TECHNICAL INSIGHTS

SENSOR

TECHNOLOGY ALERT

22nd May 2015

1. PROGRAMMABLE LIGHT SOURCE TO IMPROVE INFRARED GAS SENSING

Infrared spectroscopy involves measurement of the wavelength and intensity of the absorption of infrared light by a target gas or sample. While all molecules absorb infrared (IR) radiation at characteristic frequencies, the mid-IR region of the electromagnetic spectrum tends to be a preferred band for IR absorption measurement sensors or instruments, since it is sufficiently energetic to excite molecular vibrations to higher energy levels and the mid-IR wavelength range allows for detection of key gases. There are many strong vibrational molecular transitions in the mid-IR wavelength region (which for purposes of IR gas detection is on the order of 2.5 to 5 micrometers), rendering this region of the electromagnetic spectrum very useful for applications such as trace gas analysis.

Infrared instruments for IR absorption measurement require a light source of continuous IR radiation to irradiate molecules in a sample, as well as a sensitive IR sensor or detector. Traditional broadband IR light sources have had limitations for use with high-sensitivity detection techniques. Moreover, light sources for IR absorption measurements can have limitations in such areas as size, cost or resolution.

In the context of the H2020 European MIREGAS (Programmable multi-wavelength Mid-IR source for gas sensing) project , the Technical Research Centre of Finland VTT Ltd., Optoelectronics Research Centre at Tampere University of Technology (Finland), ITME (Poland), and industrial collaborators Vaisala (Finland), AirOptic (Poland), GasSecure (Norway), and Vigo System (Poland) are developing an innovative mid-IR light source for spectroscopic gas analysis. The light source, which leverages technology initially developed for

optical communications, can be employed when guiding light through a sample and detecting the optical transmission of the sample.

The development and availability of cost-effective multi-wavelength light sources can serve as a key enabler of wider adoption of gas sensors for the mid-IR wavelength range. Sources at the MIREGAS consortium have noted that using an innovative mid-IR silicon-based photonic integrated circuit filter and wideband mid-IR super luminescent light emitting diode emitter (SLED), the collaborators have focused on developing and demonstrating an innovative light source for the 2.7–3.5 micrometer wavelength range with a resolution of <1 nm.

The spectral bands are switchable, tunable, and can be modulated. Such a light source can enable an affordable multi-band gas sensor for multi-gas analysis that provides good sensitivity and selectivity. The unit price can be reduced in high volume by using a tailored molded IR lens technology and automated packaging and assembly methods. In applications such as safety and security, the mid-IR light source can enable detection of several harmful gas components in a single sensor.

The light source allows for more accurately selecting the wavelengths of light and for excluding other extraneous gas mixtures that are similar to the selected mixture. Since the light is adjustable, it is possible to use just a single light source instead of several traditional systems, which can substantially reduce measurement costs.

The light source is expected to be implemented in key applications, such as building ventilation, industrial asset condition monitoring, emission monitoring, gas leakage monitoring, process control and safety. The IR light source's potential is enhanced, since currently available IR spectroscopic gas detection devices tend to be complicated, expensive, or cumbersome or have stability or selectivity limitations.

The objectives of the MIREGAS project have included: use of the IR absorption measurement principle in gas sensing at the 2.7–3.5 micrometer wavelength band at a range up to 100 nm; obtaining at least ten-fold better signal-to-noise ratio over thermal emitters when using a SLED emitter; realizing specificity and re-programmability of responses for different types of target gases by using an innovative filtering technique based on a silicon photonic integrated circuit; achieving ten times better spectral resolution compared to

conventional MOEMS (micro-opto-electrical-mechanical system) filters currently employed in gas sensors; ability to fine tune and then filter rezones up to 1 nm resolution, enabling probing of single absorption lines; a manufacturing cost of less than €300 (about U$318 at the current exchange rate)/unit (with 500 units/year for a sample product) when employing advanced integration and automated assembling techniques and molded IR optics; and potential for upscaling production and reducing unit cost.

