25 FEBRUARY, 2009

ADOSE

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

European Commission
Information Society and Media

NEWS ! The first Review meeting of ADOSE project took place on 25th, Feb. 2009 at European Commission in Bruxelles. The concept design phases of the addressed ADOSE sensors (MFOS sensor, FIR imager, 3D camera, harmonic radar and tags, SRS sensor) have been completed successfully and the project has fully achieved its objectives and technical goals for the period.

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 Research Centers (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

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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 first year

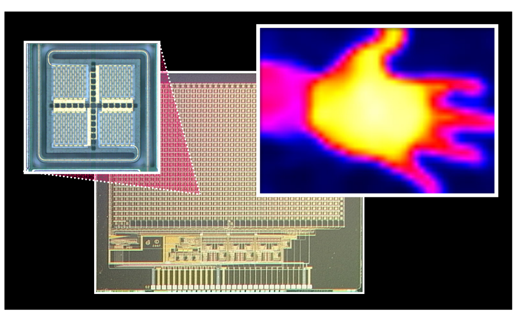
Scenarios, requirements, specifications (WP1, ARC)

The first project activity aimed at analysing and selecting the traffic scenarios to be handled by systems based on sensor technologies (new or improved sensors) under development in ADOSE. Basis was the outcome from past (PReVENT, WATCH-OVER) and current (SAFESPOT, COOPERS) research projects and data from roadmaps on road safety. ADOSE scenarios were limited to two groups: (1) Collision Avoidance (urban and extra-urban areas), (2) Pre-Crash Warning/Preparation (front, side and rear impact).

Requirements were derived from the selected scenarios and specifications took into account technology-specific potential / restrictions as well as environmental conditions and terms-of-use. Initial considerations on dependability and quality indicators were set up.

FIR imager (WP2, BOSCH)

A new concept for low-cost FIR add-on sensor arrays based on an integrated volume-proven MEMS process has been worked out and has been successfully proven in a technology test run. Inherent production of suspended mono-crystalline thermo-sensor elements during the ASIC manufacturing process ensures full compatibility with semiconductor manufacturing and batch wafer-level packaging as well as a cost-efficient production exploiting economy-of-scale with existing MEMS lines.
Optic designs have been developed pursuing the processes for low-cost volume precision moulding. To avoid costly second level FIR packages assembly and thermal management concepts are developed for compact direct imager chip attach on board.
Next step is the manufacturing of a FIR-imager and demonstration of a camera targeting the requirements derived in ADOSE WP1.

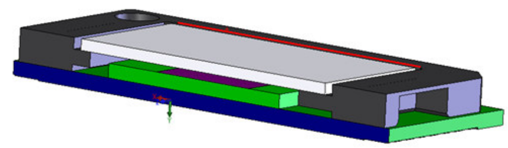


Technology test chip and FIR-image accessed

Multifunctional optical sensor (WP3, CRF)

The concept design phase started analysing the MFOS sensor principle with respect to the optical, mechanical and electrical integration features.
Planar integration technologies, favoured over larger stacks due to lower costs, led to the selection of lightguide optical concept.
Two tentative lightguide structures were designed and investigated: (1) four planar lightguides to integrate six functions on a modified ST imager package, (2) two elliptical lightguides to integrate four functions on a standard ST imager. Two basic issues were addressed: coupling of the lightguide to the pixel area of the imager and implementation of the coupling and de-coupling optical elements.

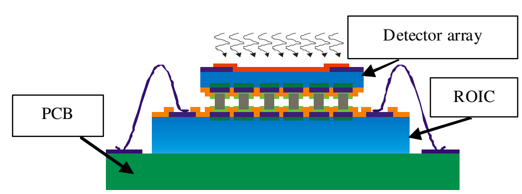
The optimisation of the IR source for active functions (fog, rain) is in progress, addressing in particular the thermal and optical constraints.
Specific developments on the current ST VL5510 CMOS imager were performed, mainly focused on the OLGA package, colour optical filters and microlenses.



Modified ST OLGA package (VL5510 imager).

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 readout electronics are being designed to be able to implement different range measurement methods in order to find the optimum one.
In the next months the design of both the photosensor and the readout electronics will be completed and a camera prototype will be manufactured and evaluated.

