4 MARCH, 2010

European Commission
Information Society and Media

ADOSE

Reliable Application specific Detection of road users with vehicle On-board Sensors

NEWS ! The second Review Meeting of the ADOSE project took place on 4th of March 2010 at IMEC in Leuven, Belgium. The design phases of the addressed ADOSE sensors (MFOS sensor, FIR imager, 3D camera, harmonic radar and tags, SRS sensor) have progressed successfully and the project has fully achieved its objectives and technical goals for the relevant period. First sensor prototypes have been demonstrated.

AT A GLANCE

Project:
Reliable application specific detection of road users with vehicle on-board sensors (ADOSE).

Project coordinator:
1. Centro Ricerche Fiat (IT)

Partners:
2. Robert Bosch (DE)
3. Magneti Marelli (IT)
4. STMicroelectronics (IT)
5. Triad AS (NO)
6. Umicore (BE)
7. Paragon LTD (GR)
8. IMEC (BE)
9. VTT (FI)
10. Austrian Institute of Technology (AT)
11. IZM (DE)
12. Uppsala Universitet (SE)

Duration: 36 months

Programme: ICT Challenge 6: Mobility, environmental sustainability & energy efficiency

Website: **www.adose-eu.org**

Contact details:
Pallaro Nereo (Project Coordinator)
Centro Ricerche Fiat S.C.p.A.
Email: nereo.pallaro@crf.it

Irmgard Heiber (Project Officer)
European Commission, DG INFSO, Unit G4

OVERVIEW

ADOSE is a Collaborative Project (STREP), started in January 2008 and co-funded by the European Commission Information Society and Media in the strategic objective "ICT for Intelligent Vehicles and Mobility Services".
The goal is the development of high performance and low cost sensing technologies, suitable for preventive and active safety systems.
Novel concepts and sensory systems will be developed based on Far Infrared cameras, CMOS imagers, 3D packaging technologies, ranging techniques, bio-inspired silicon retina sensors, harmonic microwave radar and tags.

CHALLENGES

ADOSE addresses research challenges in the area of accident prevention through improved-sensing technologies and sensor fusion. The focus is on functional, performance and cost limits of current sensors and Advanced Driver Assistance Systems for their extensive market penetration.
ADOSE has been set up in the context of the "European Technology Platform on Smart Systems Integration" (EPoSS) and it aims at being a product driven project by the development and integration of Smart Systems

and Technologies for Preventive and Active Safety.
The goal is the enhancement of safety functions through the development of high performance and low cost sensing technologies suitable for reliable detection and classification of obstacles and vulnerable road users in hostile environments. The project is focused mainly on sensing elements and their pre-processing hardware, as a complementary project to PReVENT.

PROJECT OBJECTIVES

Specific objectives

ADOSE addresses five breakthrough sensing technologies, with the goal to improve the current state-of-the-art in terms of costs, performance and reliability:

● IR-add-on sensor (FIR), with sufficiently good thermal & spatial resolution at lower cost, to be combined to a high resolution imager for enhanced night vision applications to enable a more reliable obstacle detection and classification.

● Low-cost multi-functional and multi-spectral CMOS vision sensor (MFOS), detecting critical environmental parameters (fog, rain, …) and providing, at the same time, information on the driving scenario (oncoming vehicles, VRUs in night conditions, …).

● High spatial resolution and low-cost 3D range camera (3DCAM), by the integration of 3D packaging, optical CMOS and laser radar technologies for short range ADAS requirements (high-speed object recognition and distance measurement, e.g. for Pre-crash).

● Harmonic radar combined to passive nonlinear reflector and active tags (HR-PTAG and HR-ATAG), enabling easy detection of traffic obstacles and vulnerable road users, and their identification, even in dark or adverse weather conditions.

● High temporal resolution and low-cost dbio-inspired silicon retina stereo sensor, addressing time critical decision applications (SRS).

ADOSE will have impact on the "virtual safety belt" around the vehicle by offering different sensing technologies for a set of complementary safety functions.

