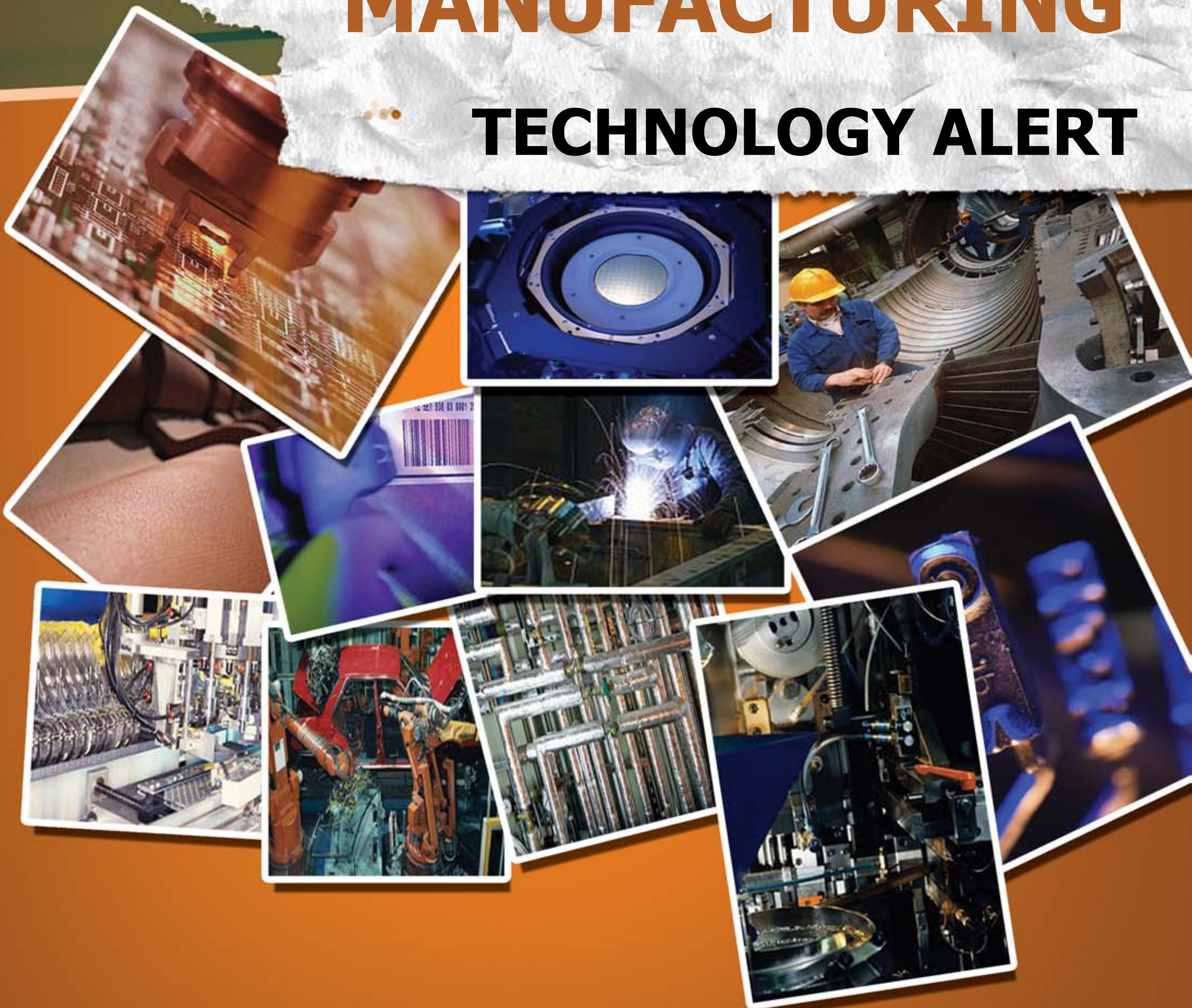
TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT



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1. IMPROVED OPTICAL SENSORS FOR POWER PLANTS

Fiber optic sensors have key benefits for operation in utilities and power plants, such as immunity to electromagnetic interference (EMI) and ability to operate at high temperatures and in harsh environments characteristic of fossil fuel-based generators. Moreover, fiber optic sensors lend themselves to distributed sensing as well as remote sensing and embedment of sensors in materials, systems, or structures.

