TECHNICAL INSIGHTS

SENSOR

TECHNOLOGY ALERT

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1. CHIPLESS RFID TAGS COULD IMPACT BARCODE INDUSTRY

A barcode is an optical machine-readable representation of data related to the object to which it is attached. Barcodes are used to automate the transfer of product information, such as price, from the product to an electronic system.

Radio-frequency identification (RFID) involves the wireless use of electromagnetic fields (radio frequency signals) to transfer data in order to automatically identify and track tags attached to objects. The tags contain electronically stored information. Some types collect energy from the interrogating radio waves and serve as a passive transponder, while other types have a local power source, such as a battery, and might operate farther from the reader. Unlike a barcode, the tag does not necessarily need to be within line of sight of the reader and may be embedded in the tracked object. RFID tags are employed in diverse industries, such as automotive, pharmaceuticals, and livestock, among others.

Researchers at Monash University in Australia, supported by the Australian Research Council (ARC)'s Discovery and Linkage Projects, have developed printable, chipless RFID tags that have potential to threaten the use of barcodes used on, for example, packaged goods.

A team led by Nemai Karmakar, from the department of electrical and computer systems engineering, has been developing chipless radio frequency identification (RFID) tags that can be printed directly onto products and packaging (such as postal items, drugs and books). This can render such tags less expensive, smaller and faster than other, commercially available tracking systems.

The researchers developed fully printable tags for metals and liquids, including water bottles and soft-drinks cans. Previously, this achievement has been elusive because the metal and liquids interfere with the technology. An inkjet printer can be used to print the tag, which can be attached to reflective surfaces, for instance, metal cans, water bottles, for being read.

Dr. Karmakar noted that the team is believed to be the first to develop fully printable chipless RFID tags on paper and plastics, and such technology could transform the RFID marketplace. Chipless tags printed directly onto products and packaging could be considerably more reliable, smaller, and cost-effective than any other barcoding system.

The chipless RFID technology, which is compact yet can contain a considerable amount of data, is a high data capacity millimeter wave (mm-wave) barcode system that operates at 60 gigahertz (GHz) mm-wave signal.

The primary challenge that the researchers surmounted was to transfer the technology to paper and plastic while retaining the required printing resolution. Printing errors and surface variations can be easily handled by the 60 GHz mm-wave tag. An additional application, for example, could be biomedical samples stored at cryogenic temperatures.

To further develop the 60 GHz chipless RFID technology, the Monash University Microwave, Antenna, RFID and Sensor Laboratory (MMARS)-affiliated researchers have received a $90,000, three-year grant from Xerox Corp.

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2. MAPPING OF APPLIED PRESSURE IMPROVES BREAST EXAMS

Measurement and mapping of applied pressure enhances a physician's ability to improve the quality and comfort of a clinical breast exam (CBE) and enhance the capability to detect breast lesions during the breast exam. Sensor technologies such as arrays of tactile or force sensors can allow for optimized applied pressure during the exam and for more ready detection of lesions in different areas of the breast. However, tactile imaging systems have required large deformations. Moreover, it has been difficult to detect information besides the size of a lesion.

Indicative of opportunities for using sensors in clinical breast exams, researchers at the University of Wisconsin Hospital and Clinics, under the direction of Dr. Carla Pugh, director of patient safety and education, have developed an effective sensor system to enhance the quality of clinical breast examinations and better enable physicians to consistently detect the presence of breast lesions during such exams. The sensor in the device is able to point out whether a physician is palpating (pressing) with sufficient force for detection of lumps in the breast.

The work was funded by the National Institute of Biomedical Imaging and Bioengineering (NIBIB) at the National Institutes of Health.

In training to perform a CBE, the physician palpates against the breast, checking for hard or irregular lumps that may be tumors. Currently, the observing physician judges whether the trainee is performing the exam properly by covering the entire breast and palpating with sufficient pressure to feel any irregularities. The study led by Dr. Pugh attempted to assess whether the integration of sensor technologies that measure the amount of pressure used by a trainee could improve the training process.

Previously validated, sensor-enabled breast models were employed to measure the CBE technique. The sensors in the breast models provide a visual map, capturing the entire area of the breast model, on a computer monitor. This map shows the amount of pressure exerted by a trainee across the breast model during an exam. The amount of pressure is shown as colors on the map of the test breast. Blue indicates low palpation pressure; red indicates the highest palpation pressure.

