TECHNICAL INSIGHTS

SENSOR

TECHNOLOGY ALERT

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1. NOVEL SENSOR BASED ON PHOTODETECTION PRINCIPLE

Current photodetector or photodetection sensors used for identification and authentication for high-security applications, such as secure payment or border monitoring, are often bulky and too expensive for easy global deployment. Typical photodetection material based products are less intuitive, more invasive and not affordable systems and solutions for identification in the medical, security, and user interface markets. There is a need for novel photo-detection material based products that enable more intuitive, less invasive, flexible and affordable systems and solutions.

To address the above challenges, NikkoIA, a company based in Grenoble, France, has developed a photodetection material that can be deposited on semiconductor substrates as a thin film layer. The photodetection material is very sensitive to visible light and infrared light, and generates an electrical signal based on the amount of infrared light it absorbs.

By harvesting certain wavelengths of light, the photodetection materials function as high-performance and cost-optimized sensors. The sensor can easily be adjusted in size, shape, sensitivity, and resolution. The photodetection material is receptive to visible and infrared light and generates an electrical signal based on the harvested light. It is made of both organic and inorganic components sensitive to specific wavelengths and can be easily adjusted by modifying the nature and mix of these components. Depending on the need of the application, this enables very high sensitivity either to a specific wavelength of light or to a large range, that is, from the visible spectrum to the near infrared spectrum. The electrical signal is processed by a transistor or semiconductor on which the photodetection material is applied. The material is deposited by extremely simple, mature, and robust processes such as spray or

spin coating, which ensures cost-efficiency and interoperability with the latest electronic substrate developments. This technology enables competitive solutions compared to current technology and opens new opportunities for near infrared image sensors.

For medical applications, the near infrared light has the capability to penetrate the upper layer of the skin, providing non-invasive access to tissues. This will allow better treatments for patients by collecting additional information on pathologies and providing more efficient healthcare. NikkoIA's multi-spectral, scalable and flat sensors will allow multi-modal identification, keeping the security process simple and raising security levels. NikkoIA technology will also help to design cost-efficient large area user interfaces with multi-touch capabilities.

NikkoIA is a spin-off from Siemens founded in 2011, and is currently part of an FP7 collaborative project to develop organic semiconductors for near infrared (NIR) optoelectronics. The company will benefit from EUR 1.5 million in subsidies over the next two years as a result of participation in several EU funded collaborative development projects it joined in 2013.

NikkoIA and Siemens AG have signed a worldwide license agreement regarding access to Siemens' patent portfolio on photodetector technology. Some of the patents have already been granted by Siemens to NikkoIA and some are in the process of being granted. A key focus is on transfer of technology and knowhow of the newly developed photodetection material and its rapid development.

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2. CHEMIRESISTIVE SENSORS FOR FOOD SAFETY

According to C2Sense, $750 billion per year is the total cost of wasted food. Wasted food has a negative impact on the social, political and economic aspect of countries. The World Health Organization (WHO) has noted that millions of people worldwide fall sick every year due to the consumption of unsafe food. The common symptoms of foodborne diseases are stomach pain, vomiting, and diarrhea. Food contamination impacts food exports, tourism, and the livelihood of farmers, affecting the economy and society as a whole. Hence,

it is necessary that food is not contaminated with potentially harmful colorless gas or chemicals. The current solutions available in the market to measure ethylene, such as gas chromatography, infrared spectroscopy, or electrochemical sensors, can have issues such as size, cost, selectivity or sensitivity.. There is a need for a device that can detect the gas released when food ripens. In addition, detecting spoiled food at an early stage will be advantageous because it will help to keep other food from spoiling.

To address the above challenge, the US-based company C2Sense has developed a chip that identifies ripening fruit by detecting colorless gases such as ethylene, amines, and other relevant gases.

The different components that can be detected with the help of chemiresistive sensor chips are ethylene, biogenic amines, carbon dioxide and humidity. C2Sense has developed chemiresistive sensors, which can detect the concentration of the gas at low parts per million. Based on the concentration of an analyte, the sensing element in the chemiresistor changes the resistance. The sensor is used to sense the specific particles which causes a chemical reaction and triggers an alarm due to changes in the electrical current. To develop a chemiresistive sensor chip, C2Sense has employed single walled carbon nanotubes and two electrodes. The sensor is fabricated on the substrate with the help of abrasion. The sensing material is compressed in the pencil and is further drawn between the electrodes. The chemical reaction generated and showcased by the change in resistance is further passed on to the user's smartphone or tablet to interpret the information with ease.

