TECHNICAL INSIGHTS

SENSOR

TECHNOLOGY ALERT

14th August 2015

1. SENSORS FOR DETECTING FOOD SPOILAGE

Detecting rotten food is very important for food packaging suppliers, grocery stores, and several others. Rotten food can damage the brand value of a company and reduce sales. Devices that are currently employed to detect rotten food tend to be cumbersome, expensive, and cannot be updated in real-time. There is a need for a cost-efficient and portable device, which can detect rotten food accurately and efficiently in real-time.

As biosensors or chemical sensors become increasingly compact with improved sensitivity and selectivity, they have expanding opportunities for integration in smart packaging for applications such as monitoring the quality and safety of food.

Researchers at the Massachusetts Institute of Technology (MIT; USA) have created a cost-effective, portable sensor, based on chemically modified carbon nanotubes, that is able to detect gases emitted from rotting meat. This capability allows consumers to understand whether the meat in a grocery store or refrigerator is safe to eat. Such a sensor could be implemented in smart packaging to provide more accurate safety information and reduce food waste as a result of discarding food that is not really spoiled. The sensor could also safeguard against food-borne illness.

In this sensor, the carbon nanotubes are chemically modified so that their ability to carry an electric current changes in the presence of a certain gas. The carbon nanotubes were modified with metalloporphyrins--metal-containing compounds containing a central metal atom bound to several nitrogen-containing rings. Hemoglobin, which carries oxygen in the blood, is a metalloporphyrin in which iron is the central atom.

The researchers used cobalt at the center of metalloporphyrins. Metalloporphyrin with cobalt is very good at binding to nitrogen-containing compounds called as amines. Putrescine and cadaverine are the biogenic amines produced by decaying meat. When metalloporphyrins containing cobalt are bound to the above amines, it increases the electrical resistance of the CNTs, which can be measured easily--thus with the help of biogenic amines, rotten food can be detected.

Once the project is successfully completed, the sensors would be first employed by food packaging suppliers. It is also expected to be employed by grocery stores, restaurants, and also at home. The sensor will help in real-time detection of rotten food, and also prevent food borne illnesses.

Funding for the research was provided by the National Science Foundation and the Army Research Office through MIT's Institute for Soldier Nanotechnologies. The researchers are working on enabling the wireless platform for the sensor, which will enable users to use their smart phone to keep track of rotten food in real-time.

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2. SMART BOOT WITH FORCE SENSOR

It is possible to get the foot or ankle injured or fractured during cycling and sports activities. Care and attention are required in terms of pressure exerted on the broken ankle or foot to ensure fast healing and recovery. Hence, there is a need of a device or a boot, which can help the patient to balance the pressure on the broken ankle or toe or foot. The device should be easy to use, cost-efficient, and accurate.

To address the above challenge, researchers from the University of Delaware have developed a smart boot using a cost-efficient and accurate force sensor. Force is a very important parameter for users of the smart boot. The force sensor in the smart boot helps to balance the weight according to user specific injury. The sensor will help users with sprained ankles or fractures in the foot or leg to efficiently perform partial weight bearing without any additional help. When the force sensor helps the patient to balance the weight, the device starts processing and storing data in regular intervals to track progress of the patient. The stored data is transmitted to the doctor. This will further help the doctor to efficiently manage and monitor the performance of the patient with regular updates on the patient's weight bearing capability. The smart boot has detectable wiring, which helps in ease of operation. The researchers have employed a three-dimensional (3D) printing mechanism to manufacture printed circuit boards and

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microprocessors for the smart boot thereby achieving low-manufacturing cost. While the smart boot is currently powered by a rechargeable battery, it is expected that in the future, energy harvesting devices might be used to make the smart boot autonomous with respect to power.

The project was funded by the College of Health Sciences, University of Delaware. The project was supported by biomedical, electrical, and mechanical departments of the University of Delaware. The researchers are currently working on reducing the weight and improving the outer structure of the smart boot. Once the smart boot is successfully commercialized, it could be prescribed by orthopaedic surgeons to patients with leg injuries. The smart boot is expected to get a good response because of it is ease of use and cost efficiency.

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3. SENSING TECHNOLOGY FOR OBTAINING LINEAR POSITION OF A TARGET

Design engineers from different fields find in difficult to accurately measure the linear position in machines, switches, brakes, pedals, and so on. This is due to the fact that the technologies used for measuring linear position do not give precise measurement due to presence of dust, oil, and other impurities in the environment.

