80×60 Pixels Thermal Diode Infrared Sensor

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1. Introduction

In 2019, Mitsubishi Electric Corporation developed MIR8032B1 with 80×32 pixels as a proprietary thermal diode infrared sensor module, MelDIR, for general consumer use. The number of pixels of this module is approximately ten times and the temperature resolution (100 mK) is approximately five times those of thermopile infrared sensors with 16×16 pixels that are generally used in the market.

This paper describes the technical characteristics of MelDIR and also the characteristics of MIR8060B1, a new model of the MelDIR series in which the number of pixels was increased to 80×60.

2. Infrared Sensors

2.1 Characteristics of infrared sensors

Infrared sensors convert the received infrared rays into electrical signals to detect the heat of objects without contact. Although infrared sensors detect the heat of objects, they do not sense visible light and so are characterized by being less affected by module by minute particles, etc. in the air. Figure 1 compares typical infrared and visible images. These images show that (1) night vision is possible, (2) the influence of ambient light is small, and (3) the influence of scattering is small (e.g., even when the area is filled with smoke, the objects can be identified). In addition, when a human is photographed, although the human body can be recognized based on the heat generation conditions, the person cannot be identified. Therefore, the module is suitable for applications requiring privacy protection.

3. MelDIR

3.1 Infrared sensor module MelDIR

Mitsubishi Electric developed new resolution and price range product MelDIR compared to conventional thermopiles and bolometers using its original thermal diode sensor technology.

3.2 Technology to improve the sensitivity of MelDIR

Thermal infrared sensors detect temperature changes by absorbing the received infrared rays with temperature detectors. If the thermal conductance between the temperature detector and surrounding environment is high, the detection sensitivity degrades.

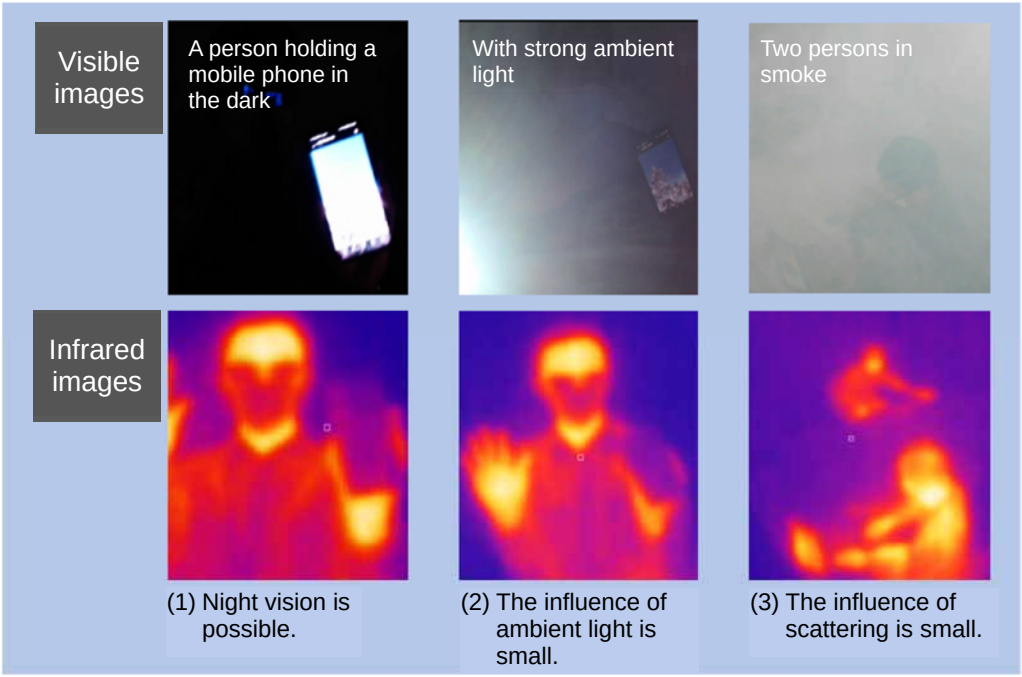

Fig. 1 Features of infrared sensor

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To prevent this, for MelDIR, a cavity structure was formed between the diodes (pixels) and silicon substrate, which is the base material used to form the element (Fig. 2), and chip-scale packaging technology for directly mounting sealing window parts onto the sensor chip (Fig. 3) was used to maintain a vacuum inside the package, thus ensuring high sensitivity.

