CATRENE

Cluster for Application and Technology Research in Europe on NanoElectronics

CT402 | Autonomous nine degrees of freedom sensor module [9D-Sense]

The CATRENE 9D-Sense project is developing an autonomous integrated 'nine degrees of freedom' sensing module which will embrace technologies for sensing, energy harvesting, energy storage and wireless communications – key to expanding the market for ambient intelligence. The miniature, integrated system will provide cost-competitive solutions relevant to the fields of consumer and healthcare electronics. Extreme energy-efficient technologies will be developed and applied. The aim is to build and test prototypes of the sensing system and provide proof of functionality in dedicated application environments. The multi-sensing approach should boost European leadership in key global markets.

PROJECT CONTRIBUTES TO

Communication	✔
Automotive and transport	
Health and aging society	✔
Safety and security	✔
Energy efficiency	
Digital lifestyle	
Design technology	✔
Sensors and actuators	✔
Process development	
Manufacturing science	✔
More than Moore	✔
More Moore	
Technology	<130 nm

SMART SENSOR AND ACTUATOR SYSTEMS

Partners:

Air Liquide
Austria Microsystems
Robert Bosch
Bosch Sensortec
Fraunhofer
Gemalto
HSG-IMIT
Micropelt
Otto Bock HC
TU Darmstadt
University of Helsinki

Project leader:

Ricardo Zamora
Robert Bosch

Key project dates:

Start: October 2011
End: October 2014

Countries involved:

Austria
Finland
France
Germany

Nanotechnologies are driven by the continuous demand for miniaturisation following Moore's law, leading to the design of increasingly complex electronic products at lower recurring cost. While the major application domains for electronics were previously computing, automation, communications and consumer products, microelectronics are now a part of virtually all processes and trends in modern Europe. These applications provide increased mobility, eco-awareness and support for an aging population.

A major trend is the rise of 'ambient intelligence' – electronic environments sensitive and responsive to the presence of people. In an ambient-intelligence world, devices and systems can be autonomous yet still work in concert to support machines and people in performing their everyday activities, tasks and routines.

Self-sustaining power

Such high aims require a direct, natural and transparent way of interaction using information intelligence hidden in the network connecting all devices. The primary objective of the CATRENE CT402 9D-Sense project is to develop an autonomous integrated 'nine-degrees-of-freedom' sensing system with its own self-sustaining power supply, consisting of a battery and an energy harvester. The system is made up of a three-axis accelerometer, three-axis gyroscope and three-axis magnetometer, all based on silicon-wafer technology.

Healthcare and the consumer environment will be the primary areas of application. As well as an autonomous power supply, wireless data communication will be a key feature of the project and will enable the system to operate on a stand-alone basis and communicate with a network which evaluates and acts in response to the data provided.

The project consortium consists of industrial partners which are global leaders in the different technology and application areas involved as well as academic partners well-known as knowledge centres of future technologies. The industrial partners will be involved in the whole value chain of the 9D sensing system, from the basic wafer technologies of single chips to the suppliers of the sensing system. The value added at each integration level within 9D Sense will be covered by partners with specific expertise.

Consumer and healthcare

9D Sense is focusing on two fundamental areas – consumer and medical/healthcare applications – where substantial demand and large market volumes are expected.

Anticipated uses include:

- Healthcare and monitoring:
  - Prosthetics/orthopaedic appliances: orientation sensor for safe joint control;

- Ambient assisted living: sensing the location, position and activity of elderly or disabled people;
- Rehabilitation: joint monitoring — such as orthopaedic knee braces for the disabled — to monitor and support motion sequences during patient rehabilitation;

- A security smart-badge holder also acting as a wireless connectivity hub, for physical access control or a remotely managed e-health system;
- Positioning/navigation systems, especially where global positioning systems do not work — such as in buildings or street canyons; and
- Security/home automation: such as intrusion detection by movement or control and condition monitoring in buildings for improvement of energy efficiency.

As a consequence of its small size, the sensing system will be easily attached to humans or everyday objects as well as to smartcard containers not much bigger than a credit card. Three demonstrators will be produced: a motion-sensing device for health monitoring; a device designed for and attached to a smart-badge holder; and a navigation device for pedestrian tracking indoors.

High level of integration

In addition to functional requirements, market relevance and acceptance of specific applications are mainly cost driven. Therefore, future markets will aim for high integration of diverse sensors and systems with minimum chip and package size.

9D-Sense is focusing on a series of technological challenges and targets:

- Integration of micro sensors on a single chip or in a single package to achieve a footprint smaller than 5x5 mm — requiring development of new wafer and packaging technologies, such as 3D integration;
- Development of a high-capacity thin-film battery capable of being integrated on a micro-electro-mechanical systems (MEMS) or application-specific integrated circuit;
- Development of an energy-efficient thermoelectric generator capable of converting small amounts of thermal energy, such as body heat in semi-clinical applications;
- Wireless data transmission technology;
- Efficient power management/low power technology; and
- Integration of the heterogeneous system in one small package.

The final product will be a highly autonomous sensing system which supports the European effort towards maintaining leadership in 'more-than-Moore' technologies as well as in technologies for heterogeneous integration. Additionally, there will be application demonstrators in the fields of future communications systems and healthcare devices. Ultra low power, extreme energy efficiency and autonomy of the sensing system as well as the increasing autonomy of the targeted devices and systems themselves are indispensable in these applications.

There is a very broad range of potential applications for such a highly integrated, energy-saving, multi-functional autonomous sensor system. Uses can be visualised in the consumer and medical fields as well as in security and industrial applications. Technologies developed in 9D-Sense will also be used in whole or in part for applications beyond the initial scope and will, therefore, also be applicable to other markets.

European leadership

The MEMS sector in Europe has reached a high level of development in terms of technologies and economic use. This success is attributable both to industry and research institutes. There is a stable network of research and industrial partners that ensures European companies have a leadership role in the MEMS sector. Large firms as well as small and medium-sized enterprises benefit from this situation.

Marketing of micro-systems is primarily cost driven by competitiveness from miniaturisation and integration as well as from innovative combinations of existing MEMS elements yielding new applications. Development of a cost-effective multi-sensing system with a small footprint in this CATRENE project that can cover a multitude of applications will enable European industry to address several markets and play an even more important global role.