TECHNICAL INSIGHTS

SENSOR

TECHNOLOGY ALERT

21st November 2014

1. ENERGY HARVESTING SENSOR SYSTEM USING PIEZOELECTRIC ELEMENT

Energy harvesting technologies often use intermittent sources of ambient energy. Energy harvesting helps to achieve backup power and can allow for more extensive use and greater longevity of batteries. Forms of energy harvesting have been used for centuries. First, water and windmills were used; subsequently, dams, geothermal plants, and solar panels were developed for producing energy. Currently, different forms of energy harvesting are used and researched, such as, tiny solar panels or thermoelectric generators that use the Seebeck effect. There is a need to identify different ways to harvest energy. Harvesting energy through vibrations is gaining momentum and increased interest in various industries and sectors. For example, there is a potential for an energy harvesting sensor system that can harvest the energy from the vibrations or strains of the helicopter rotor blades, which can be further used to power other sensor nodes. The device should be easy-to-use and cost effective.

To address the above-mentioned need, US-based MicroStrain, a Lord company, developed an energy harvesting sensor system comprising radio frequency (RF) antenna, microprocessor, thin film battery, piezoresistive strain gauge, and piezoelectric energy harvesting element.

The piezoelectric energy harvesting element is bonded with the strain field region of the rotor blade using four point bending and loading fixtures. The piezoelectric element is embedded within the resin matrix with the piezoelectric fibers. It is fixed on top of the helicopter with the help of strain gauge. The applied strain energy through the rotor blades is converted into electrical output with the help of the piezoelectric element. The output is linked with the storage circuit, which is further embedded with the rectifier and capacitor. The capacitor is used to store the energy, while a rectifier is deployed to convert alternating current (AC) current into direct current (DC), which will be a further help to power the thin film battery and store energy. During the initial experiment, because of the repeated vibration frequency of 4.3 Hz, the system was able to charge the storage capacitor. The power output ranged between 1 mW to 5.5 mW. The piezoelectric element is used to harvest the power from the strain of the blades.

Once the project is fully developed, it will be used in the US Navy helicopters to monitor dynamic and static loads, eliminating battery maintenance, which causes the cyclic strain on the rotating components of the helicopter. The major area of focus for this project was to control the rotor blades in such a way that energy from the strains of the blades could be utilized. Researchers from MicroStrain increased the chain bandwidth of the sensor signal to reduce the overall power consumption. The same approach can be used in the wide range of applications such as in aircraft components and structures, and in future, it might also be employed in aircraft engines for condition-based advanced maintenance. The project was funded by the US Navy. .

Details: Mike Robinson, Global Marketing and Sales Manager, MicroStrain, 459 Hurricane Ln, Williston, VT 05495. Phone: +1-802-862-6629. E-mail: mirobinson@microstrain.com. URL: www.microstrain.com

2. EVENT-BASED SENSOR ENABLES AUTONOMOUS VEHICLES TO MAKE DECISIONS

Unmanned autonomous ground vehicles have key opportunities in the future and companies such as Google, Volvo, and Lockheed Martin are heavily investing in research and development activities for enabling these vehicles. Currently, sensors and systems for navigation or advanced driver assistance can be very expensive. For example, a high-definition Lidar (light detection and ranging) system with numerous laser beams for vehicle navigation can cost around $75,000 or higher. The package of sensors used in advanced driver assistance systems (ADAS), which can be a component of the more advanced autonomous vehicles, such as, radar sensors, and image sensors, can also be relatively expensive. There is need for a system that will be reliable, help to reduce the cost of the ownership, and also provide accurate results with efficiency.

To address the above-mentioned need, researchers at the Laboratory for Information & Decision Systems at the Massachusetts Institute of Technology have developed a neuromorphic sensor—an event based sensor that helps to make decisions under random circumstances, such as, obstacles in the way.

The event-based sensor developed by the Laboratory for Information & Decision Systems updates information with the response time of million times a second, which helps to perform quick maneuvers. This response time is good enough for normal operating conditions such as a vehicle moving with the speed of 5 mph. However, this response time is not fast enough to handle unexpected circumstances when a vehicle is moving at the speed of 35 mph. The researchers are currently working on speeding up their algorithm, which will help to make faster decisions when required.

