TECHNICAL INSIGHTS

SENSOR

TECHNOLOGY ALERT

30th May 2014

1. TERAHERTZ TECHNOLOGY-BASED THREAT DETECTION

Chemical, Biological, Radiation, Nuclear Explosive (CBRNE) detection techniques ensure better security and safety in a variety of important or strategic locations. It can be difficult to precisely, reliably and simply screen and detect explosives in small packages or envelopes with sensitivity and selectivity. With the rising threat of terrorism across the world, there is a need for systems and technology that can effectively and safely counter terrorist threats.

Terahertz imaging has opportunities to provide key evidence using non-destructive testing to detect the presence of explosives and illegal substances.Terahertz waves can provide enhanced imaging and sensing capabilities; and the terahertz region can be sued to image through most materials that are not hot metal or liquid. Leveraging terahertz technology, researchers at the Fraunhofer Institute for Physical Measurement Techniques IPM (Germany) have collaborated with HÜBNER GmbH & Co. KG (Germany) to develop a system that is capable of scanning suspicious packages and envelopes without requiring to open them. The system, known as T-Cognition, is ideal for rapid scanning of consignments transmitted through postal medium.

In the electromagnetic spectrum, the terahertz (THz) range lies between the infrared and microwave bands. The waves have frequencies between 0.1 THz and 10 THz with wavelengths between 3 milimeters to 30 micrometers. The waves can easily penetrate materials such as wood, plastics, paper, lightweight fabrics, and ceramics. Depending on the type of material they interact with, terahertz waves generate unique spectra that can be analyzed, using software, to detect the material. Apart from these advantages, terahertz waves are also non-ionizing, which makes them safe for usage in unprotected environments.

The T-Cognition system consists of a retractable tray into which the suspicious packages and envelopes can be fed. The target is then exposed to terahertz waves; the waves get absorbed differently depending on the material composition inside the packages. Terahertz sensors located at the output of the scanner then read the wavelengths of the transmitted signals and produce a spectroscopic image of the package. The spectroscopic signature is then compared with a hazardous material database to identify potential threat. When the consignment being scanned is detected to contain illicit drugs or explosives, an alarm is triggered. It can detect through packaging up to 2 centimeters thick, and detect explosives including C4.

The T-Cognition system is very suitable for usage in various locations, such as a customs office, government agencies, prisons, company headquarters, consulates or embassies. It can enhance the security of these places in terms of preventing passage of contraband substances, saving human lives, and preventing damage to assets. The developed system has won the Prism Award at the Photonic West 2014 held in San Francisco (United States). The T-Cognition system has been commercialized by HÜBNER GmbH & Co. KG.

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2. HANDHELD OIL CONTAMINATION SCANNER THAT USES INFRARED SPECTROSCOPY

Petroleum contamination resulting from leakages in tanks or spills can seriously impact the health of an ecosystem, including the vegetation, animals, and humans. Traditional methods of detecting soil contamination have required soil samples to be taken and sent across to laboratories for extensive testing. This leads to significant costs from transportation and testing. Moreover, this process does not give immediate results that can be important in certain applications.

The Commonwealth Scientific and Industrial Research Organization (CSIRO) of Australia, in partnership with Ziltek Pty. Ltd. (Australia), has developed a handheld soil contamination detection device that can detect the presence of petroleum hydrocarbons. The device, RemScan, uses portable

infrared spectroscopy technology and has a fast detection time of about 15 seconds, which makes it possible to scan large areas effortlessly. It uses near and mid infrared spectrum information for the detection of total petroleum hydrocarbons. (TPH). The output of the scanner is given in mg/kg and has a very low relative error percentage. For best results, the soil surface needs to be air dried so minimum moisture is present. The presence of moisture affects the accuracy of the scanner. Data collected by the RemScan is stored on board in a Secure Digital (SD) card and can be easily downloaded for analysis.

The scanner enables rapid in-field screening of contaminated sites for validating oil spill clean ups and for monitoring contamination degradation. In remote locations, laboratory analysis is either unavailable or extremely costly. In such situations, the RemScan can provide a highly cost effective alternative. Moreover, the scanner uses nondestructive testing and as a result the soil composition is not disturbed. The scanner can quantitatively measure not only the concentration of oil, diesel, and crude spills, but also other lighter fuels including gasoline and jet fuel. It can be used in a variety of soil types ranging from sand to heavy clay. This ensures that a single device can be used extensively in different locations.

