TECHNICAL INSIGHTS

SENSOR

TECHNOLOGY ALERT

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1. GESTURE-CONTROLLED DRIVER SEAT

Gesture-based sensing and control, or gesture recognition allows the movement of an individual's hands, fingers, head, or body to control electronic devices or machines. Gesture-based control enables more efficient, safe, and convenient interaction between individuals and machines or equipment. For these reasons, gesture-based control is finding expanding opportunities in key application segments, such as consumer electronics (including smart phones, laptops, and gaming consoles), and automotive.

Various techniques are used in gesture-based control and touchless sensing, and are capable of acquiring 3D images and depth information, such as: stereoscopic vision (which uses two cameras to obtain a left and right stereo image); structured light (which projects a pattern of light to detect or scan 3D objects); time of flight (which transmits a light pulse from an emitter to an object, and a receiver detects the reflected pulse and determines the distance of the measured object via calculating the travel time of the light pulse from the emitter to the target and back to the receiver in a pixel configuration); ultrasonic (send ultrasonic pulses that echo off an object such as the hand or palm and are received by the sensor to determine the position of the hands and fingers); electric field (emit an electric field and detect changes in the surrounding electric field due to gestures, such as hand gestures).

In automotive applications, gesture-based control has received media attention primarily for its ability to reduce driver distraction by being applied to functions such as activating in-car infotainment systems using hand gestures, controlling the volume of the radio, or controlling the heating and air conditioning system, navigation or smart phone connectivity.

Indicative of additional automotive applications for gesture control, researchers at the Fraunhofer Institute for Silicate Research ISC, in collaboration with Isringhausen GmbH & Co. KG., have devised a driver's seat for trucks that is able to be intuitively calibrated using gestures. Due to the sensor-based control system in the driver's seat, using simple hand gestures, the driver is able to move the seat forward or backward or up and down. Furthermore, using hand gestures, the driver can set the desired incline of the thigh support and back rest.

Such gesture control capability can help prevent back pain due to driving long hours in the vehicle's cabin. Adjustment of the shape and position of the seat to the driver's particular needs and preferences can help prevent back pain. Although trucks tend to have various seat positions available, it can be complicated or inconvenient for the driver to achieve the proper setting.

The solution includes different types of sensors integrated into a synthetic cover, allowing the seat to effectively react to the driver's hand motions. Piezo pressure sensors assure activation of the motion-controlled system. For activation, the driver briefly exerts pressure on a certain point on the side cover . This mode of operation prevents accidental triggering of the motion control. Moreover, seat positions can be stored by pressing several times.

Hand gestures are detected using proximity sensors that are built into the side cover. Such sensors are able to track tiny changes in electric fields in the surroundings, including electric fields generated through hand motion. A software program devised at ISC reads the sensor data and determines the hand's direction of motion. The arrangement of the sensors in the side panel is crucial. Electrodes are attached to the relatively confined space, enabling control gestures that are easy to use and beneficial from an ergonomic standpoint. An intelligent algorithm allows for evaluating multiple electrodes simultaneously, for enhanced reliability.

To set the seat's position, the driver brushes his/her hand along the side cover. The seat elements become adjusted, depending on the direction of motion of the gesture (that is, up or down, forward, backward, or diagonal). When the hand is moved away from the sensing area, after the settings have been established, the gesture control automatically shuts off. Via an LED, the driver obtains confirmation that the gestures have been successfully stored.

The sensor-equipped seat is at the functional prototype stage. In the future, the gesture-controlled seat, which is presently focused on the automotive arena, may also find opportunities in the middle and upper class automotive market for improved driver comfort.

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2. DEVELOPMENTS IN BRAIN-COMPUTER INTERFACE HEADSETS

A brain-computer interface (BCI) is a communications channel between the brain and a computer or an implanted or external device. The BCI allows cerebral activity alone to control external devices or computers and enables bi-directional communication between the brain and a device. BCI devices control, enhance, repair, assist or can be controlled by the human cognitive or sensory motor system.