Applications in the electric power industry where fiber optic sensors are used include monitoring temperature or current in electric utility substations or transmission systems. For example, fiber optic sensors are used for direct measurement of the temperature of windings used in power transformers. The hottest spot of the winding is a key limiting factors for the load capability of the transformer.

Fiber optics technology is also finding opportunities to monitor temperature or current in power transmission lines. Indicative of key advancements in fiber optic sensing for power applications, the sensors and controls team at the US Department of Energy (DOE)’s National Energy Technology Laboratory (NETL) is now able to fabricate prototype optical sensors that are made using an innovative laser-heated pedestal growth (LHPG) system. Such sensors afford key benefits over conventional sensors, such as a wider working temperature range, higher durability, and decreased cost. LHPG-produced sensors are able to function effectively in the high-temperature and harsh environments of advanced power systems.

The LHPG crystal growth method transforms bulk high-temperature resistant materials, such as sapphire or yttrium stabilized zirconia (YSZ) into single-crystal optical fiber, resulting in optical fibers with a very high melting temperature that can be used as a sensor substrate (base material). Fiber optic sensors can enhance sensitivity and durability as a result of being fabricated using the LHPG technique. This technique allows for precisely controlling crystal growth, incorporating innovative sensing materials with fiber substrates during the growth process, and controlling the fabrication parameters and the high temperature-resistant materials.

Sensors developed using this innovative technique could also be used for monitoring various processes and controlling energy systems such as gas turbines, solid oxide fuel cells, oxy-fuel combustion, and boilers.

Details: Michael Buric, Scientist, National Energy Technology Laboratory, 3610 Collins Ferry Road, Morgantown, West Virginia. Phone: 304-285-2052. E-mail: michael.buric@netl.doe.gov. URL: www.netl.doe.gov.

2. PIEZOELECTRIC SENSOR TO HARVEST ENERGY USING CARBON FIBER BEAMS

Energy harvesting is a process for conversion of waste energy gathered from a system's environment into usable electric power by using an energy harvester. Piezoelectric energy harvesters are normally employed to harvest waste vibration energy. A particular form of such energy harvesters consist of a cantilever beam, which is filled with air and produces self-induced and self-sustaining vibrations. In the current process, an additional second vibrating structure is attached to the wing section to harvest the energy from vibrations. Thus, there is a need for a system or method to harvest energy from the beam rather than attaching an extra vibrating structure. This method will help to cut cost and generate more energy compared to the conventional process. The method to harvest energy from the beam should be easy to use and cost efficient. For future use, the method should have the capability to be integrated with sensors to make them autonomous and self-powered.

To address the above challenge, researchers from Virginia Tech have deduced the way to harvest energy from beams placed in the wind tunnel.

Researchers have developed a flexible carbon fiber cantilever beam with the help of piezoelectric transducer. Researchers have deduced a way to harvest energy from a combination of factors namely wind speed and angle. They have deduced that approximately 0.3 mW of power can be harvested when wind speed is 10 m/s and angle of 5.4 degrees. From the method to harvest the energy from the flexible beam, researchers have showcased that when the flexible beam is placed at the right angle, the attack caused by the wind speed will bend the beam so much that it will cause the flutter speed of the beam to reduce. There is a noted change in the frequency when the beam tends to bend, which further leads to harvesting energy with the help of a piezoelectric transducer.

Once the project is successfully completed, it will be deployed in aerodynamics such as airplane and in rockets. In addition, it will also be employed in structural health monitoring of air and water systems, vehicles, infrastructure, and in structures where secure data reception of transmission from sensors takes place. The system in these places will additionally require data loggers, thousands of sensors and hardware components. Self-powered systems in these areas with inbuilt energy harvesting capabilities will be very useful in the future.

The project was self-funded by Virginia Technology. Researchers are currently working on identifying different ways to harvest energy from the wind tunnel. In addition, they are identifying ways to improve the power level from the piezoelectric sensor. In the coming years, researchers plan to design small beams with specific geometries to improve the performance of the piezoelectric element. The device is expected to be commercialized in one to two years of time. Once the project is successfully commercialized, it is expected to get a good response from aerodynamics industry.

