# TECHNICAL INSIGHTS

# SENSOR

## TECHNOLOGY ALERT

**19th December 2014**

## 1. INFRARED SENSOR FOR MONITORING PETROCHEMICAL FACILITIES

Due to failure of electric power, petrochemical facilities go through unplanned downtime. This downtime further results in service failures, network outages, and hardware problems. The oil and gas operations are heavily dependent on combustion. According to the LumaSense Technologies Inc., a shutdown of this process will cost approximately $1 million per day. Hence, there is a need for a device that can help to prevent downtime and protect the refinery by monitoring gas and refractory temperatures in the refinery. In addition, the device should be easy to use and cost effective.

To address the above-mentioned challenges, researchers from US-based LumaSense Technologies Inc. have developed a petrochemical infrared sensor: the Pulsar 4, which uses a single pyrometer with two infrared filtered detectors and provides continuous measurement of gas and refractory temperatures. In IR pyrometer is a non-contact temperature sensing device that detects radiated thermal energy emitted from objects.

The infrared pyrometer in the Pulsar 4 is used to get accurate results with the precision of 0.3 degrees C, within a range of 350 degrees C to 2000 degrees C. Infrared pyrometers are explosion proof, and because of this characteristic they are able to 'see' through the flames and deliver accurate data about gas and refractory temperatures. LumaSense uses specially designed Smart Flame Measurement Algorithm to analyze the information collected by the infrared pyrometer. This algorithm takes into account the flame transparency that can further affect the temperature readings. This algorithm provides a precise view of the activity inside the vessels of the petrochemical facilities. The data collected is interpreted by the smart algorithm by using a software called InfraWin.

Once the product is successfully developed, it is expected to be deployed in petrochemical facilities with the goal to protect refinery profits and prevent downtime. The Pulsar 4 will be deployed to monitor gas temperatures inside sulfur burners, sulfur recovery units, and thermal oxidizer furnaces. The researchers are working on upgrading the InfraWin software that will help to analyze the data from the Pulsar 4. The LumaSense infrared sensor is easy to deploy and cost-effective, and can help to secure the petrochemical facilities and also prevent downtime.

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## 2. WIRELESS CHEMICAL SENSOR FOR VARIED APPLICATIONS

Chemical sensors can be found in many applications such as automotive, food, pharmaceutical, biomedical, chemical processing, residential or commercial applications (such as carbon monoxide detection), environmental, and industrial safety, among other applications. At present, the sensors available in the market are expensive and they need an external power source to function, which further limits the use of the chemical sensor. There are market opportunities for self-powered devices that can be cost efficient, and provide accurate results.

To address the above-mentioned challenge, researchers from the Massachusetts Institute of Technology have developed a wireless chemical sensor. The sensor is embedded with a nanomaterial and is capable of interacting with chemicals. The researchers at MIT are calling it the chemically actuated resonant device (CARD).

To enable a CARD, the researchers at MIT leveraged a printed RFID (radio frequency identification) tag circuit. The researchers punched a hole in the circuit and reconnected it with the help of carbon nanotubes (CNTs). The CNT is integrated into the circuit with the help of a mechanical pencil. The lead of a pencil is made up of compressed powder of CNTs. The modified RFID tag is thus referred to as CARD. This new sensor is based on the near field communication tag, which receives some power from the device reading it such as a smart phone. There is a change in the ability of CNTs to conduct electricity when the tubes are in contact with the target gas. The CARD further shifts the

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radio frequency at which the power is transmitted. The CARD will answer to the tap by the smartphone only when it is able to receive sufficient power at certain radio frequency. It further allows the smartphone to determine whether any gas is present. At present, a single CARD can detect only one gas, but a smart phone can detect multiple CARDs.

Once the project is successfully completed, it will have opportunities to be deployed indoors as well as outdoors. The device will be able to detect harmful gases and explosives. The researchers have been able to detect ammonia gas, hydrogen peroxide, and cyclohexanone. They are currently working on enabling different applications with the help of the CARD.

The project was funded by the US Army Research Office through the MIT Institute for Soldier Nanotechnologies, the US Army Research Laboratory, the National Cancer Institute, and the MIT Deshpande Center for Technological Innovation. The researchers are currently working on integrating the CARD device into smart packaging. It will allow detection of contamination and spoilage of food. Once the project is successfully commercialized, it has opportunities to get a good response from the consumers, who will be able to detect different sorts of chemicals on their own. In addition, the device will be easy to use and cost efficient.