Various BCI technologies are utilized. EEG (electroencephalography) is the prime technology in consumer BCI applications. EEG directly records the electrical activity of the brain and measures tiny differences in the voltage between neurons using electrodes attached to the scalp. EEG technology is minimally invasive and is readily translated into signals that a computer can interpret.

Traditional EEG systems have gel or wet contact electrodes; therefore, some liquid material can come between an individual's scalp and the sensor. In brain computer interface applications, such systems (depending on the number of electrodes) can take a long time (up to 45 minutes) to set up and can be uncomfortable. In contrast, dry EEG sensors do not require a liquid bridge and can take a minimal amount of time to set up.

In a move that can extend the opportunities for EEG systems for BCI in consumer applications as well as in wearable healthcare monitoring, Holst Centre, imec, and Delft University of Technology have introduced a comfortable yet high-quality wireless electroencephalogram (EEG) headset for brain-computer interfacing and monitoring emotions and mood using a smart phone application.

The imec wireless EEG headsets are suitable for consumer applications, including games for monitoring relaxation, engagement or concentration. Additional applications for the headsets can include attention or sleep training, and treatment of attention deficit hyperactivity disorder (ADHD).

There are challenges in being able to create a wireless EEG headset with dry electrodes that can achieve an optimal trade-off between comfort and signal quality. To achieve effective signal quality, sufficient pressure must be exerted to apply the dry electrodes to the sensing or measurement head. However, the user will experience greater discomfort with increased pressure.

The proper balance between comfort and signal quality in the imec and Holst Centre new headset is attained by using a design process where prototyping and testing and testing were conducted in short loops, which helped optimize the headset's shape and stiffness.

Three-dimensional (3D) printing, a layered, additive manufacturing process that enables less wasteful, rapid manufacturing and reduced product design and testing requirements, is used to make the EEG headset in a single piece. Subsequently, a 3D printed rubber inlay is used to cover the electronic components applied to the headset. The EEG sensors are at the front of the headset to be able to optimally acquire the EEG signals pertaining to changes in emotion or mood. The user's emotional condition is related to information about one's surroundings (such as location, time of day, proximity to other people) via a mobile app. In this manner, the user obtains awareness and insight about the influence of the environment on his/her emotions.

Achievement of the ergonomic design was enabled by leveraging imec's experience and skills in EEG sensing, dry polymer and active electrodes, miniature and low-power data acquisition capabilities, and low-power wireless interfaces for smart phones.

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3. ADVANCES IN HIGH-RESOLUTION MAGNETOCARDIOGRAPHY

Magnetocardiography (MCG) measures magnetic fields associated with the electric currents generated during the heart's activity. MCG is a non-invasive technique that provides very accurate measurement of very weak magnetic fields produced by currents flowing within myocardial fibers during cardiac activity. Although electrical activity of the heart is typically detected using electrocardiography (ECG) techniques, MCG can provide greater sensitivity than ECG in detecting abnormal cardiac electrophysiology. Moreover, MCG can provide information about heart function in addition to that derived from standard ECG or electrophysiological studies.

However, the MCG has typically been recorded using superconducting quantum interference device (SQUID) magnetometers in a magnetically shielded room. The shielded room serves to reduce any unwanted magnetic signals from metal objects or electrical instruments in the environment of the recording area. Furthermore, SQUIDs require cooling.

The tunnel magnetoresistance (TMR) magnetoresistive effect occurs in a magnetic tunnel junction (MJJ). TMR, a consequence of spin dependent tunneling, is based on a significant change of the tunneling current in magnetic tunnel junctions when the relative magnetizations of the two ferromagnetic layers change their alignment. The MTJ, made via thin film technology, is comprised of two ferromagnets separated by a thin insulator.