Details: Mohamed Yehia Zakaria Mohamed, Researcher, Engineering Mechanics, Virginia Tech, Blacksburg, VA 24061. Phone: 540-376-1679. E-mail: zakaria@vt.edu . URL: https://www.vt.edu/

3. ULTRA-HIGH SPEED CMOS IMAGE SENSOR

Visualization technologies and devices such as microscopes, X-ray and infrared cameras have enabled observing ultra-high-speed phenomena, which cannot be observed by the naked eye. However, these devices are normally incapable of capturing phenomena occurring at durations shorter than 50 ms to 100 ms. There is hence a need for a device that can capture the change in image with the shortest time span and in addition make it slower and enlarge it so that can the human eye can view and understand the change. The device should be easy to use and also be cost efficient.

To address the above challenge, researchers from the Tohoku University, Japan, have developed an ultra-high speed CMOS (Complementary Metal Oxide Semiconductor) image sensor, which will be used in the future for advanced scientific research. The researchers have developed the CMOS image sensor by reinvestigating the pixel structure, bottleneck, and circuit design of the previous models. The image sensor has two memory arrays and one pixel array. The array of photodiodes is integrated into the chip with antireflection coating to maximize transmittance of wavelength of light received by the photodiode. The photodiode is made up of a silicon substrate whose bottom is coated with a silicon dioxide (SiO_2) layer and the top is coated with aluminum oxide (Al_2O_3). With the help of this design, researchers have avoided the complex manufacturing process and improved the transmittance of light to capture images with the shorter intervals.

The ultra-high-speed CMOS image sensor is able to record 10 million frames per second. It is faster than other image sensors currently available in the market. After integrating the ultra-speed CMOS image sensor in the camera, it will be able to record images occurring at intervals shorter than 50 ms to 100 ms and then replay them at a much slower speed to make it viewable by the human eye. The ultra-speed CMOS image sensor will enable applications in various different fields requiring high speed of observation. The possible applications of the sensor in aerospace are airflow in wind tunnel test, high speed impact test for materials in aerospace, generation and propagation of shockwaves and behavior of high speed flying objects.

The sensor will also enable studying the combustion process in automobile engines, injection process in fuel injection equipment in the automotive industry. In the automation industry, the applications include studying machining process in welding equipment, and operation error analysis of manufacturing equipment. The sensor will also find applications in other sectors such as medical, consumer electronics, and sports.

The project was partly funded by Shimadzu Corporation and the Tohoku University. Shimadzu Corporation has incorporated the ultra-speed CMOS image sensor in its recently launched video camera, Hyper Vision HPV-X2. The ultra-speed CMOS image sensor is expected to be integrated in other companies' cameras in one to two years of time.

Details: Shigetoshi Sugawa, Professor, Graduate School of Engineering, Department of Management Science and Technology, Tohoku University, 6-6-05, Aramaki Aza Aoba, Aoba-ku, Sendai, Miyagi 980-8579, Japan. Phone: +81-22-795-4835. Email: shigetoshi.sugawa.d4@tohoku.ac.jp. URL: http://www.tohoku.ac.jp

4. RECENT PATENTS IN THE FIELD OF DRONES

Drones are finding opportunities in different sectors. The combination of sensing system and communication system is used in drones with autonomous and remote control capabilities. While the most prominent applications for drones are in the military sector, they have the capability to completely disrupt the logistics industry. Delivery drones can deliver goods very efficiently and swiftly at low costs when compared to the conventional method of using land transport and delivery personnel. They also have the capability to impact the security and surveillance and retail industries.

Developed countries and Israel have a strong fleet of drones. To strengthen national security and armies, the developing countries have accelerated the adoption of drones. The biggest market for drones is North America followed by Europe and Asia-Pacific. The United States, European and the Asian governments are establishing regulations for commercial drones in the near future. The commercial drones market is expected to witness higher growth rate than defense drones. A recent patent (WO/2015/113962) in drones assigned to EXPLICIT I/S is about a method and an unmanned aerial vehicle for determining emissions of a vessel.

Use of drones in Agriculture also holds a lot of promise for improving effectiveness and efficiency. Patent no WO/2015/106462, assigned to Beijing Research Center for Information Technology in Agriculture talks about the use of drone mounted hyperspectral imaging for precision agriculture.

