TECHNICAL INSIGHTS

SENSOR

TECHNOLOGY ALERT

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1. WEARABLE KEY DEVICE INTEGRATING SENSORS; SENSOR HUB MICROCONTROLLER; AND BLUETOOTH

Development of innovative products in wearable electronics is gaining increased attention and opportunities across various sectors, such as defense, healthcare, and consumer electronics. Sensors are playing an important role in wearable electronics. Wearable devices currently available in the market tend to just perform simple relatively simple tasks, such as activity monitoring (estimating calories burned or counting steps). There is a need for a device that is capable of performing multiple tasks and providing accurate results.

To address the above issue, ROHM Semiconductor, a Japan-based company has developed a novel wearable key device. This device is comprised of Bluetooth wireless communications, multiple sensors, a low-power sensor hub microcontroller, and lithium ion battery to power the device. The wearable key device can function for 8 hours with one hour of charging.

ROHM's innovative wearable key-shaped device is integrated with 8 different sensors. Red, green and blue (RGB) sensors are utilized to sense colors. A pressure sensor is deployed to sense the atmospheric pressure and a gyro sensor is used to sense the angular momentum of a device. The 3-in-1 proximity sensor includes an ambient light sensor and infrared (IR) light emitting diode (LED); it is used to detect the presence of nearby objects. An optical ultra violet (UV) sensor is employed to sense ultra violet rays, and the accelerometer measures the changes in acceleration. A magnetic impedance sensor is sufficiently sensitive to detect metal objects in food. A sensor hub microcontroller is used to support arithmetic operations and to communicate among sensors and the host. The Bluetooth low energy (LE) communication integrated circuit (IC) helps to create a wireless environment by sending data to

the users on their phones or tablets. With its 8 sensors, the ROHM wearable key device is designed to multitask, giving real-time updates on android Bluetooth-enabled devices.

ROHM's wearable key device utilizes sensor fusion technology to combine data from different sensors from Rohm and Kionix and provide it to sensor hub microcontrollers for interpretation; data is then transferred to the user via Bluetooth. The complete cycle of the wearable key device can be explained with the help of the UV sensor. The UV sensor is used to measure the amount of ultra violet rays contained in sunlight. Initially, to measure UV radiation, the wearable key device is attached to the human body externally to absorb sunlight. To measure the absorbance, data is passed on to the sensor hub microcontroller. The sensor hub controller calculates the information, such as excessive exposure and sunburn and passes on information to the Bluetooth. Bluetooth is used to share information with users through Bluetooth-enabled tablets or smart phones.

Sensors embedded in the wearable key device monitor the activities of users; for instance, it can detect if the user is riding a vehicle or walking up/down the stairs, count the total number of calories burned and track the time traveled. The sensors can use a gesture to lock and unlock tablets and smart phones. Users can measure the distance to travel by pointing the key device toward the preloaded landmark. It can also be used to detect metals present in food.

By December 2014, the wearable key device is slated to be ready for mass production. The device is expected to be well received by end-users due to its long battery life. comprehensive array of sensors, and high levels of accuracy enabled by its microcontroller.

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2. TRANSPARENT SENSORS WITH EMBEDDED PHOTONICS IN GLASS

The laser writing process is a technique that enables the creation of patterns on a surface in serial or spot by-spot fashion. Lasers are already in use to make photonic waveguides, but the base on which lasers are used to carve the path are made up of glass material or crystals. These types of materials can experience propagation losses in the waveguide. These materials have more irregularities and less internal stress. There remains a need for a device which is reliable, inexpensive, and transparent with greater internal stress, less irregularities and minimum propagation loss.

Addressing the above challenges, researchers from Polytechnique Montreal, University of Montreal and Corning Incorporated have developed a laser-written light-guiding system to build a transparent temperature and phone authentication sensor for commercial use. This system is comprised of Gorilla Glass, where layers of sensors, such as temperature sensors and infrared (IR) sensors, are embedded in the glass.

The researchers have used Gorilla glass as a base to carve through lasers. Gorilla Glass is used because of its low irregularity, and high internal stress. Lasers are used to carve a transparent pathway, or waveguide, into the glass. These waveguides are used as tunnels to channel light. Waveguides built on this type of glass are smoother and prevent light from escaping. Ultra short laser pulses with lower energy and high repetition rate are used to transfer information efficiently. Lasers are used by the researchers to make waveguides at depths. This depth allows creating numerous applications one on top of each other, such as layers in a burger. Layering the waveguides gives way to more compact devices to be used within the glass, such as more applications in the phone. The researchers have turned to photonics for developing phone authentication and temperature sensing using the laser written light guided system. Photonic devices are used to transmit information using light.

The researchers have developed an authentication sensor using the laser written light guided system. This sensor is developed to authenticate smartphones. To use the authentication sensor, holes are placed at various locations on the waveguides. Light escaping through these holes creates a unique pattern, so each smartphone would have its own unique pattern such as fingerprint. This unique pattern is then sensed by an infrared detector to confirm the identity of a phone. This authentication sensor can act as an

additional layer of security and can be used in making safe financial transactions.

