Project result

Cluster for Application and Technology Research in Europe on NanoElectronics

CA301 | High Dynamic Range Low Noise CMOS imagers [HiDRaLoN]

The purpose of the CATRENE HiDRaLoN project was to address societal needs in such areas as healthcare, entertainment as well as road and industrial safety. The results are expected to provide greater efficiency and fewer errors in medical diagnostics; unprecedented TV image quality; automatic visualisation of road driving conditions; enhanced image quality in low-light conditions and improved safety on production assembly lines. The successful completion of the project has resulted in the availability of CMOS imagers that are set to replace the CCD imagers that have dominated the market for many years.

CMOS image sensors now set to replace CCD technology

During 2011, the project worked towards the availability of full complementary metal-oxide on silicon (CMOS) image sensor designs and started the development of the final demonstrators. In 2012, the silicon for full CMOS imager designs was available and was evaluated. The final demonstrators were completed and were used to show the improved functionality that has been secured.

Research topics included pixel design and modelling, low-noise analogue read-out, including analogue-digital (A/D) conversion and multiplexing, modelling of thermal, optical and electrical cross-talk, optics and correction algorithms for CMOS imager and optical enhancement. The HiDRaLoN project focused on increasing the dynamic range of CMOS imagers to 120dB and lowering the noise level by at least 50% to make CMOS imagers better than today's charge-coupled devices (CCDs). Currently, CCDs still hold a dominant position over CMOS image sensors at the higher end of the market.

Best practices from CCD manufacturing have been retained so it is expected that the CCD imagers currently used in high-end broadcast equipment will now also be replaced by HiDRaLoN CMOS imaging devices.

Functional prototypes of full imager chips for medical, broadcast, time-of-flight and machine vision were evaluated and achieved or exceeded expected results. Furthermore, all planned application demonstrators based on medical, broadcast and time-of-flight imagers were built and were fully functional.

Tests with a new industrial vision test chip proved the functionality of new building blocks and concepts and exceeded the expected results of required optical performance.

The project has delivered five new imagers for the general time-of-flight, medical, broadcast and safety/security/machine vision markets, as well as algorithms to correct flaws in the imagers and the optics. For broadcast purposes, two new lenses have been designed and evaluated together with correction algorithms designed within the project. Demonstrations in the project have focused on medical, broadcast and general three-dimensional (3D) applications.

All of the main objectives of the project were achieved and all deliverables were completed. Excellent co-operation between the partners resulted in continued co-operation even after the end of the project.

Partners:

Budapest University of Technology & Economics
CRS iiMotion
e2v Semiconductors
Fraunhofer Institute
Grass Valley
Helion Vision
IMS Chips
Le2i (University of Burgundy)
Nikhef
Philips
Pilz
Technical University of Delft
Thales
Deutsche Thomson OHG
Viimagic GmbH

Project leader:

Klaas Jan Damstra,
Grass Valley (NL)

Key project dates:

Start: March 2009
End: June 2012

Countries involved:

France
Germany
Hungary
Israel
The Netherlands

PROJECT CONTRIBUTES TO

Communication	✓
Automotive and transport	✓
Health and ageing society	✓
Safety and security	✓
Energy efficiency	✓
Digital lifestyle	✓
Design technology	✓
Sensors and actuators	✓
Process development	✓
Manufacturing science	✓
More than Moore	
More Moore	
Technology node	45/32 nm

Several fields of application

While the potential range of applications for HiDRaLoN CMOS sensors is extensive, the main markets explored were medical, broadcast and industrial.

The advances obtained in the medical domain primarily involve imaging enhancements in x-ray and computer tomography (CT) equipment. The sharper images that are now possible through HiDRaLoN CMOS image sensors, greatly improve the accuracy of diagnosis to the benefit of patients and medical staff.

For applications in the broadcast environment, the first full-sized CMOS image sensors were extensively evaluated within the HiDRaLoN project. At the end of 2010, it was decided that the performance of the prototype was already so good, that it could be used to start the development of new commercial products. While the research on the CMOS image sensor continued within HiDRaLoN, parallel development continued on the first two commercial products.

There is an increasing demand and awareness in industry regarding new high dynamic range (HDR) image sensors which drive new applications or enable new image processing based systems. In addition to market reports, this is also apparent in both industry oriented and scientific conference programmes dealing with the HDR topic.

In the industrial production line environment, HiDRaLoN project developments have opened doors to considerable opportunities:

- The industrial vision image sensor developed in the project is intended to be used in new safe camera systems developments for three-dimensional zone monitoring.
- Applications requiring HDR imagers, such as welding process monitor and control systems. The main added-value lies in the reduced cost of high-performance systems.
- IMS CHIPS will deliver qualified CMOS image sensors to industrial applications in Europe in volumes of up to several tens of thousands of units per year.

In addition to machine safeguarding and the machine safety market other markets with possible applications of the logarithmic industrial vision imager are:

- Intelligent video surveillance cameras
- Automotive safety systems
- Medical imaging

Significant project outcome

The HiDRaLoN project has made a substantial contribution to the advancement of European CMOS image sensor developments. The results will have far reaching consequences for the European silicon fabs as well as for end-users in several fields of application.

All of the main objectives of the project were achieved and all deliverables were completed. Excellent co-operation between the partners resulted in continued co-operation even after the end of the project, both commercially and in terms of new European projects.

The project resulted in a long list of publications and the filing of 6 patents.

A substantial contribution was made to the EMVA1288 standard for High Dynamic Range (HDR) sensors (in version 4.0 the standard will be extended to non-linear and HDR cameras) and a Time-of-Flight Study Group was inaugurated.

One of the key factors in all CATRENE projects is the creation of a consortium of expert partners who can work together to achieve results that will advance the European strengths in various aspects of advanced technology. The CA301 project has adequately demonstrated the value of that process and the results achieved serve to illustrate the benefits.

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CATRENE focuses on delivering nano-/microelectronic solutions that respond to the needs of society at large, improving the economic prosperity of Europe and reinforcing the ability of its industry to be at the forefront of the global competition.