Details: Dr. Pentti Karioja, MIREGAS Project Coordinator and Research Professor, Technical Research Centre of Finland VTT. P.O. Box 1000, FI-02044 VTT, Finland. Phone: +358-40-730-7529. E-mail: pentti.karioja@vtt.fi

2. ULTRA LOW-POWER SMART SENSOR BEACON

Beacons are small, low-powered devices that work on Bluetooth low energy (BLE), which is used by a low frequency chip in devices such as mobile phones. When placed in a physical space, a beacon transmits radio signals around itself. The chips can communicate with multiple beacon devices to create a network. Beacons can notify nearby devices such as mobile phones; and can help smart phones or other devices to gain location and context awareness. Beacons could also be used to send information such as advertisements, coupons, additional product information to mobile phones nearby. Such devices could, moreover, collect information about customer behavior. Low-power sensors can increase the functionality of beacons by providing additional information such as motion detection. Indicative of opportunities for sensor-equipped beacons, EM Microelectronic,, headquartered in Switzerland and part of the Swatch Group, has launched the extremely low-power EMBCO2 sensor beacon, which integrates a three-axis accelerometer in the same form factor as the EMBCO1, which was recently released.

When attached to objects or people, the EMBCO2 sensor beacon can allow a smart phone or tablet to monitor proximity and motion. As is the case with standard beacons, the EMBCO2 beacon can be programmed to convey proximity or identification data. However, the new beacon can also provide enhanced motion data (movement, vibration, acceleration) or temperature information, as well as specific motion-based alarms based on accelerometer data originating from shock, free-fall or taps. The accelerometer can facilitate

extended battery life by transmitting data only when required, for example, when in motion, or during an alarm event.

While EMBC01 Bluetooth smart proximity beacon can operate for more than 12 months on a single CR2032 button cell lithium battery, the EMBC02 can provide longer battery life, as the beacon can sleep (or transmit infrequently) until the accelerometer detects movement. The ability to beacon only when in motion can considerably save energy and help enable a more effective Internet of Things platform.

The EMBC02 is able to support multiple proximity standards, such as iBeacon, AltBeacon or any other proprietary protocol in a single beacon. The new beacon is FCC/CE/IC certified and includes a multi-function button for input and two LEDs for user feedback.

Mobile applications for the new beacon can include fall detection and alarm for the elderly; child or pet activity monitoring over a defined proximity range; theft prevention (objects could beacon a warning if unexpected movement occurred); tracking of inventory or equipment.

Details: Mark Jakusovszky, US Marketing Manager, EM Microelectronic 5475 Mark Dabling Blvd., Suite 200, Colorado Springs, CO 80918. Phone: +1-719-598-9224. E-mail: markj@emmicro-us.com

3.LOW-POWER WEARABLE MICROSENSORS

The trend toward increasing connectivity is driving opportunities for ultra-low power wearable sensors that can provide key information about an individual's health and well-being or about one's local environment. There are ongoing research initiatives to reduce the size and power consumption and enhance the processing and communications capabilities of wearable sensors.

Indicative of the keen interest in wearable sensor development, Wei Tang, assistant professor of electrical and computer engineering at New Mexico State University in United States, is creating innovative, integrated, low-power, miniaturized, wearable sensors capable of detecting, transmitting and reliably processing vital data. Dr. Tang's work is inspired by the functioning of the human brain. He plans to use current sensor technology and an innovative design strategy to create improved circuits to build a bridge between the human body and the environment. The overarching goal of the work is to extend one's ability to sense the world and better respond to the environment and to develop

medical devices that can be used for rehabilitation or for prevention and detection of disease.

To design extremely low power sensors for wearable devices, Tang is learning form nature how the human brain and body function. The human brain is a type of circuit that is very compact and runs on low power. The human brain transmits information through neurons at different frequencies so that the body is able to determine different types of information. In contrast to a computer, the human brain is an asynchronous, non-weighted machine. The computer, a synchronous device, constantly runs code and communicates even when there is no information to be sent, thereby wasting energy.

Tang wants to use such knowledge about neurons science to create the next-generation circuit. He proposes to replace synchronous devices with devices that operate more efficiently, such as the human brain. For example, his group wants to demonstrate that a radio device with small circuits, developed {by them}, can communicate with another radio using very little power. Furthermore, they want to use a very compact (3 millimeter × 3 millimeter) integrated circuit that has been created on a hat and powered by a small battery to extract EEG (electroencephalogram) brain wave information.

