TECHNICAL INSIGHTS

SENSOR

TECHNOLOGY ALERT

08th August 2014

1. EXPANDING APPLICATIONS FOR CONTINUOUS MONITORING OF VITAL SIGNS

Continuous monitoring of patient vital signs as well as movement can allow for key benefits, such as improved care, improved patient safety, earlier detection of patient deterioration, and shorter stays in intensive care. It is vital that such sensors are immune to false alarms. In the hospital or in healthcare facility environments, an initial area where wireless vital sign monitors have been used is in beds, where such sensors are placed under the mattress. However, there are opportunities for using such vital sign monitors in different applications within a healthcare facility. For instance, such sensors installed in chairs can provide more comprehensive coverage of ambulatory patients as well as more real-time information about the patient's condition, whether he or she is in a bed or in a chair, and allow for detecting negative conditions before they become acute.

EarlySense, headquartered in Israel with a US facility in Waltham, MA, is a key provider of sensors that are placed under a mattress to continuously monitor a patient's heart rate, respiratory rate, and motion in a non-contact fashion. Such sensors can provide an alert when early warning signs of deterioration occur.

The sensor, a flat metal plate, is connected to a bedside monitor, where data is processed and transmitted to a central monitor or a mobile device. The sensor detects vibration signals emanating from the patient's body. The types of signals detected include general large body movements, the motion of the chest during breathing, and the cardio-ballistic effect (each time the heart beats, there is a small recoil of the entire body). Such signals go through the mattress and are collected by passive plaque (similar to a passive antenna), digitized, and, via EarlySense developed algorithms, turned into accurate vital signs that are analyzed.

Expanding the opportunities for its vital sign monitors in early July 2014, EarlySense reported receiving US Food and Drug Administration market clearance for the company's chair sensor solution, which continuously monitors patient heart rate, respiration, and movement, creating a smart chair. Purportedly the first contact-free sensor for vital signs in a chair, the solution was evaluated at Coffee Regional Medical Center, located in Georgia, USA, where it allowed a clinical team to react to early signs of patient deterioration and prevent falls.

The automatic, contact-free solution can keep patients safe in a chair, thereby allowing patients to walk from a bed to a chair, which can improve healing and reduce the risk of complications and length of stay. The chair sensor can, moreover, have opportunities in environments, such as emergency departments, outpatient clinics, and waiting areas.

Details: Tim O'Malley, President, EarlySense , 135 Beaver Street , Ste 307 ,Waltham, MA 02452 .Phone: +972-375-22330. E-mail: Tim.Omalley@earlysense.com.

2. ELIMINATION OF NOISE TO ENABLE ULTRA-STABLE SENSORS

Optical detection sensors capable of detecting extremely small forces, such as single molecules, allow for a deeper understanding of the behavior, interactions, and mechanisms affecting the target of interest. For example, single molecule detection can provide researchers with additional information and insights about the individual molecular properties and their micro environment. Analysis of single molecules can provide vital information about molecular motion, behavior and fluctuations over time and space.

However, sensors capable of detecting such small forces can be susceptible to external perturbations or noise. Researchers at Ecole Polytechnique Fédérale de Lausanne (EFPL) in Switzerland have discovered a way to eliminate external noise from interfering with their cutting-edge optomechanical measurement systems.

In 2013, a team at the Laboratory of Photonics and Quantum Measurements (LPQM1), led by Tobias Kippenberg, presented an advanced sensor able to detect very minute forces with extreme efficiency. Such systems, termed nanomechanical oscillators, were developed and fabricated at EPFL’s Center of MicroNanoFabrication. Such devices could enhance applied and fundamental science.

The nanomechanical oscillator systems, however, have been negatively impacted due to their greater sensitivity to external perturbations. For example, certain noises due to temperature variations or to chemical processes at the device’s surface have impaired the performance of these devices. However, EPFL scientists Emanuel Gavartin, Pierre Verlot and Tobias Kippenberg have managed to isolate and eliminate external noises that degrade the performance of the sensors.

The nanomechanical oscillators are comprised of a string a few hundred nanometers thick, which can be actuated by applying a known external force. The device can then be used to detect very small particles, such as single molecules on its surface because each molecule changes the string vibration in a specific way. The changes serve as a molecule's ‘signature,’ enabling researchers to know the type of molecule (even in a very small quantity) that is present in a specific area.

