Vision, Identification, with Z-sensing Technologies and key Applications

Newsletter – April 2021

The VIZTA project has reached 2-year activity, several meetings have gathered the representatives of all partners, first fruitful results have already enlightened the collaboration between the partners.

VIZTA objectives and means.

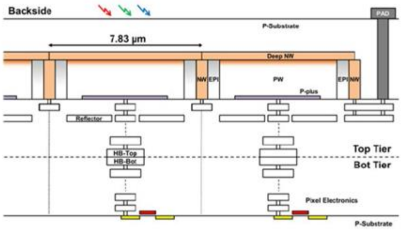
The objectives of the project are to develop innovative technologies for optical sensors and laser sources, for short to long-range 3D-imaging, and demonstrate their value in several key applications. Such objectives are addressed by building partnership ecosystems, exercise new 3D sensors and light sources in the key applications, using the new developed innovative technologies.

VIZTA progress: significant steps in 24 months

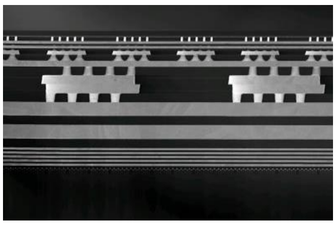
We propose hereafter a compilation of the different partners contributions starting from Technology developments, then components and application systems for short and long-range up to actions of exploitation and dissemination.

The VIZTA project developments are structured in 3 Work Packages (WP) focusing several tasks.

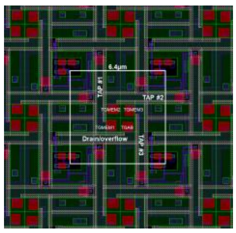
The WP2 is dedicated to advance device and technology development needed for the demonstrators used in the other work packages, and subdivided in 5 main tasks:



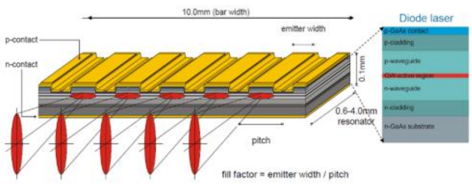
Advanced SPAD_3D



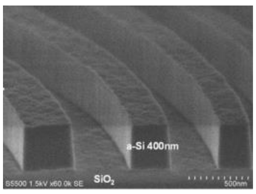
Hybrid Bonding solutions



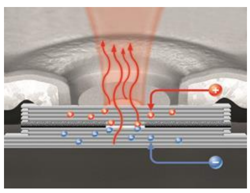
Lock-in pixels



High power Laser bar



Diffractive micro-lenses



VCSEL with integrated optics

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- SPAD (Single Photon Avalanche Diode) and lock-in pixel development: A new SPAD test chip encompassing ~32,000 SPAD is now available and being used to gather more precise data at wafer level with much more statistics.
- RGBZ sensor: Generation 1 demonstrator of RGB+Z is measured fully functional. Z-pixels with a size of 2.8µm are embedded in a 1.4µm pitch RGB-array. Detailed performances of the circuit are under evaluation, only preliminary filtering approach was used for this demonstration. New infrared filters are being investigated at **CEA** and will be assessed by end 2021 on the same test chip.
- 3D Hybrid bonding: New double-stacked hybrid bonding complete wafers have been provided by **ST SA** to **SEMILAB** for repeat of characterization using Polarized Scanning IR technique and IR overlay measurement. **SEMILAB** is optimizing these technologies specifically to be applicable for bonded wafers. Wafers had been pre-characterized at **ST SA** facilities using Scanning Acoustic Microscopy (SAM) and nano-topography measurements. **SEMILAB** is progressing with the assembly of the new testing equipment.
- F2B bonding in **CEA** has now a mask set for 1µm TSV hybrid bonding test vehicle fabrication.
- VCSEL development: The feasibility of the VCSEL concept with 10 addressable zones and integrated GaAs optics for beam shaping has been successfully demonstrated by **TRUMPF**. Chips have been made and characterized, routes for improvements in the next project phase are identified.

The WP3 consists in development and realization of several demonstrators of Z sensing applications with low range 3D sensors: Biometric system, in-cabin monitoring system, smart building management, 3D multi-camera system for Industry 4.0, automotive driver monitoring systems with 3D mapping and finally mobile robotics for smart cities.

