TECHNICAL INSIGHTS

SENSOR

TECHNOLOGY ALERT

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1. INVISIBLE HELMET WITH ADVANCED SENSORS

Bicycles are the most affordable and environmentally friendly way to travel short distances. However, the increasing number of vehicles on the road is causing major concerns over the safety of bicyclists. In 2013, according to the US National Highway Traffic Safety Administration's Center for Statistics and Analysis, 743 bicyclists were killed and about 48,000 were injured in motor vehicle crashes. Bicyclists were either hit by vehicles or injured due to a bad fall or low-quality helmets, which cannot handle the impact of the crash. There is a need for a robust helmet which can bear the impact of the crash and prevent head injuries. The helmet should be easy to wear and comfortable enough to be worn for a long time. For cyclists who are not inclined to wear a helmet, the style and design should be appealing enough to convince him/her to use one.

To address the above challenges, a Sweden-based company Hovding has developed an invisible helmet with embedded sensors and a gas inflator. The invisible helmet is basically a collar which can be hooked very easily onto the cyclist's shoulder.

Hovdings' invisible helmet serves as an airbag which inflates and surrounds the head in case of accidents. The airbag is made up of nylon fabric and takes 0.1 seconds to inflate fully before the head impact. The airbag maintains the pressure in case there are multiple head impacts. The airbag completely covers the head as well as the ears. Helium is used to inflate the airbag, which is placed inside the collar and rests on the cyclist's back. To turn the helmet on and off, the company has provided ON and OFF buttons at the front of the collar. When the helmet is switched on, a light-emitting diode glows and sensors start collecting the data about the cyclist's movements. Hovding has employed two different sensors-- accelerometers and gyros--to track the cyclist’s movements. The sensors are capable of distinguishing between normal and abnormal movements. The sensor records the data every 10 seconds in a black box, which is placed inside the collar and compares it with the records in the database. Once the abnormal movement is sensed with the help of the sensors, the airbag is inflated in 0.1 seconds before head impact. In addition, the company is also proving a USB charging slot to charge the helmet battery.

Hovding has developed the invisible helmet by taking into consideration the cyclist’s needs; it is easy to use and does not destroy the cyclist’s hair systle, which is a drawback associated with helmets. Hovding helmets have a registered CE trademark which indicates CE declaration of conformity that the helmet is safe to wear.

To attract new customers, Hovding is planning to develop helmets in new designs and colors. Hovding has begun distributing its helmets in the European market and is planning to expand to the US in the coming years. In June 2015, Hovding was listed in the NASDAQ stock exchange, confirming its entry into the US market.

At present, Hovding’s invisible helmet is expensive when compared with the other polystyrene helmets available in the market. Once the airbag is inflated, the invisible helmet cannot be reused. To make the helmets available for everyone, Hovdings could benefit from reducing the price of its helmet. If the air bag becomes more cost-efficient, it will gain greater adoption among bicycle riders.

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2. GRAPHENE AND BORON NITRIDE-BASED MAGNETIC SENSOR

Magnetoresistance (MR) magnetic field sensors undergo a change in electrical resistance in response to an applied magnetic field. The types of magnetic field sensors that are generally considered based on the magnetoresistance effect include anisotropic magnetoresistance (AMR) sensors, giant magnetoresistance (GMR) and tunneling magnetoresistance (TMR) sensing technologies.

Applications for such magnetoresistance sensors include disk drive read heads, automotive (for example, wheel speed sensing), vehicle counting, orientation in mobile devices, position and angle sensing, and so on.

Magnetic field sensors with very high sensitivity allow for more accurate measurements without being affected by noise sources such as geomagnetic noise. Furthermore, high sensitivity magnetic sensors require less signal amplification.

The level of integration is becoming very important for magnetic sensor manufacturers to differentiate their products and to target various new applications. The importance of the level of integration of sensing devices is that they can be manufactured in a batch manner, reducing manufacturing costs. Magnetic sensors with integrated on-board electronics also provide a smart sensing solution.