In the process of eliminating external noise (the external frequency fluctuations) due to changes in the environment, the researchers relied on the phenomenon that the microscopic string simultaneously oscillates up and down, left and right, and in other directions When the device is perturbed by external noise, the changes occurring in the up and down mode correlate with those in the left and right mode. Therefore, each oscillation mode responds in a similar fashion to an identical external perturbation.

Leveraging this phenomenon, the researchers used one mode to detect the external noise perturbation and then derived a correction to remove the external noise from the other mode to be used for sensing applications. When a perturbation occurs, they can analyze the variations of the oscillation mode and use a laser to counteract the fluctuation and stabilize the device.

The resulting, noise-corrected, ultra-efficient sensors show promise for detecting very small masses as well as for basic science and quantum physics.

Details: Tobias Kippenberg, Laboratory of Photonics and Quantum Measurements, EPFL. CH-1015 Lausanne, Switzerland. Phone: +41-0- 21-693-4428. E-mail: tobias.kippenberg@epfl.ch

3. DEVELOPMENTS IN THE MAGNETIC FIELD SENSOR ARENA

Magnetic field sensors, which measure various parameters based on a change in the magnetic field, are widely used in diverse applications, such as navigation and orientation, automotive engine management, and wheel speed sensing, proximity sensing, current sensing, angle and position sensing. Applications for magnetic angle and position sensors include encoders, motor feedback systems, wind turbines, steering and angle position sensing, machine tools and machinery, healthcare (for example, monitoring body position in medical equipment), robotics, material handling systems.

Magnetic angle and position sensors should be capable of high accuracy, robustness, reliability, as well as high speed and precision. Ideally, such sensors should also be immune to extraneous interfering magnetic fields.

A Hall effect sensor, which essentially produces a voltage across an electrical conductor when a magnetic field is applied perpendicular to the current flow, can be beneficial for use as a non-contact magnetic angle or position sensor, as the Hall effect sensor can provide good accuracy, robustness, reliability, resistance to harsh environments, low cost, manufacturability, and ease of wiring. Moreover, Hall Effect sensors fabricated using a standard CMOS (complementary metal oxide semiconductor) process, which is widely used for fabricating silicon electronic components, enables the integration of the Hall Effect sensor and the associated control circuitry on a single chip.

Indicative of ongoing opportunities for magnetic field sensors, in late July 2014, US-based Monolithic Power Systems (MPS), a fabless manufacturer of high-performance analog and mixed-signal semiconductors, reported it has acquired Sensima Technology SA based in Switzerland. Sensima is a pre-revenue, developer of magnetic sensor technologies for angle measurements (which do not require complex calculations or feedback loops with long time constants) as well as magnetic sensor systems containing Hall Effect devices (including integrated Hall devices that are able to detect three components of the magnetic field.

MPS acquired all of the outstanding shares of capital stock of Sensima. The purchase price included an initial cash payment of $11.7 million and a subsequent cash earn-out payment of up to $8.9 million, which will be based upon Sensima's achieving certain performance goals.

Sensima Technology specializes in the design of magnetic sensor systems that contain Hall Effect devices. The compact, integrated Hall devices with on-chip magnetic sensing can allow detection of any of the three components of the magnetic field. The company has developed 3D finite element simulation tools to predict performance and optimize the geometry of the Hall device.

Sensima sources have indicated that the spinning current technique can be used to automatically suppress the variation of the offset with temperature in integrated Hall devices. It can be challenging to minimize the naturally large offset (the output voltage when the applied field is zero) when using integrated Hall devices, which can be too large for many applications. In the spinning current technique, the Hall Effect voltage can be separated from the offset voltage by interchanging the current leads with voltage leads. The offset voltage can be decreased by a factor of 50 or higher. Furthermore, Sensima optimizes the shape and biasing of such integrated Hall sensors to facilitate an efficient spinning current technique, while maintaining a low noise level. In addition, the company has developed advanced techniques for interconnecting arrays of Hall devices or to virtually reverse the magnetic field on chip.

Sensima technology's spinaxis magnetic angle sensors do not need complex calculations or feedback loops with lengthy time constants. Sensima sources have noted that, prior to the introduction of spinaxis technology, conventional systems obtained the angle by converting two analog levels, representing orthogonal field components, into digital numbers and calculated trigonometric functions. Other systems use an interpolator based on a feedback loop. In both methods, the data arrives at the sensor output only a few milliseconds after the position was actually sampled.

