TECHNICAL INSIGHTS

SENSOR

TECHNOLOGY ALERT

06th June 2014

1. CARBON NANORODS FOR MULTISPECTRAL IMAGING

Multispectral image sensors are used to capture information from many different bands of the electromagnetic spectrum to provide images with a great deal of detail.

Researchers at the Surrey University in UK have developed a new sensor that detects light from a wide range of the electromagnetic spectrum, stretching from the ultra violet to near infrared (NIR) regions. This sensor effectively overcomes the challenges faced by bulk crystalline semiconductors that are used for NIR applications. The challenges can include high cost of manufacturing, limited spectral range, and difficulty in keeping the semiconductor material pure.

The sensor developed at Surrey University uses low-cost organic materials, as well as, semiconductor nanocrystals. The major component of the sensor is single crystal nanorods comprising Buckminsterfullerene (C60), which is a spherical fullerene. The researchers used an ultralow photodoping mechanism, employing both inorganic and organic photodopants. This process enhances the photosensitivity of the C60 nanorods. Once excited, the photodopants majorly play two important roles of absorbing the photons, and facilitating the flow of current. First, the dopants increase the photoconductivity by filling the trap states through interfacial electron transfer. The electron transfer also contribute to photocurrent generation as the holes are trapped by the photodopants. The two processes lead to an external quantum efficiency of about 100%. The sensor has a large linear dynamic range, which means that it generates a linear response for light levels ranging from nanoWatts/cm2 to milliwatts/cm2. These features enable a single detector for multispectral imaging. This will bring down the cost of such systems that normally employ multiple sensors.

The researchers further demonstrated that the developed photodetectors can be fabricated at room temperature on flexible substrates. The compatibility with flexible electronics widens the application scope of the sensors, which have potential in low-cost security cameras and medical imaging where NIR imaging can be integrated with visible light imaging. The fabrication was done using a planar interdigitated electrode architecture and ultraviolet lithography. The fabrication process can be integrated with the widely used complementary metal oxide semiconductor (CMOS) process, with a single step for metal electrode deposition.

The research team will be focusing on NIR applications and developing more robust packaging for the sensors. The findings of the research have been published (in an article titled, Ultrahigh Performance C60 Nanorod Large Area Flexible Photoconductor Devices via Ultralow Organic and Inorganic Photodoping) in Nature's Scientific Reports on May 23, 2014. The developed C60 nanorod photoconductors can represent a significant advancement in the area of organic photodetector technology and its compatibility with large area electronics architecture. In the future, such organic photodetectors will have opportunities to be employed in a variety of applications requiring NIR capabilities.

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2. GLUCOSE DETECTION USING NON-INVASIVE SENSOR

Detection of blood glucose levels for people affected by diabetes can be a rather uncomfortable experience as the process of drawing blood using a needle prick needs to be done at frequent intervals. Researchers have been looking at other alternatives; but the use of blood for detection or monitoring of diabetes has maintained dominance globally. The main challenge in using the saliva instead of blood is that the concentration of glucose in saliva is about 100 times lower than that in blood. Thus, the required sensitivity of the saliva glucose sensor should be much more than traditional blood glucose sensors.

To address this need, researchers at Brown University in United States have developed a biochip sensor that can be used to monitor glucose levels in fluids such as saliva. The researchers combined plasmonic interferometry with

dye chemistry in developing the sensor. Plasmonic interferometry is a technology for detecting chemicals using light. The sensor developed using these principles is able to determine glucose concentrations down to few thousand molecules in a sample. The sensor also exhibits high selectivity, implying that it can differentiate glucose from the other components present in saliva.

The sensor is composed of a square inch quartz piece that is coated with silver. The silver layer consists of thousands of tiny slits, known as interferometers. The slits are 100 nanometers in width and each has a groove on each side measuring 200 nanometers in width. When exposed to light, the grooves release electron waves that travel toward the slit. The waves of electrons interfere with the light passing through the slit. The pattern of interference due to this phenomenon is detected by highly sensitive detectors. When liquid is deposited on the chip, the interference pattern alters, depending on the chemical composition of the liquid. The distance between the slits and the grooves can be adjusted to calibrate the interferometers for detecting the signature of specific molecules or compounds. This process has very high sensitivity and requires only a small volume of the sample.

Dye chemistry was used to generate a marker for glucose, which can be tracked. The biochip consists of microfluidic channels through which two enzymes--glucose oxidase and horseradish peroxidise--are introduced. Glucose oxidase first reacts with glucose and forms a molecule of hydrogen peroxide, which reacts with the peroxidise to generate a molecule of resorufin. Resorufin absorbs and emits red light, rendering the solution a red color. The interferometers are tuned to track the red resorufin molecules. By detecting the number of resorufin molecules, the concentration of glucose is determined, since each glucose molecule results in the formation of one resorufin molecule.

