0351-888885-0*
info@heimannsensor.com;

Abstract

The recent years showed an increasing demand of low cost and small sized infrared arrays. These arrays can be used for various applications e.g. thermal imaging, industrial process control and person detection. Heimann Sensor improved further the size of the existing arrays so that a 16x16 and a 32x32 pixel array fits inside a TO39 housing and the 8x8Mini pixel array can be placed inside a TO46 housing. All array types are fully digital and have an integrated EEPROM on which the calibration data is stored.

Key words: thermopile array, 16x16, 32x32 and 8x8Mini pixel, TO39 and TO46 housing, infrared detection, fully digital (SPI, I²C) and calibrated

Introduction

Heimann Sensor has developed the first fully monolithic thermopile array and the world smallest thermopile sensor in TO housing [1].

These thermal arrays are competitive solutions against other technologies, wherever a thermal picture of the environment is needed and very high resolutions are not necessary, such as person detection, surveillance of temperature critical surfaces, hotspot detection, energy management and security cameras. Other applications can be found in industrial process control and air condition control [2].

The benefits of this technology are low manufacturing costs, low power consumption as well as the avoidance of thermal stabilization or shutters to compensate drift effects.

The new infrared arrays have a decreased size to fit inside a TO39 and TO46 housing. The trend towards small-format infrared arrays is shown in [3].

Decreased size of the 16x16 IR Array

Until now Heimann Sensor was only able to offer the 16x16 pixel array in a TO8 housing, due to the new smaller size the array fits inside a TO39 housing now. An EEPROM with a memory size of 2048 byte is placed next to the chip inside the housing. The fully digital interface leads to a 5+1 Pin layout.

Digital interface of the 16x16 IR Array

The digital interface requires six pins, two are needed for the voltage supply (3.3V and GND), three for the SPI communication and one for an external clock to drive the sensor. The SPI interface consists of a clock, a Master and Slave select and a bidirectional data channel.

Settings of the 16x16 IR Array

The sensor has several registers that can be used to change the performance.

The speed of the sensor can be varied from 12.5 to 400 Hz in factors of 2 via the configuration register.

An IIR and FIR filter can be turned on to reduce the noise.

The amplification and the operating point can be varied to cover a wide temperature range.

Available optics of the 16x16 IR Array

The 16x16 array can be delivered with several different optics, ranging from 23° to 90° FoV.

The different optics are shown in Fig. 1. Thermal screenshots can be seen in Fig. 2 and Fig. 3.

Fig. 1.   The different optics that are available for the 16x16 and 32x32 pixel array.

Fig. 3.   Picture showing a human head close to the sensor taken with four different optics for the 16x16 IR Array.
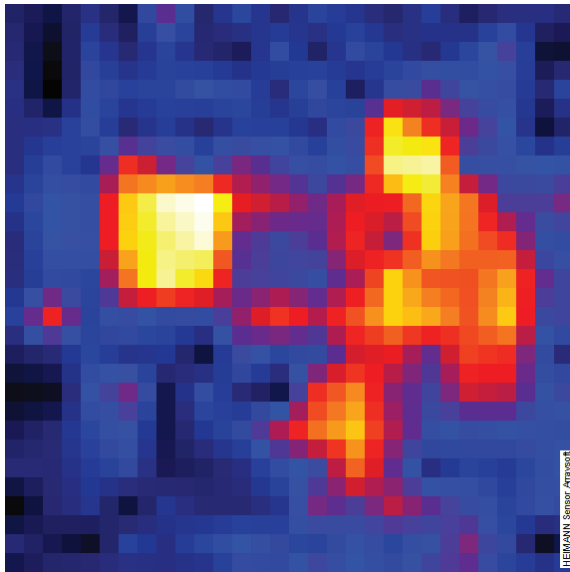

Fig. 2.   Picture showing a person sitting at his desk, screenshot captured with the 16x16 IR array, screenshot taken with the Heimann Sensor ArraySoft.
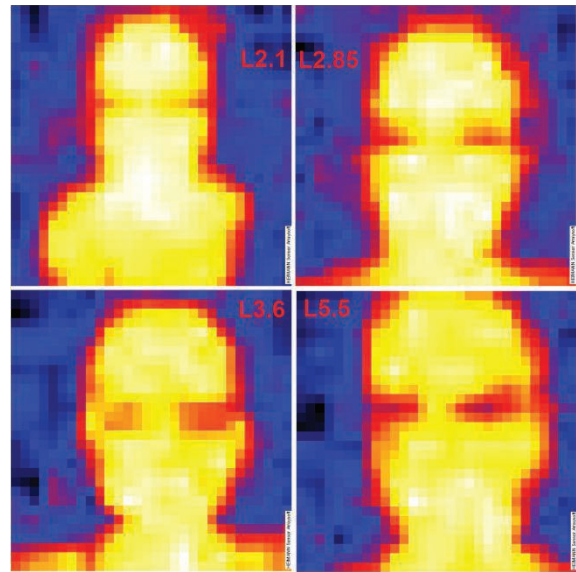
Extremely small size of the 8x8 Mini IR Array

The new 8x8 Mini pixel array is the first IR Array that fits inside a TO46 housing. This sensor is having an integrated EEPROM with a memory size of 256 words. Due to the digital I²C interface the sensor only needs a 3+1 Pin layout.