- **Development of z-sensor prototype**

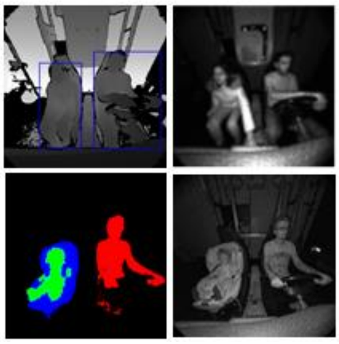
- **ST** is developing z-sensor prototypes and delivered depth map sensor (Z-sensor S2) to applicative partners based on WP2 technologies in February 2021.
- From first 3D picture in May'20 and now system validation has been performed

- **Development of application demonstrators**

- Security

- **IDEMIA**, **CEA** and **ST** specified a new robust biometric system for human identification in Z-sensor stacked layer.
- **IDEMIA** have an initial 3D face recognition prototype available.

- Automotive & Smart building



- **DFKI** provided a public annotated data set for in cabin applications: https://vizta-tof.kl.dfki.de/ publication reference to the data set is :"TICaM: A Time-of-flight In-car Cabin Monitoring Dataset", Jigyasa Singh Katrolia, Bruno Mirbach, Ahmed El-Sherif, Hartmut Feld, Jason Rambach, Didier Stricker, on arXiv.org under the ID arXiv:2103.11719.
- **DFKI** published "An Adversarial Training based Framework for Depth Domain Adaptation", Jigyasa Singh Katrolia, Lars Kramer, Jason Rambach, Bruno Mirbach and Didier Stricker, VISAPP 2021
- **IEE** and **DFKI** demonstrated good results for person detection and segmentation algorithms based on depth data.

ECSEL Joint Undertaking

VIZTA

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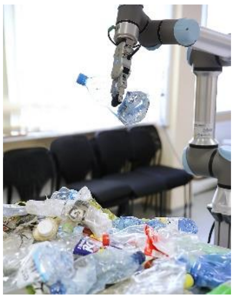
- **FICOSA** performed preliminary tests for driver status estimation based on the analysis of the respiratory signal variability of the driver with IR camera sensor + laser pattern. The system is currently working in real time; further work will focus on adapting the system developed to S2 sensor performance.

- Industry 4.0



- **ISD** is working on integration of Z-sensor S0 in multi-camera system.
- **EDI** developed a synthetic data generator and trained a detector of pickable bottles in a pile.
- **BCB** obtained first 3D results with S2 z-sensor and works on sensor fusion.

- Mobile robotics

- **EURECAT** continue developments for VIO / SLAM / Scene reconstruction / object recognition and tracking for autonomous aerial inspection.

The **WP4** consists of **two automotive LIDAR demonstrators**, one focusing on a Medium Range LIDAR (MRL) unit and another one for Long-Range LIDAR (LRL) with the development of appropriate optical sources and detectors. The 2 developed solutions aim to overcome the cost and reliability drawbacks of current LIDAR systems and address the problem of perception capability in restricted visibility conditions with adverse weather conditions. Further processing of said point-cloud for example to generate target detection and classification are not covered in the project.

- The MRL demonstrator will operate at around 900nm wavelength and aims an automotive application related LiDAR demonstration with a TRL of 3 to 5. Taking advantage of an efficient high power Optical Phased Array (OPA), offering 2D scanning of the scene, VIZTA MRL would demonstrate a true solid state Lidar. The R&D work targets a large sized latest generation SPAD array with enhanced sensitivity and an efficient high power 2D scanning Optical Phased Array approach. Technology developments in high-power laser diodes with high beam quality and GaN related laser drivers complete this work package. VIZTA MRL would introduce a compact low-cost medium range Lidar, which would benefit from novel scanning and signal processing algorithms. The MRL consortium involves the partners **ST**, **CEA**, **III-V-LAB** and **IBEO Automotive Systems**