The researchers have tested this device using artificial saliva, consisting of a mixture of water, enzymes and salt, resembling human saliva. The results were promising as the detection of resorufin was done with high accuracy and specificity. In future phases of the research, the researchers aim to start testing with human saliva. The researchers aim to develop a small device that can be used to monitor glucose levels non-invasively. Apart from being used as a substitute for conventional blood glucose monitoring, the sensor platform can be potentially used for detecting other chemicals also. The work was funded by

the National Science Foundation of United States and the Juvenile Diabetes Research Foundation.

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3. TRANSPARENT OBJECT DETECTOR FOR PROCESS CONTROL INDUSTRY

Sensors play an important role in the process control and manufacturing industry. In the process line where units move at a high speed and continuously through various stages of processing and packaging, sensors are used for detection of various parameters, such as pressure, flow, temperature, humidity, package integrity, and so on.

Omron Corporation, headquartered in Japan, has a wide portfolio of sensors for industrial automation. The company has recently added a new sensor that is able to detect transparent objects for the food and beverage industry. In this sector, the use of transparent packaging is increasing with materials such as glass and polyethylene terephthalate (PET). The sensor, E3S-DB, uses optical sensing technology to detect all kinds of transparent objects used in food and beverages packaging process.

The product was developed in collaboration with companies in the food and beverage field to meet user requirements more effectively. The optical system used in E3S-DB enables sensing with a high-dynamic range and low hysteresis, which results in the device achieving outstanding performance. The sensor is able to detect a mere 3% attenuation of light intensity from a distance of 4 meters. The high stability of the system is achieved by cutting off what is known as the bottle lens effect. This happens due to the magnification of the intensity of light through glass bottles, which affects less stable sensors. PET bottles that are used in the beverage industry are becoming thinner on a regular basis. To meet the requirement of detecting those ultra thin bottles, the E3S-DB uses special polarizing filters via a technique known as polarized opaquing. The sensor is also immune to changes in light levels normally caused by ambient conditions or due to contamination.

The E3S-DB also comes with a smart tech function, which allows the setting up of the device quickly and effortlessly. With this feature the light intensity threshold can be set seamlessly. By manually selecting the operational

threshold level using a trimmer switch maximum operating stability can be achieved for the sensing objects. The sensor can automatically adjust light emission power and sensitivity in accordance to the distance from the object and selected threshold value. The setting from one sensor can be easily copied to other sensors, which allow significant time savings while setting up multiple sensors on the same production line. The device also comes with a computer monitoring tool, which enables detection of optimum position of the sensor in a detection zone.

For processes where the gap between two units is extremely small, a narrow beam model of the E3S-DB is available. In this model, the convergent beams have a very small focused spot of 2 mm for a distance of 200 mm.

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4. RECENT PATENTS IN THE FIELD OF VEHICLE CRASH SENSING

Technological advancements are enabling modern vehicles to avoid accidents, thereby increasing the safety of passengers, pedestrians, and other road users. Sensors play an important role in vehicle crash prevention as well as crash detection. Sensors such as radar, ultrasonic sensors, laser scanners, and image sensors are primarily being used for crash avoidance, while accelerometers are widely used for crash sensing for airbag deployment. In the case of a crash, it is important to activate safety systems such as airbags and seat belt tightening.

There have been efforts to detect a crash instance before it actually happens. This helps in activating safety systems to ensure maximum possible safety is provided to the passengers and pedestrians. For pedestrian protection, airbags embedded into the hood of a vehicle are activated when a collision with pedestrians is detected. This can be detected by, for example, accelerometers in front of the vehicle. Volvo is one notable car manufacturer, which has developed such a system. Currently, sensors are able to detect direction and force of impact, which act as key inputs for subsequent safety deployment. Such technologies as radar, passive infrared sensors, and cameras can also help enable pre-crash safety. Among recent patents, patent no EP2682309 by Autoliv pertains to an alternative power source which can power a post crash

safety system in case the primary power source gets damaged in the event of a crash. Also, Continental Automotive has a patent (EP2678191) pertaining to a crash sensor for motor vehicles that includes an elastically deformable tube having a cavity and at least one pressure sensor for detecting the pressure change in the cavity in the tube.

PATENT TITLE	PUBLICATION DATE / NUMBER	ASSIGNEE	INVENTORS	ABSTRACT
A motor vehicle safety arrangement	07.05.2014; EP2727774	AUTOLIV DEV	BENGT PIPKORN	A motor vehicle safety arrangement is disclosed which is operable in the event of an impact between the vehicle (1) and an external object (2). The arrangement comprises an impact guide (5) mounted to the structure of the vehicle in a front region of the vehicle. The impact guide (5) is configured for actuation from a first configuration to a second configuration in response to an actuation signal from a crash sensor. The impact guide (5) is mounted to or formed integrally with a frontal transverse beam (6) forming part of the structure of the vehicle (1), the beam (6) being located within or behind the front bumper or fender (3) of the vehicle. The impact guide (5), when in its actuated second configuration, presents a guide surface (21,22) for impact with the external object (2), the guide surface (21,22) facing outwards and extending rearwards at an acute angle relative to the central longitudinal axis (15) of the vehicle.
Vehicle inertial sensor systems	29.04.2014; US08712599	Analog Devices Technology	Westpfahl Michael	Integrated crash and vehicle movement sensing by use of distributed new multi-axis satellite sensors combines side and/or front/rear crash sensing with other applications requiring dynamic vehicle movement data like (but not limited to) roll and/or pitch detection as well as active suspension, head light beam leveling, etc. Depending on the required functionality, two or more satellite sensor modules are used, which measure multi-axis high-g and low-g acceleration, without needing any further sensor inputs like gyroscopes while achieving a high level of failsafe and redundancy.