In event-based sensor, each and every pixel acts as an independent sensor. When the luminance is changed either in the positive or negative direction, the pixels convey the information as an event, that, it has seen something interesting. The algorithm receives the information from the event-based sensor and tries to identify the features of the information, such as, boundaries between the objects. After thirty milliseconds, the event-based sensor sends more information if something changes and communicates the information to the algorithm. The algorithm performs the same type of analysis and tries to figure out the features between two data. This method can take 50 milliseconds to 250 milliseconds to process the data and deduce an appropriate action based on any obstacles in the field. This approach needs further development with regard to time consumption and decision making.

Once the project is completed, it has potential to be deployed in unmanned aerial vehicles for surveillance purposes. It could also be employed in unmanned autonomous ground vehicles. The sensor would help a vehicle, being driven at a speed of 35 mph, to detect any obstacles on the way and find out a way to avoid those obstacles. This sensor would also help the unmanned vehicle system to be more intelligent while making decisions such as slowing down, taking a turn or applying brakes. It can help monitor the surroundings accurately and efficiently.

The project was funded by Massachusetts Institute of Technology (USA) and supported by the Institute for Neuroinformatics in Zurich. The researchers are currently working on developing a control algorithm that will help to decide the necessary action in response to an event. The project is expected to go through a fair amount of development before it can be commercialized.

Details: Andrea Censi, Research Scientist, Principal Investigator, Laboratory for Information & Decision Systems, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Vassar Street, Room 32-D608, Cambridge, MA 02139. Phone: +1-626-872-3674. E-mail: censi@mit.edu. URL: https://lids.mit.edu

3. EFFICIENT GAS SENSOR-BASED VENTILATION SYSTEM

Airborne contaminants are inside the rooms in colleges, schools, offices, and newly constructed sealed buildings. Volatile organic compounds, such as, carcinogens, are found inside schools and colleges, which cause a health hazard to older people, and particularly, to children. There is a need for a system that can reduce these air contaminants and provide good quality indoor air. The system should be easy-to-use and cost effective.

To address the above-mentioned need, a European research consortium working on the project called SENSIndoor has been developing an innovative sensor system to monitor airborne contaminants. This system will help in providing high quality indoor air without the losses in energy that are typically associated with conventional ventilation systems.

The SENSIndoor sensor system comprises novel gas sensors and an adjustable ventilation system. The gas sensors are used to detect air contamination inside the room. The gas sensors used in the ventilation system are a metal oxide semiconductor gas sensor and a gas sensitive or sensing field-effect transistor sensor. The sensors will utilize innovative nanocrystaline materials. By using the measurement system, data provided by the gas sensor is measured, and the ventilation system is adjusted accordingly. The measurement of the data also includes the time and usage of the particular room in which the air contamination is measured. When the windows of the room are closed, the indoor air becomes more contaminated because of the various unhealthy mixtures of chemicals. The various chemicals that a gas sensor can detect include formaldehyde caused because of the furniture, solvents from carpet adhesives, cleaning agent chemical vapors, xylene, carcinogens, and benzene, among others. A room can be contaminated because of these chemicals, especially when the room is completely sealed. A high quality can be maintained for the air indoors with the help of the SENSIndoor sensor system.

Once the project is fully developed, it has opportunities for deployment in new buildings where the unhealthy mix of chemicals from furniture, carpet adhesives, and numerous other indoor fittings contaminate the air inside houses and offices. The system will help to ventilate indoor spaces to avoid health hazards from airborne contaminants. Further, it can be deployed in schools and colleges to keep the environment healthy. If all the rooms of a college or school are deployed with the sensor system and connected with the ventilation control unit, problems related to ventilation can be fixed conveniently, for instance, during recess or before classes. The sensor system developed by the Consortium is expected to be inexpensive and to provide an efficient result.

