True colour X-ray imaging by dual-energy photon counting using standard contact image sensors

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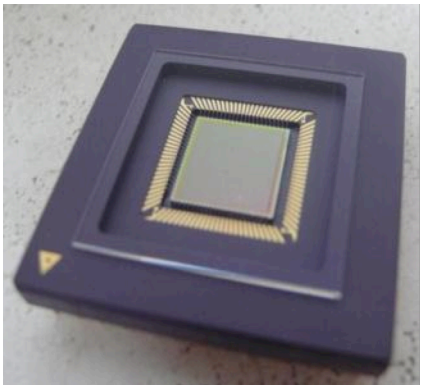


Packaged Photon Counting Sensor

Abstract

With extensive usage of radiography in medical diagnostics, achieving the lowest possible dose imaging is a driving force for the X-ray image sensor community. Furthermore, medical diagnostics would benefit greatly from true colour X-ray imaging.

A low-cost and low-power X-ray photon counting detector has been developed with the highest possible scalability and manufacturability. The sensor allows direct coupling with scintillators. It discriminates between two X-ray energy levels, allowing true colour interpretation of the data.

Standard CMOS and CIS technology are being used, which resulted in a USB camera demonstrator (92x90 pixels @ 1cm²) for true colour X-ray imaging. This demonstrator can be easily expanded to a wafer level device (e.g. 14x14cm2 area).

Beyond space and medical application, this technology could be usable in other X-ray applications such as non-destructive testing, µCT, healthcare, luggage inspections, etc. as it allows (proven) better interpretation of the images.

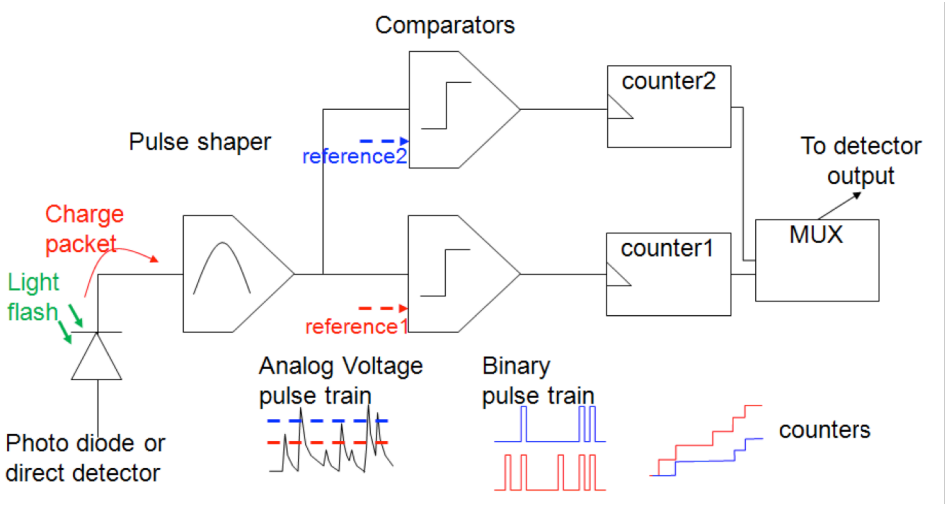
This company is a design house from Belgium for turnkey, high-end, high performance image sensors for space, medical and other application domains.

Description

This technology provider has created a true colour X-ray photon counting technology aimed at the highest possible scalability and manufacturability at an economic level.

The technology accurately counts X-ray photons and differentiates between their energy, thus deriving properties of the material through which the X-ray passed. For medical applications: by determining of the energy and amount of X-ray photons, tissue types can be discriminated with a proven higher success rate and clearer visualization e.g. the difference between Fat (Carbon rich) and blood (Oxygen rich) areas.

The proposed photon counting technology makes use of standard contact image sensors (CIS) technology and works with off-the-shelf scintillators. Due to the straightforwardness of CMOS chip design, the innovation will allow real-time, on-site evaluation of a variety of equipment. It is portable to any foundry where a pinned diode module is available. The sensor architecture is designed to maximize yield of wafer-scale devices.



Dual color photon counting pixel block diagram

Beyond a multitude of medical applications and proven benefits to medical diagnostics, this technology is also useful in other X-ray applications, for instance non-destructive testing (µCT), dentistry, luggage inspections, etc.

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Innovations and advantages of the offer

The dual channel photon counting with scintillators incorporates the following concepts:

- High scalability, by stitching and minimal gap abutting
- High manufacturability (wafer scale devices of 14x14cm2)
- No heavy semiconductor hybridization, but rather using optically coupled scintillators (more economical)
- Use of 0.18µm standard CMOS Contact Image Sensor technology
- Front side illumination
- High yield is ensured by a low transistor count per pixel and fault tolerant design
- Low power consumption due to the CMOS technology
- Real-time evaluation on site on a variety of equipment is possible

Further Information

To date, two generations of such detectors have been designed and evaluated, starting from a 16x16 B&W photon counting pixel array to the 90x92 pixel dual colour 1cm² demonstrator.

Although CMOS X-ray sensors for large scale medical application will remain more expensive than TFT plates, this photon counting technology provides tangible added value for the diagnostician at the most affordable manufacturing cost.

Unlike TFT sensors, this CMOS chip is straightforward to interface by USB. It can be evaluated in real-time, on site, on a variety of equipment.

Application

Medical applications

- medical diagnostics
- bone densitometry
- mammography
- etc.

and other X-ray related applications including:

- non-destructive testing (µCT)
- healthcare (dentistry)
- luggage inspections
- etc.

Description of Space Heritage

The heritage of this current project is the result of previous efforts of the technology provider in the development of radiation hard pixels for space application, and the development of an ASIC in the frame of an ESA project targeted at infrared sensor signal conditioning for space applications (ESA AO/1-6814/11/NL/AF, Prototype ASIC Development of Large Format NIR/SWIR Detector Array).

Both developments led to a collection of technology solutions for space applications including radiation hard pixels and a generic 0.18µm analogue and digital radiation hard library.

Starting from this expertise, X-ray imaging is a closely related field.

Comments on the technology by the broker

Due to the straightforwardness of CMOS chip design, the innovation will allow real-time evaluation on site on a variety of equipment. The tech is aimed at low-power, low-cost, scalability and manufacturability, which are all key advantages. Beyond a multitude of medical application and proven benefits to medical diagnostics, this technology is also usable as such in other X-ray applications such as non-destructive testing (µCT), dentistry, luggage inspections, etc.