When the insulator is sufficiently thin, electrons are able to tunnel from one ferromagnet to another. The direction of the magnetization of ferromagnetic films can be switched via an external magnetic field. The electrons will most likely tunnel through the insulating film when the magnetizations are in a parallel orientation than when they are in an opposite anti-parallel orientation. The magnetic tunnel junction can, therefore, be switched between the two states of electrical resistance, one state having low resistance while the other one has very high resistance.

Sizable TMR values can be achieved at room temperature. In magnetic sensing, TMR devices can provide key benefits such as a higher signal level, high field sensitivity, lower power consumption.

In a move that represents advancement in the application of TMR in MCG, researchers at the Tohoku University, in cooperation with Konica Minolta, have developed a TMR sensor that works at room temperature and is capable of detecting biomagnetic fields in the body at high sensitivity and high resolution. The research group, led by Yasuo Ando a professor of the department of applied physics at the Tohoku University, was able to successfully detect cardiac magnetic fields using the TMR device.

The TMR device enables non-invasive, non-aggressive measurement of the heart's electrical activity, for improved diagnosis of heart conditions such as coronary heart disease or arrhythmia.

As the TMR device has a large magnetic field range, in the future, a special shield room for detecting the bio-magnetic fields would be required. In this arrangement, heart conditions could be detected and treated in a relaxed setting. Potential applications for the TMR device include medical treatment, preventive healthcare, and sports activities.

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4. THERMOCOUPLES FOR TEMPERATURE SENSING

A thermocouple is a sensor, which is used to measure temperature. Such devices are capable of measuring temperature accurately and precisely in harsh, hazardous, and high-temperature environments.

A conventional thermocouple consists of two wire legs made of different metals, which are welded together at one end to create a junction. A voltage is created in the junction when there is a temperature change. The types of thermocouples available include types R, S, and B and type J, K, T, N, and E. While type R, S, and B are noble metals thermocouples; types J, K, T, & E are base metal thermocouples (which are more widely used).

The thermocouple is a traditional, well-established type of temperature sensor used in diverse industries, such as oil and gas, pharmaceutical, pulp/paper, automotive, aerospace, and so on. Thermocouples are available in wide temperature ranges, can handle high temperatures, and are robust.

Microchip Technology Inc. (USA) has created a thermocouple, the MCP9600, which has a number of discrete devices integrated to one chip. This thermocouple has combined precision instrumentation; a precision temperature sensor; and a precision, high-resolution analog-to-digital converter (ADC) integrated in its circuit. The special designed thermocouple has firmware preprogrammed with a math engine to support both the types of thermocouples.

Moreover, the designer has to create a precision instrumentation circuitry to measure the microvolt-level signals of a thermocouple accurately. One of the main advantages of MCP9600 is that it does not require a discrete implementation since it is a thermocouple with plug and play capability.

This specially designed thermocouple is integrated with cold-junction compensation and does not require an ADC circuitry and instrumentation circuitry for measuring microvolt-level signals and temperature calculations. For reducing and cancelling the effects of electromagnetic interference, temperature fluctuations and noise from the system used, a temperature-data digital filter is integrated in MCP9600 by implementing a four user-programmable temperature-alert output. The designers were able to reduce the code space and the system's overhead microcontroller. The shutdown modes present in the system helps in reducing the overall system power consumption of the thermocouple-conditioning IC.

MCP9600 is very compact in size (5 x 5 mm) and, due to the reduction in the required board area, this system-on-a-chip thermocouple has reduced power consumption and cost.

This thermocouple has opportunities to impact the temperature sensors market by the end of 2016. The MCP9600 can be used for temperature monitoring in the industrial, petrochemical, automotive, and aerospace sectors.

