TECHNICAL INSIGHTS

SENSOR

TECHNOLOGY ALERT

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1. DETECTING METALLIC CONTAMINANTS USING SENSORS

It is vital to be able to reliably detect very small metallic contaminants in food to prevent health risks. One method used to detect metallic (or other types of) contaminants, which, due to their density, chemical composition, or mechanical dimensions, absorb X- radiation to a greater extent than the surrounding product, is X-ray radiation.

However, X-ray radiation has limitations in that this method is unable to reliably detect contaminants smaller than 1 mm. Furthermore, X-ray detection cannot be used to inspect foods containing lactic acid bacteria, since such foods are subject to ionization from the X-ray radiation.

The superconducting quantum interference device (SQUID) is the most sensitive sensor of weak magnetic fields. SQUID magnetic sensors are capable of sensing magnetic fields in the range of several femto testa to 9 tesla.

In contrast to DC (direct current SQUIDs) RF SQUIDs are able to work with only one Josephson junction (superconducting tunnel junction)), and, therefore, could be less expensive to produce. However, RF SQUIDs are less effective than their DC counterparts.

SQUID sensors require cooling. Initially, SQUID sensors required cooling to liquid helium temperature. More recently, high-temperature SQUID sensors made of high-temperature superconductors such as YBCO (yttrium barium copper oxide) are cooled by liquid dnitrogen.

In a move that portends extended opportunities for SQUID sensors in significant materials characterization applications, researchers at the Department of Environmental and Life Sciences at Toyohashi University of Technology, led by Professor Saburo Tanaka, have developed a workable metallic contaminant detection system for food inspection that employs three high temperature SQUIDs. The SQUID sensors detect the contaminant’s remnant magnetic field. A

strong magnetic field applied to the food magnetizes nay metal fragments in the food; and such metals can be detected using the SQUID sensors to sense their magnetic fields.

The inspection system developed by the researchers enables detection of metal contaminants in a food package that is 100 mm in height. Digital filters allow for improving the signal-to-noise ratio for detection of even smaller metal fragments. At a stand-off distance of 100 mm, the target size of the magnetic contaminant in food is 0.5 mm.

The researchers placed the sensor in a square metallic box made of 2 mm iron-nickel alloy plates to reduce the effect of noise. The food is able to be tested as it passes through the box. Since magnetic fields have strong affinities to the nickel-alloy, the magnetic fields around the sensor are concentrated in the walls of the box. Experiments demonstrated the ability of the metallic contaminant inspection system to detect a steel ball with a diameter as minute as 0.3 mm, without being compromised by electromagnetic waves from mobile phones or steel objects.

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2. ULTRASOUND SENSORS FOR IMPROVED BREAST CANCER SCREENING METHOD

Worldwide, a large population of women are getting diagnosed and treated for breast cancer every day. It is a kind of cancer that develops from the breast cells and can affect both men and women. Many researchers and healthcare companies are determining new methods and technologies to cure breast cancer.

At present, to find traces of breast cancer, only x-ray mammography is typically used; and for further investigation, conventional ultrasound is typically used. Furthrmore, breast thermography, which uses infrared imaging to detect heat patterns indicative of breast abnormality, can be used for non-invasive, early detection of breast cancer.

Since the X-ray mammography method is only two-dimensional (2D), many x-rays at different angles should be taken. Also, this method is not capable of capturing the overlaying tissues separately. The ultrasound method that is conventionally used is not able to capture a clear image. This makes it difficult for

doctors to clearly distinguish between the healthy and the cancerous tissues, leading to false interpretations.

The National Physical Laboratory (NPL), Precision Acoustics Ltd., Designwork, North Bristol NHS Trust (NBT), and University Hospitals Bristol (UHB) have collaborated to find a novel method for detecting breast cancer. The aim was to create a method that can be more efficient and precise than the conventional ones. The team was able to develop a prototype ultrasound sensor for a new and more productive, safe and economical screening method to find traces of breast cancer in women. This method employs pyroelectric sensors made of pyroelectric material. The sensors have the ability to create an ultrasound image from electrical signals emitted by converting ultrasonic energy generated by sound waves passing through the patient's body.

NPL has developed and patented a novel detection method employing pyroelectric sensors, which convert ultrasonic energy into heat, generating electrical signals which are eventually used to form the ultrasound image.

Ultrasound waves are sent through the patient's breasts, which are placed in a hot water bath between an ultrasound transmitter and receiver. The energy emitted from this method is measured by the prototype sensor while the transmitter and receiver array are rotating at a 360 degree angle to produce a clear three dimensional (3D) image of the breast that shows different types of tissues including the ones that are affected by cancer.

The researchers call this new system 'ultrasound computed tomography (UCT)', in which, this newly developed sensor will be a vital part. Precision Acoustics has manufactured the prototype of the pyroelectric sensors, which are being analyzed, optimized and tested at NPL. The researchers think that the newly developed sensor system has the capabilities to overcome the problems faced by the conventional x-ray mammography method.

