TECHNICAL INSIGHTS

SENSOR

TECHNOLOGY ALERT

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1. IMAGE SENSOR WITH GLOBAL SHUTTER FOR MACHINE VISION

Technology advancements in complementary metal oxide semiconductor (CMOS) image sensor technology have enabled it to match and, particularly for higher-volume applications, even surpass the capabilities of the more mature charge coupled device (CCD) image sensors. But the charge readout of CMOS image sensors traditionally has been done using a rolling shutter technique. In rolling shutters, arrays on pixels are exposed, charge is accumulated, and the readout of pixels proceeds row by row, sequentially from top to bottom. This mechanism may perform well when the speed of the scene being captured is not high. For moving objects or fast moving scenes, like a fan rolling, or a car moving fast, the rolling shutter technique can lead to a distorted image where the image appears to be skewed. The image quality can be comprised, since the pixels in different rows are exposed to light at different times. Most CMOS sensors use a rolling shutter method as it leads to higher sensitivity.

In the other type of image acquisition, the global shutter technique, all the pixels are exposed and readout at the same time. This enables crisp image capturing of fast scenes. The global shutter technique is thus important for high-speed applications, such as machine vision, traffic monitoring, medical applications, security and surveillance applications, and so on.

Belgium-based Cmosis, a fabless semiconductor company, develops and provides image sensors that use a global shutter for such such applications as, for example, machine vision, medical, and intelligent traffic systems. The company has recently widened its portfolio of global shutter products by including an 8 mega pixel (MP), CMOS image sensor, which has a global shutter. The CMV8000 was developed to bridge the gap in its offerings of 4MP sensors and 12 MP sensors. The CMV 8000 is able to capture images at a frame rate of 105 frames per second (fps), which enables it to be effective for intelligent traffic systems in applications such as vehicle monitoring and high-speed machine vision systems.

The sensor comes in a 4/3 inch optical format and has 3360 x 2496 pixels with a pitch of 5.5 micrometers. It uses Cmosis' patented 8T (8 transistor) architecture, which offers low noise with respect to the image. The output of 105 fps is achieved by using 16 low voltage differential signalling (LVDS) channels, each operating at 600 megabits per second. By using multiplexing, lower frame rates can also be achieved. Higher frame rates can also be achieved by using partial read out, windowing, and sub-sampling. The sensor also provides a dynamic range of 60 decibels, which can be extended up to 90 decibels. High-dynamic range is required for capturing scenes, which have a high contrast of bright and dark areas. The sensor is available in both monochrome and RGB (red-green-blue) versions. It has an operating temperature range of -30 degrees C to +70 degrees C.

Cmosis will be exhibiting its CMV 8000 sensor at the International Machine Vision Exhibition, Vision China 2014, to be held in Shanghai between 18 March 2014 and 20 March 2014.

Details: Wim Wuyts, Director of Marketing and Sales, Cmosis, Coveliersstraat 15 B-2600 Antwerp–Belgium. Phone: +32-3-260-17-33. E-mail: wim.wuyts@cmosis.com. URL: www.cmosis.com.

2. THERMAL IMAGING USING MICROBOLOMETERS FOR SMARTPHONES

Apart from visible light imaging, which captures information in the visible spectrum, thermal imaging is established and has been gaining prominence in a variety of applications. Thermal imaging cameras detect infrared radiation emitted by an object in a particular scene. Thermal imagers use IR detector elements, such as focal plane arrays comprised of cooled or uncooled IR detectors. Cooled infrared sensors use cryogenic cooling and provide high sensitivity. However, they are more expensive and consume more space than uncooled ones. Uncooled sensors (e.g., microbolometers) can operate at room temperature. Such IR thermal imagers based on microbolometers can be less expensive that their cooled counterparts. Microbolometers consist of materials, which are able to absorb specific range of infrared wavelengths. This changes the electrical resistance of the material, which is normally vanadium oxide or amorphous silicon, gives an indication of the infrared radiation.

