TECHNICAL INSIGHTS

SENSOR

TECHNOLOGY ALERT

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1. MULTIFUNCTIONAL WIRELESS SENSORS PLATFORM

Residential and commercial buildings are consuming a lot of energy in the United States. According to the United States Department of Energy, approximately 40% of energy is consumed by residential buildings and 46% of energy is consumed by commercial buildings. At present the wireless platforms available in the market are not cost-efficient and can cost around $150 to $300 per sensor node. Hence, there is a need for an advanced sensor platform, which is cost-efficient, reliable, and accurate. The sensor platform should also be able to harvest energy, and in addition it should be able to pass the entire regulatory and standard requirement.

To address the above challenge, researchers from Oak Ridge National Laboratory are developing a low-cost multifunctional wireless sensor for monitoring buildings and achieving energy savings by controlling a building's subsystems. The sensor platform will consist of a thin film printed temperature sensor, humidity sensor, light level sensor, indoor air quality sensor, transistor, battery, and antenna.

The four key elements of the sensor platform are low-power wireless communication, a thin film battery and indoor photovoltaics, integration of sensor into thin films, and integrated system design. For printing the antenna, batteries, and sensors, the researchers are using inkjet printing via roll to roll processing. Printing electronics will address the demand of small-sized electronic components--they will be easy to fabricate and tunable. Printing electronic components will reduce the cost of the sensor platform. A monopole antenna with 2.45 GHz of frequency is used in the sensor platform; and a thin film lithium ion battery will be deployed in the sensor platform. The sensors are developed on the basis of regulatory and standard requirements. The vision of the project is to reduce the cost barriers in deploying advanced sensors in buildings and enable optimization of energy usage in buildings. The goal of the project is to develop low-cost wireless sensors using roll to roll manufacturing technique, which will enable building applications. The advanced sensor platform is expected to cost around $1 to $10 per node.

Once the project is fully developed, it will be deployed in the residential and commercial buildings because of its potential to reduce the energy consumption of the building by 20% to 30%. The technology behind the project will be adopted by various different sectors such as manufacturing, energy, automation, health, and so on. The researchers are working on the design specification of thin film printed antenna and the battery. They will also work on indoor air quality sensor using metal oxide semiconductor technology and a low-power pyroelectric sensor array for occupancy detection. The researchers look forward to identifying partners for commercializing the technology in building specific applications.

The project begun in October 2012 and is projected to conclude in September 2015. It is funded by the US Department of Energy (DOE). Once the technology is successfully commercialized, it has potential to get a good response from residential and commercial buildings to enable optimization of energy usage.

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2. SENSORS ENABLING WEARABLE ENVIRONMENT TRACKER

Across various sectors, such as defense, healthcare and consumer electronics, wearable electronics have been gaining traction. In wearable electronics, sensors are playing a vital role. There are devices to count steps taken by a person, monitor calories and weight. There are also devices for tracking the environment. However, the devices available to monitor the environment can be somewhat cumbersome and expensive. Hence, there is a need for a more compact wearable device. The device should be fast, cost-effective, and accurate for detecting airborne pollutants and UV (ultraviolet) rays. The device should be easy to use and it should be able to monitor and update user in real-time.

To address the above challenge, researchers from a Canada-based company,Tzoa, have developed an advanced sensor technology and integrated it in their device called Tzoa. This device helps to breathe clean air and prevents users from extensive UV exposure. The device is integrated with an optical air quality sensor, UV and light sensor, humidity sensor, temperature sensor, light-emitting diode (LED), and Bluetooth.

Tzoa is a wearable device; it is designed in such a way that it can be carried along with any external accessories such as bag pack. The air quality sensor deployed in the Tzoa device detects tiny particles in the air, which can cause cardiac and respiratory conditions. The device is also used to provide the pollutant count in air by means of a specially designed algorithm. The UV and light sensor monitors light intensity in the environment and guides the user on UV exposure. Excessive amount of UV exposure can lead to ageing of skin and even cause skin cancer. The LEDs embedded in Tzoa flash the color based on the level of air quality such as green and red. The device is connected to a smartphone via Bluetooth. The application on the smartphone guides the user with the air quality level and maps the area with less pollutants for commuting. Tzoa provides updates in real-time on Android and iOS-based smartphones.