A comparison between the size of this sensor and some competitors is shown in Fig. 4.

Fig. 4   Picture showing the extremely small size of the sensor, they are from left to right: 8x8 Array (competitor), 4x4 array (competitor) and 8x8 Mini IR Array (Heimann Sensor)

Digital Interface of the 8x8 Mini IR Array

The digital I²C interface of the sensor needs 2 pins, the other 2 pins are required for the voltage supply (3.3 V and GND).

Settings of the 8x8 Mini IR Array

The frame rate of the 8x8 Mini Sensor can be varied from 7 to 88 Hz in 64 steps.

Available optics of the 8x8 Mini IR Array

Currently only one optic was tested with the TO46 housing, this was a L2.1 optic with a FoV of 20°. Heimann Sensor is planning to increase the portfolio of available optics for this type in the future. The sensor can be placed easily inside a TO39 housing and the available optics from the 16x16 and 32x32 array can be used.

New 32x32 pixel IR Array

Heimann Sensor developed a new 32x32 pixel array that is fully digital with an I²C interface and fitting inside a TO39 housing. Due to the integrated EEPROM inside the cap all calibration data can be stored.

Digital Interface of the 32x32 IR Array

The 32x32 array is designed similar to the 8x8Mini array, the I²C interface requires only 2 pins and the speed can be set up to 1 MHz.

Settings of the 32x32 IR Array

The sensor is sampling always one quarter of the frame. Which frame shall be sampled can be selected from the outside. The frame rate for a capture of the full frame can be set between 2 and 60 Hz. The frame rate can be varied internally with a clock in 64 steps and by changing the resolution from 16 down to 8 bits in 8 steps.

Available optics of the 32x32 IR Array

Due to the same TO39 housing of the 16x16 pixel array all optics can be used for 32x32 as well. The pixel pitch of the 32x32 is roughly half of the 16x16 which is leading to almost the same resulting field of view of the array.

An overview of the different sensors is shown in Tab. 1 and in Tab. 2 the different field of view is stated.
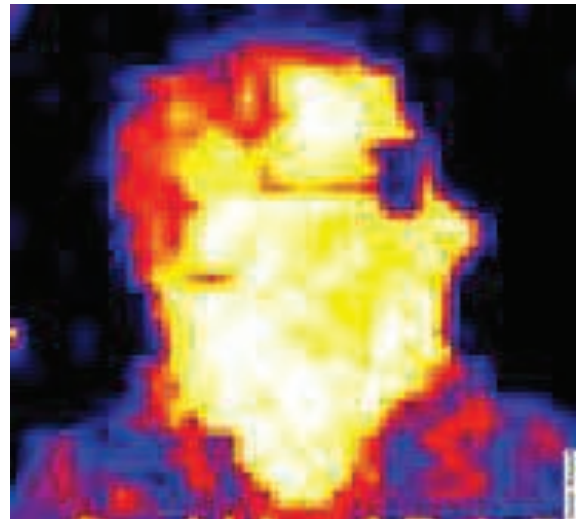

Fig. 5   First IR picture of the new 32x32 Array showing a person looking to the side wearing glasses, captured with the Heimann Sensor ArraySoft.

Tab. 1: Overview of the different sensors

Array	8x8Mini	16x16	32x32
Pixelcount	64	256	1024
Reference Pixels	64	64	64
Pixelsize [μm]	82	150	77
Pixel pitch [μm]	90	172.5	90
FPS [Hz]	7 to 88	12.5 to 400	2 to 60
FPS steps	64	6	64 x 8
possible Housing	TO46 & TO39	TO39	TO39
Pin count	4	6	4
Interface	I²C	SPI	I²C
FoV [°]	6 to 20	23 to 90	23 to 90
NETD [mK@1Hz]	100 (estimated)	300	150 (estimated)

Tab. 2: Overview of the different available optics with their corresponding FoV

Optic	Focal Length [mm]	Field of view [deg]			Lens
		8x8Mini(TO39)	16x16	32x32	
L2.1	2.1	20 x 20	90 x 90	90 x 90	
L2.85	2.85	14 x 14	52 x 52	52 x 52	AR-Coating
L3.6	3.6	11 x 11	43 x 43	43 x 43	AR-Coating
L5.5	5.5	7 x 7	29 x 29	29 x 29	AR-Coating
L7.0	7.0	6 x 6	23 x 23	23 x 23	AR-Coating

References

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