An EEG test measures the brain’s electrical activity. Sensors are attached to a patient's head and linked by wires to a computer that records the brain's electrical activity and diagnoses potential problems. Since the power consumption of his sensor is so low, Dr. Tang plans to devise an energy harvesting device based on vibrational energy or photovoltaic energy sources. Energy harvesting capability would eliminate the need for a battery and render the sensor power independent.

Furthermore, Tang has collaborated with two researchers from New Mexico State University’s biology department. Tang’s group designed a detection mechanism to alert a bird feeder (that uses radio frequency detection to afford birds access to nectar) when a bird is near with data logging capability. There has also been work on using Tang’s technology in the study of electric fish that are able to generate weak electric fields to sense their environment, select a mate, and identify members of their species. Tang has been developing a small device that could be placed on the fish to collect data about their behavior. This study could facilitate the use of miniature sensors that are able to reliably transmit information through water, contributing to

devices that could be implanted in the human body, submersed in water or incorporated in concrete structures to measure parameters such as mechanical stress.

Details: Dr. Wei Tang, Assistant Professor, Klipsch School of Electrical and Computer Engineering, New Mexico State University, Thomas and Brown Hall, Room 326, Las Cruces, NM. 88003. Phone: +1-575-646-5768. E-mail: wtang@nmsu.edu

4. RECENT PATENTS IN THE FIELD OF OPTOELECTRONIC SENSORS

A sensor in which the amount of incident light on the device area is directly proportional to the electrical output is essentially an optoelectronic sensor. Optoelectronic sensors enable many different applications, such as proximity sensing, color quality control, display management, gas sensing, ambient light detection, and many more.

Key enabling sensors for optoelectronic sensing include image sensors that consist of arrays of photodiodes, ambient light detection sensors that are used to determine the intensity of light, fiber optic sensors that use optical fibers as the sensing element, and infrared sensors that convert light from the infrared part of the electromagnetic spectrum.

The United States is leading in the number of patents published in optoelectronic sensors, followed by Europe and Asia Pacific. North America is the biggest market for optoelectronic sensors, which includes different segments such as image sensors, infrared sensors, and ambient light sensors. Some of the companies focusing on optoelectronic sensing in the North American region include Aptina Imaging,, Omnivision, FLIR Systems, and many more. Revenue in the European region is expected to increase because of the growing demand for image sensors. In the optoelectronics domain, there is a strong focus on image sensing. It is also expected that a high number of patents will be published under image sensing.

Optoelectronic sensing has great potential to converge with various technologies such as energy harvesting, robotics, and advanced nanostructured materials. Optoelectronics technology is expected to find newer areas of applications for expansion, such as in building automation and automobiles. Ambient light sensors and image sensors are expected to experience high growth potential in automobile and building automation markets. Another key

segment of optoelectronic sensing is the fiber optic sensor, which will witness growth in applications such as strain sensing and distributed temperature sensing. Infrared sensors will see continued growth in areas such as security, consumer applications, automotive night vision, gas detection, and so on.