Title	Publication Date/ Publication Number	Assignee	Inventor	Abstract
A method and an unmanned aerial vehicle for determining emissions of a vessel	06.08.2015; WO/2015/113962	Explicit I/S	Knudsen, Jon	A method for determining emissions in an exhaust plume (11) produced by a combustion engine of a vessel (10) during cruise of the vessel (10), said emissions comprising the presence or concentration of carbon dioxide (C02) and/or sulphur dioxide (S02) and/or the count and size of particles. The position and distribution of the exhaust plume (11) is determined or estimated on the basis of the position, bearing and speed of the vessel (10) and further on the basis of meteorological data, such as wind direction and speed. An unmanned aerial vehicle (UAV) (12), i.e. a so-called drone, is controlled to fly through the plume (11) to make measurements of exhaust emissions of the vessel (10).
Multipurpose aircraft	06.08.2015; WO/2015/115913	Schlumberger Technology Corporation	Chee Soon Seong	The invention relates to a multipurpose twin fuselage aircraft (17) that includes a central wing panel (1) which is releasably attached to each of the fuselages (12, 13) and is located between them. The central wing panel includes a nacelle (8) having a compartment for storage of various pieces of equipment and an engine (7) mounted on the front and/or rear of the central wing panel. In use the aircraft includes several interchangeable central wing panels, configured as determined by the nature of the task to be performed by the aircraft. Preferably the aircraft is an unmanned aerial system/drone. The central wing panels may be configured such that the nacelle and/or the compartment may be jettisoned during flight. In some embodiments the contents of the compartment may be jettisoned during flight.

Drone-mounted imaging hyperspectral geometric correction method and system	23.07.2015; WO/2015/106462	Beijing Research Center for Information Technology in Agriculture	Yang, Guijun	Related are a drone-mounted imaging hyperspectral geometric correction method and a system, comprising: collecting position attitude information of a current drone low-precision POS sensor in real time; based on the position attitude information, parsing precise photography center position attitude information of a digital photograph, and generating a DEM of an area covered by the photograph; based on the precise photography center position attitude information, performing correction on position attitude data corresponding to multiple imaging hyperspectral scan lines between photography centers of adjacent digital photographs, and obtaining high-precision linear array position attitude information of the multiple imaging hyperspectral scan lines; based on the high-precision linear array position attitude information and the DEM, establishing a collinearity equation and generating a hyperspectral image; and using high-precision POS information calculated from drone area array digital imaging data to perform optimization on drone low-precision POS data, implementing geometric precise correction of an imaging hyper-spectrometer for the scan lines one by one, and providing technical support for drone imaging hyperspectral wide application.
Personal submersible drone for aquatic exploration	02.07.2015; US20150183498	Patrick Wardle	Patrick Wardle	The invention is directed toward an autonomous submersible aquatic drone, a system utilizing an autonomous submersible aquatic drone and a control unit, a control unit for controlling an autonomous submersible aquatic drone, and a method for using the same. The autonomous submersible aquatic drone comprises a shaped housing, a propulsion system, one or more electromotors, a camera, a sonar unit, a wireless transponder, a battery, a microcontroller unit, and a control hardware unit. The control hardware unit is configured with artificial intelligence logic. The submersible drone surveys a predetermined area around a person engaged in a water sport for the presence of an underwater threat. When the aquatic drone detects the presence of an underwater threat the submersible drone sends a warning signal to a control unit worn by the person. The aquatic drone may also have a threat response unit to deter an attack on the person.
Fighting short- and medium-range drones with help of electromagnetic radiation of microwaves band	28.11.2002; US20020174728	Igor Belokon	Igor Belokon	FIELD: aircraft engineering. SUBSTANCE: invention relates to counter-drone fighting. Proposed method consists in generation of electromagnetic microwave flows to be directed towards flying drone. This causes induced currents at drone parasitic antennas to paralyze drone onboard control system. EFFECT: higher efficiency of hitting.

Drone control station	04.06.2015; WO/2015/079065	Thales	Galimberti, Arnaud	The invention relates to a station for controlling a plurality of drones, including: a display device (4) configured to display graphic elements including active graphic elements (14A) configured for the interaction of an operator (10) with the control station (2); a command interface (8) for the operator to enter commands for the control station (2); and an oculometer (6) configured to detect the direction in which the operator (10) is looking. The control station (2) is configured such as to selectively activate one of a plurality of first operating modes of the control station (2) respectively associated with one of the active graphic elements (14A) in response to detecting that the operator (10) is looking at the corresponding active graphic element (14), each first operating mode being configured such as to enable the operator to interact with one or more graphic elements (14) and/or one or more drones via the command interface (8), according to a given set of functionalities.

Exhibit 1 lists some of the patents related to drones.

Picture Credit: Frost & Sullivan

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