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### 3. WEARABLE SENSOR PLATFORM FOR MAPPING THE SURROUNDINGS

In the wearable electronics industry, sensors are playing a crucial role. In conjunction with wearable electronics, sensors have been gaining traction in various sectors such as healthcare and consumer electronics, among others. At present, there are devices such as GPS (global positioning system), advanced GPS, and LIDAR (light detection and ranging) to map the surroundings. However, these devices are not wearable, can be a bit complicated to use, are expensive, and may not offer personal assistance in unplanned situations such earthquakes. Hence, there is a need for a device that is wearable, can effectively map the surroundings of the user, and help the user in various unplanned situations such as an earthquake. In addition, the device should be easy to use, accurate, and cost efficient.

To address the above-mentioned challenge, researchers from the Massachusetts Institute of Technology (MIT) have developed a sensor system that can be worn by the user and can form a digital map of the surroundings while the wearer is on the go. The wearable sensor system is embedded with an array of sensors such as an accelerometer, gyroscope, laser rangefinder, and camera.

To enable the wearable sensor platform, researchers from MIT have applied the technique used by robots to map their environment. The wearable sensor platform is deployed with a laser rangefinder to determine the distance of the nearest wall. The laser rangefinder uses the laser beam with 270 degree arc and measures the total time taken by the light pulse to return. The gyroscope is employed to monitor whether the laser rangefinder is tilted or not. This information is further interpreted with the help of algorithms. The accelerometer is used to provide information about the velocity of light and change in the altitude. For every few meters that the user commutes, the camera takes the snapshot of the surroundings. Software is used to interpret the information given by the camera in terms of contours, colors, and three dimensional shapes. In this way, the wearable sensor platform automatically creates a map of the surroundings.

The wearable sensor platform might be deployed in the military and can be useful during combat situations. It can be used in disaster response where users wearing the sensor platform can use its ability to generate maps to find ways out of at-risk locations and buildings. This wearable sensor platform can distinguish variations in altitude. The platform is easy to use and can be invaluable for guiding the wearer in emergencies.

The project was funded by the Office of Naval Research and the US Air Force. The researchers are currently working on reducing the size of the sensor platform. Once the project is successfully commercialized, it is expected to be used in defense operations.

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## 4. RECENT PATENTS IN THE FIELD OF PROXIMITY SENSING

Sensors that can sense the presence of specific objects nearby without having an actual contact with those objects are called proximity sensors. Types of proximity sensing technologies include capacitive, inductive, ultrasonic, magnetic, optical . Applications for proximity sensing include detecting, inspecting, and positioning in manufacturing systems and automated machines; plastic modeling; packaging; food processing; metal working; conveyor systems; touch screens; automobile park assist.

LIXIL Corporation has approximately 109 patents registered, among which two are related to proximity sensors. One among these (WO/2014/192230), presented in Exhibit 1, pertains to a proximity sensor and automatic faucet,and includes a proximity sensor for measuring distance to the detected object and a light reception detection unit. Samsung and Apple have been some of the major developers of proximity sensors

From 1965 to December 2014, approximately 2132 patents have been registered with the title proximity sensor. In 2014, approximately 185 patents have been registered under proximity sensing. There is an emerging and increasing trend of using proximity sensing in smart phones.

