TECHNICAL INSIGHTS

SENSOR

TECHNOLOGY ALERT

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1. FLEXIBLE DEVICE WITH EMBEDDED SENSOR TO MONITOR HEALTH CONDITIONS

Wearable electronics is gaining strong traction from a wide range of industries, such as healthcare, defense, and consumer electronics among others. The devices used by the healthcare industry to monitor patients can be overly complex and connected with numerous wires. There is a need for devices that can operate without wires and are self-powered, easy to use and inexpensive to manufacture. In addition, the device should generate an alarm as an additional safety feature to ensure proper monitoring.

To address the above challenge, researchers from the University of Tokyo, Japan, have developed a wearable device called fever arm band which sounds an alarm if the temperature of the body is high.

The flexible fever arm band is a self-powered device. The researchers have used inkjet printing to incorporate organic components on a flexible substrate. They have used a temperature sensor, piezoelectric speaker a flexible amorphous silicon solar panel and a power supply circuit. The full circuit is created with the help of organic components in a single wearable and flexible package. When the circuit senses the high temperature, it produces the sound output and alarms the user or the caretaker about the high fever. The circuit detects the preset value range between 36.5 degrees C to 38.5 degrees C.

According to the researchers, the flexible arm band will constantly monitor health conditions, such as body temperature and heart rate. It will be very useful for infants, the elderly and patient care personnel. In addition, the researchers are currently identifying different applications for the device. They are also planning to add other sensors to the device to help monitor other aspects of the human body. The device is very easy to use and flexible and improves patient comfort as it is wireless. The device does not require any external energy supply, and it is easily disposable, enabling hygienic maintenance of the environment around the patient.

The project was supported by the Institute of Industrial Science, Tokyo. The researchers are currently working on advancing the device in terms of monitoring other aspects of the human body. The flexible arm band for monitoring health conditions is an evolving technology which is expected to impact the market in one to two years' time. This technology can have an impact on megatrends in terms of health, wellness, and wellbeing. In the future, flexible and disposable films have opportunities to replace the current products in the market in a wide range of industries due to their cost efficiency and sensitivity. Greater adoption of flexible electronics in a wide range of industries will open up opportunities for government funding. Flexible electronics for healthcare has good adoption potential in North America, followed by Western European Union, China, and Israel.

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2. SMART BANDAGE WITH EMBEDDED SENSORS

There are many small and large issues related to healthcare, such as wounds and burns. For these issues, if the patient consults a doctor he/she has to pay heavy fees with additional charges for medication. The consulting and medication charges can significantly increase with the number of visits and treatment. There is a need for a device which can monitor the environment of the wound and deliver the medication depending on the need. The device should be easy to use and cost efficient.

To address the above challenge, researchers from Harvard Medical School, Brigham & Women's Hospital are developing a smart bandage that will distribute the medicine when required and heal wounds.

The researchers are developing the smart bandage to monitor the wound environment. They have placed multiple sensors on the bandage that can monitor the wound in terms of temperature, pH, and oxygen and interfere if something goes wrong. The particles are incorporated on the back of the smart bandage. The particle shrinks when the bandage is heated up because of the heating filament on the back of the bandage and releases the medication when needed. The smart bandage can send a signal to the smartphone through Bluetooth if there is some problem. If the problem is related to infection or pH, the doctor will press the button on the device to deliver larger amounts of drugs to the wound.

According to the researchers, the device will sense the pH balance which will signify the changes in bacterial infection. Before the device gets commercialized, it has to go through certain tests. It will have to be tested on animals first to obtain regulatory approval. The smart bandage will not be able to heal diabetic foot ulcer and the researchers are currently working toward this issue. In the future, the device is expected to address the ulcer challenge. According to the researchers, the cost of the device will be reduced if it is produced on a large scale. In addition, it will also prevent hospitalization and charges for doctor visits, thus contributing to lower healthcare costs.

The National Science Foundation funded the project with a grant of $2 million. The smart bandage is an emerging technology, which is expected to be commercialized in three to four years' time.. There could be more government funding for this technology. In the European Commission, only four projects are currently linked to this technology. The smart bandage is expected to have adoption potential in all regions. Once the smart bandage is commercialized, it is expected to be widely adopted in the healthcare industry.

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3. ELECTRONIC SKIN WITH PRESSURE SENSING

Robotic technology is witnessing increased adoption in various industries, such as automotives, industrial automation, and aerospace among others. At present, robots are used in the industrial arena for lifting heavy loads and helping the workforce in the industry. There is a need for advancements in sensory intelligence for robots, where robots can feel touch and understand the dynamics of an object and can safely hold and position it in the desirable place.

To address the above challenge, researchers from Ulsan National Institute of Science and Technology have developed an electronic skin to detect pressure and the direction of pressure.