An interdisciplinary team of researchers, led by Yang Hyunsoo, associate professor in the department of electrical and computer engineering at the National University of Singapore (NUS), has developed a hybrid magnetic sensor comprised of graphene and boron nitride that provides considerably greater sensitivity than the magnetic sensors typically commercially available; for instance, existing sensors made of silicon or indium antimonide. Such sensing materials are used in Hall effect magnetic sensors. Hall effect sensors are widely used in applications such as, automotive engine management and wheel speed sensing, consumer electronics, computing, current sensing, flow rate sensors, proximity sensors, brushless DC motors.

For example, when measured at 127 degrees C (the maximum temperature at which most electronics products are operated), the researchers observed a gain in sensitivity of over eight-fold compared to previously reported laboratory results and more than 200 times that of most commercially available sensors. Moreover, in "Extremely large magnetoresistance in few-layer graphene/boron-nitride heterostructures," published on September 21, 2015, in Nature Communications, the researchers reported an extremely large local magnetoresistance of approximately 2,000% at 400 K and a non-local magnetoresistance of greater than 90,000% in an applied magnetic field of 9T (tesla) at 300K in few-layer graphene/boron-nitride heterostructures.

The new sensor, made of graphene and boron nitride, comprises a few layers of carrier-moving channels, and each one can be controlled by the magnetic field. The sensor was tested at different temperatures, angles of magnetic field, and with a different pairing material. It was found that a bilayer structure of graphene and boron nitride exhibits a very large response with respect to magnetic fields. In addition, by employing graphene, the mobility of the carrier can be adjusted to tune the voltage across the sensor.

The new sensor has the potential to lead to the development of more compact, less expensive magnetic sensors for diverse areas, ranging from consumer electronics, communications technology, and healthcare to automotive applications. It also has the potential to provide enhanced properties, such as high sensitivity to low and high magnetic fields, tunability, and very small resistance changes due to temperature. The ability of graphene to display stable performance over temperature variations can eliminate the need for expensive wafers or temperature compensation circuitry.

For example, the digital compass sector is providing a boost to the magnetic sensor market. Not only is the digital compass becoming a standard feature in conjunction with the global positioning systems (GPS) of tablets and mobile phones, the device is finding its way into gaming applications, cameras, and other devices.

Controlling the proper thickness of the magnetic film layers can be improved from the above manufacturing methods. The emerging technologies of magnetic sensors are expected to have improved fabrication processes. This can facilitate an increase in performance and quality and a decrease in offset and thermal dependency.

Due to the latest developments in low-margin mass market applications, a high volume of sales is generally required to achieve profitability. In the future, the manufacturing method which will reduce the time to market will serve as a main differentiator.

A patent for this invention has been filed; and, after this proof-of-concept study, the researchers plan to scale up their investigation and manufacture wafers for industrial use.

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3. MICROFLUIDIC TACTILE SENSOR

In unstructured work environments, robots are often in contact with humans. In such situations, the sense of touch is critical to the safety, accuracy, and efficiency of operations. In household applications, contact, force, and tactile data are required or beneficial for educated manipulation of soft materials. To maximize productivity, robots must have the ability to better gauge or emulate the emotional and physical state of human beings involved in operations. To achieve this, improved tactile sensors are required. Acquiring and interpreting spatially distributed touch information is difficult because of the large area and high resolution requirements of sensors. At present, tactile sensors have limitations in size, robustness, resolution, and deformability.

To address the above challenge, researchers from the National University of Singapore have developed a liquid-based microfluidic tactile sensor. According to the researchers, the tactile sensor is cost effective to produce and simple. In addition, the sensor is thin, small, durable and highly flexible.

The researchers have employed a sensing method based on liquid-based pressure sensing to develop a microfluidic tactile sensor. A flexible substrate of silicon rubber is employed by the researchers. This further helps the sensor to be highly flexible, thin, small and wearable. In addition, graphene oxide is employed in liquid form as a two dimensional nontoxic nanomaterial. The graphene oxide is used to sense the change induced by the applied force. The two materials help the novel tactile sensor to bear stretching, pressing, and bending.

The researchers have filed the patent for a highly flexible tactile sensor. In addition, the university is planning to commercialize its technology by adopting two different types of business models, that is, licensing or partnership. The university is more inclined towards licensing its technology to OEMs (original equipment manufacturers).

Tactile feedback and vision systems provide robots with greater accuracy. Advances in sensors will enable robots to expand into less traditional applications, such as biomedical and clinical laboratories. Automated warehouse distribution is expected to be one of the applications that will experience growth in the future. Fusing data from tactile sensing, force control and vision will help robots to gain intelligence and sense their environment efficiently.

