PROJECT RESULTS

CAT406

Improved mammogram screening through high-quality imaging, fewer retakes, lower X-ray dose and greater patient comfort

[NEMADE]

The NEMADE project developed a new mammography detector using a multi-tiles wafer-scale CMOS imager for efficient breast-cancer screening and tomosynthesis. In addition to reducing breast-compression discomfort previously experienced by users, this solution also delivers other societal benefits, together with technical and environmental ones.

Some 450,000 women are diagnosed with breast cancer annually In the European Union and more than 100,000 women die from it every year. Regular screening can significantly reduce the risk. However, there is a downside to it: breast compression is very painful and the X-rays used for screening can be harmful. At the time when this project was proposed, X-ray detectors for mammography screening typically used slow and noisy amorphous silicon-based detectors with direct X-ray conversion which has significant lag. While the performance was sufficient for screening (static application, single image), this way of screening had reached its limits for biopsy, and especially when compared to the emerging tomosynthesis with its dynamic application and sequence of images.

And on the business side, Europe was looking to play a significant role in the screening market, which was then dominated by North American and Asian suppliers.

Efficient, reduced-pain and affordable breast-cancer diagnosis

NEMADE's goals were to improve mammography screening by developing a system capable of consistently high image-quality and fewer retakes, at a lower X-ray dose; and with greater patient comfort.

These project goals translated into several technical objectives and deliverables. Significantly, by replacing the amorphous silicon with a CMOS imager (CMOS or complementary metal oxide semiconductor is a technology for constructing integrated circuits), the mammography detector – the key deliverable – achieved the higher speeds needed to meet biopsy and tomosynthesis requirements, while still maintaining a low total X-ray dose. Thanks to several important features – like binning pixels, region-of-interest readout, selectable X-ray saturation dose and real-time dose sensing (all enabled through CMOS technology) – a single detector could produce the best possible images and without needing retakes. Furthermore, the lower CMOS noise-level and the use of structured scintillators (a scintillator is luminescent material which, when struck by an incoming particle, absorbs its energy and then re-emits it in the form of light), which combine high-resolution with high light-output, means that all this can be done at a lower X-ray dose to the patient. Crucially, the use of personalised mammography allows breast-compression to be fine-tuned to the patient's needs, thus minimising associated pain.

To summarise, NEMADE's key achievements/ deliverables include:

- A new mammography detector using newly developed multi-tiles wafer-scale CMOS imagers combined with conventional CsI (Cesium Iodide) indirect conversion. This solution includes innovative features at different levels which provide efficient support for screening and tomosynthesis;
- Improvements to the assembly process with changes in tooling to move to a fully automated assembly and to increase more uniform flatness of the tiled CMOS array;
- Evaluation (also through simulations) of the structured scintillator demonstrating high-quality results based mainly on the modulation transfer function (MTF);
- From semi- to fully-automatic adjustment of image receptor height to balance forces and subsequently improve the image quality (by about 10%) and provide comfort to users undergoing mammography.

There were also other achievements. NEMADE delivered prototypes to a significant number of customers/OEMs, resulting in positive feedback and in several cases to business opportunities. The project also generated six patent applications and 10 publications, and consortium members participated in three international trade shows.

PROJECT CONTRIBUTES TO

- Health and aging society
- Manufacturing science

PARTNERS

Teledyne DALSA
SigmaScreening
Scint-X

COUNTRIES INVOLVED

- The Netherlands
- Sweden

PROJECT LEADER

Jan Bosiers
Teledyne DALSA, Netherlands

KEY PROJECT DATES

January 1, 2015 - December 31, 2017

Environmental and societal benefits

NEMADE delivered personalised and affordable mammography scanning that strongly improves patient comfort, image quality and diagnosis. Crucially, this will lead to fewer complications in breast cancer – and thus a higher degree of safety for the patient – for two reasons. Firstly, better accuracy of screening through vastly improved image-quality means fewer retakes and a lower overall X-ray dose. And secondly, reduced pain caused by breast compression and higher efficiency will reduce health-care costs and also result in a higher percentage of women participating in the screening programmes (fewer no-shows) and with fewer complications.

On the technical side, the scintillator uses silicon-based CMOS/MEMS technologies to etch deep pores in silicon to be filled with a scintillator. Combining this with CMOS imagers results in true silicon photonics. Using silicon as a 'carrier' for the CsI scintillators facilitates environmental protection. In addition, the scintillator imager assembly can be made more robust since both parts are now made on silicon, with the same thermal expansion coefficients. The new environmentally robust assembly technology for conventional scintillators also improves overall detector reliability.

Promising market and market position

Screening programmes that drive overall mammography demand are taking off, especially in emerging markets, where a larger percentage of income is spent on health care as income per capita grows. Notably, this increase in income is also leading to the adoption of a more Western lifestyle, which is causing (for some unknown reason) a higher incidence of breast cancer.

The full ramp up is planned and programmed for mid-2018. Encouragingly, more and more patients and hospitals are requesting this new technology. Based on feedback from 2016, expected business volumes will increase from € 15m in 2019 to some € 25m in 2020. The total addressable market (TAM) for digital mammography will exceed US$155m in 2019, the highest growth-rate among all types of X-ray applications for flat panel detectors.

Meeting a business objective, NEMADE has significantly strengthened Europe's current market position in mammography X-ray systems and detectors, even challenging the dominant position of a key North American competitor.

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