TECHNICAL INSIGHTS

SENSOR

TECHNOLOGY ALERT

28th February 2014

1. 3D IMAGING DEVICE FOR USE INSIDE BLOOD VESSELS

The trend of miniaturization in electronics has benefitted various devices, including sensors. Technological advancements have led to sensors becoming smaller and at the same time offer better functionality and intelligence while drawing a less amount of power. One of the key application areas which have benefitted is healthcare and medical devices. The small size of sensors can enable devices to be implanted inside the body of a patient to retrieve important information that enables better healthcare.

Researchers at the Georgia Institute of Technology, USA, have developed a miniaturized device that can provide three- dimensional (3D) images from inside the blood vessels and heart. The device is a silicon chip that integrates ultrasonic transducers and processing electronics. It will allow doctors to have a real-time view of whole volumes inside blood vessels. This will aid doctors and surgeons during an operation of the heart or blood vessels.

The chips consist of capacitive micromachined ultrasonic transducer (CMUT) arrays of 56 transmitters and 48 receivers. The elements are arranged in two concentric circles with a hole in the center that measures 430 micrometers in diameter. This hole can be used to accommodate guide wires. The entire device has a diameter of just 1.5 millimeters, which is small enough to pass through arteries. The complementary metal oxide semiconductor (CMOS) electronics at the front end help provide 3D intravascular ultrasound (IVUS) and intracardiac echography (ICE) images. The transducers have an operating frequency of 20 megahertz, and the device can operate with just 20 milliwatts of power. The small operating power ensures that not much heat is generated inside the body because of the sensor. To transmit the images, ultrathin cables were used. In total only 13 cables can transmit the information, which is a key achievement for the researchers, since the space available for operation inside the vessels is extremely small.

A prototype developed by the researchers is able to provide images at a rate of 60 frames per second (fps). A paper concerning the research titled, 'Single-Chip CMUT-on-CMOS Front-end System for Real-Time Volumetric IVUS and ICE Imaging,' was published in, *IEEE Transactions on Ultrasonics, Ferroelectrics and Frequency Contro*l(Volume 61, Issue 2) (February 2014). This research was supported by the National Institute of Biomedical Imaging and Bioengineering (NIBIB).

The researchers are currently planning to conduct research on animals with this chip. Successful testing on animals will be a key step toward obtaining US Food and Drug Administration (FDA) approval and commercializing the device.

It is expected to happen in the next 3 to 4 years. The team of researchers hope to further develop the device so that it can be placed on a 400-micrometer guide wire.

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2. REAL-TIME WATER QUALITY MONITORING PLATFORM

There has been a concerted effort in reducing pollution to enable a better and healthier quality of life. Although airborne pollution has been a primary focus area for discussions, water quality is also important. Water quality monitoring systems employ sensors to obtain information about basic parameters, which can indicate the level of pollution in any water body. One key challenge in water quality monitoring is the transmission of data from on-site sensors to a control room. This limitation can make it difficult to deploy sensors in hard to reach areas, so maintenance and data collection become difficult.

Spanish company Libelium has come up with a smart water monitoring platform, which aims to address the above mentioned challenges. The company’s Waspmote Smart Water is a sensing platform, which simplifies remote water monitoring by being able to transmit collected data to the cloud in real-time. The system integrates multiple sensors, which are able to monitor parameters such as dissolved oxygen, pH, conductivity (salinity), oxidation-

reduction potential, temperature, and dissolved ions. The ions include odium, calcium, fluorine, chlorine, bromine, iodine, copper, potassium, magnesium, and nitrate. By monitoring these parameters, the quality of water can be monitored to detect any change in composition such as chemical leakage and so on.

The sensor platform is an ultra-low power node that has been made rugged enough to be used in difficult environments for remote water quality monitoring. By early detection of any potential danger to public or aquatic life, possible measures can be taken. For wireless data transmission, the Waspmote can use cellular services such as 3G, GPRS (general packet radio service), and WCDMA (wideband code division multiple access). It also provides long range connectivity using ZigBee. The waspmote platform also has the capability to accommodate microenergy harvesting using solar panels, which can be used to charge the on-board battery. Having a self-powered sensor node will enable maintenance-free operation in difficult to reach locations.

The Waspmote Smart water platform can be deployed for multiple applications in water monitoring. A low level of dissolved oxygen can indicate the presence of microorganisms such as E.Coli, which has potential threat to public health. A high pH level indicates potential chemical spillage in water from industries or sewage treatment plants. Salinity, temperature, ion concentration, dissolved oxygen, can be used to monitor sea water quality. The platform can also be used to monitor swimming pools, fish tanks, and water tanks; and can be deployed in a variety of water bodies, such as rivers, lakes, pools, sea, and sewers, which makes it a product able to address diverse needs.