The breast screening system will be ready for deployment at NBT for clinical evaluation after all the project components are merged in one single platform. To convert this novel method and system to a proper clinical process, the team is planning to collaborate with a commercial partner to start the production and manufacturing process.

The researchers believe that this method of capturing the 3D images is highly accurate, easier to interpret, and very economical compared to x-ray-based mammography. Clinical assessment of ultrasound computed tomography is expected to start on a small group of patients by the end of 2017.

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3. SMALLER MICROSENSOR FOR IMAGE CAPTURING IN SMART PHONES

As technologies advance, they are also integrated and implemented in common devices used on a daily bases. One such market in which the devices are improved and technology upgraded extensively is smartphones. The key companies in this market continuously analyze and research different possibilities and technologies that will optimize or increase the efficiency and performance of smart phones.

One such leading company, Samsung Electronics, has announced a new image sensor for 16 megapixel (Mp) cameras. The S5K3P3 is a unique image sensor in the market, with 1.0ìm (micrometers) pixels. This new sensor will leverage existing ISOCELL technology which Samsung is currently using.

The pixels in ISOCELL technology decrease any crosstalk between neighboring pixels by forming a barrier between the neighboring cells. This controls the electron collections from other cells, thereby increasing the color fidelity and lighting conditions during contrasting lighting conditions. When the magnetic or electric field of one circuit affects the signal of another, a disturbance arises. This disturbance is termed as crosstalk. ISOCELL technology decreases the noise and excess color generated from crosstalk by 30%, resulting in capturing an image with improved quality, sharpness, and original color by accurately capturing the photons emitted by light. To obtain a greater dynamic range, S5K3P3 designed with ISOCELL will use the pixels isolated inside the walls to photo sense and capture images with more depth.

Most of the major smart phone manufacturing companies use larger sensors that generate larger pixels so that more light can be captured in an image. Samsung has decreased the sensor size from 1.2ìm to 1.0ìm so that these sensors can better fit devices that will be slimmer and smaller. The new sensors have reduced the module size by 20%, providing smart phone manufacturers the ability to design and develop smart phone devices that have z axis height less than 5 mm, without compromising on the resolution of the camera.

The main disadvantage of these new sensors is that during dim lighting, the image captured by ISOCELL technology will not be properly enhanced. The company is working toward addressing this problem as this technology will be

used for producing thin and slim profile smart phones which many end users prefer.

The S5K3P3 sensors are already being manufactured and are available in the market from July 2015 for other smart phone manufactures to purchase. Since Samsung has not revealed the release of a new smart phone with this sensor and technology, there is a high possibility that other companies will obtain this product and manufacture devices supporting the high-end sensors. Devices with S5K3P3 sensors are expected to commercialize by the end of 2015.

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4. RECENT PATENTS IN THE FIELD OF BIOACOUSTICS SENSING

Bioacoustics is a combination of biology and acoustics. Bioacoustics technology comprises the creation, detection, and reception of sound, as well as the relation of acoustics signals to the medium through which they are dispersed. Bioacoustics sensing captures natural acoustics conduction properties in a human and animal body using different sensing technologies, such as acoustics or ultrasound signals, vibration, or pressure.

Bioacoustics sensing has been used on humans for medical applications, such as measuring body sounds on skin surface. Other medical applications where bioacoustics sensors have opportunities include regeneration of hearing and restoration of the body, reducing cancer tumors, allergies, and body pain. In addition, it can also be employed in electronic applications, and to locate and identify animals.

There are a relatively limited number of patents registered under bioacoustics sensing. The United States is leading, with the largest number of patents in bioacoustics sensing in the world. Patent activity for bioacoustics sensing in the Asia Pacific region is relatively less than in the United States and Europe. The global patent trend suggests that bioacoustics sensing is in the nascent stage and will witness global adoption in the next five to six years.

The development of bioacoustics sensing is emerging with increasing research. The market is still in its infancy, but is projected to grow significantly over the next ten years. Bioacoustics sensing is a disruptive technology, which will replace existing technologies such as wearable user interfaces and other devices used in

the medical sector. Bioacoustics sensing will be used to diagnose diseases in the early stages. Commercial applications enabling smart phones are expected to drive the demand for bioacoustics sensing in the next five years.

A recent patent in bioacoustics sensing (US20150119758), assigned to 3M Innovative Properties Company, pertains to bioacoustic sensing with active noise correction. The invention includes a transducer that generates an acoustic signal and an actuator to deform a portion of the signal from the transducer to increase the signal-to-noise ratio of the acoustic signal.