In order to understand whether the palpation force used by physicians during CBE could detect breast tumors correctly and whether the force applied by them could be measured by human observation, 553 practicing physicians performed a CBE on four sensor-enabled breast models. Each model had a mass (representing a potential tumor) of different density, located in different areas of the breast. Sensor data showed that 15% of the physicians tested were using a technique that was not able to discover deep tissue lesions near the chest wall. The results indicated that the physician's palpation force during a breast exam cannot be reliably measured by human observation and that the use of sensors can help physicians understand where the palpation force has been inadequate.

The sensor data indicated that while palpation force below 10 newtons (10 newtons corresponds to pressing with a force of approximately 2.25 pounds) could detect the superficial masses in the breast models, deeper masses located at the chest wall were missed. To detect the deeper masses, the optimal amount of force required was between 12 and 17 newtons.

The ultimate aim of the researchers is to integrate technologies such as sensors into the clinical skills training, assessment, and credentialing. The system has key opportunities to provide more accurate breast cancer diagnosis, contributing to enhanced treatment.

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3. MINIATURE WEARABLE INPUT DEVICE

Wearable sensing devices are finding expanding opportunities in connection with mobile phones or other consumer products. As an ever-increasing amount of data is accessed from mobile devices, there will be expanding opportunities for innovative ways of displaying and controlling devices while individuals are mobile. Key challenges in designing wearable sensing devices include space constraints, and need for ultra-low power; also, there is a strong need for advancements in user interface technologies.

Researchers at the Massachusetts Institute of Technology Media Laboratory are developing a wearable device that can transform the user's thumbnail into a miniature wireless track pad. Such technology could enable users whose hands are full to control wireless devices, for example, answering the phone while cooking. The technology could also enhance other interfaces, for instance, allowing someone texting on a mobile phone to toggle between symbol sets without interrupting his/her typing. The technology could, moreover, facilitate communication such as sending a quick, personal text while attending an important meeting, allowing subtlety and preserving privacy.

A prototype device, NailO, a thumbnail-mounted wireless track pad to control digital devices, has been inspired by the stickers that women apply to their nails.

It is envisioned that a commercial version of the unobtrusive device would have a detachable membrane on its surface, allowing users to custom surface patterns according to their outfits. The researchers used capacitive sensing, which can tolerate a thin, nonactive layer between the user's finger and the underlying sensors, to detect touch. They needed to devise a way to put the capacitive sensors, a battery, and three separate chips (a microcontroller, Bluetooth radio chip, and a capacitive-sensing chip) into a space that would not be larger than a thumbnail.

In the prototype, the researchers printed copper electrodes on sheets of flexible polyester to build the sensors, which allowed experimentation with different electrode layouts. However, in ongoing experiments, off-the-shelf sheets of electrodes, similar to those employed in some track pads, are being used.

Furthermore, the researchers have pinpointed a technology that could result in a battery that fits in the space of a thumbnail, while being only half a millimeter thick. Use of a special-purpose chip that would incorporate the functions of the microcontroller, radio, and capacitive sensor could further conserve space.

Since at such a minuscule scale energy efficiency is coveted, the device would have to be deactivated when not actually in use. The researchers discovered that requiring surface contact with the operator's finger for merely two or three seconds was sufficient to safeguard against inadvertent activation or deactivation.

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4. RECENT PATENTS IN THE FIELD OF PRINTED SENSORS

Printed sensors are an advancement in the field of sensors, which use inks and different printing techniques to print a conductive pattern on different substrates. Printed sensors help to achieve light weight and flexibility with low cost. This further facilitates new application opportunities in various sectors, including sensors for consumer electronics.

Each application for printed sensors relies on specific inks and printing techniques dedicated to either low-or high-volume production. Inks and printing techniques are the key enablers of printed sensors. The different types of printing techniques include flexography, gravure, offset, inkjet, screen, and stepnanoimprinting, lithography, aerosol jet technology, and atomic layer deposition. The different types of inks include conductive, resistive, and dielectric. Printed sensors are expected to have high impact on in such application segments as medical and diagnostics, defense and security, Internet of things, smart packaging, consumer electronics, and wearable devices.

In the last four years, patents published on printed sensors have increased. Most of the patents on printed sensors are published in Korea followed by North America and Europe. North America is the main market for the printed sensors, supported by government initiatives and private funding. Asia-Pacific region has been a rapidly growing region.

