Expected outcomes

World's first light-field dynamic vision sensor and SDK for monocular-image-based depth perception.

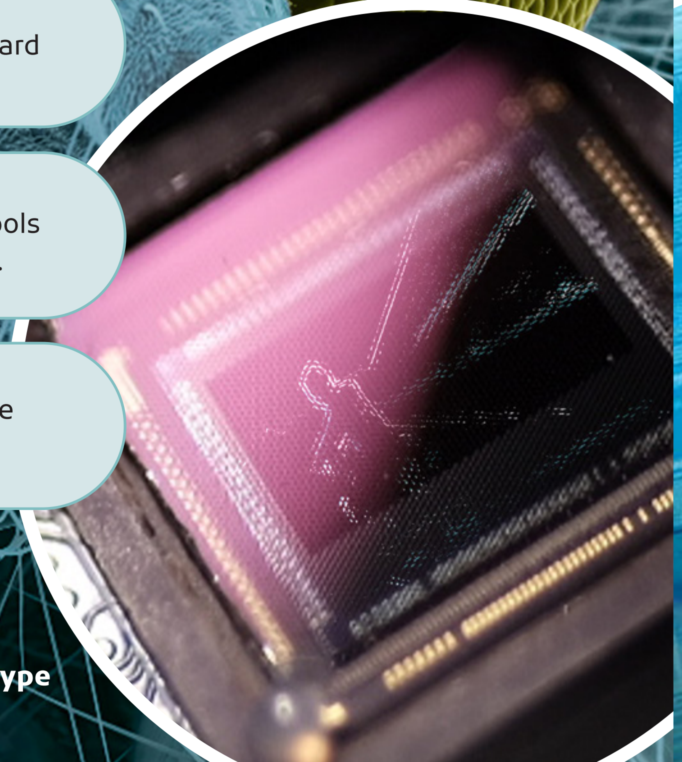
Silicon-proven implementations for use in next-generation commercial neuromorphic chips.

EDA tools to advance 3D silicon integration and exceed the pace of Moore's Law.

World's first event-driven full perception stack that runs industry standard convolutional neural networks.

Prototypic platform and programming tools to test new AI and computer vision algorithms.

Applications that showcase the competitive advantage of NimbleAI technology.



World's first Light-field Dynamic Vision Sensor Prototype

Use cases

- Hand-held **medical imaging device** by ULMA
- **Smart monitors with 3D perception** for highly automated and autonomous cars by AVL
- **Eye-tracking sensors for smart glasses** by Viewpointsystem
- Human attention for **worm-inspired neural networks** by TU Wien

Follow our journey!

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Partners

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nimbleai.eu

nimble AI

Perceiving a **3D world** from a **3D silicon architecture**

100x Energy-efficiency improvement

50x Latency reduction

≈10s mW Energy budget

In NimbleAI, we are designing a 3D integrated sensing-processing neuromorphic chip that mimics the efficient way our eyes and brains capture and process visual information. NimbleAI also advances towards new vision modalities not present in humans, such as insect-inspired light-field vision, for instantaneous 3D perception.

The top layer in the architecture senses light and delivers meaningful visual information to processing and inference engines in the interior layers to achieve efficient end-to-end perception. NimbleAI adopts the biological data economy principle systematically across the chip layers, starting in the light-electrical sensing interface.

Key features of our chip are:

Sense
light and depth

ONLY changing light is sensed, inspired by the retina. Depth perception is inspired by the insect compound eye.

Ignore?
or recognise

Our chip ONLY processes feature-rich and/or critical sensor regions.

Process
efficiently

ONLY significant neuron state changes are propagated and processed by other neurons.

Adaptive
visual pathways

Sensing and processing are adjusted at runtime to operate jointly at the optimal temporal and data resolution.

3D
integrated silicon

Sensing, memory, and processing components are physically fused in a 3D silicon volume to boost the communication bandwidth.

How it works

Event-driven

Sensing

Sensor pixels generate visual events ONLY if/when significant light changes are detected. Pixels can be dynamically grouped and ungrouped to allocate different resolution levels across sensor regions. This mimics the foveation mechanism in eyes, which allows foveated regions to be seen in greater detail than peripheral regions.

The NimbleAI sensing layer enables depth perception in the sub-ms range by capturing directional information of incoming light by means of light-field micro-lenses by Raytrix. This is the world's first light-field DVS sensor, which estimates the origin of light rays by triangulating disparities from neighbour views formed by the micro-lenses. 3D visual scenes are thus encoded in the form of sparse visual event flows.