IR thermal imagers have diverse applications, such as industrial (e.g., detecting hot spots in electrical wiring, monitoring production processes), building diagnostics, border or infrastructure security, law enforcement, gas leak detection, automobile night vision, and so on.

Indicative of expanding applications for IR thermal imagers, US-based FLIR systems have come up with a microthermal imaging camera core, which will enable thermal imaging to be incorporated in small and mobile devices such as smartphones. The FLIR Lepton core is based on microbolometer technology. The Lepton core has similar dimensions to a cell phone camera module, and is touted as it the smallest microboloometer-based thermal imaging camera currently available. The small form factor of the core enables it to be fit into the tight space constraints of mobile devices such as smartphones.

FLIR has showcased the applicability of the Lepton core in a smartphone at CES 2014. The system is known as the FLIR ONE smartphone accessory. Integrating thermal imaging in the smartphone platform will lead to various benefits. The smartphone can then enable enhanced security in dark conditions both indoor and outdoor. Since the thermal imager is able to see through smoke it provides an added advantage. Applications can include detecting water leakage, thermal instability, and electrical faults in houses; as well as detecting intruders and animals during night or in dark places. The Lepton can also be easily integrated into tablets, automobiles, toys, building controls, security systems, machine vision systems, and so on.

The Lepton provides high quality images that can be transmitted through standard interfaces currently used. FLIR has used various proprietary technologies, such as wafer level detector packaging and micro-optics, that have resulted in the small form factor of the core. The core also employs a low power chip which is key in battery powered devices. FLIR has filed more than 100 patents worldwide related to the Lepton core, including processes and applications. The core is compatible with FLIR's multi-spectral dynamic imaging technology, geared toward enabling better clarity in thermal images by providing details from visible light images.

With the increase in competition in the smartphone industry, OEMs (original equipment manufacturers) are trying to add advanced features, with imaging being a key area of focus. FLIR's microbolometers will be able to enable advanced smartphones targeted toward such applications as enhancing security and enabling monitoring of household components.

Details: Christiaan Maras, Marketing Director-EMEA & APAC, FLIR Commercial Systems AB, Luxemburgstraat 2, 2321 Meer, Belgium. Phone: +32-0-3665-5100. Fax: +32-0-3303-5624. E-mail: flir@flir.com. URL: http://www.flir.com.

3. IN-SITU WATER QUALITY MONITORING SENSOR

Water quality monitoring is a key issue in countries around the world as water contamination affects millions of people. Contaminated water can be threatening to animal as well as aquatic life. Currently, most precise instruments used for water quality monitoring are laboratory based. There has been an effort to change this trend to in-situ monitoring, which can provide multiple benefits such as real-time monitoring, lower cost of monitoring, ease of conducting tests, and so on.

Researchers at the Center for Environmental Sensing and Modeling (CENSAM) of the Singapore–Massachusetts Institute of Technology Alliance for Research and Technology (SMART) have developed a sensor solution for in-situ monitoring of water quality which is a compact and low cost solution. The sensor, known as LEDIF (which stands for LED-induced fluorescence), has dimensions of 20 x 20 x 15 cms and can be used on multiple platforms including autonomous underwater vehicles, as demonstrated by the researchers. It can also be kept submerged for long-term evaluation and monitoring of water quality.

The LEDIF uses combined optical technology for identifying contaminants in water. It uses the principles of fluorescence, absorbance and scattering in water. The sensing device withdraws about 10 ml to 20 ml of water and performs the tests on site. This enables lab tests such as water quality analysis to be done in-situ and in real time. Apart from simple detection and measurements, the device can also perform three-dimensional (3D) mapping of the water body when present on the autonomous platform. Apart from contaminants, the sensor is also able to detect natural substances such as algae, dissolved organic matter, and so on.

Most water quality sensors are able to identify one particular component. The ability of the LEDIF to sense multiple contaminants and natural substances makes it a more suitable and complete device capable of holistic sensing. The sensor can detect chemical species such as, chlorophyll, humic, fluorescein, rhodamine, high-molecular weight hydrocarbons, and uncharacterized elements. While chlorophyll detection can be used for detecting blue-green algae; hydrocarbons can detect petroleum spills, leakage from gas plants, and so on. Uncharacterized fluorescence can also provide warnings so that specific tests can be performed as a follow up process. With the 3D mapping system contamination hotspots and even source of contamination can be identified.

