TECHNICAL INSIGHTS

SENSOR

TECHNOLOGY ALERT

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1. ADVANCED SENSORS KEY TO GROWTH OF WEARABLE ELECTRONICS

Wearable electronics has been a major point of interest with the development of many innovative products for multiple markets, such as, health care, fitness, consumer electronics, augmented reality, military/defense, and homeland security. Sensors play a pivotal role in these devices as they enable key functionalities in wearables. At present, a key market and target for development of wearable electronics technologies and products is healthcare. Fitness tracking is another area where many companies are investing as customers are becoming more concerned about a fit and healthy lifestyle. The augmented reality (AR) market also promises to boost the use of wearable sensors. Apart from basic sensors, AR also can integrate other sensors, such as image sensors, voice recognition, and gesture recognition capabilities that provide advanced functionalities.

Accelerometers and gyroscopes are commonly used sensors as they give motion and position information of the device and the user. The data gathered by these sensors is used to determine activities such as workouts, running, and jogging. The data can be clubbed with physiological data and give an overall health monitoring during such sessions. Among sensors for monitoring physiological parameters, body temperature sensors, electrocardiogram monitoring, and strain gauge sensors for muscle activity monitoring are seeing increased interest and use. The key challenge is to make the sensors small enough without compromising on their accuracy. Micro electromechanical systems (MEMS)-based sensors can play an important role to facilitate such capabilities..

Flexible electronics and sensors also have a lot of potential in wearable electronics. Flexible sensors can be easily worn on the body as skin patches and can also be part of smart fabrics. Companies such as MC10 (USA), Zephyr (USA), and Hidalgo (UK), and research institutes, such as, IMEC (Belgium) and Holst Centre (The Netherlands)(established by IMEC and TNO) are developing innovative sensor-based wearable health monitoring solutions based on flexible electronics.

Micro energy harvesting can prove to be a key enabling technology for wearable sensors. Since currently available battery capacity is not suitable for providing power for prolonged periods, harvesting ambient energy is a lucrative alternative. As more sensors get integrated into wearables, the amount of power required will also increase. Thus, energy harnessed from sources such as body heat, sunlight, and body movement (kinetic energy) needs to be channeled to power the electronics.

The widespread adoption of wearable electronics will depend on the accuracy of sensors and also the battery life of the products. Charging of the electronics at frequent intervals can be a deterring factor against adoption. Integration of energy harvesting, sensor fusion, and multi-parameter sensing capabilities will provide companies with a competitive edge in this market.

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2. BIOMETRIC FINGERPRINT SENSOR FOR ANDROID AND WINDOWS-BASED MOBILE DEVICES

Biometrics has been identified as a key enabler of enhanced security in passports and other applications such as smartphones. Biometric authentication is more secure than passwords or codes because the biometric trait is unique for each individual. The various biometric authentication techniques that are currently used include capturing, storing, and comparing information pertaining to a fingerprint, palm vein, iris, or face. Among these, fingerprint authentication is the most common type since the technology is highly mature. With the development of miniaturized sensors for fingerprint sensing, biometrics authentication has entered into portable consumer electronics devices, such as, smartphones, and portable computers.

The Swedish company Fingerprint Cards AB (FPC) is one of the key companies in the fingerprint sensing industry. The company has recently launched FPC 1021, which is an extremely small fingerprint sensor aimed at the smartphones market. The sensor is about 30% smaller than the previously launched FPC 1020, but retains the same functionalities. The FPC 1021 also comes with pre-integrated software and algorithms that enable faster integration with Android and Windows-based original equipment manufacturers (OEMs).

The sensor leverages the capacitive three-dimensional (3D) pixel sensing technology of FPC, which enables it to read both dry and wet types of fingerprints. The sensor consists of capacitive plates that have their own circuitry embedded in the chip. When a finger is placed on these plates, weak electrical signals are generated. FPC's high sensitive pixel amplifier (HSPA) method enables detection of even the weakest signals by each pixel and amplifies them to usable information. This leads to high quality of image of the fingerprint that facilitates better comparison of biometric information. The technology is able to deliver 256 gray scale values for every pixel even at the reduced size. A durable coating on the sensor makes it capable of extended usage of more than 10 million finger placements. In mobile devices, power consumption is a key issue, and each sensor or component is expected to consume as low power as possible. The FPC 1021 has ultra-low power consuming characteristics of less than 3 mA during image capturing, which acts as an added advantage for OEMs. The sensor also comes with dedicated software packages for android-based phones and tablets, as well as, for the Windows biometric framework.

The use of fingerprint scanning in smartphones has generated a lot of excitement among consumers as key companies such as Apple Inc. (USA) and Samsung Electronics Co. (Korea) have utilized this feature in their latest high-end smartphones. With wider penetration, biometric scanning is expected to penetrate lower end phones as well.