From the patent analysis on temperature sensors, it is evident that most of the patents filed are from the United Sates, Korea followed by Japan and China. Companies such as Samsung Electronics (Korea), Denso Cooperation (Japan), and LG Electronics (Korea) have filed the most number of patents related temperature sensors. Patent DE000003806308 filed by Robert Bosch GmbH (Germany) pertains to a temperature sensor, which can also detect air velocity and radiation. Likewise, the patent WO1997032188 filed by AB Svensk Värmemätning SVM (Sweden) is related to manufacturing methods required to construct a temperature sensor with a measuring body.

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5. PATENT ANALYSIS--STRAIN SENSOR

A strain sensor converts pressure, tension, force into a measurable change in electrical resistance Strain results from the displacement and deformation that occurs when external force is applied to an object. A common, traditional type of strain sensor is the strain gage, a measuring device whose resistance changes with applied force.

The most number of patents are filed in United States followed by Japan, China, and Korea. Companies such as Matsushita Electric Industrial Co. Ltd., (Japan), Denso Corporation (Japan) and NTN Corporation (Japan) have filed the most number of patents on strain sensors.

From the patent analysis for strain sensors, it is evident that most of the patents filed are based on the manufacturing methods used to produce a strain sensor. A patent (EP 2889596) filed by Honeywell Romania S R L (Romania) pertains to a dynamic strain sensor that includes a strain-sensitive resistor and light-emitting diode and can include piezoelectric material. Hamilton Sundstrand Corporation (United States) has filed a patent (US20150204745) pertaining to a strain gauge pressure sensor circuit with a sensor disconnect detection. An electronic circuit for processing signals from a strain gauge pressure sensor includes an analog-to-digital conversion circuit, and a circuit for detecting when the sensor is suddenly disconnected from the signal processing circuit.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Strain sensor device with a biological substrate and method of manufacturing thereof	Aug 06, 2015/ US 20150216476	Innovative In Vivo Sensing, LLC	Hilmi Volkan Demir	A strain sensor device having a biological substrate composed of a standalone bone graft or an isolated piece of bone that can be incorporated directly into, or attached to another piece of bone that is then implantable, in a biological subject, and a method thereof. The strain sensor device can includes a strain sensing circuit, which is composed of at least a first dielectric layer and a first conductive layer, that functions as a strain gauge. The first dielectric layer can be composed of dielectric material disposed over the biological substrate. The first conductive layer, which has a pattern, can be disposed over the first dielectric material. A bonding interface is disposed between the biological substrate and the first dielectric layer. The bonding interface can be composed of an underlayer of polydimethylsiloxane and a first interface layer. The underlayer can be disposed on the bone graft substrate.
Strain sensor assembly	Aug 06, 2015/ US 20150219508	Thomas M. Bryant	Thomas M. Bryant	A strain sensor assembly is configured to detect one or more of forces applied to a structure having a recess. The strain sensor can include at least a pair of opposed strain gauge members that extend from the support member. Each strain gauge member defines a support portion carried by the support member and a biasing portion. The support portion includes at least one strain gauge sensor. The biasing portion is configured to bias against a wall of the recess of the structure when the strain sensor assembly is disposed in the recess. The strain sensor assembly is configured such that the at least a pair of strain gauge members form an interference fit with the wall of the recess when the strain sensor assembly is inserted in the recess.
Strain sensor assembly	Aug 06, 2015/ WO 2015117149	APS Technology, Inc.	Shapiro, Danny	A strain sensor assembly is configured to detect one or more of forces applied to a structure having a recess. The strain sensor can include at least a pair of opposed strain gauge members that extend from the support member. Each strain gauge member defines a support portion carried by the support member and a biasing portion. The support portion includes at least one strain gauge sensor. The biasing portion is configured to bias against a wall of the recess of the structure when the strain sensor assembly is disposed in the recess. The strain sensor assembly is configured such that the at least a pair of strain gauge members form an interference fit with the wall of the recess when the strain sensor assembly is inserted in the recess.
Optical fiber strain sensor system and method	July 30, 2015/ US 20150211899	Avago Technologies General IP (Singapore) Pte. Ltd.	Milos Davidovic	An optical fiber strain sensor system and method are provided that use pixels of a three-dimension (3-D) pixel sensor to sense the respective light beams passing out of the ends of a reference fiber and a measurement fiber and for converting the respective light beams into respective electrical signals. Because 3-D camera pixels have photodiodes that are directly connected by switches to integrators within the same die, the need to use separate TIAs and phase detection circuitry in each receive channel is eliminated, which reduces system complexity and overall cost. In addition, omitting the separate TIAs and phase detection circuitry for each channel eliminates the phase uncertainty that can occur when using those components, and thus improves measurement precision.