The sensors by C2Sense can be deployed in various places, ranging from farms to household refrigerators. The new capability of the sensor helps to better manage the food supply chain. It can be used in retail shops, while shipping food, in storage areas and receiving docks. The sensor is cost efficient to produce and easy to use with other commercial electronics. The company's goal is to make its chip cost efficient and to enable it to be built into food product packaging. Intelligent packaging will monitor certain aspects of a food product in terms of quality of the food, keeping track of the abuse which might take place in the food supply chain. The technology can be used for all types of packaged food.

C2Sense, a spin off from MIT, was founded in 2013. The company and its research were funded by a National Science Foundation SBIR Phase I grant. Growth in awareness of the need for improved food safety will drive the demand for associated C2Ssense products. Increasing global food trade requirements that promote harmonization of standards and the implementation of safe food practices will help to reduce potential expensive food product recalls and drive the demand for innovative food safety products.

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3. ELECTROCHEMICAL SENSOR-BASED FOOD SAFETY CHECKER DEVICE

There are many harmful elements in food, such as antibiotic residue in meat, poultry, dairy, fish, and pesticide residue in vegetables and fruits and others such as acidity, salinity and glucose. Although consumers buy food with the organic label on it, they cannot determine if the food they consume is truly organic or not. The US Food and Drug Administration (FDA) has noted that 80% of the antibiotics sold were not made for humans; this is a global concern. There is a need for an accurate and highly sensitive food safety checking device.

To address the above challenge, researchers from a Korea-based company, Biosensor Laboratories Inc., have developed a food safety checker device called Penguin. According to Biosensor Laboratories, Penguin is the ideal solution for family food safety.

Biosensor Laboratories developed Penguin with a lab-on-a-chip, electrochemistry solution, noise reduction algorithms and nanotechnologies. With the help of Penguin, the consumer can check harmful elements inside food on their own. The procedure designed by Biosensor Laboratories to check food condition is very simple and easy. The researchers have provided Penguin with a removable cartridge. This cartridge can be fitted inside the structure of the Penguin and the internal algorithm helps to determine the food condition and sends the data over to the consumers' smartphone or tablet. To detect food condition, the consumer first needs to squeeze the food and allow the drops to flow onto the cartridge. The cartridge is further inserted in the Penguin and the result is displayed on the Penguin screen.

Penguin can be used in the complete food supply chain from farms to consumer refrigerators to maintain food quality till the time it is consumed. Because of its portable structure, it is easy to use and handle. It can be used in retail stores without any training; in addition, it can be used by farmers, chefs in hotels as well as in kitchens. Retailer demand for safer products and the need for increased value chain speed have forced companies to skip time consuming procedures to complete manual line and quality checks and to perform the necessary paper-based reports. With this device, Penguin has succeeded in addressing consumer demand.

Penguin is designed by Biosensor Laboratories and has been incubated by Seoul National University, Korea. Penguin was displayed at the CES 2015 exhibition and according to Biosensor Laboratories, it will be available in the market by January 2016. At present, it can be assumed that the total ownership cost of Penguin will be quite high because of which it might not be able to get a good response from individual consumers. In addition, the cartridge is made of a nanoporous, material which helps to increase the surface area of the sample that is being tested. In addition, the cartridge is removable and works like a printer cartridge which needs to be replaced after a certain amount of time. In this scenario, the return on investment for Penguin will be quite low.

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4. NANOMAGNETS ENHANCE SENSOR CAPABILITIES

Magnetic field sensors can detect magnetic fields from sources such as permanent magnets, currents in coils, magnetized objects, or the Earth's magnetic field. Magnets can concentrate the magnetic field to render it stronger where it is more useful. The phenomenon of nanomagnetism can result in nanomagnets with an increased surface or volume ratio, which renders them more susceptible to interaction effects with neighboring magnetic materials. Furthermore, nanomagnetic-based sensors can have key beneficial properties, such smaller size, higher sensitivity, and lower power.

In a move that advances nanomagnets with opportunities in areas, such as sensors or information encoding, researchers at US-based Los Alamos National Laboratory, in collaboration with a team at the Department of Physics at the University of Illinois at Urbana-Champaign, the Lawrence Berkeley National Laboratory's Advanced Light Source and other researchers nationwide, have achieved a nanoscale, artificial magnet. This feat was accomplished by arranging an array of magnetic nanoislands along a geometry that is not found in natural magnets.