Only 'technology-dependent' pre-processing algorithms will be developed for each sensor: (a) algorithms implemented into the sensor hardware; (b) algorithms on raw data, coming from the sensor hardware, implemented on a PC-based processing hardware, strictly related to the sensing technology and its demonstration. Algorithm developments will not be extended to Sensor Data Fusion.

The algorithms will be compliant to PReVENT-PROFUSION guidelines and ready to be integrated in the standard software architecture for driver assistant systems.

Demonstration will be limited to functional sensor prototypes installed on concept cars without integrating the complete safety system.

Major final achievements

Five sensor module prototypes will be designed, fabricated and tested:

- FIR camera (FIR)
- Multifunctional CMOS vision sensor (MFOS)
- 3D range camera and eye-safety illuminator (3DCAM)
- Harmonic radar with passive and active tags (HR P-TAG, HR A-TAG)
- Silicon retina stereo sensor (SRS)

Technology-dependent pre-processing algorithms will be developed for each sensory system.

Two demonstrator vehicles will be set-up integrating two groups of sensors: (a) MFOS sensor, FIR and 3DCAM cameras; (b) SRS sensor and harmonic radar.

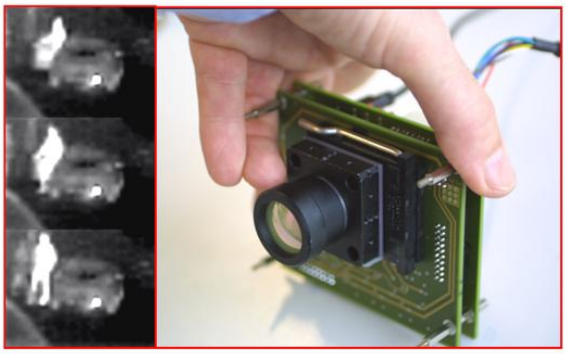
PROJECT ACTIVITIES

Work performed in the second year

<u>FIR imager (WP2, BOSCH)</u>

The new, integrated process for low-cost, mid-resolution far-infrared (FIR) arrays using suspended mono-crystalline thermo-sensors has been further optimized. Sensor elements are produced inherently during the ASIC manufacturing process on a micromechanically pre-structured silicon wafer. The wafer-level packaged and gettered sensors achieve the responsivity expected for automotive hot spot detection in the 8÷14 µm wavelength range. The demanding chip cost targets of an add-on FIR sensor are possible with the process developed.

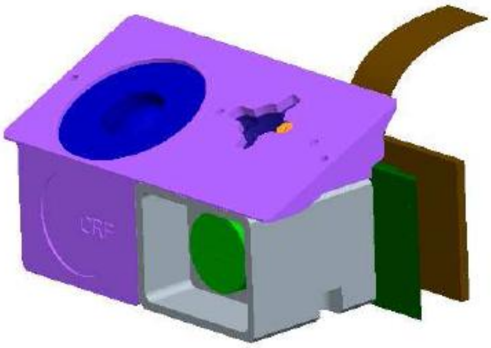
An ASIC- and array design for the final FIR imager chip with 100 x 50 pixels specified in the ADOSE requirements has been completed. The chip production was started.
Two different FIR optic designs utilizing batch precision moulding of GASIR material have been selected for the ADOSE FIR imager, allowing a final cost / performance fine-tuning of the system.
Concepts for thermal management and stress-free chip mounting have been worked out for the chip-on-board packaging of the FIR device. The final FIR demonstrator camera is expected to be ready by mid 2010.



Test setup for preliminary 1k pixel FIR array and scene taken with it (driver leaving his car).

Multifunctional optical sensor (WP3, CRF)

Two optical solutions for the realisation of the multifunctional optical sensor have been selected and investigated for fabrication. The first one is characterised by two optical channels able to guarantee two ROIs on the corners of the imager chip whilst the latter could integrate up to four optical channels. The optical solutions are based on dioptric and planar ligthguides able to deliver the collected radiation to the selected ROIs. The optical components have been fabricated by injection moulding and hot embossing and the first sensor prototype have been assembled for testing and characterisation.