In the next three years, applications such as healthcare, defense, security, and consumer electronics and wearables will be key focus areas for the development of printed sensors. Printed sensors for the medical market are expected to have a large market share because of the demand from the increasing populations of elderly people and the growing awareness of public about early detection of diseases.

A recent patent in printed sensors (US20140295063), assigned to Unipixel Displays, Inc., pertains to a technique for manufacturing a capacative touch sensor circuit used in displays via a roll-to-roll process to print a conductive microscopic patterns on a flexible dielectric substrate.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
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	02.10.2014; US20140295063	Unipixel Displays Inc.	Petcavich 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	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.
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.
Electronic paper using a touch sensor and a printing device thereof	10.10.2013; KR1020130111298	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

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Printed temperature sensor	08.08.2013; US20130203201	David Thomas Britton	David Thomas Britton	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 nanometers to 100 micrometers, 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.
Transmission gear position sensor using printed circuit element	20.12.2012; US20120319708	Orrico Mario M.	Orrico Mario M.	A gear position sensor employs a sliding electrical connection between arcuate conductors and flexible wiper arms held on opposite surfaces that rotate relative to each other with the movement of a gear selector shaft. The traces may have multiple segments joined by resistors to provide flexible change in resistance value and resistance range for different applications.
Method using non-impact printing processes together with printing fluids that contain active biological molecules to produce sensors and complex analytical systems	27.01.2011; WO/2011/009422	Schwertner, Heiko	Schwertner, Heiko	The analysis of metabolic processes is significant to medicine. The general aim is to miniaturize the detection method and to evaluate results directly electronically. Such sensors can currently be produced only at great technical expense. The aim of the invention is to provide a simple, flexible, and low-cost method for producing analytical sensors. Further aims of the invention are to increase the biocompatibility, to reduce the production costs, to simplify the production, and to construct finer conductor structures, and to increase the quality. In addition, not only should it be possible to analyze molecules, but also cells or cell aggregates should be detected analytically. The aim is achieved by using "non-impact printing processes" together with special printing fluids. Said special printing fluids contain biologically active molecules such as antibodies or RNA in combination with inorganic or organic molecules or polymers, by means of which electronic, optical, and three-dimensional components are constructed. Thus selective optical sensors, PCR cyclers or DNA sequencers, and mechanical components such as valves or pumps can be constructed, in other words, completely printed out.

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

Picture Credit: Frost &Sullivan

5. TECHVISION 2015

The TechVision program is the premier offering of Technical Insights, the global technology innovation-, disruption-, and convergence-focused practice of Frost & Sullivan. TechVision embodies a very selective collection of emerging and disruptive technologies that will shape our world in the near future. This body of work is a culmination of thousands of hours of focused effort put in by over 60 global technology analysts based in six continents.

A unique feature of the TechVision program is an annual selection of 50 technologies that are driving visionary innovation and stimulating global growth. The selected technologies are spread across nine Technology Clusters that represent the bulk of R&D and innovation activity today. Each Cluster represents a unique group of game-changing and disruptive technologies that attract huge investments, demonstrate cutting-edge developments, and drive the creation of new products and services through convergence.

Our technology analysts regularly collect deep-dive intelligence on several emerging and disruptive technologies and innovations from around the globe. Interviews are conducted every day with innovators, technology developers, funders, and others who are a part of various technology ecosystems. The respondents are spread across public and private sectors, universities, research institutions, and government R&D agencies. Each technology is rated and compared across several parameters, such as global R&D footprint, year of impact, global IP patenting activity, private and public funding, current and emerging applications, potential adoption rate, market potential, and so on. This organic and continuous research effort spread across several technologies, regions, organizations, applications, and industries is used to generate an annual list of Top 50 technologies that have the maximum potential to spawn innovative products, services, and business models.

Furthermore, we analyze several possible convergence scenarios where two or more of the Top 50 technologies can potentially come together to disrupt, collapse, and transform the status quo. Driven by IP interactivity emanating from each of the top technologies, a whole range of innovative business models, products, and services will be launched at unprecedented speed in the future. We have come up with over 25 such unique convergence scenarios.

The Top 50 technologies we have selected for TechVision 2015 have the power to drive unique convergence and catalyze wide-scale industry disruptions. Frost and Sullivan's TechVision program empowers you with ideas and strategies to leverage the innovations and disruptive technologies that can drive the transformational growth of your organization.

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