The SENSIndoor project is funded by the European Commission under the Seventh Framework Programme. The project has received a grant of €3.4 million (about US $4.25 million at the current exchange rate). The project partners for the consortium are Saarland University, Germany; Linköping University, Sweden; University of Oulu, Finland; Fraunhofer Institute for Chemical Technology, Germany; Picodeon Ltd. Oy, Finland; SGX Sensortech S.A., Switzerland; SenSiC AB, Sweden; 3S – Sensors, Signal processing, Systems GmbH, Germany; NanoSense S.à.r.l., France; European Research and Project Office GmbH (Eurice), Germany. The researchers are currently working on examining the ventilation patterns of buildings such as schools, offices.

Details: Andreas Schütze, Professor, Lab for Measurement Technology, Saarland University, Department of Mechatronics, Saarland University, Campus A5.1, 66123 Saarbrücken, Germany. Phone: +49-681-302- 4663. E-mail: schuetze@LMT.uni–saarland.de. URL: www.lmt.uni–saarland.de

4. RECENT PATENTS IN THE FIELD OF CMOS IMAGE SENSORS

An image sensor converts an optical image into electrical signal. Image sensors are mainly used in digital cameras, camera modules, and other imaging devices used in industrial, medical, and consumer applications. Furthermore, there are numerous other applications for image sensors, such as, consumer electronics (including notebook or tablet computers, mobile phones), medical imaging, automotive driver assistance, security and surveillance, scientific imaging, and machine vision.

Two main types of image sensors are charge coupled device (CCD) and complementary metal oxide semiconductor (CMOS) image sensors. The quality of CMOS image sensors, which are less expensive, has been improving, with higher level performance and improved integration capabilities. In the CCD image sensor, the pixels capture the light and move it to the edge of the chip where it is converted into a digital signal. In the CMOS image sensor, the pixels capture light and directly convert it into a digital signal. CMOS sensors can be implemented with fewer components, use less power or provide faster readout than CCD sensors. While CCD is a more mature image sensor technology, CMOS sensors have on-chip functionality and can integrate image processing blocks, such as, amplifiers, and analog-to-digital circuit, for data compression and color processing on the chip.

A recent patent in CMOS image sensing powered by digital pixel (WO/2014/163991) is assigned to Ecole Polytechnique Federale de Lausanne (EPFL). The technology pertains to a CMOS image sensor with event detection, change detection, and reduced data redundancy capabilities.

