ANDANTE

ANDANTE Use Cases

ANDANTE aims to validate and evaluate the applicability of the neuromorphic technologies for various application domains, which are essential for the future of European competitiveness. Five domains were selected involving 13 use cases in total. These domains are Digital Industry, Digital Farming, Transport and Smart Mobility, Healthcare and Digital Life. A short overview of the use cases addressed by domain is given here.

Digital Industry | **Digital Farming** | **Transport and Smart Mobility** | **Healthcare** | **Digital Life**

Digital Industry

Use Case 1.1

Indoor Positioning, Recognition and People Counting

Description
Indoor positioning recognition and people counting for smart laboratory/factory applications (e.g. robot co-working)

Challenges
- Real time computation
- Scaling to handle input of multiple sensors

Positioning vs State of the Art
Existing solutions are too slow to fulfill the safety requirement of a smart factory/laboratory

Partners
IFAG, EESY, TUD, FHG, HEI

Digital Farming

Use Case 2.1

Autonomous Weeding System

Description
- Crops and weeds detection
- Intra-row weeding
- Mechanically: alternative to chemical weeding
- Autonomous: limiting human intervention

Challenges
- Computation in real-time
- High precision needed to differentiate crops and weeds

Positioning vs State-of-the art
To date, for most crops, only inter-row mechanized/autonomous weeding solutions exists

Partners
Bordeaux-INP, CEA and STGNB

Use Case 2.2

Tomato pests and diseases forecast

Description
Pest and disease detection model for the tomato agriculture industry.

Challenges
- Collecting enough and good quality data
- Time-series analysis for forecasting
- Model selection and development for edge devices

Positioning vs State-of-the art
State-of-the-art solutions do not resort to image analysis with ANNs, which produce many false positive events.

Partners
CCTI, Italagro, TPRO-Tech., CEA, STGNB

Transport and Smart Mobility

Use Case 3.1

Drones/USV

Description
Detection, classification and segmentation of high-altitude images using either ANN, SNN or hybrid technology

Challenges
- Real time computation
- High resolution inputs
- Power consumption

Positioning vs State-of-the art
Existing solutions are not compatible with drone constraints

Partners Thales, CEA, STGNB

Use Case 3.2

Underwater Acoustic Signal Classification

Description
The ocean soundscape is a continuously changing mosaic of sounds that originate from various sources. This is of primary interest to recognize in real time the components of the soundscape.

Challenges
- Real time computation
- Low power

Positioning vs State-of-the art
Long-term monitoring
Real time communication with shore

Partners ALSEAMAR, CEA, STGNB, Synsense

Use Case 3.3

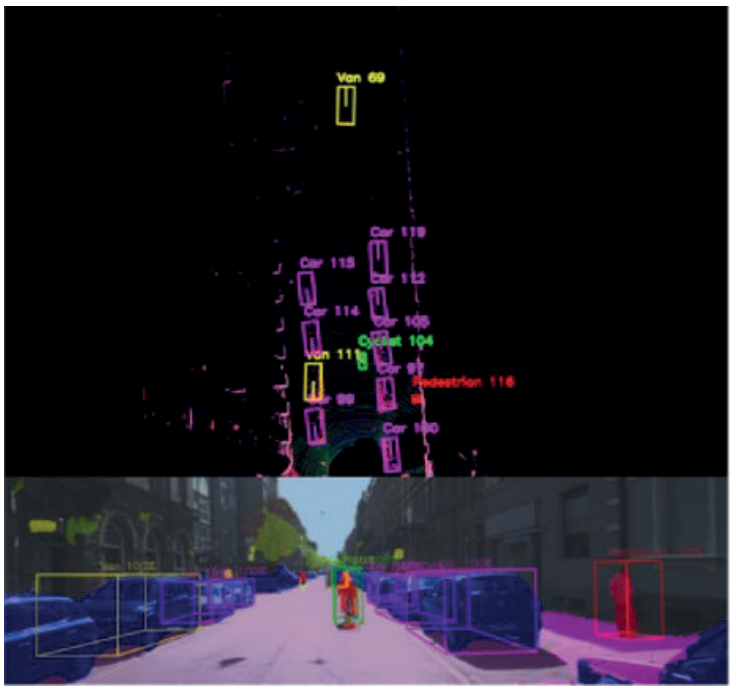
3D Object Detection and Classification of Road Users based on LiDAR and camera

Description
Object detection on lidar point clouds that will be fused with camera semantic image data implemented on ANDANTE Platform

Challenges
- Real time computation with received sensor data (bandwidth bottlenecks)
- Scaling to handle input of multiple sensors

Positioning vs State-of-the art
No fusion of both sensors/sensor data yet done on neuromorphic hardware

Partners
Valeo, CEA, STGNB, UZH



Transport and Smart Mobility

Use Case 3.4

Robust Autonomous Landing

Description
Four critical functionalities are considered:
1. image-based runway relative localization for navigation,
2. image registration for navigation,
3. foreign object detection on runway,
4. robust communications.

Challenges
• Real time computation
• Adaptation of large networks to efficient hardware without sacrificing performance levels
• Learning on the edge

Positioning vs State-of-the art
Many smaller aircraft cannot permit energy cost of large number of conventional AI algorithms in standard hardware, which on the other hand, are necessary to enable autonomous operations.