The key benefit of this sensor platform is its ability to offer real-time multisensing functionality. Since water quality monitoring is an important aspect in realizing the concept of smart cities, the Waspmote Smart Water platform has potential to have a high impact in the near- to medium-term.

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3. 25 MEGAPIXEL IMAGE SENSOR FOR MOBILE DEVICES

The gap in quality of images between a digital still camera and a smart phone camera is shrinking largely due to technological advancements in CMOS (complementary metal oxide semiconductor) image sensors. Imaging has become a key parameter for customers who use a smartphone. A major differentiator in this product segment is the resolution of the camera.

Aptina Imaging Corporation, is a major provider of CMOS image sensors for a variety of applications in mobile imaging, automotive imaging, security and surveillance, medical imaging, and so on. The company has recently unveiled a mobile image sensor, AR2520HS, which is able to capture images having a resolution of 25 Megapixels (MP). The sensor is able to capture 4K video and full resolution images at a speed of 30 frames per second (fps). While for 1080p High Definition (HD) video capture, the speed goes up to 120 fps.

The sensor uses Aptina's MobileHDR technology, which enables capturing of images with a high dynamic range (HDR). HDR enables crisp and accurate capturing of scenes, which contain both low lit areas as well as extremely bright areas together. Without HDR, these scenes tend to get over saturated or under exposed and an inaccurate and often distorted image is generated.

The high-performance CMOS image sensors are shifting from the traditional front side illumination (FSI) layout to back side illumination (BSI). and the AR2520HS is no exception. The BSI technology allows more amount of light, that is, photons, to fall on each pixel (photodiode), which leads to the capturing of more information. This results in a better image quality and also leads to better imaging in low-light conditions. Aptina's sensor has a half inch optical format, which again leads to more light capturing than in the traditional one-third inch format.

With the increase in resolution (in terms of the number of pixels in the sensor), the amount of information that requires processing also increases. To ensure that the image processing speed is not largely compromised, the AR2520HS uses an 8-lane mobile industry processor interface (MIPI) as well as a 12 lane High-Speed Pixel Interface (HiSPi). The new sensor has been made compatible with the 18 MP lens design of Aptina. This will ensure that mobile camera module makers and original equipment manufacturers (OEMs) will be able to incorporate the ARS2520HS easily into new device designs.

The sensor will be available for sampling in the second quarter of 2014. Products employing this 25 MP sensor can be expected to hit the market in 2015 or early 2016. As the mobile phone industry is rapidly evolving and competitors are always aiming to provide better performance and advanced features with every iteration of their products, it is expected that the AR2520HS has opportunities to be accepted by the OEMs. The sensor is expected to be initially part of premium mobile devices and will slowly be incorporated into lower less premium segments.

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4. PATENT ANALYSIS--MOTION SENSORS

Motion sensors, which detect people, objects, or animals, are employed in a variety of industries or applications, such as building automation (for example, automated lighting control), security and surveillance (including burglar alarms, perimeter intrusion detection/protection), industrial process control (for example, to detect change in motion and speed of conveying, reciprocating, or rotating machinery), and automotive (for example, car alarms). Various sensor technologies are employed to detect motion, depending on application requirements. They include passive infrared sensors, ultrasonic sensors, microwave sensors, and vision-based systems (for example, autonomous robots).

Passive infrared sensors (which have typically been made from pyroelectric materials) detect the infrared energy emitted from a person or object. Ultrasonic and microwave sensors detect motion by emitting a signal (either an ultrasonic/acoustic sound wave or an electromagnetic pulse) and measuring the reflected signal. Vision-based systems use an algorithm to detect objects and track their position.

Motion sensors can also be based on accelerometers and gyroscopes. Accelerometers detect linear or gravitational acceleration and can detect movement from a vertical to a horizontal state. Gyros measure angular rate of rotation and can measure and track position or rotation of a moving object. Such sensors have been finding increased opportunities in consumer electronics.

A major drawback of motion sensors can be susceptible to false alarms. Due to this, there has been a focus on increasing the accuracy and reliability of these systems. One method of achieving this is to employ multiple sensor technologies for a single motion detector. For example, a PIR sensor and ultrasound sensor are integrated into the same device and the system provides a positive output only when both the individual sensors sense motion.

Key patent assignees include Samsung Electronics Co. Ltd., LG Electronics, Honeywell International Inc., and Qualcomm, Inc. Patents indicate that motion sensors are also used as input for noise reduction in images (in a sequence of frames). The most number of patents regarding motion sensors has been published in the United States, followed by Republic of Korea.

