TECHNICAL INSIGHTS

SENSOR

TECHNOLOGY ALERT

19th September 2014

1. LOW-POWER YET FAST 3D SENSOR

Conventional 3D image or 3D position sensors have tended to either passively capture 3D information via triangulation (in which information from images of different angles are calculated) or capture 3D information actively using time-of-flight measurements (in which a camera can emit infrared light and measures the time required for the IR signal to travel to the object and back to the camera). Such traditional techniques use a significant amount of computing power and require post-production processing.

In 2011, scientists at Germany-based BASF invented a new technology with the potential to impact diverse markets/applications, such as consumer electronics (cameras, computers, television, smartphones, tablet PCs) and automotive and transportation (fast object recognition; driver assistance systems such as rear-end collision earning, park assist, adaptive cruise control, lane keeping, blind spot detection; sign recognition; or industrial or passenger autonomous vehicles). The technology can also impact other sectors, such as medical (virtual physiotherapy, minimally invasive surgery, endoscopy, optical microscopy. 3D scanning, and so on), security and surveillance (surveillance through motion sensing, indoor navigation, monitoring critical infrastructure), sports and entertainment (distance and speed measurement, motion capture, and gaming consoles), machine vision and measuring (3D scanning of objects, quality control, ensuring product uniformity).

At the core of this technology is a new physical effect, described in Patent Application WO 2012110924 A1, "Detector for optically detecting at least one object," published in 2012. The applicant is BASF (China) Company Limited, BASF SE. The patent pertains to a detector for optically detecting one object or more The detector comprises at minimum one optical sensor. The optical sensor, which has one sensor region or more, is designed to generate a sensor

signal in a manner that depends on illumination of the sensor region. The sensor signal, given the same total power of the illumination, depends on the geometry of the illumination, particularly on a beam cross section of the illumination on the sensor area. Moreover, the detector has one evaluation device (or more), which is designed to generate an item of geometrical information from the sensor signal, particularly at least one item of geometrical information about the illumination and/or the object.

The new physical effect is enabled by chemistry developed within BASF. Through an innovative distance measurement technique, based on technology allowing for simplified optical detection of one object, 3D position detection and 3D imaging can be enhanced.

The BASF sensor, which has not yet been commercialized, works passively, using only one lens. It does not need triangulation for 3D data capture; thereby significantly reducing demand for computing power and enabling very rapid 3D data capture.

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2. INTELLIGENT CLIMATE CONTROL WITH SENSORS

In countries with warm climates, the usage of air conditioners is bound to increase over time. Air conditioners consume high amounts of energy and also impact the peak load. People are moving from old air conditioners to new ones but the issues surrounding energy consumption remain the same. There is a need for efficient, inexpensive, small and easy-to-use devices which can save energy and cost by providing intelligent climate control.

To address the above challenge, Germany-based tado has developed a device called tado Cooling. tado Cooling was enabled by tado's previous product called tado Heating. tado Cooling has been developed to control air conditioning (AC) units. It comprises a flat box in a slim format and includes a capacitive LED screen. Users can manually control the system using touch gestures. The box is embedded with Bluetooth, Wi-Fi, a temperature sensor, humidity sensor, andan infrared emitter.

Bluetooth is deployed for room-to-room communication between the device and smartphone. The device is Wi-Fi enabled so users can get updates remotely about the temperature. The temperature sensor is deployed in the tado cooling system to control the AC according to the users' preferences. A humidity sensor controls the humidity level when the user is not at home. Theiinfrared emitter is used to control the AC units. The device is connected to a smartphone through the local Wi-Fi network. The device can be controlled with an application and intelligent software on the smart phone. The device is expected to reduce the consumption of AC electricity by approximately 40%.

The tado intelligent cooling system can be used in homes and offices to provide a smart cooling environment. tado has designed the application for Android and Apple smart phones. In the future, the tado team is planning to enable the application for Windows-based smart phones. On smartphones, the application will help users to manage their cooling systems smartly. With location awareness, the application helps the user to turn off the AC automatically when the last person leaves the house. It will also help to pre-cool the house or office environment by tracking the user location. When the user approaches the house, location awareness will instruct the tado system to turn on the AC. Thus, tado's intelligent system helps to save energy costs and intelligently manage the climate based on user needs.

The project was funded by the Kickstarter crowdfunding platform. A total of $204,287 has been collected through crowdfunding. Target Partner and Shortcut Ventures have also invested in the tado intelligent climate control system. The active partners of tado are Germany-based Climate KIC (knowledge innovation community), Fraunhofer Institute for Building Physics, and the Federal Ministry of Economics and Technology. The device can be pre-ordered from tado's website. It is expected to be available in the market by the end of 2014. Once the device is fully commercialized, it is expected to have opportunities get a good response from end users because it saves energy as well as cost and controls the indoor climate of the house intelligently.