Inductive sensing is a method that can be applied in these circumstances since it is a magnet-free technology, provides precise measurement accuracy, and is also contactless with respect to the conductive target. This method uses an inductance-to-digital converter (LDC) that measures inductance shift caused in the inductive target as it moves along an AC magnetic field. An eddy current is generated in the target due to the magnetic field from the sensor. A secondary magnetic field, which opposes the sensors field, is generated by the eddy current causing a change in the already observed inductance shift as the target moves along the sensor.

One of the methods in inductive sensing is to use a circular coil and a target shaped like a triangle. The travel range of the target is directly proportional to the length of the target and it is 130% of the overall length of the target. The resolution obtained during this method is excellent and the coil size is 20% of the travel range.

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The second method is for a rectangular target and it uses a stretched coil. The travel range in this method is directly proportional to the length of the coil. The coil size is 130% of the travel range of the target and the target size is 10% to 20% of the coil's length. Both the methods can be used on conductive materials with the need for a magnet and in situations where dust, moisture, oil, and permanent magnetic fields are present in the environment.

Instead of shaping the target according to the magnetic field, in inductive sensing method it is possible to shape the AC-magnetic field around the target. A stronger magnetic field can be produced and shaped on one side by stretching the coil according to the targets shape. As the distance of the coil from the inductive target is increased, the strength of the magnetic field slowly starts to decay. Higher resolution can be obtained when the distance between the target and the coil is very minimal. A longer target will also generate a higher resolution since the metal exposure will be more and the eddy current formed will cause a heavy secondary magnetic field. Since the travel length of the inductive target is not related to the size of the target, a target smaller than the travel range of the coil can be used. This allows using this method for liner measurements in space constrained situations.

This novel method allows shaping the AC-magnetic field of the sensor coil around a target according to its design. While designing the system, designers can decrease the space requirements of the target and the resolution obtained is in the micrometer range. The main advantage of this method is that it gives a precise measurement of the linear position, it is highly reliable, and the position sensing of the target is contactless.

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4. PATENTS FOR IMAGE SENSORS

Charged coupled device (CCD) and complementary metal oxide semiconductors (CMOS) are two main types of image sensors that convert light into an electric charge.

In the CCD sensor, every pixel's charge is transferred through a limited number of output nodes to be converted to voltage, buffered, and sent off-chip as an analog signal. All the pixels are devoted to light capture, and the output has high uniformity. In the CMOS sensor, each pixel has its own charge-to-voltage conversion, and the sensor can often include amplifiers, noise-correction, and

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digitization circuits, so the chip outputs digital bits. While the CMOS sensor can have a more complex design with reduced area for capturing light, CMOS image sensors have lower noise and higher speed than CCD image sensors, require less power to function, and are less expensive to manufacture.

Key players are constantly optimizing and innovating in the field of image sensors. It is evident that new patents are being filled on a regular basis mostly from the United Nations and Korea, followed by other Asian countries such as Japan and China.

Two patents have been filed by Samsung Electronics in this domain. One of the patents (US 20150208006) pertains to an image sensor and the method of correcting the output signal of the image sensor, while the other patent (US 20150208010) pertains to an image sensor and its processing system.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Image sensor	JULY 30,2015/ WO 2015110647	Universite Catholique de Louvain	Bol, David	In an image sensor, a photo detector circuit (305) provides a detection quantity (308) having a level that depends on an amount of light to which the photo detector circuit has been exposed during a photo detection time interval. A front-end circuit (306) provides an output signal (309) indicative of the amount of light in response to at least one input signal, among which is the detection quantity (308). The front-end circuit comprises a transistor (315) having a threshold voltage that affects a relationship between the output signal (309) and the level of the detection quantity (308). This transistor (315) has a biasing node (319) via which a biasing voltage (320) can be applied to a semiconductor region (318) that affects the threshold voltage of the transistor. A replica (1401) of the front-end circuit receives at least one defined input signal (1406, 1407), among which is a substitute of the detection quantity (308) having a defined level (1406). The replica (1401) is arranged in a control loop (1408) that controls the biasing voltage (320) that is applied to the biasing node in the replica, so that the replica (1401) provides a defined output signal (1412). This biasing voltage (320) is then also applied to the biasing node (319) in the front-end circuit.
Image sensor having improved dicing properties, manufacturing apparatus, and manufacturing method of the same	JULY 30,2015/ WO 2015111419	Sony Corporation	Yamamoto, Atsushi	The present technology relates to techniques of preventing intrusion of moisture into a chip. Various illustrative embodiments include image sensors that include: a substrate; a plurality of layers stacked on the substrate; the plurality of layers including a photodiode layer having a plurality of photodiodes formed on a surface of the photodiode layer; the plurality of layers including at least one layer having a groove formed such that a portion of the at least one layer is excavated; and a transparent resin layer formed above the photodiode layer and formed in the groove. The present technology can be applied to, for example, an image sensor.