The electronic skin designed by the researchers at Ulsan National Institute of Science and Technology is a flexible film-like device, which is mainly developed to detect pressure in three directions using a pressure sensor. The researchers have used inkjet printing to fabricate the circuit on a flexible substrate. In addition, to boost the sensitivity of touch, the researchers used some mimic microstructures inspired from the human skin which can be found in dragonflies and beetles. This information will help the electronic skin embedded in the robot to determine the shape and structure of the object. In the future, the device will also be used to monitor the heart rate and brain activity and perform some other functions.

According to the researchers, the electronic skin will be able to sense the location, direction and intensity of pokes, vibrations and air flow. The electronic skin will accelerate lifetime extension, conceivably enhance intelligence, and provide increased access to information. In addition, the researchers are intensively working on e-skin, and their current focus is to apply the electronic skin directly to the human body. This type of bionic skin will be able to monitor medical conditions and provide life-like and more sensitive prosthetics. At present, the European Commission is working on approximately 20 projects which are linked to robotic skin. The rapidly growing markets for adoption of robotics include China as well as Japan, Germany, France, the US, and Italy. Electronic skin has enormous potential in robotics.

The project was self-funded by Ulsan National Institute of Science and Technology. The researchers are currently working on identifying and enabling the applications of the electronic skin. In addition, the researchers' main aim was to develop an electronic skin which can be embedded with pressure and temperature sensors that could be worn by a robot. Electronic skin is an emerging technology and it is expected to impact the market over the next five years. In a wide range of industries, robots are beginning to replace and augment the workforce. Electronic skins are expected to transform the economics of manufacturing and reshape the business landscape.

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4. RECENT PATENTS IN THE FIELD OF PRINTED SENSORS

Printed sensors that can be printed using various printing techniques are very flexible, low-cost sensors that can be manufactured on a large scale economically. The flexibility, ease of use, and low power opens up expanding application sectors for them. It is vital for printed sensors to use materials and equipment that lend themselves to efficient volume production.

The latest generation of printed sensors uses inks that can be printed on plastic substrates. Such sensors are compatible with plastic components and provide flexibility, thinness, light weight and the potential to be manufactured with roll-to-roll equipment. While printed sensors can be considered relatively mature technology, the emerging applications of large-area manufacturing and organic electronics are bringing about new opportunities for the integration of sensors into unconventional substrates.

The different types of conventional printing techniques include mass-printing (flexography, gravure and offset), and sheet-fed (inkjet and screen), and step-by-step (stamping or nano imprinting and UV lithography). New printing techniques include aerosol jet technology, atomic layer deposition (ALD), and extreme ultraviolet lithography (EUV).

The different types of inks used in printed electronics are conductors (conducting polymers, metal nanoparticles, carbon nanotube inks), dielectrics (polymers, inorganic oxides), and resistors (carbon film). The challenges faced are the stabilization of particles with relatively small quantities of additives without using a high amount of emulsifiers as it reduces the conductivity of the printed electronics. Research efforts to resolve these issues with nanoparticles are ongoing.

In the next three years or so, high-value applications (for example, healthcare, security/defense) will remain the key focus areas for the development of printed sensors. Medical diagnostics is projected to have the largest market share. The demand is driven by the increasing population of elderly people and the growing public awareness of early detection of diseases. In the medium term, lower value applications, such as smart packaging and consumer electronics, are projected to have revenues relatively equal to those of high-value applications. In the long term, driven by the large-scale deployment of Internet-of-Things, it is expected that the application of printed sensors in pervasive computing will be dominant.

Patents published on printed sensors have increased over the last 4 years. The maximum number of patents has been published in Korea, followed by the US. Printed sensors will impact key megatrends: connectivity and convergence, health and wellbeing, and smart is the new green.

Some of the entities involved in the research and development activities of printed sensors include KWJ Engineering (USA), North Carolina State University (USA), ISORG (France) and Plastic Logic (UK), Acreo Swedish ICT and Linköping University (Sweden), Thinfilm Electronics (Norway), and Peratech (UK).