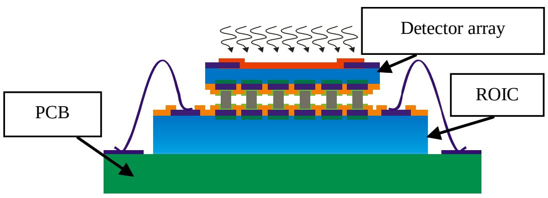


CAD model of the sensor prototype integrating the ST VL5510 CMOS imager.

In parallel, the optimisation activities related to the other optical components have been done: an high power IR illuminator based on eight dies, the beam forming optical lens and the micro-optical objective.

3D range camera (WP4, IMEC)

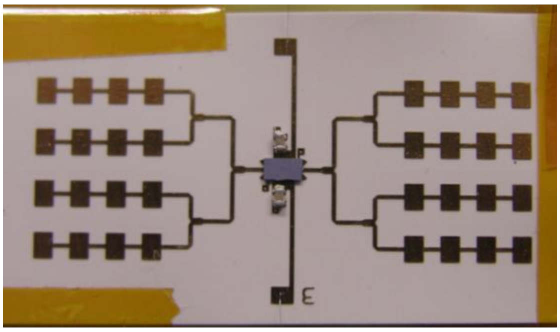
The different 3D imaging methods have been analysed and simulated. As outcome, the development of a range-imaging hybrid camera concept has started. The camera will consist of a photosensor and its corresponding readout electronics. These two components are hybridized using existing IMEC capabilities for wafer processing and flip-chip technology, as the figure shows.
The photosensor will use back-side illuminated (BSI) technology to increase the quantum efficiency and the fill factor of the detector elements. The photosensor has been designed and is currently being fabricated at IMEC's facilities.
The readout electronics are being designed to be able to implement different range measurement methods in order to find the optimum one.
The system controlling the camera has been designed and is currently to be fabricated. It comprises an FPGA implementing the control of the camera and the communication with the ADOSE central control system and software. It also contains the necessary power supply, bias and clocking sources.



Camera hybrid module

Harmonic radar and tags (WP5, VTT)

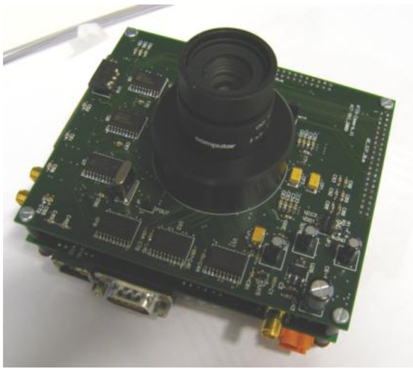
The radar relies on intermodulation principle, which provides smaller frequency offset as compared to the traditional harmonic radar. The radar prototype, which is being developed, transmits two nearby signals at the 77 GHz band allocated for automotive radars. Harmonic reflectors, or tags have a nonlinear components that create an intermodulation response at a nearby frequency. Because nonlinear reflections are rare in nature, tags can be easily identified from the radar reflection. If the tag is carried by a vulnerable road user, he/she can be detected even in dark or fog. Several nonlinear elements have been studied: Schottky diodes, ferroelectric varactors and MEMS resonators. For longer detection range, semipassive or active tags can be used. In these designs, a switch or an amplifier is switched on and off to achieve modulated backscattering. Tag antennas are developed on a flexible substrate, to make tag integration to textiles and curved surfaces easier. In the third year of the ADOSE project, the study will proceed from individual components to an integrated radar and tag demonstration.



Active non-linear radar reflector.

Silicon retina stereo sensor (WP6, AIT)