As noted in "Emergent reduced dimensionality by vertex frustration in artificial spin ice," published online in Nature Physics (26 October 2015), the reduction in the dimensionality of a physical system can significantly affect its properties, as in, for example, the ordering of low-dimensional magnetic materials and the electronic states of graphene. The researchers investigated the emergence of quasi-one-dimensional behavior in two-dimensional artificial spin ice, a class of lithographically fabricated nanomagnet arrays used to study geometrical frustration. The implementation of artificial spin ice was extended by fabricating new array geometry, the tetris lattice. It was demonstrated that the ground state of the tetris lattice consists of alternating ordered and disordered bands of nanomagnetic moments. The disordered bands can be mapped onto an emerging thermal one-dimensional Ising model. Moreover, it was revealed that the level of degeneracy associated with such bands governs the susceptibility of island moments to thermally induced reversals, thereby establishing that vertex frustration can reduce the relevant dimensionality of physical behavior in a magnetic system.

Each nanoisland magnet has a north and south pole. Furthermore, its magnetization can change by flipping north or south via the use of applied fields or thermal fluctuations. In addition, the interaction of such islands leads to a collective behavior that can be exploited with respect to emerging properties and applications, which could range from general magnetism (for example, developing sensors) to information encoding.

The magnet is designed to go from two-dimensional behavior to one-dimensional behavior. As temperature is reduced to room temperature, the magnet transitions from being a standard magnet into a condition where it exhibits dimensional reduction, in which the alternating ordered and disordered stripes have distinct kinetic behaviors. The ordered stripes are static.

The work pertains to efforts to achieve bottom-up design of the desired properties and emerging behaviors of magnets. The latest research is part of an effort begun in 2006, when the team designed the first artificial spin ice, a two-dimensional array of magnetic nanoislands fabricated to interact in complex ways, depending on the chosen design of the array. The highly complex ordering of nanoscale magnets in spin ice materials (rare-Earth titanates) obey the same rules that determine the positional ordering of hydrogen and oxygen atoms in frozen water ice. Both have spin, or degrees of freedom, with frustrated interactions that prevent complete freezing, even at absolute zero.

Certain challenges were encountered with respect to, for example, developing an approach for randomizing the systems and producing consistent magnetic ensembles. Employing new experimental protocols that allowed for thermally active materials, Cristiano Nisoli, a Los Alamos staff scientist, designed topologies based on a new level of frustration. Frustration is a vital ingredient in the design of such materials. Frustration in artificial spin ice materials arises because many different constraints cannot be satisfied simultaneously. By designing constraints and engineering the frustration of the magnet, desired emerging behaviors can be obtained.

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5. RECENT PATENTS IN THE FIELD OF GESTURE RECOGNITION

The gesture recognition capability of electronic devices enables them to communicate with users in an easy and natural way, eliminating the need for manual input mediums such as keyboards, buttons, a mouse and so on. The current focus is on interpreting face and hand gestures which are decoded by algorithms to understand what the user is trying to communicate to the computing device. Gesture recognition can allow for natural human-machine communication without conventional input devices.

The key gesture control technologies include vision-based technology (such as stereoscopic vision), ultrasonic technology, infrared sensing technology, optical technologies using light-emitting diodes (LEDs) or lasers as light emitters, and electric field sensing technology. The advantages of gesture control technologies are that users can control the device without having to be

present in close proximity. In addition, touchless controls provide ease of communication and real life simulation in a virtual world.

There is a concerted effort to further develop gesture control techniques in the North American region. In Europe, different countries, such as Belgium and Germany are actively developing gesture recognition techniques.

Some of the companies in gesture recognition include Leap Motion, Microchip Technologies, Samsung Electronics Co., Point Grab, and Omek Interactive.

With the help of patent filing trends it can be said that the consumer electronics industry will be hugely impacted by gesture recognition technologies. The major products in which gesture recognition will be deployed are smartphones, tablets, personal computers, laptops, and television sets. It will then percolate to a plethora of electronic devices including toys. Automotive, home automation, healthcare, virtual gaming, and robotics will witness the impact of gesture control technologies.

According to the patent filing scenario, sensor-based gesture recognition technologies will be initially incorporated into consumer electronics. However, it has the potential to converge with any industry where man-machine interaction is required. From controlling machines to interacting with a humanoid robot, gesture recognition is likely to be adopted at a rapid pace.