Reflecting the importance of touch sensing for printed sensors, US Patent 20140242294, Method of Manufacturing a Resistive Touch Sensor Circuit By Flexible Printing, assigned to Unipixel Displays, pertains to a technique for manufacturing a resistive touch sensor circuit using a roll to roll process to print microscopic patterns on a single side of at least one flexible dielectric substrate.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
METHOD OF MANUFACTURING A RESISTIVE TOUCH SENSOR CIRCUIT BY FLEXOGRAPHIC PRINTING	28.08.2014; US20140242294	UNIPIXEL DISPLAYS, INC.	Petcavich Robert J.	Method of manufacturing a resistive touch sensor circuit using a roll to roll process to print microscopic patterns on a single side of at least one flexible dielectric substrate using a plurality of flexo-masters to print the microscopic patterns which are then plated to form conductive microscopic patterns.
Method of manufacturing a capacative touch sensor circuit using a roll-to-roll process to print a conductive microscopic patterns on a flexible dielectric substrate	30.07.2014; CN103959215	You Nipi Kessel Display Co., Ltd	Robert · J	Mutual capacitance touch sensor circuits are used in manufacturing displays, including touch screen displays, such as LED, LCD, plasma, 3D, and other displays used in computing as well as stationary and portable electronic devices. A flexographic printing process may be used, for example, in a roll to roll handling system to print geometric patterns on a substrate, for example, a flexible dielectric substrate. These patterns may then be coated with a conductive material by, for example, an electroless plating process.
Method of manufacturing a resistive touch sensor circuit by flexographic printing	30.07.2014; CN103959218	You Nipi Kessel Display Co., Ltd.	Robert · J	Method of manufacturing a resistive touch sensor circuit using a roll to roll process to print microscopic patterns on a single side of at least one flexible dielectric substrate using a plurality of flexo-masters to print the microscopic patterns which are then plated to form conductive microscopic patterns.

Antenna and proximity sensor structures having printed circuit and dielectric carrier layers	04.12.2013; CN103427150	Apple	S.Jakarta	The invention discloses an antenna and a proximity sensor structures having printed circuit and dielectric carrier layers. An electronic device may have a conductive housing with an antenna window. A display cover layer may be mounted on the front face of the device. Antenna and proximity sensor structures may include a dielectric support structure with a notch. The antenna window may have a protruding portion that extends into the notch between the display cover layer and the antenna and proximity sensor structures. The antenna and proximity sensor structures may have an antenna feed that is coupled to a first conductive layer by a high pass circuit and capacitive proximity sensor circuitry that is coupled to the first conductive layer and a parallel second conductive layer by a low pass circuit. The first conductive layer may be formed from a metal coating on the support structure. The second conductive layer may be formed from patterned metal traces in a flexible printed circuit
PROXIMITY SENSOR STRUCTURE AND ANTENNA HAVING PRINTED CIRCUIT AND DIELECTRIC CARRIER LAYER	20.11.2013; KR1020130126490	APPLE INC.	YARGA SALIH	An electronic device may have a conductive housing having an antenna window. A display cover layer may be mounted on the front side of a device. An antenna and a proximity sensor structure may comprise a dielectric supporting structure having a notch. The antenna window may have a protruding part which is extended to the notch between the display cover layer, the antenna, and the proximity sensor structure. The antenna and the proximity sensor structure may have an antenna feed which is combined to a first conductive layer by a high pass circuit and a capacitive proximity sensor circuit which is combined by a low pass circuit to the first conductive layer a second conductive layer parallel to each other. The first conductive layer may be formed with metal coating on a supporting structure. The second conductive layer may be formed with patterned metal traces within a flexible printed circuit. COPYRIGHT KIPO 2014
ELECTRONIC PAPER USING A TOUCH SENSOR AND A PRINTING DEVICE THEREOF	10.10.2013; KR 1020130111298	SAMSUNG ELECTRONICS CO., LTD.	LEE, JONG IN	PURPOSE: An electronic paper and a printing device thereof are provided to have a flexible and a thin form as well as to reduce production costs. CONSTITUTION: An electronic paper control unit (1610) generates a control signal for the imprint of an image and outputs the control signal on an electronic paper. The electronic paper is put on a touch sensor (1620), and the touch sensor detects user input commands. A touch sensor control unit (1630) outputs a control signal for operating the touch sensor to the touch sensor and receives user input commands detected by the touch sensor. A main control unit (1690) controls the electronic paper control unit to change the image displayed on the electronic paper according to the user input commands. COPYRIGHT KIPO 2013 null [Reference numerals] (100) EPD panel; (150) Driving unit; (1610) EPD control unit; (1620) Touch sensor; (1621) Coordinate correction sensor; (1630) Touch sensor control unit; (1640,1641) Sensor unit; (1650,1651) Memory; (1660) User interface; (1670) Communication unit; (1680,1681) Power management unit; (1690) Control unit; (AA) EPD driving algorithm

Printed Temperature Sensor	08.08.2013; US20130203201	Britton David Thomas	Britton David Thomas	A method of producing a temperature sensing device is provided. The method includes forming at least one silicon layer and at least one electrode or contact to define a thermistor structure. At least the silicon layer is formed by printing, and at least one of the silicon layer and the electrode or contact is supported by a substrate during printing thereof. Preferably, the electrodes or contacts are formed by printing, using an ink comprising silicon particles having a size in the range 10 nanometres to 100 micrometres, and a liquid vehicle composed of a binder and a suitable solvent. In some embodiments the substrate is an object the temperature of which is to be measured. Instead, the substrate may be a template, may be sacrificial, or may be a flexible or rigid material. Various device geometries are disclosed.

Exhibit 1 lists some of the patents related to printed sensors.

Picture Credit: Frost & Sullivan

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