PATENT TITLE	PUBLICATION DATE / NUMBER	APPLICANT/ ASSIGNEE	INVENTORS	ABSTRACT
MOTION SENSOR, METHOD FOR DETECTING OBJECT ACTION, AND GAME DEVICE	03.01.2014; WO/2014/002803	OMRON CORPORATION	ADACHI, Tatsuya	A motion sensor has: an object-region extraction unit (51) for extracting the object region projected by a detection object based on a first and a second image projected by the detection object; a reference-point-specifying unit (52) for determining a reference point showing the boundary between a moving portion of a detection object moving by performing a predetermined action in the first and the second images, and a fixed portion of the detection object which moves less than the moving portion even when the predetermined action is performed; a movable-portion-position-detecting unit (53) for determining the position of the moving portion within a region closer to the movable-portion than the reference point in the first and the second image; and an assessment unit (54) for assessing whether the predetermined action has been performed when the difference between the position of the moving portion in the first image and the position of the moving portion in the second image is equivalent to the movement of the detection object in the predetermined action

METHOD OF PROCESSING SENSOR SIGNALS FOR DETERMINING MOTION OF A MOTOR SHAFT	03.01.2014; WO/2014/004252	CHRYSLER GROUP LLC	WESLATI, Feisel	Methods and systems of processing sensor signals to determine motion of a motor shaft are disclosed. This disclosure relates to the processing of sequences of pulses from a sensor for computing the motion of an electric motor output shaft. Furthermore, this disclosure relates to the processing of two sequences of pulses from sensor outputs, which may be separated by only a few electrical degrees, to compute the motion of an electrical motor output shaft while using a limited bandwidth controller. Motor shaft direction, displacement, speed, phase, and phase offset may be determined from processing the sensor signals
TEMPORAL BASED MOTION SENSOR REPORTING	02.01.2014; US 20140002270	Intel-GE Care Innovations LLC	O'Shea Terrance J	Methods and systems may include a motion sensor and logic to sample an output signal of the motion sensor. The logic can also be configured to track an amount of time the motion sensor is triggered based on the output signal, and transmit the amount of time over a wireless link on a periodic basis
Location And Motion Estimation Using Ground Imaging Sensor	02.01.2014; US 20140005932	KOZAK Kristopher C.	KOZAK Kristopher C.	A system and method for estimating location and motion of an object. An image of a ground surface is obtained and a first set of features is extracted from the image. A map database is searched for a second set of features that match the first set of features and a geo-location is retrieved from the map database, wherein the geo-location is associated with the second set of features. The location is estimated based on the retrieved geo-location. The motion of the object, such as distance travelled, path travelled and/or speed may be estimated in a similar manner by comparing the location of extracted features that are present in two or more images over a selected time period

NOISE REDUCTION BASED ON MOTION SENSORS	12.12.2013; US 20130329063	APPLE INC	Zhou Jianping	A method for reducing noise in a sequence of frames may include generating a transformed frame from an input frame according to a perspective transform of a transform matrix, wherein the transform matrix corrects for motion associated with input frame. A determination may be made to identify pixels in the transformed frame that have a difference with corresponding pixels in a neighboring frame below a threshold. An output frame may be generated by adjusting pixels in the transformed frame that are identified to have the difference with the corresponding pixels in the neighboring frame below the threshold.
High Dynamic Range Image Registration Using Motion Sensor Data	12.12.2013; US 20130329087	Tico Marius	Tico Marius	Motion sensor data may be used to register a sequence of standard dynamic range images for producing a high dynamic range (HDR) image, reducing use of computational resources over software visual feature mapping techniques. A rotational motion sensor may produce information about orientation changes in the imaging device between images in the sequence of images sufficient to allow registration of the images, instead of using registration based on analysis of visual features of the images. If the imaging device has been moved laterally, then the motion sensor data may not be useful and visual feature mapping techniques may be employed to produce the HDR image.

WIRELESS, MOTION AND POSITION-SENSING, INTEGRATING RADIATION SENSOR FOR OCCUPATIONAL AND ENVIRONMENTAL DOSIMETRY	05.12.2013; US 20130320212	VALENTINO DANIEL J.	VALENTINO DANIEL J.	Described is a radiation dosimeter including multiple sensor devices (including one or more passive integrating electronic radiation sensor, a MEMS accelerometer, a wireless transmitter and, optionally, a GPS, a thermistor, or other chemical, biological or EMF sensors) and a computer program for the simultaneous detection and wireless transmission of ionizing radiation, motion and global position for use in occupational and environmental dosimetry. The described dosimeter utilizes new processes and algorithms to create a self-contained, passive, integrating dosimeter. Furthermore, disclosed embodiments provide the use of MEMS and nanotechnology manufacturing techniques to encapsulate individual ionizing radiation sensor elements within a radiation attenuating material that provides a "filtration bubble" around the sensor element, the use of multiple attenuating materials (filters) around multiple sensor elements, and the use of a software algorithm to discriminate between different types of ionizing radiation and different radiation energy.

Exhibit 1 lists some of the recent published patents in the field of motion sensors.

Picture Credit: WIPO/Frost & Sullivan

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