| Title | Publication Date/Publication Number | Assignee | Inventor | Abstract |
|---|---|---|---|---|
| Proximity sensor and automatic faucet | 04.12.2014; WO/2014/192230 | Lixil Corporation | Shirai, Yuki | A proximity sensor (1) provided with a measurement distance determination unit (321) for determining whether the distance to a detection object is within a prescribed detection distance range, a light reception amount determination unit (322) for determining whether an amount of received light is greater than or equal to a light reception amount threshold, and a continuation determination unit (323) for determining whether a state in which a detection object is present is continuing, said light reception amount determination unit (322) being such that after it is determined that there is a detection state and water discharge starts, during the period in which the continuation determination unit (323) determines that the state in which the detection object is present is continuing, the light reception amount threshold is set to a lower value than the value before water discharge started. |
| Optical proximity sensors | 04.12.2014; WO/2014/194151 | Neonode Inc. | Holmgren, Stefan | A proximity sensor including a housing, a plurality of light pulse emitters for projecting light out of the housing along a detection plane, a plurality of primary light detectors for detecting reflections of the light projected by the emitters, by a reflective object in the detection plane, a plurality of primary lenses oriented relative to the emitters and primary detectors in such a manner that for each emitter-detector pair, light emitted by the emitter of that pair passes through one of the primary lenses and is reflected by the object back through one of the primary lenses to the detector of that pair when the object is located at a position, from among a primary set of positions in the detection plane, that position being associated with that emitter-detector pair, and a processor for coactivating emitter-detector pairs, and configured to calculate a location of the object in the detection plane. |
| Proximity luminance sensor and method for manufacturing same | 13.11.2014; WO/2014/181958 | ITM Semiconductor Co. Ltd. | Kim, Yung Jun | The present invention relates to a proximity luminance sensor obtained by assembling a housing array to a printed circuit board array using an adhesive layer, prior to separation into individual proximity luminance sensors, thereby preventing contamination or damage to lenses, decreasing the optical interference phenomenon, reducing the manufacturing cost and manufacturing time, and thus substantially improving productivity. The proximity luminance sensor may comprise: a printed circuit board; a light-emitting chip mounted on the printed circuit board; a light-receiving chip mounted on the printed circuit board; a light-emitting lens unit surrounding the light-emitting chip; a light-receiving lens unit surrounding the light-receiving chip; a housing shaped to surround the light-emitting chip and the light-receiving chip and provided with a light-emitting window, which corresponds to the light-emitting lens unit, and a light-receiving window, which corresponds to the light-receiving lens unit; and an adhesive layer installed between the housing and the printed circuit board. |
| Proximity sensor system for electric submersible pumps | 06.11.2014; WO/2014/179160 | Schlumberger Canada Limited | Camacho Cardenas, Alejandro | An electric submersible pump (ESP) can include a shaft; an electric motor configured to rotatably drive the shaft; a housing; a stack of diffusers disposed in the housing; impellers disposed in the housing and operatively coupled to the shaft; and a proximity sensor operatively coupled to the housing. |

| Title | Publication Date/Publication Number | Assignee | Inventor | Abstract |
|---|---|---|---|---|
| Integrated normal sensing and proximity sensing on a multi-dimensional sensor array | 04.11.2014; 08878811 | Baumbach Jason G. | Baumbach Jason G. | Apparatuses and methods for coupling a group of sensor elements together in one mode to collectively measure a capacitance on the group of sensor elements, in addition to individually measuring a capacitance on each of the sensor elements in another mode. The apparatus may include a processing device, and a plurality of sensor elements that are individually coupled in a first mode for normal sensing and collectively coupled in a second mode for proximity sensing. |
| Proximity detection using sensors based on a programmable multi-array structures | 30.10.2014; WO/2014/176574 | Readme Systems Inc. | Kulkarni, Raghavendra | Embodiments of the present disclosure is directed to the use of spatially diverse multiple antenna structures and associated radio transmitters and receivers in a sensor for accurate proximity detection. In a retail environment, a system based on a network of such (smart) sensors can accurately detect presence and location of a shopper's wireless mobile device as the shopper moves along the shopping aisles carrying the wireless mobile device (e.g. smartphone). Based on the location of the shopper and the duration of the shopper stopping in front of a product shelf in an aisle, embodiments can engage the shopper (through the wireless mobile device) in transaction-oriented interactions using the 'sense, analyze, and connect' capability of the various embodiments described herein. Such interactions result in increased revenue for the retailers as well as better understanding of the shopping behavior of the retail shoppers. Such understanding can be embodied in improved analytics. |
| Device and method for evaluating the capacitance of a sensor electrode of a proximity sensor | 29.10.2014; EP2795798 | HUF Hülsbeck & Fürst GmbH & Co KG | Sieg Berthold | A method for evaluating the capacitance (Cs) of a sensor electrode of a proximity sensor. First, the sensor electrode is charged with a charge voltage (Uo) by coupling of the sensor electrode. At the same time, a compensation capacitance (CK) is charged by coupling in the compensation capacitance between a reference voltage (UREF) and ground. Then, the sensor electrode and the compensation capacitance (CK) are decoupled from voltage sources, wherein a state of charge of the sensor electrode and of the compensation capacitance is maintained. The sensor electrode is coupled to the compensation capacitance (CK) and charge balancing is performed. Now, the sensor electrode is decoupled from the compensation capacitance (CK), wherein the charge of the compensation capacitance which is present as a result of the charge balancing is maintained and the compensation capacitance (CK)is coupled to an evaluation network in order to effect a current flow from the compensation capacitance through the evaluation network. The charge of a hold capacitance (CH) in the evaluation network is reversed by means of a charge-reversal current which is dependent on the current flow of the compensation capacitance, and the charge of the hold capacitance is evaluated after one or more such cycles. |

**Exhibit 1 lists some of the patents related to proximity sensors.**

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