In contrast, the spinaxis system is a direct way to measure the angle and deliver the digital value, without requiring analog to digital conversion or feedback loops. It can generate instantaneous, accurate information about the actual rotor or angular position. The magnetic field is continuously scanned by an array of integrated magnetic probes to generate a sine wave, whose phase represents the angle to be measured. The digital angle is readily obtained by measuring this phase, that is, counting the time between a reference edge and the zero crossing of the sine wave signal. This time-to-digital conversion is performed by the system clock and a counter. A digital sample is generated within each field scan, which takes about 2 μs (microseconds).

Details: Radivoje Popovic, Professor Emeritus, EPFL and Co-Founder of Sensima Technology, EPFL STI-DO, CM 1 620 (Centre Midi), Station 10, CH-1015 Lausanne, Switzerland. Phone: +41-2169-33853. E-mail: adivoje.popovic@epfl.ch

4. RECENT PATENTS IN THE FIELD OF IMAGE SENSING

Electronic devices, such as image recorders or cameras use image sensors, such as complementary metal-oxide-semiconductor (CMOS) or charged coupled device (CCD). These sensors are either implemented in global shutter configuration or rolling shutter configuration. In rolling shutter configuration, light is captured row by row. In this configuration, there is a possibility of time delay between first pixel capture and last pixel capture which can provide low-quality images. In the global shutter configuration, all the pixels are captured at the same time. However, in this configuration, there is a requirement for storage space to reduce the resolution or increase the size of the image.

A recent patent in Image sensing involves the incorporation of eight units, that is, processor, input/output interface, storage memory, display, 1st camera, 2nd camera, sensors and power source. All the units are connected to each other with a binary unit system (BUS). It is expected to use the microprocessor to control the operations. The microprocessor will communicate (receive and transmit instructions) between cameras, display and sensors through BUS. The storage memory is used to store electrical data or content such as document files, video files, and audio files. The input and output interfaces receive data from the user and other units. The input and output interfaces are expected to support multiple networks or communication mechanisms. The inventor is expected to use a battery as the power source. A sensor unit is used to provide data to the processor and enhance the functions of the device.

Cameras used in the image sensing device are very similar. These cameras consist of the lens and they communicate optically with the image sensor. An image sensing device comprises a photodiode chip for receiving light. It is also comprised of a transistor array chip; this chip is vertically stacked on the photodiode chip. The transfer gate is connected to the transistor array chip and communicates with the photodiode and transistor array. The lens directs the light on the photodiode layer of the image sensor. The image sensor captures the light, which is optically transmitted through the lens and converts it into an electrical signal.

Fan Xiaofeng invented the image sensing device and the patent number of the invention is US20140211056. It works on the principle of automatic optical character recognition and shared pixel. The process of the imaging device begins with the image sensor, which senses the light condition. For example, the test image is captured and sent to the processor to analyze the light condition. If the light effect is good, then the device will automatically be in the neutral option and capture an image with individual pixels. The device also consists of a color filter. If the light is very low, then the device shifts to the low light or monochrome mode. After shifting the mode of the device, the device captures the image by summing the group of pixels. The image captured during this mode reduces the noise as the cross talk between pixels gets eliminated by summing the pixel. Color noise occurs because one color pixel receives more light than the other color pixel, and this noise can be eliminated by adding the pixels together. If the color information is required, the device will automatically shift to color mode and capture the image with color and apply the color data to the captured image in low light mode. Thus, a vertically stacked image sensor device captures high-quality images by eliminating noise.

PATENT TITLE	PUBLICATION DATE / NUMBER	ASSIGNEE	INVENTORS	ABSTRACT
Vertically stacked image sensor	31.07.2014; US20140211056	Apple Inc.	Fan Xiaofeng	A vertically stacked image sensor having a photodiode chip and a transistor array chip. The photodiode chip includes at least one photodiode and a transfer gate extends vertically from a top surface of the photodiode chip. The image sensor further includes a transistor array chip stacked on top of the photodiode chip. The transistor array chip includes the control circuitry and storage nodes. The image sensor further includes a logic chip vertically stacked on the transistor array chip. The transfer gate communicates data from the at least one photodiode to the transistor array chip and the logic chip selectively activates the vertical transfer gate, the reset gate, the source follower gate, and the row

