6. Publishable Summary

Project acronym	EXIST
Project full title	EXtended Image Sensing Technologies
Anticipated start date of project	01/04/2015
Duration of project in months	36 Months
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Image capture is a generic technology that is used in a multitude of business applications, including Security, Healthcare, Automotive, Digital Entertainment (broadcast video, entertainment like gaming), and more recently in Agriculture. A highly qualified and multi-disciplinary team is required to develop the various aspects of the technologies such as optics, image capture, and video processing. To develop and optimize these technologies for professional image capture, a consortium with a critical mass of world class engineering and research skills is required. The EXIST consortium achieves this for the research on technologies needed for the next generations of CMOS image sensors. The project brings together important European players in the imaging industry with proven track records in their field of expertise and application domains. The team consists of R&D institutes advanced in image sensor technologies, image sensor designs and video processing (IMEC, Fraunhofer IMS, Le2i, TNO, iMinds and TU Delft) and fabless design houses, semiconductor manufacturer (Sofradir) and system integrators (CMOSIS, Grass Valley, Softkinetic, Thales Angenieux, Adimec, Silios, Sofradir, Focal, and Quest).

The EXIST consortium will investigate and develop innovative new technologies for image sensors needed in the *next plus one (N+2)* generation of several application domains. The image sensor research will focus on enhancing and extending the capabilities of current CMOS imaging devices:

- New design (architectures) and process technology (e.g. 3D stacking) for better pixels (lower noise, higher dynamic range, higher quantum efficiency, new functionality in the pixel) and more pixels at higher speed (higher spatial and temporal resolutions, higher bit depth), time-of-flight pixels, local (on-chip) processing,
- Extended sensitivity and functionality of the pixels: extension into infrared, filters for hyperspectral and multispectral imaging, better colour filters for a wider colour gamut, and FabryPérot Interference cells
- Increasing the optical, analog and data imaging pipelines to enable high frame rates, better memory management, etc.

After developing the related technologies, six prototype image sensors will be designed

- two high resolution, high frame rate image sensors with 32Mpixels or more;
- two Time of Flight image sensors;
- one 3D stacked image sensor.
- one Integrated high performance hyperspectral image sensor

Next to these image sensor designs, the team will make a number of filter designs for integration on top of above mentioned and commercially available image sensors:

- Multispectral filters for MWIR
- Hyperspectral filters for NIR-passband and NIR-cutoff filters;

- HSI filters and BSI imager for VISNIR range;

Finally the consortium will focus on optimizing the entire imaging chain as a whole through integrated video processing. Using simulations, measures directly related to human visual task performance will be computed.

Together with sensor related processing these image sensor and filter designs will be demonstrated in 9 different demonstrators in the following application domains:

- **Security**: high-end security camera with UHDTV resolution, multispectral IR prototype camera for gas detection, multispectral image capture that focuses on face detection and face recognition;
- **Healthcare**: hyperspectral camera for retinal oximetry and full spectral retinal screening, NIR + VIS HIS camera for laparoscopy;
- **Automotive**: Flash LIDAR demonstrator for Advanced Driver Assistance Systems;
- **Digital Lifestyle**: 8Kx4K UHDTV television camera, 3D imaging demonstrator for consumer/smart home applications, 35mm lenses supporting 8Kx4K;
- **Agriculture**: 4D Imaging Using Multi-Camera HSI system application for automated continuous monitoring of plant health and growth.

The technologies and demonstrators developed within the EXIST project will enable a number of new vision systems answering the following societal needs

- broadcast cameras with improved image quality, image capture for the second generation of Ultra High Definition Television (UHDTV), enhanced experience for TV viewers by unprecedented image quality (in spatial details, motion portrayal, and colour perception), enhanced interaction in the digital world;
- hyperspectral detection cameras allowing the extraction of more detailed information, e.g., enabling smart sorting in the food industry;
- citizens' security through Ultra High Definition surveillance systems giving better detection rate;
- road safety through driver assistance: an additional pair of "automatic" eyes on the road;
- citizens' security through intelligent security systems using 3D vision;
- citizens' safety through more sensitive and versatile gas detection systems for industrial applications.
- citizens' healthcare/medical applications like diabetic foot monitoring and laparoscopy

Strategically, it is important for Europe to remain at the forefront of image capture due to the diversity of applications that support many key industries in Europe (as shown with the plurality of demonstrators EXIST will deliver), which in turn have export markets beyond Europe. Similarly the industrial partners in the project all have significant export markets outside Europe with their respective image capture products. By launching new process technologies based on innovative materials, designs and concepts into image sensor process technology, the EXIST project will facilitate a strongly growing market share, increased employment and investments for innovative equipment, materials and for manufacturing of semiconductor devices and systems through European leadership positions in, Moore than Moore and System in Package. Furthermore it will strengthen the image capture, image processing ecosystem and optimally position its members at the forefront of these technologies in their respective markets.