Ziltek already commercialized the RemScan scanner in Australia two years ago. It has been extensively used by the oil and gas industry and mining sector in various Australian states. CSIRO holds the intellectual property for RemScan in United States, which has been licensed to Ziltek. The initial development of the technology was funded by HazWaste fund, Bio Innovation SA, and the Australian Government. The success of the device in Australia has prompted Ziltek to launch RemScan in the US market.

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3. ENHANCED INDUSTRIAL SAFETY USING BODY WORN SENSORS

Personnel safety is a major concern for firms operating in industries such as oil and gas, manufacturing, and mining. The workers are often exposed to hazardous locations with dangers such as toxic gases, fire, and uncertain environment. For more efficient, real-time monitoring of workers, sensors worn on the body of the workers can communicate in real-time. Key challenges in employing such a body worn system for multiple individuals include integrating the sensor data, transferring the data in real time, and drawing relevant meaning from data analysis.

UK-based Hidalgo Ltd has come up with a real-time personnel monitoring system, the BlackGhost ISAW, which ensures enhanced safety of workers in such potentially dangerous environments. The system not only comprises body worn sensors, but also integrates information from other sources, such as environmental data, and subject data, to provide a holistic view of the health and environment of individual workers. The body worn sensors collect information on health parameters that include ECG (electrocardiography), breathing rate, heart rate, and core body temperature. Activity information includes calories burned, ambulation status, number of steps taken, distances travelled, and so on. The data are collected from the LifeMonitor system of Hidalgo, which the worker wears on his/her body. The Black Ghost ISAW integrates the data from the LifeMonitor with data from other sources such as GPS (global positioning system), and gas sensors, to give a contextual status of the workers. The data can be viewed locally or remotely through the Internet, ensuring that all the stakeholders have access to critical information. A Web-based dashboard is provided that can be customized based on the user's requirement, adding flexibility to system. The data can also be viewed on mobile applications.

The Black Ghost ISAW aids operation managers in critical decision making. The availability of real-time information helps in preventing unwanted accidents. The location information generated by the system can also be used by first responders to locate and rescue trapped workers during an emergency.

The Black Ghost ISAW has a high potential for acceptance in the industry. The system can be incorporated as mandatory personal protective equipment (PPE) in various industries. In future versions, Hidalgo plans to integrate more functionality, such as, video sensors. The Black Ghost ISAW is

IECEx, ATEX Class 1 Division 1 certified, which permits the system to be used in an environment containing explosive gases. The robustness of the system, ability to monitor numerous workers simultaneously, and real-time information availability confers a high customer acquisition potential on Black Ghost ISAW.

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4. RECENT PATENTS IN THE FIELD OF HYPERSPECTRAL IMAGING

Hyperspectral imaging involves capturing information from numerous narrow, essentially contiguous bands across the electromagnetic spectrum. This capability provides a more detailed pixel spectrum, leading to more information about the surface of a material or object and more detailed, accurate information about remotely sensed imagery. In hyperspectral imaging, the spatial images can be combined with spectral analysis to create a three-dimensional (3D) data cube.

Hyperspectral imagers provide remote sensing of light reflected from objects that are generally some distance away from the sensing system. There are various ways to acquire hyperspectral images--pushbroom, whiskbroom, snapshot imaging, interferometric/Fourier transform. In the pushbroom technique, where imaging of a scene is conducted line-by-line, the reflected light from the source is passed through sensor lenses and enters a slit that allows a very thin light beam to pass. The thin beam of light is projected onto a diffraction grating or prism that disperses the light into its spectra. The dispersed light is spread across the imaging sensor/camera, which measures the spectral intensities of the dispersed light and converts the intensities into an electrical signal.

Hyperspectral imaging is increasingly finding opportunities in applications including remote sensing, precision agriculture, food processing, security and surveillance, chemical imaging, healthcare, forensics, environmental monitoring, pharmaceutical inspection, and astronomy.

The major factors hindering the adoption of hyperspectral imaging have been cost and complexity. There are opportunities to reduce cost, increase versatility, and drive opportunities for less expensive, handheld hyperspectral sensing systems by, for example, eliminating bulky optics.

Among recent patents in this field, patent no WO/2014/063117 indicates the use of a single sensor imaging system with a photo sensor array. Patent no WO/2014/018305 indicates an hyperspectral imaging system with a scannable slit mechanism.