Strain gauge pressure sensor circuit with sensor disconnect detection	JULY 23,2015/ US 20150204745	Hamilton Sundstrand Corporation	Edward John Marrota	An electronic circuit for processing signals from a strain gauge pressure sensor includes an anti-alias filter, an analog-to-digital conversion circuit, and a detection circuit for detecting when the sensor is unexpectedly disconnected from the signal processing circuit. The detection circuit provides a yes/no indication of the connection of the pressure sensor to the circuit based upon whether a common mode voltage associated with one of the signal terminals of the pressure sensor is out of range.
Mounting bracket for strain sensor	JULY 02,2015/ WO 2015099763	Halliburton Energy Services Inc.	Sobolewski, Zbigniew	The subject matter of this specification can be embodied in, among other things, a system for mounting a strain sensor on a tubular pipe, which includes a mechanical clamp. The clamp has a bottom flexing section having an arcuate portion terminating at a first terminal and at a second end, and a first and second upper flexing sections having an arcuate portions terminating at first terminal ends and at second terminal ends in a pivot pin assembly having a bore parallel to a central longitudinal axis of the clamp, the bore there through for receiving a removable connector. Sensor mounting arms are disposed outwardly on the first and second upper flexing sections, said sensor mounting arms including at least one receptacle sized to receive and retain ends of a strain gauge.
Strain sensor and strain sensor installation method	JULY 02,2015/ WO 2015098425	CMIWS Co., Ltd.	Wakahara Masato	In this strain sensor and strain sensor installation method, a first base member fixes and supports one side of an optical fiber. A second base member fixes and supports the other side of the optical fiber. A connection member is configured from a separate member from the first base member and the second base member and is removably provided between the first base member and the second base member. Tension is applied to the optical fiber in a state in which the connection member is provided between the first base member and second base member, and in the state in which tension is applied, the optical fiber is fixed and supported by both the first base member and second base member.
Dynamic strain sensor and method	JULY 01,2015/ EP 2889596	Honeywell Romania S. R. L.	Dumitru Viorel Georgel	A dynamic strain sensor includes a strain sensitive transistor (38) and a light emitting diode (40) coupled to the strain sensitive transistor (38). The dynamic strain sensor can include a piezoelectric layer (16) incorporated into the structure of the strain sensitive transistor. The dynamic strain sensor can sense dynamic strain and can measure and monitor the dynamic strain wirelessly.
Dynamic strain sensor and method	JUNE 25,2015/ US 20150177078	Honeywell Romania S. R. L.	Viorel Georgel Dumitru	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.

Strain sensor and manufacturing method for strain sensor	JUNE 04,2015/ WO 2015080222	CMIWS Co., Ltd.	Wakahara Masato	In a strain sensor and a manufacturing method for a strain sensor according to the present invention, a plurality of support members are provided in a base member while protruding therefrom. An optical fiber is wound around each of the support members. When viewed from the side opposite to the base member, the optical fiber is provided while having fiber portions facing in different directions from each other between the support members. A securing material secures the optical fiber to the support member in a state where tension is applied to the fiber portions between the support members.

Exhibit 1 depicts patents on strain sensors.

Picture Credit: Frost & Sullivan, WIPO

Back to TOC

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