A recent patent (EP2834661) in optoelectronic sensors is pertains to a laser scanner in which the receiving optical unit has a diaphragm to reduce the intensity of the receiving signal. It is assigned to VALEO SCHALTER & SENSOREN GMBH and relates to an optoelctronic sensor for detecting objects in a motor vehicle's environment.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
OPTOELECTRONIC SENSOR DEVICE, PARTICULARLY LASER SCANNER, WITH AN ADAPTED RECEIVING UNIT FOR OPTIMIZED RECEPTION LEVEL REDUCTION	11.02.2015; EP2834661	VALEO SCHALTER & SENSOREN GMBH	BAYHA HEINER	The invention relates to an optoelectronic sensor device (1) for a motor vehicle, for detecting objects located in an environment of the motor vehicle, with a transmitting unit (2) for emitting an optical transmission signal (5), with a receiving unit (7) for receiving a reception signal (8), which is the transmission signal (5) reflected from an object, wherein the receiving unit (7) has at least two receiving elements (9, 10, 11) arranged distributed along a distribution direction (12) and a receiving optical unit (13), particularly a receiving lens, which is upstream of the receiving elements (9, 10, 11) in the propagation direction (14) of the reception signal (8), with a holding device (22) for holding the receiving optical unit (13) and with a diaphragm (21, 21') for reducing the intensity of the reception signal (8), the diaphragm (21, 21') being held on the holding device (22).
Optoelectronic measuring device for a motor vehicle and scan sensor for the same	04.02.2015; EP2833161	VALEO SCHALTER & SENSOREN GMBH	KIEHN MICHAEL	The invention relates to an optical measurement device for a motor vehicle with at least one scanning optoelectronic detection device. The invention also relates to a scanning sensor for such an optical measuring device. In order to provide an optical measuring device for a motor vehicle, which requires a minimum of space for mounting on a motor vehicle 1, the optical elements of one or more transmitting and receiving combinations of the optoelectronic detection device in a structurally separate from the electronic elements Scan Sensor 2, 3 are according to the invention arranged and connected to the respective associated electronic elements via optical conductor 8
METHOD FOR OPERATING AN OPTOELECTRONIC PROXIMITY SENSOR	29.01.2015; WO/2015/011094	OSRAM OPTO SEMICONDUCTORS GMBH	HALBRITTER, Hubert	The invention relates to a method for operating an optoelectronic proximity sensor (1), wherein the proximity sensor (1) comprises a radiation-emitting component (2), a radiation-detecting component (3) and a control unit (4), the radiation-emitting component (2) is operated by means of a pulsed current (Ie), during a measurement period (Tm) the pulsed current (Ie) of the radiation-emitting component (2) has in each case an on-time (ton) and an off-time (toff), wherein the pulsed current (Ie) has a pulse current intensity (Ion) during the on-time (ton), and the control unit (4) evaluates a detector signal (Id) of the radiation-detecting component (3) and lowers the pulse current intensity (Ion) for a subsequent measurement period (Tm), when the detector signal (Id) exceeds a threshold value (Ith) during at least one measurement period (Tm).

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Optoelectronic sensor and method for detecting objects	21.01.2015; EP2827173	SICK AG	NÜBLING RALF ULRICH	It an optoelectronic sensor (10) for detecting objects in a monitoring region (18) is provided, in particular a laser scanner having a light transmitter (12) for emitting a transmitted light beam (16), a light receiver (26) for generating a received signal from that of Objects in the surveillance area (18) of the remitted light (20), a receiving optics (22, 24) with at least one receiving lens (22) for focusing the returned light (20) onto the light receiver (26), an about a rotational axis (34) movable optical unit (32), in the light transmitter (12) and light receiver (26) together with the optical receiving system (22, 24) are housed for periodic scanning of the monitored zone (18), as well as an evaluation unit (28, 42) for detecting information about objects in the monitoring area (18) on the basis of the received signal. In this case, the receiving optics (22, 24) in addition to a beam shaping mirror element (24).
Optoelectronic sensor and method for detecting and measuring the distance of objects in a monitored area	14.01.2015; EP2824478	SICK AG	Jachmann Fabian	An optoelectronic sensor (10) for distance determination comprises a transmitter (12) for transmitting a light beam (14) having a plurality of consecutive individual light pulses, a rotatable deflection unit (16) for deflecting the light beam (14), an angle measuring unit (28) for determining an angular position of the deflection unit (16), a light receiver (24) for generating reception pulses from remitted transmission light, a plurality of histogram memories (34) each associated with an angular position, and an evaluation unit (30) which is configured to accumulate time histograms in the histogram memodes (34) across several periods of the rotational movement of the deflection unit (16) from reception pulses which are each detected at the angular position associated with the respective histogram memory (34), and to determine, from the histograms of the associated histogram memory (34), an object distance for an angular position.
Apparatus comprising an optoelectronic 3D-sensor and method for recognising objects	31.12.2014; EP2818824	SICK AG	MACNAMARA SHANE	There is provided an opto-electronic 3D-sensor (10) for detecting objects (42) within at least a predetermined detection field (32), the 3D-sensor (10) comprises a 3D image sensor (14a, 14b) for receiving a depth map, a configuration unit (28) for defining field limits suggested the detection field (32), and an object recognition unit (30) for evaluating the depth map has to detect object interfering with the detection field (32). The configuration unit (30) is adapted from the predetermined detection areas (32) for generating at least one reference card (40), in which the field boundaries in the projective perspective of the 3D sensor (10) and thus in a comparable directly with the depth map format are converted.
THREE-DIMENSIONAL OPTOELECTRONIC SIMULATION METHOD FOR ENHANCING ACCURACY OF CROSSTALK PREDICTION FOR IMAGE SENSOR	29.10.2014; KR1020140125622	SAMSUNG ELECTRONICS CO., LTD.	LEE, WOOK.	A three-dimensional optoelectronic simulation method for an image sensor comprises the following steps of: generating a process simulation result including a doping profile of a silicon substrate in the image sensor; generating a simulation result of a structure after the back end of line of the image sensor; generating an expanded result by selectively reusing a result of combining the process simulation result with the structure simulation result after the back end of line; and generating a result of dividing the expanded result by pixel; generating an optical crosstalk simulation result of the image sensor by receiving the structure simulation result after the back end of line and an optical mesh; and generating a finial simulation result including an electrical crosstalk simulation result of the image sensor by receiving the divided result by pixel and the optical crosstalk simulation result. COPYRIGHT KIPO 2015