The researchers have developed the temperature sensor using the laser written light guided system. The temperature sensor on Gorilla glass consists of curved and straight waveguides. This device can measure the temperature of anything that touches the glass. With the heat, glass changes and expands the path length of the waveguide.

The researchers have patented both the temperature sensors and phone authentication systems. In the future, this technology will allow computing devices, such as tabletops, to be embedded in glass surfaces. To further develop this technology, the researchers are looking for partners within industry. They are currently working on minimizing light loss. The laser written light guiding system is expected to be integrated commercially into smartphones in a year's time.

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3. HIGH SENSITIVITY OPTICAL SENSORS THAT SWELL ON INTERACTION WITH TOXIC GASES

The presence of toxic harmful chemicals from industrial plants and the environment can cause various diseases, including cancer. To keep track of harmful gases in the environment, sensing of diluted gases plays a vital role. The devices currently being used to detect toxic gases can have difficulty keeping track of small toxic molecules. These devices can encounter a distortion in the signal because of electromagnetic interference and may not operate over a wide dynamic range. There remains a need for a device which is reliable, efficient, immune from electromagnetic interference, and can detect a wide range of toxic gases.

To address the above challenges, researchers from Massachusetts Institute of Technology (MIT) have developed a novel, highly sensitive optical sensor. The sensors can detect small amounts of toxic gas molecules. This device is fabricated in polymethyl methacrylate (PMMA) polymer. PMMA is a

flexible, inexpensive, and long chain polymer. The sensors are patterned with one dimensional crystal cavities and infused with fluorescent dye.

The MIT researchers have developed a sensitive optical sensor using a microscopic polymer light resonator. Microscopic polymer light resonators expand in the presence of toxic gases. PMMA polymer is filled with fluorescent dye. When the sensor traces the gases in the environment, the polymer emits a fluorescent light. Optical sensors are compact and light in weight. These sensors have high signal-to-noise ratio and they are immune to electromagnetic interference. These qualities make optical sensors very suitable for detecting traces of gas concentration. This sensor detects molecules in the parts per billion range.

The working principle of the high sensitivity detector can be explained with respect to detection of isopropyl alcohol vapor. The PMMA film needs to be surrounded by air. It allows the polymer to swell when exposed to the target vapor or gas. Optical properties of the air trap light traveling in the polymer film. The high sensitivity optical sensor detects the diluted vapor by monitoring resonance. When the optical sensor detects vapor molecules, there is a deflection in the wavelength of a resonance. With a change in resonance, PMMA polymer illuminates fluorescent light and swells indicating detection of a molecule. To determine minimum concentration, the relationship between the concentration of gas and change in resonance is measured with the help of mathematical formula. The polymer shrinks back to its original length once targeted vapor has been removed and it is ready to for reuse.

The solution, once developed, will interact with a wide range of chemicals such as nitric oxide, hydrogen sulfide, and so on. In the future, this optical sensor has opportunities in environmental sensing applications, such as sensing volatile organic compounds, nitrogen dioxide, ozone, and many more. It could also be used in homeland security applications for detecting toxic gases, such as hydrochloric acid, methyl chloride and so on.

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4. RECENT PATENTS IN THE FIELD OF HUMIDITY SENSING

A humidity sensor undergoes a change in electrical characteristics based on the amount of humidity in the air. Such sensors detect atmospheric humidity. Absolute humidity is the ratio of the mass of water vapor to the volume of air or gas. Relative humidity (RH) refers to the ratio of the actual partial pressure of water vapor in a gas mixture to the saturation water vapor pressure with respect to water at a prevailing temperature. Humidity measurement and control have become increasingly important in varied industries and applications, such as in commercial HVAC (heating, ventilating, air conditioning), computer rooms, museums, industrial dryers, agriculture, meteorology, handling of humidity-sensitive materials, and so on. Humidity sensors have also been finding opportunities in such areas as automotive (for example, engine management or climate control), home appliances, printers, and so on).

The most common types of RH humidity sensors are capacitive humidity sensors (which undergo a change of dielectric constant proportional to the relative humidity of the environment) and resistive humidity sensors (which measure a change in electrical impedance of a hygroscopic medium such as a conductive polymer). Capacitive RH sensors have provided broader temperature and humidity ranges than resistive RH sensors along with good stability. However, capacitive RH sensors may have limitations above 95% RH, require calibration to a know humidity level, and could be vulnerable to damage from electrical discharge. Integrated humidity sensors with the sensing element and electronics on a single chip can provide key advantages, such as smaller size, better performance and ease of integration into the user's system. There are opportunities to improve the durability, longevity and accuracy of humidity sensors.

.The recent patents indicate interest in humidity sensing for various applications and in developments in humidity sensors; for example, a sensor with a control electrode to provide variable control voltage, and a refrigeration having a dew point prevention or control device which includes humidity sensors or detectors to determine humidity around the refrigerator.