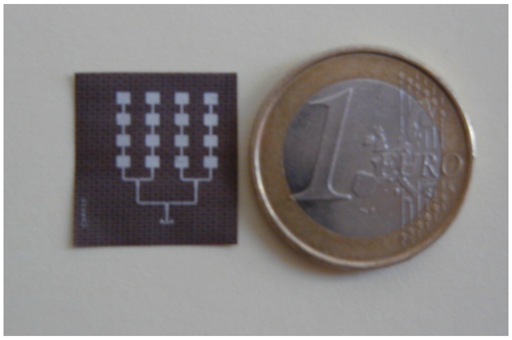


Camera hybrid module

Harmonic radar and tags (WP5, VTT)

The preliminary design of the harmonic radar architecture has been finalized. The radar relies on the intermodulation principle, which provides smaller frequency offset as compared to the traditional harmonic radar. The small frequency offset facilitates the circuit design and the intermodulation radar can be realized within the 77 GHz band allocated for automotive radars.
The study on passive radar reflectors has been focused on the nonlinear element and the wearable antenna. The Schottky diode has the

best availability of the studied nonlinear elements, but ferroelectric varactors and MEMS resonators offer very low mixing loss and thus long detection range. Different wearable antenna materials and structures have been studied and the first antenna prototypes have been realized. The integration into different types of textiles has also been considered.



Four-by-four element wearable array antenna.

Silicon retina stereo sensor (WP6, ARC)

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.
Two different vision system prototypes have been developed by ARC prior to ADOSE: a 2D vision system for roadside traffic data acquisition and a real-time stereo vision system for reliable person counting.
ADOSE deals with the need of high-speed and low-cost ranging sensors for time-critical decision making applications. In a first step the automotive requirements for such a sensor system were collected and a reference application for the silicon retina stereo sensor (SRS) was identified. It is a pre-crash warning application for side-impact and SRS can serve e.g. as a pre-crash sensor for side-impact airbags. Based on these requirements the technical specifications of the sensor were determined.

Prototype of SRS sensor.

Data processing and functional system integration (WP6, MM)

The ADOSE sensor specifications related to the communication bus, protocol and data format have been analysed and defined preliminarily. A rough overview of the software architectures to be developed within the project and the test plans have been also provided. The former contents are included in D6.2 deliverable report which will be updated during the project as soon as the sensor design phase will be completed and the final decisions will be taken on the configuration of the sensor prototypes (hardware interfaces, bus, protocols, etc.). Interactions with other EU projects will allow developing algorithms compliant to PReVENT-PROFUSION guidelines and ready to be integrated in the standard software architecture for driver assistant systems.

Dissemination and exploitation (WP8, CRF)

The ADOSE web site (http://www.adose-eu.org/result.html) was set-up by CRF and the maintenance phase started. A public area for dissemination purposes and a private area for file recording and sharing were established.

Homepage of ADOSE website

The project dissemination started 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 were included in D8.3 deliverable report focused on *Dissemination and Use Plan*.
The first Workshop in co-operation with related eSafety projects is under preparation.

Main results in the first year

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

- Analysis and assessment of potential scenarios (D1.1, R, **PU**)
- Definition of sensor requirements and specifications (D1.2, R, **PU**)
- Concept definition for technology, process & function of the FIR imager device (D2.1, R, CO)
- Simulation, design and manufacturing of FIR components
- Concept design of the multifunctional optical sensor (D3.1, R, CO)
- Preliminary design of the MFOS optical components and package (D3.2, R, CO)
- Preliminary developments on the CMOS imager for MFOS sensor
- Concept design of the 3D ranging camera (D4.1, R, CO)
- Design of passive non-linear radar reflector (D5.1 R, CO)
- Design of active tag (D5.2, R, CO)
- System design of the harmonic radar sensor
- Specifications of the silicon retina stereo sensor (D6.1, R, CO)
- Definition of sensor specifications, software architecture and test plans (D6.2, R, **PU**)
- Preliminary algorithm design of silicon retina stereo sensor (D6.3, R, CO)
- Monitoring and review of sensor technology development (D7.4, R, CO)
- Project presentation (D8.1, O, **PU**)
- Project website (D8.2, O, **PU**)
- Dissemination and use plan (D8.3, 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).