Exhibit 1 lists some of the patents related to optoelectronic sensors.

Picture Credit: Frost & Sullivan

5. TECHVISION 2015

The TechVision program is the premier offering of Technical Insights, the global technology innovation-, disruption-, and convergence-focused practice of Frost & Sullivan. TechVision embodies a very selective collection of emerging and disruptive technologies that will shape our world in the near future. This body of work is a culmination of thousands of hours of focused effort put in by over 60 global technology analysts based in six continents.

A unique feature of the TechVision program is an annual selection of 50 technologies that are driving visionary innovation and stimulating global growth. The selected technologies are spread across nine Technology Clusters that represent the bulk of R&D and innovation activity today. Each Cluster represents a unique group of game-changing and disruptive technologies that attract huge investments, demonstrate cutting-edge developments, and drive the creation of new products and services through convergence.

Our technology analysts regularly collect deep-dive intelligence on several emerging and disruptive technologies and innovations from around the globe. Interviews are conducted every day with innovators, technology developers, funders, and others who are a part of various technology ecosystems. The respondents are spread across public and private sectors, universities, research institutions, and government R&D agencies. Each technology is rated and compared across several parameters, such as global R&D footprint, year of impact, global IP patenting activity, private and public funding, current and emerging applications, potential adoption rate, market potential, and so on. This organic and continuous research effort spread across several technologies, regions, organizations, applications, and industries is used to generate an annual list of Top 50 technologies that have the maximum potential to spawn innovative products, services, and business models.

Furthermore, we analyse several possible convergence scenarios where two or more of the Top 50 technologies can potentially come together to disrupt, collapse, and transform the status quo. Driven by IP interactivity emanating from each of the top technologies, a whole range of innovative business models, products, and services will be launched at unprecedented speed in the future. We have come up with over 25 such unique convergence scenarios.

The Top 50 technologies we have selected for TechVision 2015 have the power to drive unique convergence and catalyse wide-scale industry disruptions. Frost and Sullivan's TechVision program empowers you with ideas and strategies to leverage the innovations and disruptive technologies that can drive the transformational growth of your organization.

Rajiv Kumar
Senior Partner

For more information contact:
techvision@frost.com

Visit us on:

www.frost.com/techvision

Follow us on:

@TechVision_FS

www.frost.com/techvisionlinkedin

Back to TOC

To find out more about Technical Insights and our Alerts, Newsletters, and Research Services, access http://ti.frost.com/

To comment on these articles, write to us at tiresearch@frost.com

---

You can call us at: **North America**: +1-843.795.8059, **London**: +44 207 343 8352, **Chennai**: +91-44-42005820, **Singapore**: +65.6890.0275