Once the project is fully developed, it can be used to measure air pollutants at home or in the office. It will also provide the user with a real time solution, such as opening windows for ventilation, giving a freedom to choose less polluted routes while commuting. The device and the application on the smartphone will help the user to take enough sunshine required for the human skin. Tzoa measures in real-time UV exposure and air pollution using advanced sensor technology.

The project is currently seeking crowd funding on Kickstarter .The company is working with environmental scientists and health researchers to benchmark their optical air quality sensor. The researchers are currently working toward quality assurance testing of software and hardware. The project is expected to be commercialized by August 2015.

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3. ADVANCEMENTS IN SENSORS FOR HOME APPLIANCES

Innovations in sensors for advanced home appliances--such as refrigerators, clothes washers/dryers, dishwashers, or air conditioners--are being driven by increasing needs for improved energy efficiency, wireless communications, convenience, ease and quality of human-appliance interaction, and enhanced functionality and safety.

There are numerous areas where innovative sensors are or can be applied to help achieve enhanced home appliances. Key types of sensor technologies that have opportunities over the relative near-term include organic printed photodetectors sensors to provide a more compelling interface for appliances such as washing machines; highly sensitive touch sensors that could replace mechanical switches or buttons in, for example, refrigerators, washers, dryers, or ovens for program or function selection; infrared sensors used in a home intelligence network that could control appliances (for example, air conditioners or cooking ranges) in accordance with the presence or motion of individuals in a room; hand gesture recognition solutions to control home appliances such as air conditioners by simply pointing at the appliance.

Furthermore, there are opportunities over the longer term for sensing technologies in home appliances. For instance, electronic noses have potential to more effectively sense food quality or detect food odor by sensing volatile organic compounds in refrigerators. Electronic noses can also provide a more cost-effective and less time consuming means of ensuring food quality in cooking processes and help optimize cooking, as food smell is caused by gases emitted from food products. However, it can be complex to produce electronic nose gas sensors for home appliances.

Over time, with improvements in the sensor's repeatability, reliability, and temperature compensation,; surface acoustic wave (SAW) sensors could have some opportunities in washing machines to optimize rinsing and detergent dispensing for reduced water consumption. SAW sensors are very sensitive and measure the change in propagation characteristics of a surface acoustic wave traveling along the sensor’s surface, due to electrical or mechanical changes in the adjacent medium. SAW sensors can have potential to enable smart washers that allow for less water use and precise dosing of detergents. Such sensors could also have applications in other types of appliances, such as monitoring temperature in refrigerators or ovens, or monitoring temperature, pressure, and strain in HVAC systems, clothes washers, or clothes dryers. There is also interest in bulk acoustic wave sensors (where the wave propagates through rather than on the piezoelectric material), which can have reduced size compared to SAW sensors.

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4. RECENT PATENTS IN THE FIELD OF FORCE SENSING

Transducers that convert an input mechanical force into an electrical output signal are termed force sensors. The different forces, which can be converted into electric signals with the help of force sensors, include weight, load, pressure, or touch (tactile force sensors).. The technologies that are used to measure forces include piezoelectric sensors, capacitive sensors, and piezoresistive (including strain gauge) sensors, force sensing resistors. Piezoresistive sensors undergo a change in resistance with applied pressure.

A recent patent in force sensing (EP2792075), assigned to Apple Inc., pertains to a strain gauge that may flex in response to pressure applied by a fingerThe system also has an analog to digital converter circuit that will be used to collect and process signal from the strain gauge.

From 1864, Apple Inc., has approximately 18,879 patents registered in the field of computer, smart phones, music players, and many more. Of these, 391 patents are sensor-based and 15 patents purely focus on force sensing, which is mostly incorporated in smartphones.

From 1960 to October 2014, approximately 3329 patents have been registered to measure force. In 2014, approximately 126 patents have been registered for force sensing. There are opportunities for force sensors as interfaces in smart phones. In various sporting activities, such as in sprint and rowing; force sensor are getting incorporated. In racing activities such as F1, force sensors are becoming deployed.

Applications for force sensors include test and measurement, weighing, automation and robotics, health care (for example, infusion pumps, kidney dialysis machines), traffic sensing, computer pointing/input devices, automotive (for example, vehicle seat occupant monitoring and classification, driver presence detection), and switches for handheld devices. Moreover, opportunities have been opening up for force sensors in activity monitoring (for example, foot-force).