Microfluidic tactile technology is poised to impact the electronics industry, enabling OEMs to produce lighter and more compact devices. In addition, the thin layer does not require re-engineering of the device display stack. It replaces the front layer of the display stack, without any change to the underlying touch panel or display of the device. In the future, companies will employ liquid microfluidic technology to produce thin tactile layers for devices of different sizes, ranging from mobile phones to TV screens.

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4. NOVEL METHOD TO DEVELOP FLEXIBLE SENSOR

Flexible manufacturing systems aim at high variety, high volume production of goods, or to be able to efficiently produce the volume of goods required. The major factors which are driving the industry to move towards adoption of flexible manufacturing are shorter life cycles of products, smaller plant floors, and pressure to improve quality and increase variety. With respect to the conventional solutions, there are certain unmet needs in the fabrication process, such as reducing the end-to-end processing time, achieving good quality, and increasing the level of fabrication yield. In addition, developers of flexible manufacturing systems need to keep the cost barriers and the technical requirements such as cycle time, efficiency, and repeatability in mind.

To address the above challenge, researchers from the University of California, San Diego have developed a new method that reduces the time taken to produce highly flexible sensors for medical applications, which can easily be stuck on the skin and peeled off from the body. The project is funded by the National Science Foundation Center for Science of Information, Naval

Medical Research Center, The Hartwell Foundation, the Bill and Melinda Gates Foundation, Kavli Foundation and other graduate research fellowship programs.

The researchers at the University of California, San Diego have identified a microfabrication approach and adhesive-peeled (AP) processing to manufacture flexible sensors in fifty percent less time than the conventional approach. To develop a flexible sensor, the researchers have employed a poly dimethylsiloxane (PDMS) substrate. The PDMS substrate is a 50 micrometers thick layer, which is prepared with the help of spin coating and curing. Thin metal film of gold and chromium is deposited on the PDMS substrate with the help of an electron beam evaporator. The gold layer is 200 nm in thickness and the chromium layer is 5 nm in thickness forming a photodefinable polyimide. The polyimide is further spin coated, soft baked and exposed to UV (ultraviolet radiation) to ensure complete curing and bonding of the gold and chromium layers. The wafer is then dipped in the chromium and gold etchants to remove the metal surfaces that are not necessary. Then the device is laminated with the help of target adhesive films and delaminated. For the complete end-to-end process, the total time required for the researchers was 5 hours. With the conventional process, the total time required to manufacture the flexible sensors is 10 hours. Thus, the novel method for development of the highly flexible sensor requires only half the time taken by conventional methods.

The above-mentioned flexible sensor is expected to first be adopted in the biomedical industry for monitoring brain and heart signals. In the future, the technology will be explored for cancer detection and genetic analysis.

Compared to traditional silicon-based electronic devices, flexible biosensors can provide an economical solution for high-volume medical applications such as single-use, disposable sensors. The lightweight and flexibility features allow it to be integrated or embedded into a wide range of form factors such as the body and accessories, enabling smart-systems integration. Advantages such as low-cost and quick manufacturing process will drive the adoption of flexible sensors in the large-area sensor matrix in the short-term.

During the long-term, silicon manufacturers are likely to invest more in improving the capability of silicon-based flexible sensors. The organic materials used in flexible sensors have a short life time, limiting their applicability to short-term application sectors. Additionally, they do not have stable characteristics, which affect their reliability. The technology is still in the development phase with activities in place to address technical challenges.

The potential of flexible sensors has garnered the interest of the private sector and the government. There is an increase in investment on research and development activities to improve the capabilities of the technology. Global partnerships are accelerating development and commercialization activities. Collaborations are formed not only between research institutes and companies, but also between companies across different value chains.

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5. RECENT PATENTS IN THE FIELD OF ULTRASOUND TRANSDUCERS

In healthcare, an ultrasound transducer generates high-frequency ultrasound waves to produce images of structures within the human body. Such waves are reflected off bodily tissues and a transducer recives the echoes and sent to create a sonogram. Medical applications for ultrasound include radiology, obstetrics and gynecology, cardiology, surgical and other emerging segments.

