Project Parterns

Politecnico di Milano, IT

Fraunhofer-Gesellschaft zur Foerderung der angewandten Forschung e.V, DE

Heriot-Watt University, UK

Micro Photon Devices s.r.l., IT

Centro Ricerche FIAT scpa, IT

EMZA Visual Sense LTD, IL

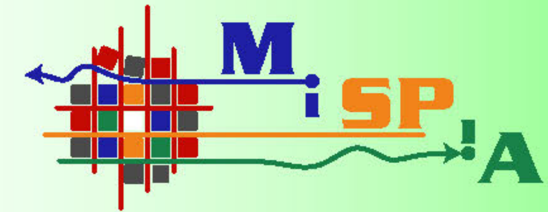
CF Consulting Finanziamenti Unione Europea s.r.l., IT

Contact

Name: Prof. Zappa Franco

Tel: +39 02 2399 6149
Fax: +39 02 2399 3699
E-mail: franco.zappa@polimi.it

Affiliation and Address:
PoliMI - Politecnico di Milano
DEI - Dip. Elettronica e Informazione
Piazza Leonardo da Vinci 32
I-20133 Milan - ITALY

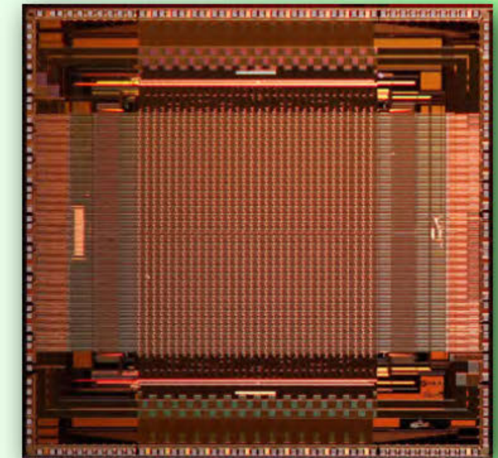


Microelectronic Single-Photon 3D Imaging Arrays for low-light high-speed Safety and Security Applications

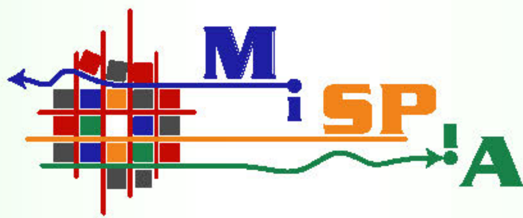
MiSPIA consortium consists of 7 partners, who are among the leading European research groups in the fields of SPAD arrays and single-photon instrumentation (Politecnico di Milano, Italy), CMOS sensors fabrication and advanced SOI processes (Fraunhofer-Gesellschaft zur Foerderung der angewandten Forschung e.V, Germany), design and fabrication of microlens arrays (Heriot-Watt University, United Kingdom), development of time-correlated single-photon counting detection modules and cameras (Micro Photon Devices s.r.l., Italy), safety applications in automotive field (Centro Ricerche Fiat scpa, Italy), then a leader in the security surveillance monitoring (EMZA Visual Sense Ltd, Israel) and finally CF consulting srl (Italy) with vast experience in the management and dissemination of European projects.

