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New high resolution 120x84 Thermopile Arrays for IR Imaging applications

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Abstract:
Infrared arrays found their way into wide spread applications in various industries. Due to increasing resolutions and decreasing costs the growth rates for Infrared (IR) imaging sensors and cameras are assumed to continue having double digit annual growth rates also for the coming decade of the 20th. While photon IR detectors have been the drivers for thermal imaging in last century, the innovations in Si microelectronics and MEMS paved the way of success for uncooled thermal detector arrays. Pyroelectric arrays, which lead to the very first automotive night vision camera with 80000 pixels in year 2000 /1/, fell back due to their need of continuous mechanical modulation and the difficulty to integrate pyroelectric sensitive materials into monolithic CMOS structures. After that, micro-bolometers dominated the high resolution imaging markets /2/; while fully monolithic Poly-Si type IR thermopiles where the trendsetters for lower resolution consumer applications.

Unlike the other array technologies the thermopile arrays allow to build true shutterless radiometric IR cameras. The reason is, that thermopile arrays are DC sensitive devices and do not need to be biased. Thermopile arrays with pixel numbers from 8x8, 16x16, 32x32 resp. 32x24 were introduced to mass production for various consumer applications. In addition, the pixel size of 90 µm allowed a first thermopile array with 80x64 pixels /3/. Array formats above 80x64 pixel were so far clearly the domain of micro bolometers or other technologies.

In this paper, Heimann Sensor introduces first thermopile arrays with 60 µm pixel size allowing to extend the application range into thermal Imaging and surveillance. All necessary signal conditioning and readout electronics including SPI interface are monolithically integrated on the sensor chip and allow thermopile arrays up to 120x84 pixels to fit in a standard TO-8 housing.

The digital output via SPI interface reduces the number of necessary connections to 6-pin only. Thanks to integrated 16 Bit AD converters on-chip the sensor arrays can be operated with Frame Rates up to 12 Hz (full resolution) and allow a very wide dynamic range with object temperatures up to 1000 °C. Higher frame rates are possible with setting the ADC resolution to 15 or 14 Bit.

All thermopile arrays and array modules are equipped with an infrared optics. These infrared optics are designated for the required field of view in the application; e.g. from 9-12 deg FOV for far distances up to 120x90 deg FOV for ultra wide field of view.

Since the new 120x84 array chip has 60 µm pixels vs the 90 µm pixels of the 80x64, both chips come with similar focal plane and chip sizes. Due to their identical SPI interface both chips can be mounted in same housing with same optics, giving rise to a “drop in” solution.

Thermal images obtained from the 120x84 demonstrate its abilities for thermal imaging (see Fig. 1 and 2):

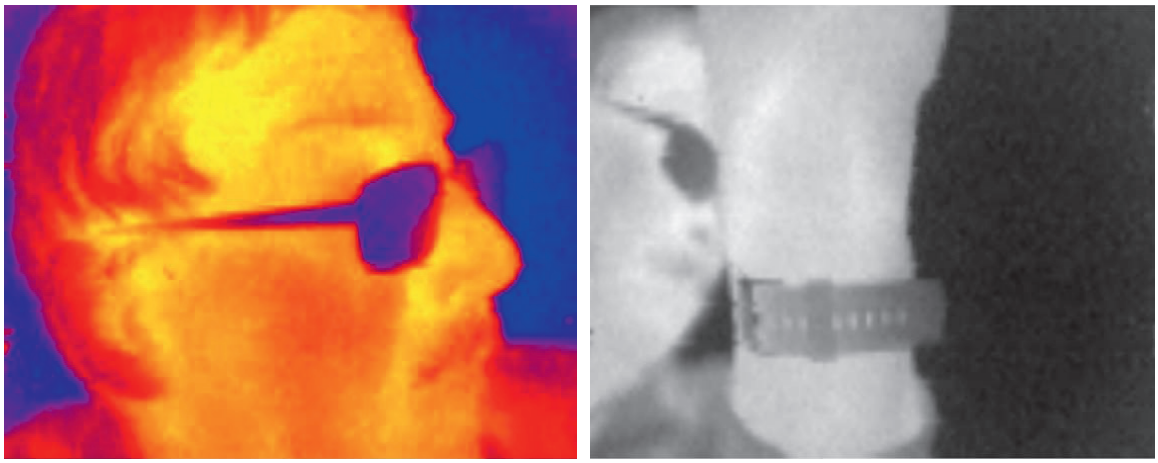

Fig. 1 shows examples for thermal images created by the 120x84 array module.

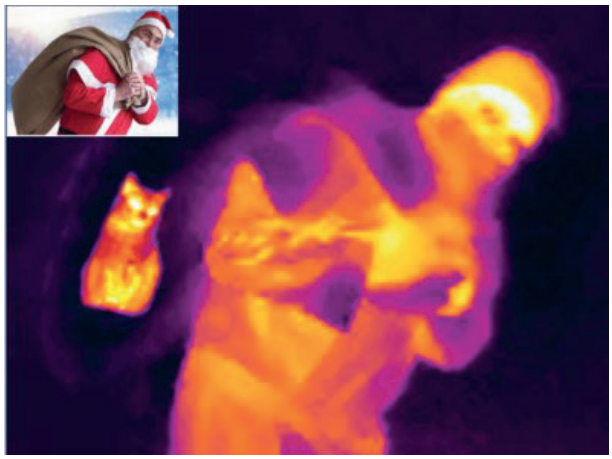

Fig. 2 Can the IR array 120x84 really detect the “pig in the poke” (Katze im Sack)?

References:

/1/ Martinelli, N., Boulanger S.: “Cadillac de Ville Thermal Imaging Night vision system”, SAE Technical Paper 2000-01-0323, 2000

/2/ T. Hoelter, A. Kathman, A. Richards, M. Walters; “Key Technology Trends and Emerging Applications for Compact Thermal Imagers”, Proceeedings, Conference Sensor & Test, Nuremburg, 2015, p. 938.

/3/ Schieferdecker, J.; Schnorr, M., Forg. B.; Herrmann, F., Schmidt, C.; Leneke, W.; Simon, M.: A new family of digital Thermopile Arrays for high volume applications; Proceedings Conference Sensor & Test 2019, Nuremburg, Germany