Ultrasound equipment has been in use in hospitals for a long time for imaging and diagnosis. Although ultrasound images are not as precise as images obtained from magnetic resonance imaging, ultrasound is relatively quick and inexpensive and the sound waves are potentially less harmful to human tissues than X-rays. Moreover, the need to perform diagnostic imaging at primary care centers has driven the adoption of ultrasound modalities in the primary care centers and imaging clinics that are not a part of hospitals. Employing ultrasound as a diagnostic tool caters to the increasing demand, and also helps in streamlining the treatment workflow. As a result, more primary centers will adopt the latest ultrasound systems, and this trend will drive the ultrasound market and technology advances as well as patent filings in ultrasound.

Technological advances in handheld ultrasound technology have allowed the equipment to be used across different departments for diagnosis. More recently, it is finding application in image-guided interventional surgeries, owing to its portability and size.

The radiology ultrasound and obstetrics and gynecology ultrasound segments are relatively mature, and the cardiology ultrasound segment will soon approach maturity as a result of increased patent filings and adoption in many hospitals. The surgical ultrasound segment is still in the growth phase and is expected to grow at a solid pace.

With the help of the patent filing scenario, it can be said that many companies are investing in the emerging ultrasound technologies. Competition in this niche market is set to gradually intensify.

Some of the participants in the ultrasound market include Siemens AG, Koninklijke Philips N.V. (Philips Healthcare), and GE Healthcare, Hitachi Medical Systems, Teratech Corporation, FUJIFILM SonoSite, Inc., and Samsung Medison Co. Ltd.

A recent patent for an ultrasound transducer (WO/2015/164301), assigned to Koninklijke Philips N.V, includes an intravascular ultrasound device and a catheter with an integrated controller for imaging and pressure sensing.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Catheter with integrated controller for imaging and pressure sensing	29.10.2015; WO/2015/164301	KONINKLIJKE PHILIPS N.V.	STIGALL, Jeremy	An intravascular ultrasound (IVUS) device that includes a flexible elongate member having a proximal portion and a distal portion; a controller coupled to the distal portion of the flexible elongate member; an ultrasound transducer disposed at the distal portion of the flexible elongate member and in communication with the controller; a pressure transducer disposed at the distal portion of the flexible elongate member and in communication with the controller; and plurality of conductors extending from the controller to the proximal portion of the catheter, at least one conductor of the plurality of conductors being configured to carry both the signals representing information captured by the ultrasound transducer and information captured by the pressure transducer.
Reconfigurable device for checking a composite structure using ultrasound	28.10.2015; EP2936140	EADS EUROP AERONAUTIC DEFENCE	AUFFRAY STÉPHANE	The invention concerns an ultrasound device for checking the quality of a composite material structure (11) during the production cycle. The device is intended to be incorporated in production tooling, of the type enabling the LRI process to be performed, in which the composite material structure is placed between two moulds during the production cycle. To that end, it comprises a layer of piezoelectric material (22) deposited on the face of one (13) of the moulds, opposite the face which is in contact with the structure (1), and a film (21) of flexible material which is electrically insulating and one face of which is placed against the outer face of the layer (22). This face of the film further comprises conductive pads (31) which are thus placed in contact with the piezoelectric material, it being possible for each pad to be energized by electric voltage applied by means of a conductive strip (32). Each pad (31) forms an independent ultrasonic transducer with the region of the layer (22) opposite which it is placed.
Focused rotational IVUS transducer using single crystal composite material	28.10.2015; EP2934329	VOLCANO CORP	CORL PAUL DOUGLAS	An ultrasound transducer for use in intravascular ultrasound (IVUS) imaging systems including a single crystal composite (SCC) layer is provided. The transducer has a front electrode on a side of the SCC layer; and a back electrode on the opposite side of the SCC layer. The SCC layer may have a bowl shape including pillars made of a single crystal piezoelectric material embedded in a polymer matrix. Also provided is an ultrasound transducer as above, with the back electrode split into two electrodes electrically isolated from one another. A method of forming an ultrasound transducer as above is also provided. An IVUS imaging system is provided, including an ultrasound emitter and receiver rotationally disposed within an elongate member; an actuator; and a control system controlling emission of pulses and receiving ultrasound echo data associated with the pulses. The ultrasound emitter and receiver include an ultrasound transducer as above.
Ultrasound generation	28.10.2015; EP2934770	UNIV LEEDS	FREEAR STEVEN	An ultrasound generator comprising a signal generator and a transducer, and a method of generating ultrasound. The signal generator is arranged to receive, generate or calculate when instructed a modulating signal with a magnitude that varies within a first range, the signal generator is further arranged to generate a pulsed drive signal having a predefined first relationship to the modulating signal, the pulsed drive signal having at least a zero output level, a positive output level and a negative output level, wherein the position and width of pulses are defined by at least first and second switching angles per half cycle of the modulating signal. The transducer is arranged to generate ultrasound in response to the pulsed drive signal. The first relationship is selected such that within at least part of the range of magnitude of the modulating signal the first and second switching angles are adjusted simultaneously to provide for an increase or decrease in the magnitude of the fundamental frequency of the pulsed drive signal corresponding to an increase or decrease in the magnitude of the modulating signal. The first relationship is also selected such that a selected harmonic component of the generated pulsed drive signal is maintained below a first threshold..