3.3 Technologies for the small module

In addition to a sensor element that detects infrared rays, an infrared sensor requires an optical system that gathers infrared rays emitted from a distant place to the temperature detector, a control function for driving the sensor element, and a function for converting the voltage that the temperature detector converted from the heat through thermoelectric conversion and output into digital signals.

MelDIR module consists of a silicon lens that gathers infrared rays to the sensor temperature detector, a sensor IC that detects infrared rays, a thermistor that measures the temperature of the module and an application-specific integrated circuit (ASIC) that contains sensor control, signal processing, and MCU communication functions. The ASIC also has a one-time programmable read-only memory (OTP ROM) to which various parameters are saved as factory settings, in addition to the main control functions. Information specific to each module can be stored in the OPT ROM before it is shipped.

Figure 4 shows the appearance of MelDIR. The thermal diode sensor and ASIC developed for MelDIR have been mounted inside the lens cap of the silicon lens. On the rear of the sensor are mounted a thermistor that measures the temperature of the module, a connector for exchanging signals with the outside of the sensor, and other surface mount devices.

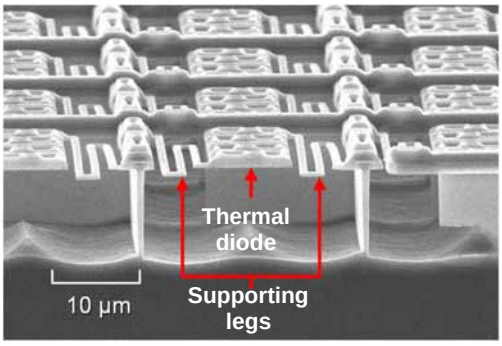

Fig. 2 Enlarged photo of temperature detector

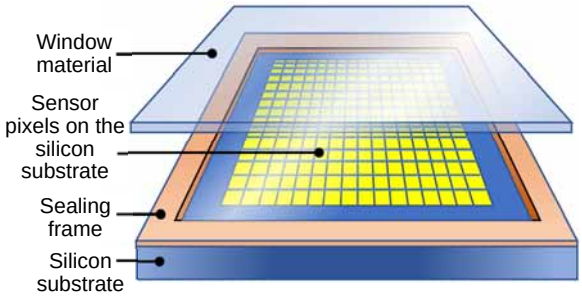

Fig. 3 Structural drawing of chip-scale vacuum package

4. Sensor MIR8060B1 with 80×60 Pixels

4.1 Characteristics of MIR8060B1

Although the shape of MIR8060B1 is the same as that of the conventional MIR8032B1, the angle of view was expanded to approximately 1.8 times and the number of pixels was increased to approximately 1.9 times. The new product can detect an area two to four times larger than the conventional product even under the same installation conditions. The increase in number of pixels and wider angle of view have made it possible to recognize heat objects and understand their behavior in a wide area. In addition, the new product has a function for switching to eight frames per second (fps) in addition to the conventional four fps, delivering higher performance for detecting moving heat objects.

A camera and the two types of sensors were installed on the ceiling (approximately 2.5-m high) of a general office building. Figure 5 shows a visible image of the corridor and thermal images in the angle of view of MIR8032B1 and in the angle of view of MIR8060B1.

In the angle of view of MIR8032B1, the person at the end of the corridor is outside the angle of view and so cannot be clearly recognized. Meanwhile, in the MIR8060B1 image, the person at the end can be clearly seen.