AN AUTOMATIC VEHICLE BRAKING SYSTEM AND A CONTROL METHOD THEREOF	10.04.2014; WO/2014/054937	CHONG, Woi Joon	CHONG, Woi Joon	The present disclosure relates to an automatic vehicle braking system for avoiding crash or collision and to mitigate the effects or severity of an imminent crash or collision to provide better safety. The automatic vehicle braking system comprises of at least one distance measuring sensor and speed measuring sensor, wherein the sensor measures the relative distance between the own vehicle and a leading vehicle as well as the speed of the own vehicle and the leading vehicle, and a processor which receives sensor signals from the sensor(s) and calculates the relative distance between the own vehicle and the leading vehicle as well as the speed of the own vehicle and leading vehicle. The processor is set with threshold distance values for maintaining distance between the own vehicle and other vehicle(s) or obstacle(s). If the relative distance measured by the distance measuring sensors, taking into account the speed of both the own vehicle and the leading vehicle, is calculated to be lower than the predefined threshold distance value(s), the processor automatically applies the brakes of the own vehicle and locks the wheels of the own vehicle to slow down and to stop the own vehicle almost instantly, avoiding a crash or collision between the own vehicle and other vehicle(s) or obstacle(s). The wheels of the own vehicle remain locked and the braking effects are maintained during and after an imminent crash or collision to mitigate the effects or severity of the crash or collision. This invention overcomes the weaknesses of current vehicle braking technologies, where the optimum braking force of the own vehicle cannot be achieved to stop the vehicles from crashing or colliding into other vehicles or obstacles and braking effects are not maintained during or after a crash or collision to mitigate the effects and severity of the crash or collision.
ROLL OVER BUNK RESTRAINT SYSTEM AND METHOD	27.02.2014; WO/2014/031109	VOLVO GROUP NORTH AMERICA, LLC	LANGHOFF, Richard V	The present invention relates to a roll over restraint system for a vehicle. The roll over restraint system includes a mattress, restraint belt section, and one or more activation sensors. The restraint belt section extends laterally across the mattress. The one or more activation sensors detect the occurrence of at least one of a vehicle declaration threshold, a vehicle attitude change threshold, or a vehicle crash and in response thereto generate a signal. The signal results in at least one pre-tensioning devices increasing the tension applied to the restraint belt section and/or inflation of the restraint belt section.

A power supply arrangement	08.01.2014; EP2682309	AUTOLIV DEV	DARRABA ROGER	A power supply arrangement (1) for supplying power to a vehicle safety device comprises a power supply line (5), a re-chargeable auxiliary power source in the form of a supercapacitor (21), a DC-DC converter (19), a control unit (13) and a voltage sensor (7). The control unit (13) controls the DC-DC converter (19) to operate in a buck mode to charge the supercapacitor (21) during normal vehicle operation. If the voltage on the supply line (5) drops below a predetermined level, for instance when a primary vehicle power source is disconnected during a crash situation, then the control unit (13) controls the DC-DC converter (19) to operate in a boost mode to increase the voltage from the supercapacitor (21) to output a supply line voltage to power components in a vehicle occupant restraint system.
CRASH SENSOR HAVING AN ELASTICALLY DEFORMABLE TUBE AND AT LEAST ONE PRESSURE SENSOR	01.01.2014; EP2678191	CONTINENTAL AUTOMOTIVE GMBH	GOETZ THOMAS	The invention relates to a crash sensor, in particular for motor vehicles, consisting of an elastically deformable tube having a cavity and at least one pressure sensor for detecting the pressure change in the cavity in the tube, wherein the tube has an inside diameter of between 2.5 and 6 millimeters and an outside diameter of less than 12 millimeters. The dimensions of said tube are surprisingly small in relation to the size of the bumper, in particular while also considering that the tube is preferably arranged behind an absorbing element. However, such a small, thin tube proves to be especially suitable for providing a significant pressure signal for differentiating a pedestrian impact from an impact against a rigid obstacle, for example a lamppost or tree, in the specified speed range.

Exhibit 1 lists some of the recent published patents in the field of vehicle crash sensing.

Picture Credit: USPTO/Frost & Sullivan

Back to TOC

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