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3. ULTRA-LOW POWER SYSTEM-ON-CHIP FOR SELF-POWERED WIRELESS SENSORS

The proliferation of wireless sensor networks (WSNs) and the Internet of things (IoT) will depend largely on the development of self-powered low-power consuming sensors. The IoT is a concept where any device or object will be able to transfer information to the Internet. One of the key challenges for the realization of IoT is power consumption. For collecting and sending information, electric power is required, which normally is sourced from a battery. Since the battery has a limited charge holding capacity, it requires recharging or replacing after a specific amount of time/usage. For IoT and WSNs, this maintenance would represent a huge cost factor and, in such large networks, would not likely be practically possible as the number of sensors connected would be countless. There is thus a requirement for wireless sensors that consume very little power and are able to source the power from ambient energy sources.

Technology Startup PsiKick, USA, is commercializing an innovative low-power wireless sensor technology that can accelerate the growth of WSNs across various industries. The company's technology is based on research originally conducted at the University of Virginia, USA, and the University of Michigan, USA. The technology enables ultra-low power system-on-chip (SoC) designs using sub-threshold processing. Sub-threshold operation involves utilizing a supply voltage (VDD) less than a transistor's threshold voltage (VT). It uses the leakage current of transistors for performing useful operations, which enables slashing of power consumption by more than 10 times in many cases.

The wireless SoC has the capability of operating at upto 1/1000th power budget of contemporary IC platforms. This enables them to utilize ambient energy sources for entire operations. Energy sources can be thermal gradients, solar energy, vibration, radio frequency, and so on. The SoC consists of analog front-ends for connection with sensors, power management, programmable processing, memory and hardware accelerators, and wireless communication capabilities. This will enable truly self-powered sensors that can transmit data wirelessly and be part of WSNs and the IoT revolution.

PsiKick's technology was already backed by angel investors. The company closed a round of Series A funding, which was led by New Enterprise Associates (NEA) and supported by the University of Michigan's venture fund and Osage University partners. This new funding will help PsiKick to accelerate commercialization of its technology.

Apart from WSNs and IoT, PsiKick's SoC has potential applications in wearable electronics also. This field has garnered a lot of interest of late and has an unmet need of ultra low-power consuming, self-powered sensors. It is expected that PsiKick's technology will have impact across multiple industries.

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4. RECENT PATENTS IN THE FIELD OF TACTILE SENSORS

Tactile sensors are devices that measure the parameters of contact between a sensor and an object in its environment. Tactile sensing is one of the key enabling technologies for advanced robotics, which helps robots to understand unknown environments or to more effectively interact with or handle objects. Apart from robotics, tactile sensors are commonly used in touch screens employed in consumer electronics devices and displays. Tactile sensors are normally used to recognize touch, or the spatial distribution of forces perpendicular to a sensory area; but tactile sensors can also be used to differentiate between materials based on the interaction or surface texture. The use of polymer materials for tactile sensing is well known. Sensors used for tactile sensing (that is, touch sensing at a single point) can be single sensors located at key points, while tactile sensing arrays represent a coordinated group of touch sensors spread over wide areas.

Key technologies used in tactile sensing include capacitive, piezoelectric, piezoresistive, and elastoresistive technologies. Recent patents such as patent no. WO/2013/163549 indicate efforts in developing flexible tactile sensors employing conductive nanostructures. Flexible tactile sensors can be potentially used in humanoid robots as well as flexible displays of next generation consumer electronics devices. Patent no. WO/2013/168956 indicates the use of nanotechnology for enabling tactile sensing. The invention refers to the use of a carbon nanotube composite as sensor elements.

PATENT TITLE	PUBLICATION DATE / NUMBER	ASSIGNEE	INVENTORS	ABSTRACT
SENSOR PATTERN FOR A TACTILE INPUT DEVICE	10.04.2014; WO/2014/055742	GOOGLE INC.	TENUTA, Matthew Dominic	A tactile sensor includes a plurality of first sensing elements that are arranged in a plurality of rows on a first layer and a plurality of second sensing elements that are vertically aligned in a plurality of columns on the first layer. The second sensing elements in each column are electrically connected together and each of the plurality of columns are separate conductors from one another. The plurality of second sensing elements include a plurality of vertical elements that form an interlocking pattern with the plurality of first sensing elements.
TACTILE ARRAY SENSOR	27.03.2014; US 20140088764	Naidu Prakash CRJ	Naidu Prakash CRJ	A capacitance based tactile array sensor is disclosed that provides for close resolution of sensing pixels by using insulated conductors as electrodes, and allows for eliminating the need for a joint or connection interface near periphery of the sensor array. Optional aspects of the invention include provision for allowing use of stretchable conductors, reduction of the burden of number of connections at one layer of conductors in the sensor, providing for differential sensing resolutions at different areas of sensing, and modularity in configuration allowing replacement of a defective sensor pixel in the array. The tactile array sensor may be integrated with surface of a robotic hand's finger, palm, or any other surface of a device that requires multi-point sensing of external contacts. The capacitance information is processed for useful display or control of systems based on the contact feedback.
COMPLIANT TACTILE SENSOR WITH FLUID-FILLED, SPONGE-LIKE MATERIAL	20.03.2014; WO/2014/043037	SYNTOUCH, LLC	FISHEL, Jeremy, A.	A compliant tactile sensor may include sponge-like material, a flexible skin, and a fluid pressure sensor. The flexible skin may have a shape, absorb fluid, compress in response to force applied to the sponge-like material, and decompress and return to its original shape when the force is removed. The flexible skin may cover an outer surface of the sponge-like material. The