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- The VIZTA MRL will represent a Lidar demonstrator, which applies a novel scanning solution based on Optical Phase Array (OPA). The key components are laser, laser driver and OPA, as the illuminator, as well as a SPAD Receiver Chip.
- While developing a high-power laser with short pulses, **III-V-Lab** achieved to finish processing of different epitaxial structures in different generic geometries and to complete characterization of all structures. Based on these experimental and modelling results, design of Laser Gen2 accomplished. Two laser drivers, which represent two different approaches to achieve the requirements, such as short pulses and high repetition rate, are purchased. The electrical and optical characterization of the drivers made a good progress. **III-V lab** considers innovative ways to mount the laser on the driver. Additionally, different lasers are provided to **CEA-LETI** and **IBEO** by **III-V Lab** for various coupling test between laser and OPA and for intermediate assembly of Lidar, respectively.
- For development of the OPA, **CEA-LETI** designed two different mask sets, containing various circuits, so called VIZ0 & VIZ1. the first is successfully characterized and most features validated. The results were fed for the VIZ1 designs. The fabrication of this mask set is close to its end. Meanwhile **CEA-LETI** has improved the measurement and characterization benches to make them optimal and compatible for upcoming tests with VIZ1, such as laser coupling to OPA and 2D/1D scanning demonstration.
- Concerning the development of the SPAD receiver Chip by **ST**, a SPAD test chip, designed by University of Edinburgh on **ST** technology, was tested, and is used for verification of numerous TDCs implemented on FPGA by **IBEO**. Additionally, new generation of SPAD Receiver Chip (SRC2), has been specified and its design will begin soon. This version features high performances and full compatibilities with different scanning approaches of OPA.
- For Time of Flight (TOF) measurement a demonstrator system, based on FPGA, has been prepared by **IBEO**. Verification and calibration of this system will take place soon, through a planned intermediate Lidar assembly. Apart from that, **IBEO** developed a 1D OPA driver circuit and its related firmware, implemented on FPGA, for integration of OPA in the second phase of the intermediate assembly.

- The LRL system aims to overcome the cost and reliability problems of current LIDAR systems and addresses the problem of limited perception capability in restricted visibility conditions in adverse weather conditions. The LRL demonstrator uses the more eye safe wavelength at 1550nm instead of the common 905-940nm bands. The longer 1550nm wavelength will allow a higher emitted power level while maintaining eye safety class 1 level. A multiplexed single point detector will be used coupled with appropriate optical sources and detectors. For timing and financial reasons, the sensors in the project are intended as proof-of-concept (POC). They will therefore not comply with an ultimate production targeted system. Further processing of generated point-cloud for example to generate target detection and classification will not be covered in the project. The LRL demonstrator involves VIZTA partners, **III-V Lab**, **Beamagine**, **LETI**, **Keopsys**, **Quantel**, **UPC** and **Veoneer**.
  - The COVID-19 shut-down of **III-VLAB** facilities has had significant effects on parts of the work, resulting in a delay with delivery D4.6 delayed due to dependent D4.2, impacting partner **Quantel's** activities. Other sub-tasks believed to have managed the shut-down reasonably well.
  - Modular tabletop LIDAR unit based on COTS components and the use of sub-system references will reduce 'down-stream' pile-up of integration work.

Within the WP1 – consisting in Exploitation and Dissemination of the results obtained in each development WP, individual workshops with majority of partners have been carried out to prepare the update of the exploitation plan and to redefine, if necessary, the identified exploitation results. In parallel, those partners who are developing components within the project are carrying out component compliance activities to assure the safety of their potential future products. Cooperation with Horizon Result Buster has been established.

During COVID-19 time, conferences are moved into webinar, and partner's contribution are converted into this new communication style. Meetings are moved not only in style, but also through the calendar, shifted in time. A paper has been proposed by LETI ("Three-dimensional hybrid bonding integration challenges and solutions toward multiwafer stacking", L.

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Arnaud et al.). DFKI & IEE disclosed in public domain a deliverable on annotated vehicle in-cabin data. Promotion is done on our website and on LinkedIn for all events related to VIZTA, as well as a publication of an ID-Card for all partners.

Finally, ST assure the continuous project management with the support of Ayming in WP5; during the last period, the 24 EB meeting via vision-conference was successfully organized in April 2021.

Summary

After 24-month activity, the VIZTA project and its consortium generate first outcomes in Technologies and Applications systems. The deliberate choice to gather complementary industrial actors across the supply-chain from equipment tools up to system OEMs with scientific support from academics and RTOs results in a dynamic collaborative spirit while addressing concrete exploitation targets. In the next coming months, the demonstrators will be delivered as proof of concept, leading the path to industrial products.

Follow us to stay tuned for further news...

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