MiSPIA iTOF camera and illuminator

www.mispia.eu

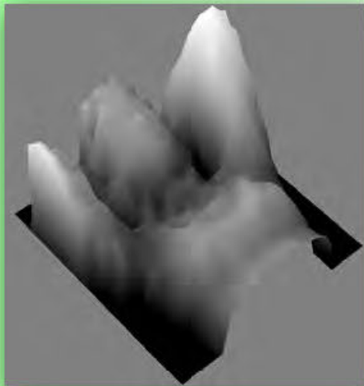


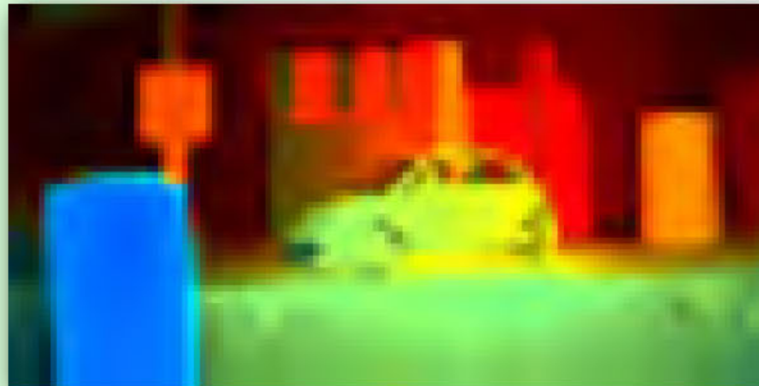
Grant agreement no: 257646
01.06.2010 — 31.05.2013
Information and Communications Technologies
Seventh Framework Programme

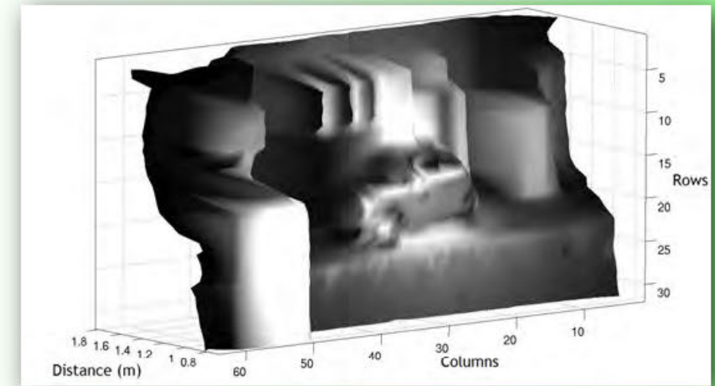


MiSPIA results at the end of the project

- ✓ **state-of-the-art CMOS SPAD detectors and arrays, with Dark-Counting Rate DCR<80cps at 5V excess bias for 30µm SPADs at room-temperature; Photon Detection Efficiency PDE** of 55% at 400nm, >30% in the 300-600nm range, 10% at 750nm and still 5% at 850nm; Time-of-Flight (TOF) precision better than 40psFWHM; SPAD diameters up to 500µm (never reported so far).
- ✓ **3D ranging chips for "direct TOF" and photon-timing** with best-detection performance so far reported, based on smart-pixels with 30µm SPADs and in-pixel time-to-digital converters (TDCs) for TOF measurement of individual single photons: both linear arrays and 1048 pixels imagers, acquiring 2D images and 3D movies at 100,000fps with 5cm single-shot depth-precision while 0.9mm at 200fps, with 6bit photon-counting dynamics and <100cps/pixel noise, 10bit photon-timing with $212ps_{rms}$ resolution and 320 ns full-scale range.
- ✓ **3D ranging chips for "indirect TOF" and photon-counting** with among the best cutting-edge performance among SPAD imagers, based on smart-pixels with 30µm SPADs and digital counters for phase-resolved detection of either pulsed-light (PL) or continuous-wave (CW) actively illuminate scenes: linear arrays or matrixes, 2048 pixels acquiring 2D images at 100,000fps and 3D maps movies at 33,000fps, with 9bit photon-counting dynamics and <100cps/pixel.







- ✓ **two compact and modular low-power fully-programmable active illuminators**, to be coupled with 3D iTOF cameras for short-ranges up to 50m, based on commercially-available **LEDs or solid-state lasers, able to switch between two operating mode, namely pulsed-light (PL) mode, with flashes lasting few hundreds of ns, or continuous-wave (CW) modulation, at** MHz rates.
- ✓ **one reconfigurable user-friendly compact camera module for 2D/3D acquisitions** of pictures and movies by any (linear array or imager, iTOF or dTOF based) MiSPiA CMOS SPAD chip, to be remotely controlled by a remote pc through USB 2.0 link and a graphical user interface .
- ✓ **two different cost-effective CMOS technologies for SPAD manufacturing**, in a robust and reliable 0.35µm node, to fabricate either fully-planar single-chip, front-illuminated CMOS FrontSPAD imagers or advanced two-chip wafer-to-wafer bonded, back-illuminated SOI-based BackSPAD imagers.