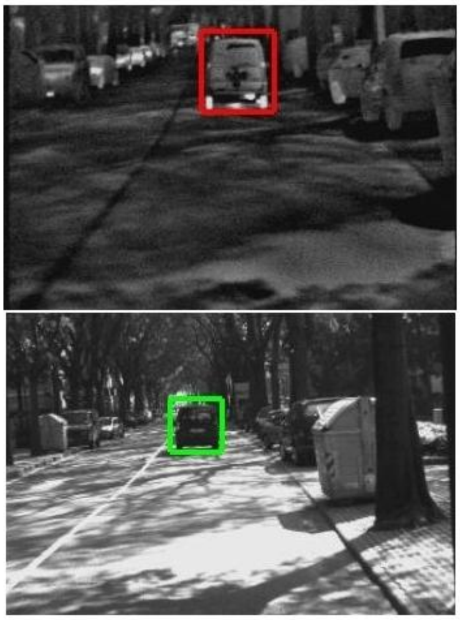
The "silicon retina" sensor technology is based on bio-inspired analogue circuits that pre-process the visual information on-chip in parallel for each pixel. These optical sensors provide excellent temporal resolution, a wide dynamic range and have low power consumption.
Typical applications include vision system for roadside traffic data acquisition, real-time stereo vision system for reliable person counting and in ADOSE as high-speed and low-cost ranging sensors for time-critical decision making functions. In a first step the automotive requirements for such a sensor system were collected, and the technical specifications were determined. In ADOSE the high resolution (304x240 Pixel) SRSS will be used as a pre-crash sensor for side-impact airbags control.
Novel algorithms based on locality and timely correlation of asynchronous data streams have developed in order to fully exploit the advantages of the silicon retina technology for safety-critical automotive applications.



High resolution SRS sensor demonstrator.

Data processing and functional system integration (WP6, MM)

The ADOSE sensor specifications (related to the communication bus, protocol and data format), the software architectures to be developed within the project and the test plans have been defined in D6.2 deliverable report.
Preliminary algorithms for pre-processing of raw data have been defined in deliverable D6.5 in terms of high level (flow chart) and low level (pseudo-code) design. The development of such algorithms (based on features extraction, timing and spatial common reference between FIR and NIR sensors) started in a simulation environment without real sensor data.
Test procedures (indoor, outdoor, static and dynamic) have been also analyzed and identified.



Tracking of preceding vehicles.

Dissemination and exploitation (WP8, CRF)

The ADOSE web site (http://www.adose-eu.org/) was established in 2008 and the maintenance phase is ongoing. A public area for dissemination purposes and a private area for file recording and sharing are available.
A *News&Events* section includes all related major events until end of 2009 in a standardized, very concise format with text and associated picture or logo.
The project dissemination continued at several national and international events, conferences, workshops and seminars. The basic dissemination documents can be downloaded from the website: project logo, factsheet, presentation, leaflet, etc.

A multi-annual dissemination roadmap and plan is included in D8.3b deliverable report focused on *Dissemination and Use Plan*.

Homepage of ADOSE website

Main results in the second year

The main project results* relevant to the second year are as follows:

- Design Freeze FIR-Array Chip (D2.2, R, CO)
- Fab-in of demonstrator wafer charge (D2.3, R, CO)
- Hardware components for FIR-camera (D2.4, R, CO) - *Draft version*
- Packaging concept for FIR camera subsystem (D2.5, R, CO) - *Draft version*
- Optical design and fabrication – Dioptric lightguide (D3.4, R, CO)
- Optical design and fabrication – Planar lightguide (D3.5, R, CO)
- CMOS image sensor (D3.6, R, CO)
- Preliminary design of 3D ranging camera detector (D4.2, R, CO).
- Detailed Design report for 3D ranging camera detector (D4.3, R, CO).
- Hardware Components for 3D Ranging Camera (D4.4, R, CO)
- Design of final radar prototype (D5.3, R, CO)
- Radio communication technologies (D5.4, R, CO)
- Design of antennas (D5.5, R, CO)
- Advanced prototypes of radar system and tags (D5.6, R, CO) - *Draft version*
- Definition of sensor specifications, software architecture and test plans (D6.2, R, **PU**)
- Algorithm design of silicon retina stereo sensor (D6.4, R, CO)
- Preliminary algorithms for pre-processing of raw data (D6.5, R, CO)
- Silicon retina, hardware design and fabrication (D6.6, R, CO)
- Dissemination and use plan (D8.3b, R, **PU**)

Public deliverables can be downloaded at the following link:
http://www.adose-eu.org/result.html

* Codes about nature of the deliverable and dissemination level:

R=Report, **P**=Prototype, **D**=Demonstrator, **O**=Other

PU=Public, **CO**=Confidential, only for members of the consortium (including the Commission Services).