				select gate.
Apparatus for vertically integrated backside illuminated image sensors	14.01.2014; US08629524	Wang Tzu-Jui	Wang Tzu-Jui	A backside illuminated image sensor comprises a photodiode and a first transistor located in a first chip, wherein the first transistor is electrically coupled to the photodiode. The backside illuminated image sensor further comprises a second transistor formed in a second chip and a plurality of logic circuits formed in a third chip, wherein the second chip is stacked on the first chip and the third chip is stacked on the second chip. The logic circuit, the second transistor and the first transistor are coupled to each other through a plurality of boding pads and through vias.
Image sensor with hybrid heterostructure	19.12.2013; US20130334403	Kozlowski Lester	Kozlowski Lester	An image sensor architecture for an active pixel sensor array are separated and arranged vertically in at least two different layers in a hybrid chip structure. The top layer includes the photodiode and amplifier circuitry for each pixel. A bottom includes the pixel circuit components and any digital circuitry required for signal processing. By forming the top layer in a process optimized for forming low-noise pixels, the pixel performance can be greatly improved. In addition, since the digital circuitry is now separated from the imaging circuitry, it can be formed using a process which has been optimized for circuit speed and manufacturing cost. By combining the two layers into a stacked structure, the top layer (and any intermediate layer(s)) acts to optically shield the lower layer, thereby allowing charge to be stored and shielded without the need for a mechanical shutter.
Image sensor with flexible interconnect capabilities	21.03.2013; US20130070139	Kirsch Graham	Kirsch Graham	Electronic devices may include image sensors having configurable image sensor pixel interconnections. Image sensors may include image sensor pixels coupled to analog circuitry via configurable interconnect circuitry. The analog circuitry may include many analog circuit blocks. The analog circuit blocks may control and read out signals from associated image sensor pixels. The configurable interconnect circuitry may be controlled to reroute the connections between the analog circuit blocks and

				specific groups of image sensor pixels. Digital circuitry may be coupled to the analog circuitry via configurable interconnect circuitry. The digital circuitry may include digital circuit blocks. There may be significantly more image pixels controlled by a small number of analog circuit blocks, which are in turn controlled by a smaller number of digital circuit blocks. The image sensor pixel array, the configurable interconnect circuitry, the analog circuitry, and the digital circuitry may be vertically stacked.
Image sensor with hybrid heterostructure	25.10.2012; US20120267511	Kozlowski Lester	Kozlowski Lester	An image sensor architecture provides an SNR in excess of 100 dB, without requiring the use of a mechanical shutter. The circuit components for an active pixel sensor array are separated and arranged vertically in at least two different layers in a hybrid chip structure. The top layer is preferably manufactured using a low-noise PMOS manufacturing process, and includes the photodiode and amplifier circuitry for each pixel. A bottom layer is preferably manufactured using a standard CMOS process, and includes the NMOS pixel circuit components and any digital circuitry required for signal processing. By forming the top layer in a PMOS process to optimized for forming low-noise pixels, the pixel performance can be greatly improved, compared to using CMOS. In addition, since the digital circuitry is now separated from the imaging circuitry, it can be formed using a standard CMOS process, which has been optimized for circuit speed and manufacturing cost. By combining the two layers into a stacked structure, the top layer (and any intermediate layer(s)) acts to optically shield the lower layer, thereby allowing charge to be stored and shielded without the need for a mechanical shutter.

Image capture device	31.05.2012; US20120133807	Wu Cheng-Wen	Wu Cheng-Wen	An image capture apparatus comprises an image sensor array including a plurality of image sensors arranged in a two-dimensional (2-D) array and an analog-to-digital converter (ADC) array including a plurality of ADCs arranged in a 2-D array. The image sensor array is divided into a plurality of sub-arrays, each of which includes at least two image sensors. The image sensor array is vertically stacked on the ADC array. Each ADC corresponds to one sub-array of image sensors and is coupled to process signals output by the image sensors in the corresponding sub-array.
Image sensor and a method for manufacturing an image sensor capable of minimizing a spectrum type interference phenomenon	15.06.2011; KR1020110065177	Dongbu Hitek Co., Ltd.	Yun, Young Je	An image sensor and a method for manufacturing an image sensor are provided to form red color, green color, and blue color pixel arrays with the same density by mixing a bayer type mosaic pixel structure and a stacked type pixel structure. CONSTITUTION: A first photo diode(120) is respectively formed in a first pixel region and a third pixel region. A second photo diode(130) is formed on the upper side of the first photo diode. A third photo diode(110) is formed in the second pixel region. An insulating layer(140) is formed on a semiconductor substrate(100). A color filter layer(150) is formed on the insulating layer and includes a first color filter, a second color filter, and a third color filter vertically corresponding to the first pixel region, the second pixel region, and the third pixel region. COPYRIGHT KIPO 2011

Exhibit 1 lists some of the patents related to Image sensing.

Picture Credit: Frost & Sullivan

Back to TOC