				fluid pressure sensor may sense changes in pressure in fluid that is within the sponge-like material caused by a force applied to the flexible skin. A robotic system may include a movable robotic arm, a compliant tactile sensor on the movable robotic arm that senses contact between the compliant tactile sensor and an object during movement of the movable robotic arm and that cushions the effect of that contact, and a reflex system that causes the moveable robotic arm to move in response to commands.
Use of LED or OLED Array to Implement Integrated Combinations of Touch Screen Tactile, Touch Gesture Sensor, Color Image Display, Hand-Image Gesture Sensor, Document Scanner, Secure Optical Data Exchange, and Fingerprint Processing Capabilities	06.02.2014; US 20140036168	LUDWIG LESTER F.	LUDWIG LESTER F.	A system and method for implementing a display which also serves as one or more of a tactile user interface touchscreen, proximate hand gesture sensor, light field sensor, lensless imaging camera, document scanner, fingerprint scanner, and secure optical communications interface. In an implementation, an OLED array can be used for light sensing as well as light emission functions. In one implementation a single OLED array is used as the only optoelectronic user interface element in the system. In another implementation two OLED arrays are used, each performing and/or optimized from different functions. In another implementation, an LCD and an OLED array are used in various configurations. The resulting arrangements allow for sharing of both optoelectric devices as well as associated electronics and computational processors, and are accordingly advantageous for use in handheld devices such as cellphone, smartphones, PDAs, tablet computers, and other such devices.
FRONT-SURFACE PLATE FOR TACTILE SENSOR	03.01.2014; WO/2014/002731	ASAHI GLASS COMPANY, LIMITED	FUJII Kensuke	Provided is a front-surface plate for a tactile sensor with good sensor accuracy for perceiving by touch, in which any reduction in the external appearance due to an interference pattern is suppressed, light permeability is excellent, and readability is exceptional. A front-surface plate (1) for a tactile sensor comprising a high-resistance layer (3) and an electrically insulating insulation layer (4) layered on a transparent substrate (2) in the stated order from the transparent substrate (2) side, wherein the high-resistance layer (3) has a

				surface resistance value of 1-100 MΩ/□, a refraction index of 1.8-2.5, and a thickness of 5-50 nm; the insulation layer (4) has a refraction index of 1.3-1.6 and a thickness of 0.5-15 μm; and the transparent substrate (2) has a surface roughness Ra on the surface facing the high-resistance layer (3) of 0.05-0.5 μm. The surface roughness Ra of the surface of the front-surface plate (1) for the tactile sensor is no more than 0.05 μm.
CRABON NABOTUBE COMPOSITE INCLUDING MICRO PILLARS HAVING VERTICAL SHAPES, METHOD FOR MANUFACTURING THE CRABON NABOTUBE COMPOSITE, AND TACTILE SENSOR INCLUDING THE CRABON NABOTUBE COMPOSITE	14.11.2013; WO/2013/168956	KOREA RESEARCH INSTITUTE OF STANDARDS AND SCIENCE	KWON, Su-Yong	The present invention relates to a carbon nanotube composite in which micro pillars having vertical shapes are formed, a method of manufacturing the carbon nanotube composite, and a tactile sensor including the carbon nanotube composite. The carbon nanotube composite includes a polymer matrix including a base and a plurality of micro pillars extended and protruded from the base and carbon nanotubes mixed with the polymer matrix. The carbon nanotubes can be easily modified and a change in the resistance of the carbon nanotubes can be maximized using the elasticity of the micro pillars that are easy to be compressed or bent.
FLEXIBLE TACTILE SENSORS AND METHOD OF MAKING	31.10.2013; WO/2013/163549	THE UNIVERSITY OF AKRON	CHOI, Jae-Won	A tactile sensor includes a flexible medium having electrically conductive strips embedded therein and extending in a first direction, said electrically conductive strips including conductive nanostructures dispersed in a flexible support material, said nanostructures selected from conductive nanowires, carbon nanotubes, and graphene, wherein each electrically conductive strip is connected at each end to an impedance measuring device that measures the impedance across each electrically conductive strip. The electrically conductive strips may be formed on a

				first layer of the flexible medium by using direct-write technology.
PHOTOSENSITIVE TACTILE SENSOR	24.10.2013; WO/2013/156702	COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES	ALIANE, Abdelkader	The invention relates to a tactile sensor (10) comprising: an at least partially light-permeable piezoresistive layer (16), the electrical resistance of which varies according to mechanical stresses exerted thereon; a photosensitive layer (38) facing the piezoresistive layer (16), the electrical resistance of said photosensitive layer varying according to the quantity of light incident thereon; and electrical connection elements (22, 40, 52) electrically connecting the piezoresistive layer (16) and the photosensitive layer (38) in parallel.

Exhibit 1 lists some of the recent published patents on tactile sensors.

Picture Credit: USPTO/Frost & Sullivan

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