Title	Publication Date/ Publication Number	Assignee	Inventor	Abstract
BIOACOUSTIC SENSOR WITH ACTIVE NOISE CORRECTION	30.04.2015; US20150119758	3M INNOVATIVE PROPERTIES COMPANY	Daniel J. Rogers	A bioacoustic sensor assembly is described including a transducer generating an acoustic signal and an actuator configured to deform a portion of the transducer to increase a signal-to-noise ratio of the acoustic signal. The disclosure also provides methods and systems for reducing the impact of noise vibrations at the transducer.
BIOACOUSTIC PROCESSING APPARATUS AND BIOACOUSTIC PROCESSING METHOD	29.01.2014; EP2689728	PANASONIC CORP	ENDO MITSURU	A bioacoustic processing apparatus capable of outputting information that represents the current state of attachment of a bioacoustic sensor. The bioacoustic processing apparatus (300), which processes acoustic signals from a bioacoustic sensor (200) attached to a body surface, comprises: a noise-extracting unit (320) for extracting the noise component contained in an acoustic signal from the acoustic signal, and a noise type classification unit (340) for classifying the extracted noise component into one of a plurality of noise types that correspond to different respective states of attachment of the bioacoustic sensor (200) and outputting information that corresponds to the results of said classification.
Bioacoustic processing apparatus and bioacoustic processing method	20.06.2013; US20130158435	Mitsuru Endo	Mitsuru Endo	A bioacoustic processing apparatus capable of outputting information that represents the current state of attachment of a bioacoustic sensor. The bioacoustic processing apparatus (**300**), which processes acoustic signals from a bioacoustic sensor (**200**) attached to a body surface, comprises: a noise-extracting unit (**320**) for extracting the noise component contained in an acoustic signal from the acoustic signal, and a noise type classification unit (**340**) for classifying the extracted noise component into one of a plurality of noise types that correspond to different respective states of attachment of the bioacoustic sensor (**200**) and outputting information that corresponds to the results of said classification.

Weighted bioacoustic sensor and method of using same	08.12.2011; US20110301503	3M Innovative Properties Company	Carim Hatim M.	A sensor for sensing bioacoustic energy includes a housing comprising an interfacing portion configured to establish coupling with a body part during use. The sensor includes a transducer element coupled to the interfacing portion of the housing and configured to sense sounds produced by matter of biological origin. One or more conductors are coupled to the transducer element. A mass element is compliantly coupled to a surface of the transducer element. Intervening material is disposed between the transducer element surface and the mass element, and allows for differential motion between the transducer element surface and the mass element during excitation of the transducer element.
Detection of body sounds	11.12.2008; US20080306367	Koehler Ulrich	Koehler Ulrich	Disclosed is a method for detecting and monitoring body sounds in humans and animals, in which bioacoustic sensors and analyzers that are mounted downstream are used for the stationary or mobile long-term monitoring of intensive care patients' respiration, for example. The patients' lung sounds are detected and stored along with measured data which are available right away especially for the early detection of diseases and acute disturbances. Adequately monitoring intestinal sounds makes it possible to evaluate peristalsis and detect mechanical/paralytic ileus early on. An early warning system for the clinical sector immediately generates signals allowing doctors and nurses to take rapid action in case of an emergency. The inventive apparatus requires a maximum of only three bioacoustic sensors (12), each of which can be fixed to a point of an object body (K) facing the object, a maximum of one sensor (14) for recording surrounding noises, a maximum of four separable channels (11) for recording and transmitting sound signals or sound data detected by the sensors (12), and devices for supplying power and forwarding, converting, storing, and displaying sequences of signals or data on or in a recorder or a computer unit (20).
Cantilevered bioacoustic sensor and method using same	10.12.2008; CN01321497	3M Innovative Properties Co.	Bharti Vivek	A sensor for sensing bioacoustic energy includes a housing comprising an interfacing portion configured to establish coupling with a body part during use of the sensor. An anchoring arrangement is defined on the housing. A transducer member has an anchoring end and at least one free end. The anchoring end of the transducer is coupled to the housing such that the transducer member is arranged to be preferentially sensitive to bioacoustic energy transferred to the transducer via the interfacing portion relative to other portions of the housing.

BIOACOUSTIC ANALYSIS SYSTEM, BIOACOUSTIC SENSOR AND BIOACOUSTIC ANALYSIS PROGRAM	25.09.2008; JP2008220558	KONICA MINOLTA MEDICAL & GRAPHIC INC	WADA YASUNORI	PROBLEM TO BE SOLVED: To highly accurately analyze biological sound related to a bioacoustic analysis system, a bioacoustic sensor and a bioacoustic analysis program. SOLUTION: This bioacoustic analysis system extracts voice information part caused by a subject included in first voice information or second voice information and being attributable to a subject on the bases of the first voice information based on biological sound emitted via the biological surface of the subject and the second voice information based on biological sound emitted via the mouth or the nose of the subject, and analyzes the biological sound of the subject using the extracted voice information part as an object.

Exhibit 1 lists some of the patents related to bioacoustics sensing.

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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Back to TOC