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3. TEMPERATURE FLUCTUATIONS HELP TO POWER DEVICES

According to the United Nations 'New Climate Economy Report' 2014, the new goal of various countries is to reduce greenhouse gas emission and stimulate growth by improving energy efficiency. There are a number of technologies, such as radio frequency waves and solar power which focus on battery-free devices. However, in some places, the light from the sun is not enough to power devices. There is a need for a device which can power with the least energy source available, such as solar. The device should be efficient, easy to use, and cheap to operate in various environments.

To address the above challenge, researchers from the University of Washington have developed an energy harvester device, which uses natural fluctuations in pressure and temperature as its power source. The device comprises metal bellows, cantilever motion harvesters, and power sensors.

The researchers have deployed metal bellows and filled it with temperature sensitive gas. Metal bellows are vessels with elastic properties. The bellow gets compressed when pressure is applied to the walls of the vessel from the outside and expands under the vacuum. The size of the metal bellow deployed for this project is similar to the size of cantaloupe. The temperature sensitive gas inside the bellow will react with the outside temperature. When the gas is heated it will expand and allow the bellow to do the same and vice versa. The cantilever motion harvester employed by the researchers will convert the kinetic energy from the bellow into electrical energy. Power sensors deployed on the bellow will collect the data and pass it on to the receiver. Thus, the power harvester developed by the University of Washington will collect the data from natural fluctuations.

The device can be utilized in places where sunlight is not available. The device can be used where only small fluctuations in temperature are possible, such as below ground, bridges, and inside walls. When the device is placed inside walls, the sensors can be tuned to monitor any water leaks. When the device is placed inside the bridge, the sensors can be tuned to monitor the structural deficiencies of the bridge. The device can sense the temperature change of 0.25 degrees C. This change in the temperature can create energy to power the sensor. The range for the sensor to send the data is approximately 5 meters. Even a slight change in the office air conditioning or the natural outside

temperature can trigger the chemicals inside the bellows. Thus, the power harvesting device is very easy to use and cost efficient.

The project was funded by Intel Science and Technology Center for Pervasive Computing at the University of Washington and Sloan Foundation, USA. The project was supported by Southern Methodist University. The project is expected to be commercialized in two or three years' time. The researchers are working on shrinking the size of the device to the size of a small battery. In the future, the researchers are also planning to deploy different chemicals into the device so that it can be used in various climates. The device has potential to be well received by end users as it offers an economical method for powering electronic appliances.

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4. RECENT PATENTS IN THE FIELD OF PHOTOVOLTAIC ENERGY HARVESTERS

Existing ambient energy sources are used by energy harvesting technologies to power devices. This energy can be stored in the battery for later use; and it can also be used for low-power applications. Compared to battery-powered sources, sensors powered by energy harvesters are more cost effective. Depending on the field of application, energy harvesting enables sensors to be located in sensitive and remote areas.

Photovoltaic energy harvesters harness solar energy through use of photovoltaic cells, usually composed of silicon-based material. Such systems can be especially effective for outdoor applications.

A recent patent in photovoltaic energy harvesting (US20140159763) pertains to a system to harvesting solar energy to generate current.

From 1932 to September 2014, approximately 85,410 patents have been registered under photovoltaics. From 2008 onwards, approximately 32 patents have been classified under the electric generation category.

Technology is serving people through solar generated electricity. In 1954, a photovoltaic module built by Bell Laboratories was first used for space programs. At present, photovoltaic modules or cells are used to charge

batteries, generating electricity and more. Photovoltaic sensors are being used by architects, farmers, homeowners and so on. Photovoltaics can find application in power generation, battery storage, hybrid power systems, and utility-scale power production.