A recent patent in gesture recognition, (WO/2015/167683), assigned to Qualcomm Incorporated, pertains to technology for touch and gesture sensing with an interactive display. The display includes a planar light guide, a light source, and at least one photo sensing element coupled with the first planar light guide.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Pressure, rotation and stylus functionality for interactive display screens	05.11.2015; WO/2015/167683	Qualcomm Incorporated	Wyrwas, John Michael	This disclosure provides systems, methods and apparatus related to touch and gesture recognition with an electronic interactive display. The interactive display has a front surface that includes a viewing area, a planar light guide disposed proximate to and behind the front surface, a light source, and at least one photo sensing element coupled with the first planar light guide. The planar light guide is configured to receive scattered light, the received scattered light resulting from interaction between light emitted by the light source and an object in optical contact with the front surface. The photo sensing element is configured to detect at least some of the received scattered light and to output, to a processor, image data. The processor is configured to recognize, from the image data, one or both of a contact pressure and a rotational orientation of the object.
Air and surface multi-touch detection in mobile platform	05.11.2015; WO/2015/167742	Qualcomm Incorporated	Seo, Hae-jong	Systems, methods, and apparatus for recognizing user interactions with an electronic device are provided. Implementations of the systems, methods, and apparatus include surface and air gesture recognition and identification of fingertips or other objects. In some implementations, a device including a plurality of detectors configured to receive signals indicating interaction of an object with the device at or above a detection area, such that a low resolution image can be generated from the signals, is provided. The device is configured to obtain low resolution image data from the signals and obtain a first reconstructed depth map from the low resolution image data. The first reconstructed depth map may have a higher resolution than the low resolution image. The device is further configured to obtain a second reconstructed depth map from the first reconstructed depth map. The second reconstructed depth map may provide improved boundaries and less noise within the object.
Gesture interaction with a driver information system of a vehicle	29.10.2015; WO/2015/162058	Bayerische Motoren Werke Aktiengesellschaft	Menath, Andreas	The invention relates to a control device for moving and/or magnifying display content, wherein the control device comprises: a display unit having display content; at least one camera, which is designed to record a sensing region in front of the display unit; a gesture-recognition unit, which is coupled to the at least one camera and is designed to recognize a predetermined gesture performed with a hand and a current position of the gesture in the sensing region; and a display-content adapting unit, which is designed to adapt the display content in accordance with a change of the current position of the gesture, in particular to move the display content accordingly in the event of a change of the position in a plane parallel to the display unit and/or to enlarge or reduce the size of the display content in the event of a change of the position toward or away from the display unit.
Using distance between objects in touchless gestural interfaces	28.10.2015; EP2936279	Google Inc.	Kauffmann Alejandro	A function of a device, such as volume, may be controlled using a combination of gesture recognition and an interpolation scheme. Distance between two objects such as a user's hands may be determined at a first time point and a second time point. The difference between the distances calculated at two time points may be mapped onto a plot of determined difference versus a value of the function to set the function of a device to the mapped value.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Gesture-based cues for an automatic speech recognition system	22.10.2015; WO/2015/011094	General Motors LLC	Gaurav Talwar	A method of recognizing continuous digits uttered by a speaker using an automatic speech recognition (ASR) system includes receiving continuous digits via a microphone as speech from a user; detecting that recognition of one or more of the continuous digits falls below a predetermined confidence threshold; prompting the user to identify the continuous digits using a body gesture; detecting the body gesture made by the user; and identifying one or more of the continuous digits based on the body gesture.
Image processing device and image display device	22.10.2015; US20150301612	Hitachi Maxell, Ltd.	Bondan Setiawan	The input device and the input system include a hand detection means which detects the position of the hand, a body part detection means which detects positions of user's body parts such as the face, for example, a relative position calculation means which calculates a relative position of the hand with respect to body parts from hand position information being a detection result of the hand detection means and body part position information being a detection result of the body part detection means, and a gesture recognition means which recognizes a hand gesture on the basis of a change in the hand position information being the detection result of the hand detection means, wherein when a hand gesture is recognized, the operation of the input device with respect to the user's gesture is changed according to a relative position of the hand with respect to body parts.
Gesture recognition method and gesture recognition apparatus	22.10.2015; US20150301609	Samsung Electronics Co., Ltd.	Jeongmin Park	A gesture recognition method and apparatus are provided. The gesture recognition method includes extracting one or more vector values from an input gesture; generating a pattern of a vector based on the extracted one or more vector values; comparing the generated pattern to one or more patterns of stored vectors; and determining a type of the input gesture based on the comparing.

Exhibit 1 lists some of the patents related to gesture recognition.

Picture Credit: Frost & Sullivan

Back to TOC