Partners
BR&T-E, Gradiant, TVES, CARTO

Use Case 3.5

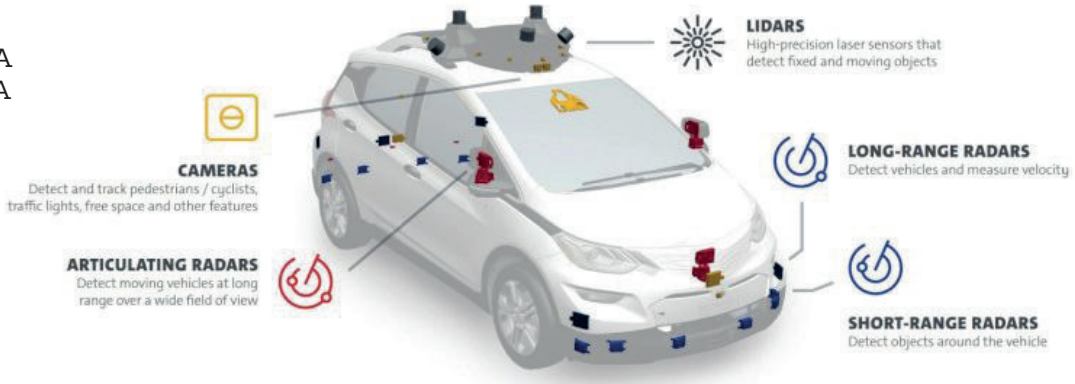
Path Planning for Autonomous steering

Description
Continuously calculate trajectories, based on deltas in world map, avoid intersects, while optimally steering the vehicle, e.g. by solving many diff equations

Challenges
100Hz world map update rates and
<10ms latency → huge comp. loads
Small form-factor (<200x200mm) and power consumption (<2W)

Positioning vs State-of-the art
• Reduce power by 100x over SoA
• Reduce latency by 10x over SoA

Partners
GML, Valeo



Healthcare

Use Case 4.1

Multi-modal image processing and device tracking in medical X-ray & ultrasound images

Description
Navigating a medical device like a Mitral Clip to the right location in the heart is challenging and requires accurate and intuitive image guidance.

Challenges
- Detection accuracy → placement of device
- System latency → eye-hand coordination

Positioning vs State-of-the art
Benchmark the SNN version of the detection algorithm against an implementation in state of the art GPU HW

Partners PMS, and imec-NL

Use Case 4.2

Ultrasound acquisition or processing

Description
Lung ultrasound can detect healthy/unhealthy (Covid-19, Pneumonia) patients. We create a neural network to automatically detect healthy/unhealthy lungs

Challenges
Make NN fit on the two platforms

Positioning vs State-of-the art
Automatic detection
Need low power consumption for mobile ultrasound

Partners PRE, imec-NL and GML

Use Case 4.3

Glucose Monitoring

Description
Apply SNN algorithms to high-frequency sensor data to classify different glucose level in water dilutions.

Challenges
To distinguish standard human body glucose concentrations

Positioning vs State-of-the art
Leverage the faster computation of the SNN to reach accurate results of the glucose level using less time and energy resources

Partners EESY, IFAG

Use Case 5.1

Consumer Auditory Processing

5.1.1: Continuous audio scene classification. The audio environment is monitored continually, to assist in selecting a noise reduction scheme appropriate for the environment.

5.1.2: Audio event detection: Continuous monitoring of audio signals for pre-defined trigger events, such as glass break (for security purposes) or distress call (for health monitoring purposes).

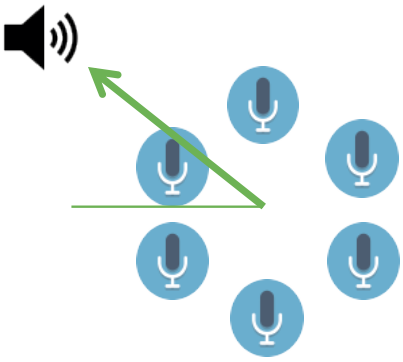
Challenges:

- Continuous real time computation
- Low-latency (for 5.1.2), low-power requirements

5.1.3: Multi-microphone auditory processing: A low-power sensory processing task designed for multiple simultaneous input channels (i.e. a microphone array), to assist in noise reduction in smart home devices.

Challenges:

- Continuous real time computation
- Low-power requirements



5.1.4: Voice Activity Detection: Monitoring of audio scene for detection of voiced speech which acts as a wake up signal for smart devices.

5.1.5: Key-Word-Spotting: Spot words like "Alexa" or "Siri" directly at microphone via tinyML.

Challenges:

- Continuous real time computation
- Low-latency, low-power requirements
- Low false-reject and false-accept rate requirements

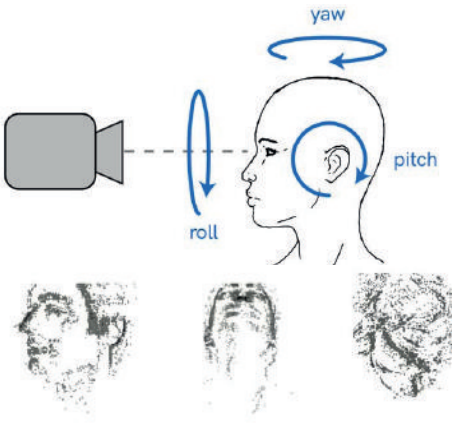
Partners: Synsense, UZH, FhG, IFAG, STGNB

Use Case 5.2

Vision -based human computer interaction application

Description

Glance detection for mobile hand-held devices, to be used as a smart wake-up trigger



Challenges

Low-latency and low-energy requirements
Low false-reject rate requirements

Partners Synsense, UZH, CSEM, STGNB