Thermal image sensor and user interface	JULY 23,2015/ US 20150204556	Panasonic Intellectual Property Corporation of America	Koichi Kusukame	A thermal image sensor including: a plurality of infrared detector elements that detect infrared light in a detection area; and rotors that scan the detection area in a scanning direction to detect, with the plurality of infrared detector elements, infrared light in an area to be captured as a single thermal image. The plurality of infrared detector elements include infrared detector elements arranged in mutually different positions in a rotational direction corresponding to the scanning direction of the plurality of infrared detector elements.
Fast image sensor for body protection gear or equipment	JULY 23,2015/ US 20150206322	Kiomars Anvari	Kiomars Anvari	An image sensor for body protection gear and equipment for monitoring and detection of impacts from surrounding object. The image sensor comprises multiple image processors to record images, use images to estimate and calculate environment parameters, and a controller to process the data. The controller utilizes the received information from image processors to estimate and calculate various environmental parameters which can be used to activate certain functions and devices.
Image sensor and method of correcting output signal of the image sensor	JULY 23,2015/ US 20150208006	Samsung Electronics Co., Ltd.	Young-Chan Kim	A method of processing signals from an image sensor outputting signals from rows of pixels in the image sensor having optical signals, outputting signals from rows of pixels in the image sensor not having optical signals, and correcting the signals from the rows of pixels having optical signals based on the signals corresponding to the rows of pixels not having optical signals.
Image sensor and image processing system including the same	JULY 23,2015/ US 20150208010	Samsung Electronics Co., Ltd.	Tae Chan Kim	An image sensor includes a plurality of pixel groups each of which includes pixels corresponding to at least two row lines among a plurality of row lines in a pixel array, a readout block configured to read out pixel signals output from the pixels in each of the pixel groups, and a row driver configured to control an operation of the pixel groups. The row lines are differently spaced according to position information of the pixels.
Image sensor with oblique pick up plug and semiconductor structure comprising	JULY 23,2015/ US 20150206918	Himax Imaging, Inc.	Kihong Kim	An image sensor includes a substrate, multiple pixel regions separately disposed in the substrate, and a pickup region including a doping region and a pick up plug obliquely disposed on the doping region and directly contacting the doping region.
Image-sensor device structure and method of manufacturing	JULY 23,2015/ US 20150206917	Taiwan Semiconductor Manufacturing Co., Ltd.	Cheng-Ming CHIU	Embodiments of an image-sensor device structure and a method of manufacturing thereof are provided. The image-sensor device structure includes a semiconductor substrate and a light-sensing region in the semiconductor substrate. The image-sensor device structure also includes an interconnect structure over the semiconductor substrate, and the interconnect structure includes a transparent dielectric layer over the light-sensing region. The transparent dielectric layer has an optical transmittance ranging from about 90% to about 97%.
Photoelectric conversion element, imaging device, and optical sensor	JULY 23,2015/ US 20150207087	Sony Corporation	Toru Udaka	An organic photoelectric conversion element, an imaging device, and an optical sensor, which can detect a plurality of wavelength regions by a single element structure, are provided. The photoelectric conversion element is formed by providing an organic photoelectric conversion portion including two or more types of organic semiconductor materials having different spectral sensitivities between the first and the second electrodes. Wavelength sensitivity characteristics of the photoelectric conversion element change according to a voltage (bias voltage) applied between the first

				and the second electrodes. The photoelectric conversion element is mounted in the imaging device and the optical sensor.
Image sensor, driving method, and electronic apparatus	JULY 23,2015/ US 20150208008	Sony Corporation	Yuji Gendai	An image sensor includes a capacitor, a low-impedance virtual battery, and a boost current source. The capacitor includes one end connected to a vertical signal line and the other end. The low-impedance virtual battery is connected to the other end of the capacitor and configured to detect a current flowing in the capacitor. The boost current source is configured to provide a boost current to the vertical signal line, the boost current being a current corresponding to the current flowing in the capacitor.

Exhibit 1 depicts patents for image 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.

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