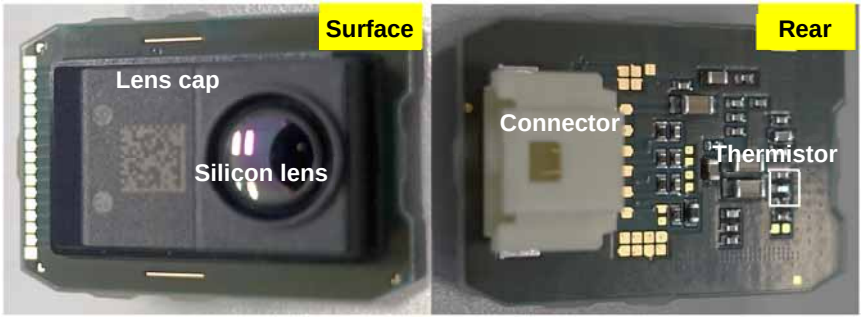

Fig. 4 Exterior photo of MelDIR

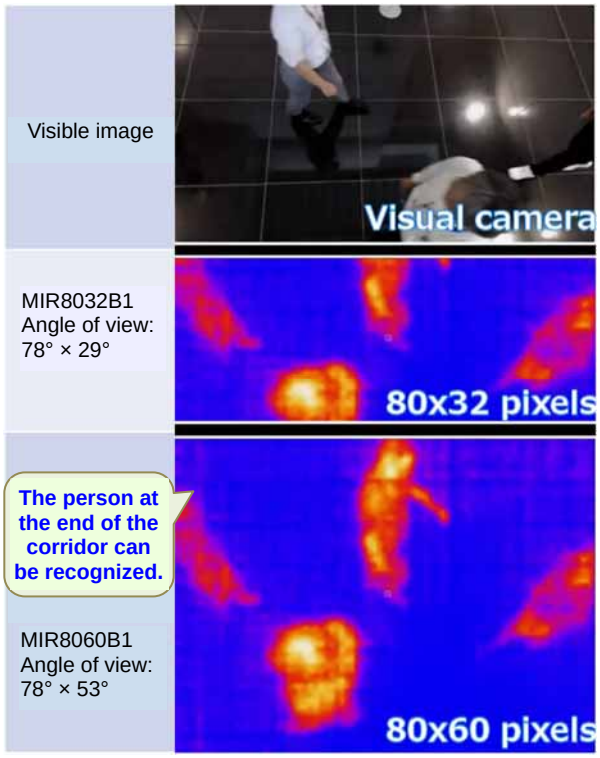

Fig. 5 Image comparison by angle of view

4.2 User support tool

Regarding MelDIR, since launching sales of MIR8032B1, we have been expanding the tool for supporting evaluation and development by customers. For MIR8060B1, the tool started to be provided at the same time as the release of the product.

The user support tool includes a document suggesting various ways to use MelDIR assuming various applications by customers, a thermal image library containing actual scene images, a microcomputer kit for evaluation that can be used to evaluate the product, reference codes for supporting software and hardware design in users' product development, and a reference design.

5. Conclusion

Mitsubishi Electric has developed the infrared sensor module MelDIR for markets where conventional infrared sensors are unsuitable. In addition to the 80×32-pixel MIR8032B1 which went on sale in 2019, we developed, in 2021, the new MIR8060B1 to increase our product types. Although MIR8060B1 has the same shape as MIR8032B1, the number of pixels was increased to 80×60 pixels to make it possible to sense wider area, and eight fps was added as the frame rate in addition to the conventional four fps, enabling switching. This improved performance expands applications in new markets, such as crime prevention, monitoring, person counting, and smart buildings, by leveraging the wider angle of view and the performance for detecting moving heat objects, in addition to the conventional markets of air conditioning and body surface temperature measurement, thus contributing to society.