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Method for verifying the reliability of ascertained measurement data from an ultrasonic flow measurement according to the transit-time difference method and ultrasonic flow meter	28.10.2015; EP2936080	FLOWTEC AG.	WANDELER FRANK	Method for verifying the reliability of ascertained measurement data from an ultrasonic flow measurement according to the transit-time difference method, wherein an ultrasonic flow meter having at least two ultrasonic transducers is used to emit and receive ultrasound signals transversely in a flow direction or counter to a flow direction of a measurement medium, wherein within a first time window prior to receipt of a first useful ultrasound signal, which propagates substantially through the measurement medium between the transducers, a first ultrasound interference signal is recorded, wherein the first ultrasound interference signal propagates at least partially in the measurement medium between the ultrasound transducers, wherein within a second time window prior to receipt of a second useful ultrasound signal, which propagates substantially through the measurement medium between the transducers, a second ultrasound interference signal is recorded, wherein the second ultrasound interference signal propagates at least partially in the measurement medium between the ultrasonic transducers; wherein the first and the second useful ultrasound signals are assigned in each case to two ultrasound signals which are transmitted in opposite directions through the medium, and wherein a quality criterion for evaluating the measurement uncertainty of a measurement value is ascertained, which is proportional to the transit-time difference ascertained from the first and second useful ultrasound signals, the ascertainment of which comprises a difference formation between the first and the second interference signal.
Method and system for generation of sound fields	22.10.2015; US20150304789	NOVETO SYSTEMS LTD	Noam Babayoff	A system and method for providing sound-data indicative of an audible sound to be produced and location-data indicative of a designated spatial location at which the audible sound is to be produced; and utilizing the sound-data and determining frequency content of ultrasound beams to be transmitted by an acoustic transducer system including an arrangement of ultrasound transducer elements for generating said audible sound. The ultrasound beams include primary audio modulated ultrasound beam(s), whose frequency contents includes ultrasonic frequency components selected to produce the audible sound after undergoing non-linear interaction in a non-linear medium, and additional ultrasound beam(s) each including ultrasonic frequency component(s). The location-data is utilized for determining focal points for the ultrasound beams respectively such that focusing the ultrasound beams on the focal points enables generation of a localized sound field with the audible sound in the vicinity of the designated spatial location..
Hand-held medical imaging system with thumb controller and associated systems and methods	22.10.2015; US20150297185	FUJIFILM Sonosite, Inc.	Amanda Mander	A portable ultrasound system having a thumb controller is disclosed herein. A portable ultrasound system configured in accordance with one embodiment of the disclosure includes a transducer device and a hand-held base unit removably coupled to the transducer device. The base unit is configured to perform an ultrasound scan and to produce a split screen display. The split screen display includes an active image area at which images of a patient obtained from ultrasound signals received by the transducer device are displayed. The split screen display also includes a thumb control area that is accessible by a user's thumb when holding the portable ultrasound system. For example, the thumb control area can include a thumbwheel having one or more controls that can be selectively activated by the user's thumb when holding the portable ultrasound system and are rotatable on and off of the thumb control area.

Exhibit 1 lists some of the patents related to ultrasound transducers.

Picture Credit: Frost &Sullivan

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