

# Motion Sensors

By Gunter Pauli

*This article introduces sensors of movement as one of the 100 innovations that shape "The Blue Economy". This article is part of a broad effort to stimulate entrepreneurship, competitiveness and employment.*

## The Market for Motion Sensors

The market value of sensors has topped the US\$ 70 billion dollar mark in 2010. This market is poised for a growth rate in excess of ten percent across the board for years to come. The automotive sensors will reach \$15.8 billion by 2012, one of the fastest expanding markets. The chemical sensors are expected to reach \$17.3 billion by 2015. The global market for sensors in consumer electronics is expected to grow to \$22.1 billion in 2015 with an annual growth rate of 12 percent. The entertainment applications for sensors are beating all other segments with a strong growth in excess of 16 percent per annum for the next five years. The image sensors represent the largest in value. The US market for sensors is valued at \$10 billion, Europe exceeds the \$15 billion, excluding military applications.

At a time of a looming recession, the sensor market remains one of few high growth niches dominated by European and American companies. This is due to the fact that military applications originally were at the source of this industry and funded its research and development. This explains the presence of companies like Northrop Grumman and Honeywell amongst the leading suppliers in the world. However, the market for sensors has seen the strength in innovation from medium-sized family controlled German companies like Robert Bosch (crash sensors for airbags), First Sensor AG (Berlin-based custom designer of sensors), Pepperl+Fuchs (one of the leaders in electronic sensing) and nearly one hundred additional niche sensor suppliers that are German-based.

One of the key new areas of development encompasses sensors based on micro-electro-mechanical systems (MEMS), also known in Japan as micro-machines. The MEMS can be as small as 20 micrometers (20 million times smaller than a meter), or as big as one millimeter. These minute systems can sense speed, acceleration, vibration, and shock triggering the release of air in a bag to protect passengers in cars or trains. The MEMS-based applications are now penetrating all sectors of the economy from the prediction of earthquakes or volcano eruptions, noise, vibration and harshness indicators identifying discomfort, speed measurement in sports watches, or step and distance counters for strollers keen on tracking the burning of calories, monitoring pumps, fans, compressors and cooling towers, or to evaluate the efficiency of brakes. Thanks mainly to breakthroughs in the automobile sector, MEMS-based sensors can be as cheap as one dollar, while offering security and performance over extended periods of time at very competitive cost.

## Innovations

The world of sensors is still in infant stage. Soon these devices are poised to replace numerous products and systems that are considered part of modernity. The remote control for example, based on batteries will be replaced by gestures without the need for any devices. The product that can achieve exactly that is already marketed by Gesture Studios (USA) which is the brainchild of John Underkoffler (MIT) who helped design the hardware for GoodPoint. This presentation tool captures motion and translates this into electronically steered actions. The powerpoint presentation will never suffer again from incompatibility with the remote, while there is no more remote needed. This innovation will change the way consumers will interact with home electronics. Intel is developing an advanced form of motion capture that will permit to wave at a TV set to turn up or down the volume, or change channels. This will permit within 5 years to start eradicate remote controls for home audio/visual systems and replace these devices through gesture recognition without the need for any goggle or glove. Intel is developing nothing less than a body tracking system. Their interest is to drive demand for a new generation of semiconductors and super processors. However, motion capture is complex, and this field of innovation requires a new way of sensing acceleration and motion in order to be more effective and precise than is the standard today.

Santosh Kumar was on a fast track career at Siemens in India, developing code for telecom switches. He decided to quit his well-paid job and pursue a doctorate in Computer Science and Engineering at the Ohio State University where he graduated in 2006. He realized that many sensors require the integration of miniaturization (MEMS) and low power wireless communication technology to solve real world challenges. Since most tracking devices that are mainstream today stay connected to a satellite, these devices are battery-intensive and prone to signal loss.

Kumar's team decided to develop a small circuit board (led by Prof. Prabal Dutta at University of Michigan), a one dollar wireless sensor, an accelerometer, a gyroscope, a connection to a GSM phone or radio and supporting software. The core sensing equipment (accelerometer and gyroscope) operate on the simple principles of physics monitoring 6 degrees of freedom in movement. One could even add a magnetic compass to arrive at 9 degrees of freedom for complete perfection. These units could one day operate without batteries and therefore this represents innovation that complies with the principles of The Blue Economy. It is a platform technology with hundreds of potential applications replacing "something with nothing".