The researchers have been working on this technology for the past five years and are confident that it will help industrial users as well as civic bodies to monitor water quality more efficiently. The research was funded by the Singapore National Research Foundation (NRF), Singapore. The team tested the sensor on the autonomous vehicle in collaboration with the Tropical Marine Science Institute of the National University of Singapore.

Details: Dr Kevin Ng Chee Loon, Research Scientist, Center for Environmental Sensing and Modeling, Singapore-MIT Alliance for Research and Technology, 1 Create Way, #10-01 Create Tower, Singapore 138602. Phone: +65-65-16-5230. E-mail: kelvinng@smart.mit.edu. URL: www.smart.mit.edu.

4. RECENT PATENTS IN THE FIELD OF INFRARED IMAGE SENSORS

Image sensors absorb wavelengths in a specific range of the electromagnetic spectrum, and using specific processing techniques,, are able to generate an image of a scene. In visible light image sensing, information from the visible spectrum is captured. Infrared image sensors capture infrared radiation having a wavelength from 700 nanometers to 1 mm and a frequency from 430 THz to 300 GHz. Thermal infrared radiation spans a wavelength rang of about 3- 30 microns. Infrared thermal imaging sensors, which are passive detection devices, detect the infrared radiation emitted from an object or person, and may provide a thermal map of the scene. Applications for infrared thermal imaging sensors include night vision, building diagnostics, monitoring industrial processes or assets, law enforcement, gas detection, multi-spectral or hyperspectral imaging, security and surveillance, and so on. Thermal infrared sensors can also have some opportunities in automobile occupant detection.

Infrared thermal imaging sensors are basically of two types, cooled and uncooled. Cooled infrared sensors need to be artificially cooled down to very low temperatures. Materials normally used in cooled detectors include mercury cadmium telluride (HgCdTe) and indium antimonide (InSb). While cooled detectors are able to provide high sensitivity, they are normally more bulky and more costly than uncooled detectors. Uncooled infrared image sensors can be used at room temperatures without the need for artificial cooling. Uncooled sensors can employ microbolometers, thermopiles, pyroelectric, and ferroelectric detectors.

Among recent patents published in this field , patent no US 20130335550 by FLIR Systems Inc., indicates the use of infrared sensors for moisture detection in structural monitoring. As infrared imaging provides a heat map of a scene, cooler areas can indicate the presence of water. Patent no WO/2013/171010 by Robert Bosch GmbH, indicates a process by which a high-image refresh rate can be achieved.

PATENT TITLE	PUBLICATION DATE / NUMBER	APPLICANT/ ASSIGNEE	INVENTORS	ABSTRACT
INFRARED CAMERA SYSTEM HOUSING WITH METALIZED SURFACE	20.02.2014; WO/2014/028540	FLIR SYSTEMS, INC	HOELTER, Theodore R.	A housing for an infrared camera module may be implemented with a substantially non-metal cover configured to substantially or completely enclose various components of an infrared imaging device. A metal layer may be disposed on various interior and/or exterior surfaces of the cover. Such implementations may be used to reduce the effects of various environmental conditions which may otherwise adversely affect the performance of the infrared imaging device. In addition, one or more conductive traces may be built into the housing and/or on interior surfaces of the housing to facilitate the passing of signals from components of the infrared imaging device such as infrared sensors, read out circuitry, a temperature measurement component, and/or other components. One or more fiducial markers may be provided to align various components of the infrared