Force sensors also have opportunities to be increasingly deployed in activities associated with sports.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Electronic device with noise-cancelling force sensor	22.10.2014; EP2792075	Apple Inc.	Yang Bingrui	An electronic device may have a housing in which components such as a display are mounted. A strain gauge may be mounted on a layer of the display such as a cover layer or may be mounted on a portion of the housing or other support structure. The layer of material on which the strain gauge is mounted may be configured to flex in response to pressure applied by a finger of a user. The strain gauge may serve as a button for the electronic device or may form part of other input circuitry. A differential amplifier and analog-to-digital converter circuit may be used to gather and process strain gauge signals. The strain gauge may be formed form variable resistor structures that make up part of a bridge circuit that is coupled to the differential amplifier. The bridge circuit may be configured to reduce the impact of capacitively coupled noise.
Grip force sensor array for one-handed and multimodal interaction on handheld devices and methods	23.10.2014; WO/2014/172385	Qualcomm Incorporated	Tartz, Robert Scott	Aspects of the disclosure relate to a handheld device equipped with arrays of force sensors located along both sides of the device that can provide a novel user interface for operating the device. The sensors can be configured to recognize various grip patterns, gestures, and biometric information of a user operating the device. Using the arrays of force sensors in addition to a touchscreen, a new paradigm for operating a handheld device is provided.
Sensor assembly and method for measuring forces and torques	09.10.2014; WO/2014/164207	Stryker Corporation	Janik, John, J.	A sensor assembly comprises a base plate and a sensor member displaceable relative to the base plate. A spring arrangement operates in first and second stages in response to displacement of the sensor member relative to the base plate. Different resolutions of force and torque measurements are associated with the first and second stages. A light sensitive transducer senses displacement of the sensor member relative to the base plate and generates corresponding output signals. A collimator directs a plurality of light beams onto the light sensitive transducer so that the light beams strike different pixels of the light sensitive transducer to sense displacement of the sensor member relative to the base plate
Touch pad with force sensors and actuator feedback	03.04.2014; US20140092064	Apple Inc.	Bernstein Jeffrey Traer	Electronic devices may use touch pads that have touch sensor arrays, force sensors, and actuators for providing tactile feedback. A touch pad may be mounted in a computer housing. The touch pad may have a rectangular planar touch pad member that has a glass layer covered with ink and contains a capacitive touch sensor array. Force sensors may be mounted under each of the four corners of the rectangular planar touch pad member. The force sensors may be used to measure how much force is applied to the surface of the planar touch pad member by a user. Processed force sensor signals may indicate the presence of button activity such as press and release events. In response to detected button activity or other activity in the device, actuator drive signals may be generated for controlling the actuator. The user may supply settings to adjust signal processing and tactile feedback parameters.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Force sensor for use in an input device and methods for constructing and using the sensor	26.09.2013; US20130249799	Apple Inc.	Baskett Lawrence J.	The disclosure addresses a force sensor that is scalable in size and adaptable to a variety of form factors, including those suitable for use in an input device for a computer or other processing system, and in some cases including those of the configuration normally referred to as a computer mouse. The force sensor will include at least two structural members that are cooperatively attached one another as to be displaced from one another in response to a force acting upon one of the structural members. In some examples, the engagement between the two structural members will be specifically configured to allow such displacement in response to forces acting laterally on the force sensor. The force sensor will also include one or more sensing mechanisms to provide a measurement of the sensed deflection.
Force sensor interface for touch controller	28.03.2013; WO/2013/043594	Apple Inc.	Krah, Christoph, Horst	A force sensor interface in a touch controller of a touch sensitive device is disclosed. The force sensor interface can couple to touch circuitry to integrate one or more force sensors with touch sensors of the device. The force sensor interface can include one portion to transmit stimulation signals generated by the touch circuitry to the force sensors to drive the sensors. The interface can also include another portion to receive force signals, indicative of a force applied to the device, from the force sensors for processing by the touch circuitry. The device can use the touch circuitry to concurrently and seamlessly operate both the force sensors and the touch sensors.
Resistive force sensor with capacitive discrimination	22.01.2009; US20090019949	Apple Inc.	Rothkopf Fletcher R.	A resistive force sensor with capacitive discrimination is disclosed. According to an example of the disclosure, a sensor is directed to detect resistance and capacitance in an alternating fashion, the resistance indicating a force being applied to an input area of a device, and the capacitance indicating a proximity of a body part to the input area of the device, and the detected resistance and capacitance are utilized to determine whether the body part has pressed the input area of the device.

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

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