In the future, photovoltaics will be more involved with utilities. The Department of Energy has entered into joint ventures with several utilities and the Electric Power Research Institute. Under the joint venture, the project's main focus is to develop new photovoltaics for utilities. In the future, utilities are expected to step up investments in photovoltaics. The recent trends in photovoltaic sensing purely focus on deploying these sensors for utility-scale power production.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
SOLAR PHOTOVOLTAIC SYSTEM AND A METHOD FOR ENERGY HARVEST OPTIMIZATION THEREOF AND A METHOD FOR FAULT DETECTION THEREOF	12.06.2014; US20140159763	Altenergy Power System, Inc.	LUO Yuhao	This invention provides a solar photovoltaic system, comprising: a plurality of photovoltaic assemblies, for harvesting solar energy to generate DC currents; a plurality of micro-optimizers having input terminals coupled to the photovoltaic assemblies and having output terminals connected in series with each other, for optimizing output currents and/or output voltages of the photovoltaic assemblies, to generate maximum power; a manager configured to communicate with the plurality of micro-optimizers, for managing operating states of the micro-optimizers; and an inverter coupled to one or more strings of the micro-optimizers, for converting the optimized DC currents into AC currents and outputting the AC currents to a power grid. This invention further provides a method for energy harvest optimization and a method for fault detection of a solar photovoltaic system.
DISPLAY DEVICE HAVING PLASMONIC COLOR FILTERS AND PHOTOVOLTAIC CAPABILITIES	30.01.2014; US20140029104	The Regents of the University of Michigan	Guo Lingjie Jay	A plasmonic optical spectrum filtering device is provided that filters electromagnetic waves by optical resonance, for example, by selective conversion between the free-space waves and spatially confined modes in plasmonic nano-resonators. Frequency-selective transmission and reflection spectra are engineered and can be used as spectrum filters for display and imaging applications. A thin film stack color filter is further disclosed, which can be designed to either function as a transmission color filter with efficiency twice that of conventional colorant based color filter; or as a reflective color filter for display devices (e.g., used in an energy harvesting reflective display). In other variations, a novel reflective colored display is viewable under direct sunlight, and can simultaneously harvest both incident light and generate electrical power. Methods of making such plasmonic optical spectrum filtering devices are also provide
SOLAR PHOTOVOLTAIC SYSTEMS	27.11.2013; EP2666222	ENECSYS LTD	MUMTAZ ASIM	Improved techniques for photovoltaic power generation are described. Inverter failure is can be a significant problem in solar photovoltaic systems as it can lead to loss of opportunity to harvest energy. A solar photovoltaic (PV) power generation system is described comprising solar PV panels and power conditioning units. A dc power distribution bus is coupled to the solar PV panels and the power conditioning units to switchably share dc power from the solar PV panels between the power conditioning units. Power distribution controllers detect a faulty power conditioning unit and reroute power from a solar PV panel coupled to the faulty power conditioning unit to other power conditioning units via the dc distribution bus.
PHOTOVOLTAIC POWER CONDITIONING UNITS	10.05.2013; WO/2013/064828	ENECSYS LIMITED	GARRITY, Paul	We describe a photovoltaic (PV) panel power conditioning circuits, in particular for a PV panel with multiple sub-strings of connected solar cells. The power conditioning unit comprises a set of input power converters, one connected to each sub-string, a shared dc link to provide a common dc bus for the set of input power converters, and a common output power conversion stage coupled to the shared dc link to convert power from the shared dc link to ac power for a mains power supply output from the power conditioning unit. Local conversion of the sub-strings facilitates control of the power available from the panel and optimum energy harvesting, as well as local maximum power point tracking (MPPT) adjustment.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
DISPLAY DEVICE HAVING PLASMONIC COLOR FILTERS AND PHOTOVOLTAIC CAPABILITIES	06.03.2013; EP2564247	UNIV MICHIGAN	GUO LINGJIE JAY	A plasmonic optical spectrum filtering device is provided that filters electromagnetic waves by optical resonance, for example, by selective conversion between the free-space waves and spatially confined modes in plasmonic nano-resonators. Frequency-selective transmission and reflection spectra are engineered and can be used as spectrum filters for display and imaging applications. A thin film stack color filter is further disclosed, which can be designed to either function as a transmission color filter with efficiency twice that of conventional colorant based color filter; or as a reflective color filter for display devices (e.g., used in an energy harvesting reflective display). In other variations, a novel reflective colored display is viewable under direct sunlight, and can simultaneously harvest both incident light and generate electrical power. Methods of making such plamonic optical spectrumfiltering devices are also provided.
PHOTOVOLTAIC CAPACITOR FOR DIRECT SOLAR ENERGY CONVERSION AND STORAGE	14.02.2013; US20130038267	Jiang Hongrui	Jiang Hongrui	A method and device for harvesting and storing solar energy is provided. The device converts solar energy to electrical energy via the photovoltaic effect. The device includes a pair of electrodes, at least one of which is transparent to allow solar energy to pass through. A medium is disposed between the electrodes which exhibits a combination of photovoltaic and ferroelectric properties. When solar energy passes through the transparent electrode and is received by the medium, electron-hole pairs establish a voltage potential between electrodes in the device via the photovoltaic effect. The voltage potential may be retained and the mobile charge may be stored in the absence of solar energy via the ferroelectric effect.
PHOTOVOLTAIC PANEL-INTERFACED SOLAR-GREENHOUSE DISTILLATION SYSTEMS	29.11.2012; US20120298499	Lee James Weifu	Lee James Weifu	A hybrid photovoltaic panel-interfaced solar-greenhouse distillation technology is disclosed that is capable of utilizing solar waste heat to perform liquid distillation while co-generating solar electricity. Solar waste heat co-generated at a photovoltaic panel is effectively utilized by in situ distillation liquid as an immediate heat sink in thermal contact with the photovoltaic panel, thus providing beneficial cooling of the photovoltaic panel and co-making of distillation products while generating electricity with significant improvement on total-process solar energy utilization efficiency. Use of this invention can provide a series of distillation-related products such as freshwater, distilled water, hot water, hot steam, sea salts, saline/brine products, and/or harvest biofuels and bioproducts such as ethanol from renewable resources while co-generating solar electricity.

Exhibit 1 lists some of the patents related to photovoltaic energy harvesters,

Picture Credit: Frost & Sullivan

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Back to TOC