				camera module during manufacture.
INFRARED IMAGE SENSOR AND SIGNAL READ METHOD	30.01.2014; US 20140027642	Warashina Yoshihisa	Warashina Yoshihisa	Provided is an infrared image sensor for detecting infrared rays. The infrared image sensor includes a light-receiving unit including a pixel region in which a plurality of pixels are arranged and at least one reference pixel; a difference circuit for acquiring a first differential signal that is a differential signal between a signal of one pixel contained in the pixel region and a signal of the reference pixel and a second differential signal that is a differential signal between signals of two predetermined pixels out of the pixels contained in the pixel region; and a pixel signal calculating unit that calculates a signal of each of the pixels on the basis of the first differential signal and the second differential signal
INFRARED IMAGING SYSTEM	23.01.2014; WO/2014/014547	RAYTHEON COMPANY	KINGDON, Frederic, W	An infrared imaging sensor compatible with 2nd Generation Forward Looking Infrared (FLIR) Horizontal Technology Integration (HTI) B-Kit based sensors. In one example, the infrared imaging sensor includes a set of refractive opto-mechanical modules, including an afocal optical module, a receiver assembly, and backward- and forward-compatible electronics modules. The afocal optical module is configured to provide a plurality of different fields of view for the infrared imaging sensor. In one example, the sensor is configured for MWIR and LWIR imagery.
INFRARED SENSOR SYSTEMS AND METHODS	19.12.2013; US 20130335550	FLIR Systems, Inc.	Rochenski Thomas W.	Infrared imaging systems and methods disclosed herein, in accordance with one or more embodiments, provide for a wireless thermal imaging system comprising one or more wireless thermal image sensors adapted to capture and provide thermal images of structural objects of a structure for monitoring moisture of the structural objects and a processing component adapted to receive the thermal images of the structural objects from the one or more wireless thermal image sensors, and process the thermal images of the structural objects to generate moisture content information for remote analysis of restoration

				conditions of the structural objects.
INFRARED SENSOR DEVICE AND METHOD FOR PRODUCING AN INFRARED SENSOR DEVICE	21.11.2013; WO/2013/171010	ROBERT BOSCH GMBH	HERRMANN, Ingo	The invention relates to an infrared sensor device which comprises at least one sensor element formed in a semiconductor substrate, a gap being provided in an SOI wafer below and around the sensor element; and to a suspension means by which the sensor element is suspended in the SOI wafer. The infrared sensor device is characterized in that the sensor element is substantially arranged below the suspension device. In this way, a high sensitivity, low thermal capacity, low thermal coupling to the substrate and thus a high image refresh rate can be achieved.
DEVICE ATTACHMENT WITH INFRARED IMAGING SENSOR	03.10.2013; US 20130258111	FLIR Systems, Inc	Frank Jeffrey D.	Various techniques are disclosed for providing a device attachment configured to releasably attach to and provide infrared imaging functionality to mobile phones or other portable electronic devices. For example, a device attachment may include a housing with a tub on a rear surface thereof shaped to at least partially receive a user device, an infrared sensor assembly disposed within the housing and configured to capture infrared image data, and a processing module communicatively coupled to the infrared sensor assembly and configured to transmit the infrared image data to the user device. Infrared image data may be captured by the infrared sensor assembly and transmitted to the user device by the processing module in response to a request transmitted by an application program or other software/hardware routines running on the user device. The infrared image data may be transmitted to the user device via a device connector or a wireless connection.

ELECTRONIC DEVICE CONFIGURED TO APPLY FACIAL RECOGNITION BASED UPON REFLECTED INFRARED ILLUMINATION AND RELATED METHODS	26.09.2013; US 20130251215	COONS David D.	COONS David D.	An electronic device may include a housing and at least one infrared (IR) proximity sensor carried by the housing. The at least one IR proximity sensor may include an IR emitter configured to emit IR illumination toward a user, and an IR sensor configured to sense reflected IR illumination from the user. The electronic device may also include a camera carried by the housing and configured to capture an image of the user's face based upon the reflected IR illumination. The electronic device may further include a controller configured to apply facial recognition to the captured image of the user's face based upon the reflected IR illumination

Exhibit 1 lists some of the recent published patents related to infrared image sensors (as well as a patent pertaining to an active IR illumination sensor).

Picture Credit: WIPO/Frost & Sullivan

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