PATENT TITLE	PUBLICATION DATE / NUMBER	ASSIGNEE	INVENTORS	ABSTRACT
HYPERSPECTRAL IMAGING SYSTEMS AND METHODS FOR IMAGING A REMOTE OBJECT	22.05.2014; WO/2014/078281	CORNING INCORPORATED	Comstock II Lovell Elgin	A hyperspectral imaging system (100a) and a method are described herein for providing a hyperspectral image of an area of a remote object (e.g., scene of interest (104)). In one aspect, the hyperspectral imaging system includes at least one optic (106), a rotatable disk (202) which has at least one spiral slit (204) formed therein, a spectrometer (110), a two-dimensional image sensor (112), and a controller (114). In another aspect, the hyperspectral imaging system includes at least one optic, a rotatable disk which has multiple straight slits formed therein, a spectrometer, a two- dimensional image sensor, and a controller. In yet another aspect, the hyperspectral imaging system includes at least one optic, a rotatable drum (which has a plurality of slits formed on the outer surface thereof and a fold mirror located therein), a spectrometer, a two-dimensional image sensor, and a controller.
SINGLE-SENSOR HYPERSPECTRAL IMAGING DEVICE	24.04.2014; WO/2014/063117	HYPERMED IMAGING, INC	DARTY, Mark, Anthony	A hyperspectral imaging device comprising a photo-sensor array including a plurality of photo-sensors, each providing a respective output, is provided. The device comprises a spectral filter array having a plurality of filter elements, each filter element arranged to filter light received by a respective one or more of the photo-sensors. Each filter element is one of a plurality of filter-types. Each filter-type characterized by a unique spectral pass-band. The device comprises an interface module to select a plurality of subsets of photo-sensor outputs. Each such subset is associated with a single respective filter-type. The device comprises a control module that generates a hyperspectral data cube from the subsets of photo-sensor outputs by generating a plurality of images. Each such image is produced from a single corresponding subset of photo-sensor outputs in the plurality of photo-sensor outputs and so is associated with a corresponding filter-type in the plurality of filter-types.
DETECTING A TARGET IN A SCENE	27.03.2013; WO/2014/045012	BAE SYSTEMS PLC	BLAGG, Adrian Simon	A system and method are disclosed for detecting a target within a scene. The system comprises a sensor for acquiring hyperspectral image data of the scene, a repository for storing a set of target spectra and a processor for processing spectra generated from locations within the scene with the known set of target spectra. The processor is further arranged to generate a probability that the spectra generated from locations within the scene correspond with one or more target spectra based on the comparison between the spectra generated from locations within the scene with the target spectra.

PATENT TITLE	PUBLICATION DATE / NUMBER	ASSIGNEE	INVENTORS	ABSTRACT
METHOD OF CONTROLLING THE RESOLUTION OF A HYPERSPECTRAL IMAGE	05.03.2014; EP2703792	GE AVIAT SYSTEMS LLC	Buehler Eric Daniel	Method of controlling the resolution (80) of a hyperspectral image from an image sensor comprising pixels and at least one filter that defines subpixels within each pixel includes defining a window (82) on the image sensor with an array of rows and columns of subpixels; weighting the subpixels (86) within the window based upon one or more predefined parameters of the hyperspectral image to establish a value for a weighted average (88) for the array for the predefined parameters; shifting the window by a predefined number of rows or columns; repeating the weighting and shifting steps for all possible windows (90, 92) on the image sensor; and processing the hyperspectral image based on the weighted averages.
Method of evaluating the confidence of matching signatures of a hyperspectral image	19.02.2014; EP2698741	GE AVIAT SYSTEMS LLC	DELAMO ANA ISABEL	The invention relates to a method (10) of evaluating the confidence of matching signatures of a hyperspectral image of at least one tracked object (310,312), defined by pixels on an image sensor, to a hyperspectral image template in real time while tracking the at least one tracked object
HYPERSPECTRAL IMAGING SYSTEM AND METHOD FOR IMAGING A REMOTE OBJECT	30.01.2014; WO/2014/018305	CORNING INCORPORATED	BHATIA, Vikram	A hyperspectral imaging system and method are described herein for providing a hyperspectral image of an area of a remote object (e.g., scene of interest). The hyperspectral imaging system includes at least one optic, a scannable slit mechanism, a spectrometer, a two-dimensional image sensor, and a controller. The scannable slit mechanism can be a micro-electromechanical system spatial light modulator (MEMS SLM), a diffractive Micro-Opto-Electro-Mechanical Systems (MOEMS) spatial light modulator (SLM), a digital light processing (DLP) system, a liquid crystal display, a rotating drum with at least one slit formed therein, or a rotating disk with at least one slit formed therein

Exhibit 1 lists some of the recent published patents on hyperspectral imaging.

Picture Credit: USPTO/ Frost & Sullivan

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