## **The First Cash Flow**

Kumar went on to create commercial products. The first one is named “AutoWitness”, a burglar tracking device. When this tracker is affixed to a computer or a painting, it detects motion, distinguishing the difference between theft, cleaning and house maintenance. If the stolen item ends up in a car, the sensor reports all the movements over widely available public cellular networks, along with the geographical coordinates. The system text messages the car’s exact location to the police. The ease of use and the low cost motivated the police departments of Memphis and Jackson (Tennessee) to test these devices. This invention earned Kumar the recognition by Popular Science Magazine as one of the top ten brilliant scientists of the United States under the age of 38. In the meantime he has been named Faudree Professor at the University of Memphis where he heads the Wireless Sensors and Mobile Ad Hoc Networks (WiSe MaNet) Lab. He engages in both theoretical research and practical applications for commercial use. Kumar is one of the rare scientists who bridges fundamental science and pragmatic project implementation.

## **The Opportunity**

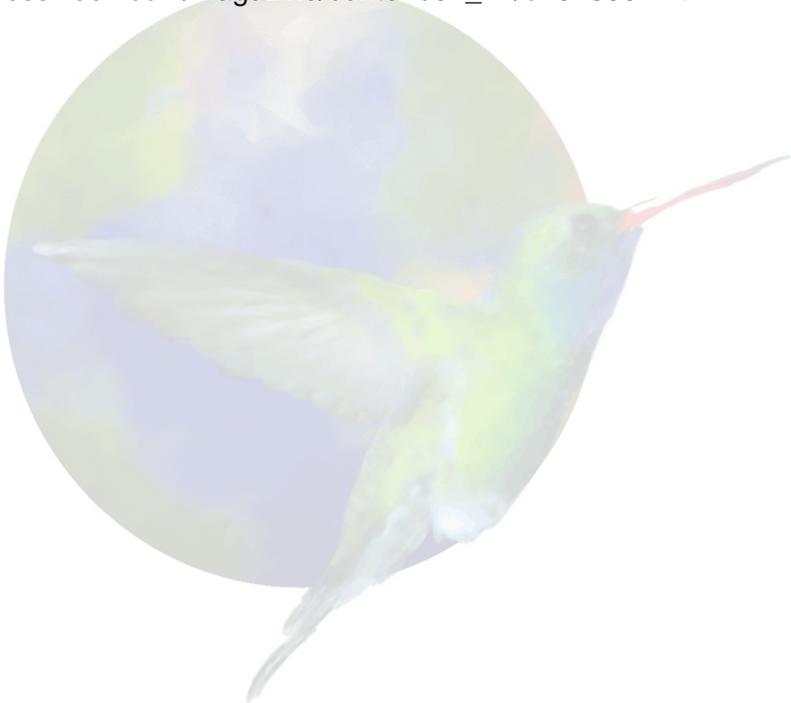
Using a similar technology, Santosh Kumar’s team has designed a second application named “AutoSense”. This minute device is worn under clothing and monitors stress levels through measuring simultaneously respiration, heart rate and physical activity. The software applications on a smart phone permit medical doctors to follow each patient in treatment individually, knowing if he or she is indoors, outdoors, speaking or smoking. The information is processed permitting the identification of stress so that doctors can anticipate susceptibility and relapse to addictive behaviors. The first application is geared towards monitoring persons addicted to substances. This project sponsored by the National Institutes of Health (NIH) and National Science Foundation (NSF) enabling detection of stress, craving, and panic attacks without the need of permanent and personal monitoring. One of the unique features of this research is that it forges a collaboration amongst diverse disciplines like computer scientists, electronic engineers, mathematicians, psychologists, behavior scientists, physiologists, anthropologists, biochemists and physicists.

The integration of sciences will change the way planes operate, computer games function, and how advertising will entice us to watch the latest product releases as Adidas, the sports’ wear group has demonstrated with the snowflakes interactive ads on subway stations in New York. Falling snowflakes change to a city skyline by swiping your hand in the air, and the flakes were sent into a swirl by waving both hands. The gyroscope driven MEMS technology supplied by Asahi Kasei Microsystems (AKM) from Japan for the iPhone4 impressed Steve Jobs so much with its capacity to detect changes in orientation that it is now a standard feature for Apple.

The microscopic version of a vibrational gyroscope combined with a MEMS and a chip rumored to be designed for this purpose by STMicroelectronics offers the iPhone4 and iPads2 unique features for which few applications exist today. The gyroscope, originally invented by Johann Bohnenberger in 1817 and made famous by Leon Foucault, who used it to see the Earth's rotation is now converted into a central piece that will spin the imagination of thousands of entrepreneurs for decades to come. It is no surprise that a visionary like Steve Jobs saw it coming and made it standard in his latest product releases.

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... Further information on the 100 innovations at [www.theblueeconomy.org](http://www.theblueeconomy.org)

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