PATENT TITLE	PUBLICATION DATE / NUMBER	ASSIGNEE	INVENTORS	ABSTRACT
Humidity Sensor	18.06.2014; EP2315013 B1	Micronas Gmbh	Fredrichs Heinz-peter Dr	The sensor has a control electrode (7) connected to a signal source such that a variable control voltage is applicable to the control electrode. A voltage sensor and the control electrode are arranged on a substrate (2), and a moisture-permeable sensor layer (12) is arranged on a sensor region (5) of the voltage sensor. The control electrode is placed adjacent to the sensor layer such that a measured voltage signal of the voltage sensor depends on the control voltage and humidity. The voltage sensor is connected to an analysis unit.
Air-exchange System For The Ventilation Of At Least One Room In A Building	18.06.2014; EP1912026 A3	Meltem Wärmerückgewinnung Gmbh & Co Kg	Reynartz Armin	The ventilation system (1) has a square casing containing a diagonally-arranged flat square heat exchanger (2). Inlet and outlet air streams pass each other at right-angles. Air enters an inlet (4) from outside and passes a humidity sensor (25) and a temperature sensor (27). The air passes through the heat exchanger to an air distribution module (10) with a humidity sensor (30) and a temperature sensor (31). Outlet air passes a humidity sensor (26) a temperature sensor (28) and a general air quality sensor (29). The air passes through the heat exchanger and is expelled to the outside through an outlet (7).
Refrigerator Having A Dew Prevention And/or Control Device And Method For Preventing Formation Of Dew Therein And/or Thereon	18.06.2014; EP2743616 A2	Dongbu Daewoo Electronics Corp	Kwon Won Joo	A refrigerator having a dew prevention and/or control device and a method for preventing the formation of dew in and/or on the refrigerator includes a compressor (20) adapted to compress a refrigerant, a condenser 30) adapted to condense the refrigerant from the compressor, an evaporator (40) adapted to cool air existing there around by evaporating the refrigerant that passes through the condenser, a pipe (70) between the condenser and the evaporator, configured to pass through the refrigerator body, humidity sensors and/or detectors (90) configured to determine a humidity around the refrigerator, and a controller (80) adapted to vary rotational speed of a fan (50) in accordance with

				the humidity determined by the humidity sensors and/or detectors, thereby efficiently preventing the formation of dew on or in the refrigerator.
Air Powered Signaling System	18.06.2014; EP2377119 B1	Woodscan Ind Inc	Woods David Terry, Johnson Scott, Soutar Ian	A portable air horn apparatus includes a housing, an air horn assembly for generating a warning sound, a switch for activating the air horn assembly and a power source. A microprocessor is provided in communication with the switch, the air horn assembly and the power source. The microprocessor includes at least one port for receiving an electronic component and is capable of automatically loading and executing software of the electronic component.
Liquid-cooled Heat Exchanger In A Vapor Compression Refrigeration System	18.06.2014; EP2470841 B1	Carrier Corp	Huff Hans-joachim, Asprovski Zvonko	A refrigerant vapor compression system includes a compressor having a suction port and a discharge port, an air-cooled heat exchanger operatively coupled to the discharge port, a liquid-cooled heat exchanger operatively coupled to the air-cooled heat exchanger, a coolant pump operatively coupled to a liquid coolant inlet conduit of the liquid-cooled heat exchanger, an evaporator heat exchanger unit operatively coupled to the liquid-cooled heat exchanger and the suction port, a coolant pump operatively coupled to the liquid coolant inlet conduit for pumping a liquid coolant, and a controller operatively associated with the liquid coolant inlet conduit for controlling the flow of liquid coolant into the liquid-cooled heat exchanger. In one embodiment, the liquid-cooled heat exchanger comprises a low-profile enclosure defining an interior volume. The enclosure has a liquid coolant inlet port and a liquid coolant discharge port fluidly coupled to the interior volume, and a continuous refrigerant tube sealingly disposed within the enclosure. The refrigerant tube is fluidly isolated from and in heat exchange relationship with the interior volume in which the liquid coolant flows.

Humidity Control Apparatus And Air-conditioning System	12.06.2014; US2014/0157806 A1	Ito Shinichi, Toyoshima Masaki, Unezaki Fumitake, Mitsubishi Electric Corp	Pa Ito Shinichi, Toyoshima Masaki, Unezaki Fumitakerk	A humidity control apparatus and an air-conditioning system are capable of controlling the latent heat processing amount and the sensible heat processing amount in accordance with an indoor heat load without decreasing the operation efficiency. Every time an air route is switched to an air route A or an air route B, the route maintenance time for the switched air route is set on the basis of the heat load within a dehumidification target space, and switching of switching devices is controlled such that the set route maintenance time is ensured.
Dryer For Portable Electronics	12.06.2014; US2014/0157619 A1	Tekdry Llc	Cookson Adam Roy, Jones Eric Andrew	Systems and methods are described for conductively heated vacuum-based drying of portable electronic devices. For example, a portable electronic device that has been exposed to excessive liquid is placed inside a drying chamber. The drying chamber is closed and a drying routine commences. During the drying routine, the chamber is pressurized to a vacuum level sufficient to gasify liquids inside the device, and the device is conductively heated at least to replace latent heat of vaporization lost during the pressurization. Some embodiments include techniques relating to payment processing, monitoring and feedback control, decontamination, and/or other functionality.

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

Picture Credit: Frost & Sullivan

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