From the year 1968 to November 2014, approximately 24,163 patents have been registered under Image Sensing. From 1995 to October 2014, approximately 3640 patents have been registered under CMOS Image Sensing. The maximum number of patents in CMOS image sensing has been assigned to Sony Corporation.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
A NOVEL CMOS IMAGE SENSOR WITH EVENT/CHANGE DETECTION AND REDUCED DATA REDUNDANCY	30.10.2014; WO/2014/174498	ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE (EPFL	KÖKLÜ, Gözen	A Digital Pixel Sensor (DPS) based CMOS camera configured to record frames and comprising an event detection sensor configured to look for an event happening in a determined frame, comprising an array of event detection pixels, a first reference voltage generator, first row and column arbiters, and first row and column address encoders; the DPS based CMOS camera further comprises a change detection sensor configured to look for a change happening in between frames, comprising an array of change detection pixels, a second binary search value generator, second row and column arbiters, and second row and column address encoders.
HIGH DYNAMIC RANGE CMOS IMAGE SENSOR HAVING ANTI-BLOOMING PROPERTIES AND ASSOCIATED METHODS	23.10.2014; US20140313386			A method of providing blooming protection to a CMOS imager having a pixel array of a plurality of pixels arranged in rows and columns, where the CMOS imager is operable to capture high dynamic range images using a rolling shutter, is provided. Such a method can include reading out charge accumulated by the pixels in a readout row of a first integration time, applying a reset to the readout row for a reset time sufficient to allow readout and reset to occur in at least one subsequent row, and starting a second integration time of the pixels in the readout row, wherein the second integration time is shorter than the first integration time, and wherein the at least one subsequent row is a sufficient number of rows to have a combined reset to preclude blooming effects from the pixel array during the second integration time.
VIDEOSTROBOSCOPY OF VOCAL CHORDS WITH CMOS SENSORS	23.10.2014; US20140316196			The disclosure relates and extends to a light source having a strobing or pulsing sequence suitable for use with a CMOS sensor that does not require, have, or use a global shutter. Instead, the CMOS sensor synchronizes the strobing input with the blanking portion of the sensor readout pattern and disables the strobing during sensor readout, or when the strobing would otherwise leave artifacts in the image. The CMOS sensor freezes its readout during the strobing.
SOLID-STATE IMAGING ELEMENT AND ELECTRONIC DEVICE	22.10.2014; EP2793263	SONY CORP	SATO NAOYUKI	The present disclosure relates to a solid-state imaging element and an electronic device capable of suppressing occurrence of a dark current and acquiring higher image quality. The solid-state imaging element includes a high-concentration diffusion layer configured to serve as a connection portion by which a wiring is connected to a semiconductor substrate, and a junction leak control film formed to cover a surface of the diffusion layer. Also, to connect the wiring to the diffusion layer, a width of an opening formed in an insulation film stacked on the semiconductor substrate is greater than a width of the diffusion layer. Further, in a charge accumulation portion configured to accumulate a charge generated by a photoelectric conversion portion generating the charge according to an amount of received light, the junction leak control film is also used as a capacitor film of the charge accumulation portion. Furthermore, a stack structure in which a silicon oxide or low interface state oxide film is formed is included between the diffusion layer and the junction leak control film. The present technology can be applied to, for example, a CMOS image sensor.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
SOLID-STATE IMAGE PICKUP DEVICE, DRIVING METHOD THEREOF, AND ELECTRONIC APPARATUS	16.10.2014; WO/2014/167794	SONY CORPORATION	SAKANO, Yorito	A photoelectric conversion element that generates charges according to a light quantity of incident light and accumulates the charges in the inside thereof, a transfer transistor (TRG) that transfers the charges accumulated by the photoelectric conversion element, a first charge voltage conversion section that converts the charges transferred by the transfer transistor (TRG) into a voltage, and a substrate electrode of a MOS capacitor (a region of a second charge voltage conversion section facing a gate electrode) that connects the first charge voltage conversion section via a connection transistor (FDG). The gate electrode of the MOS capacitor is applied with a voltage that is different in a read period of the voltage signal converted by the first charge voltage conversion section and in a period other than the read period. The present disclosure can also be applied to a CMOS image sensor or the like.
MODULAR AUTOMOTIVE CAMERA AND IMAGE PROCESSING SYSTEM FOR AUTOMATED PORTAL ENTRY	15.10.2014; EP2788226			Described herein is a system and method for vehicle portal activation without a user having to use a manually activated mechanism. In one embodiment, a modular automotive camera solution (MACS) module in conjunction with an image processing system is used for automated portal entry. The MACS module recognizes the presence of a user and controls the opening of, for example, a lift gate, when operating as a rear view camera and working in conjunction with a passive entry system and power lift gate module (PLGM). The MACS module has a camera module functioning as a continuous sensor. The camera module is a complementary metal-oxide-semiconductor (CMOS) sensor based camera configured to output analog National Television System Committee (NTSC) composite video and digital video. The image processing module performs image processing and communicates with the PLGM and the MACS module. The system is configured for local interconnect network (LIN) communication.
CMOS IMAGE SENSOR WITH RESET SHIELD LINE	09.10.2014; US20140299925			Techniques and mechanisms to improve potential well characteristics in a pixel cell. In an embodiment, a coupling portion of a pixel cell couples a reset transistor of the pixel cell to a floating diffusion node of the pixel cell, the reset transistor to reset a voltage of the floating diffusion node. In another embodiment, the pixel cell includes a shield line which extends athwart the coupling portion, where the shield line is to reduce a parasitic capacitance of the reset transistor to the floating diffusion node.

Exhibit 1 lists some of the patents related to CMOS image sensors.

Picture Credit: Frost & Sullivan

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