Event-driven

Early Perception:

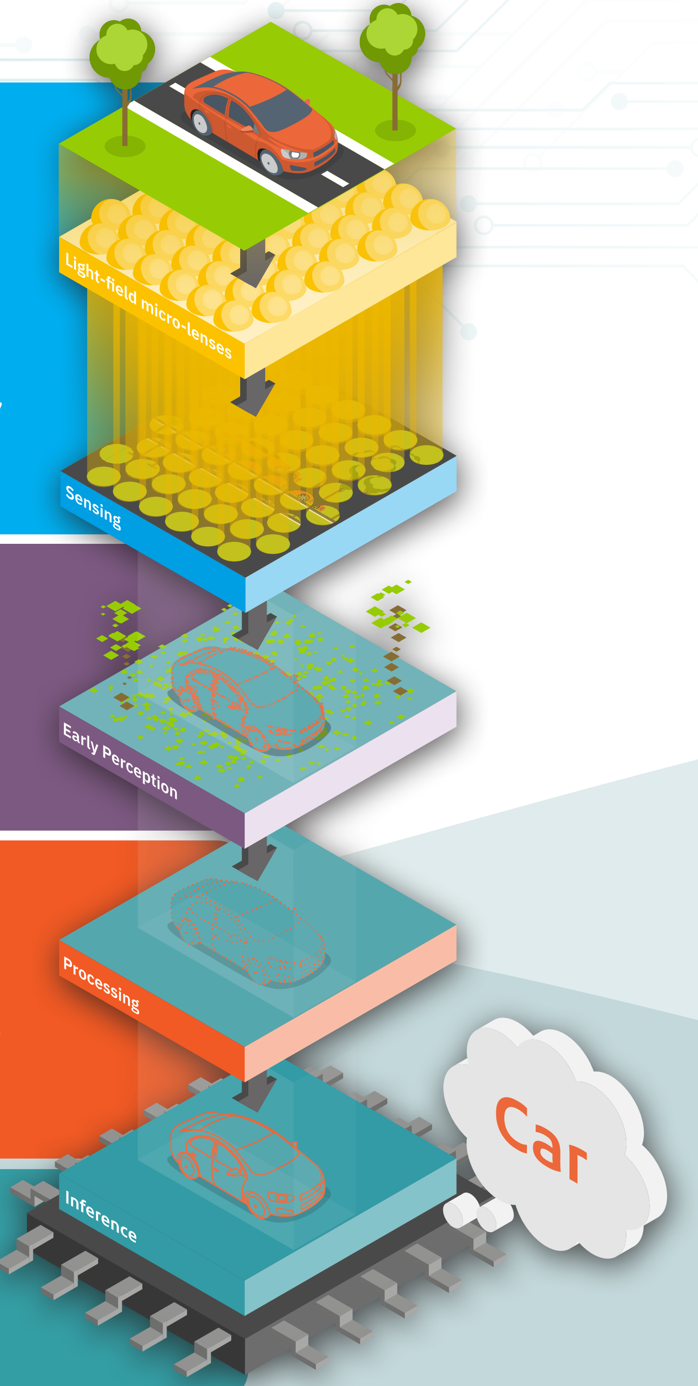
Our always-on early perception engine continuously analyzes the sensed visual events in a spatio-temporal mode to extract the optical flow and identify and select ONLY salient regions of interest (ROIs) for further processing in high-resolution (foveated regions). This engine is powered by Spiking Neural Networks (SNNs), which process incoming visual events and adjust foveation settings in the DVS sensor with ultra-low latency and minimal energy consumption.

Processing:

Format and properties of visual event flows from salient regions are adapted in the processing engine to match data structures of user AI models (e.g., Convolutional Neural Networks - CNNs) and to best exploit optimization mechanisms implemented in the inference engine (e.g., sparsity). Processing kernels are tailored to each salient region properties, including size, shape and movement patterns of objects in those regions. The processing engine uses in-memory computing blocks by CEA and a Menta eFPGA fabric, both tightly coupled to a Codasip RISC-V CPU.

Inference with user AI models:

We are exploring the use of event-driven dataflow architectures that exploit sparsity properties of incoming visual data. For practical use in real-world applications, size-limited CNNs can be run on-chip using the NimbleAI processing engine above, while industry standard AI models can be run in mainstream commercial architectures, including GPUs and NPUs.



Harness the biological advantage in your vision pipelines

NimbleAI will deliver a functional prototype of the 3D integrated sensing-processing neuromorphic chip along with the corresponding programming tools and OS drivers (i.e., Linux/ROS) to enable users run their AI models on it. The prototype will be flexible to accommodate user RTL IP in a Xilinx MPSoC and combines commercial neuromorphic and AI chips (e.g., HAILO, BrainChip, Prophesee) and NimbleAI 2D testchips (e.g., foveated DVS sensor and SNN engine).

Raytrix is advancing its light-field SDK to support event-based inputs, making it easy for researchers and early adopters to seamlessly integrate nimbleAI's groundbreaking vision modality – 3D perception DVS – and evolve this technology with their projects, prior to deployment on the NimbleAI functional prototype. The NimbleAI light-field SDK by Raytrix will be compatible with Prophesee's Metavision DVS SDK.

Reach out to test combined use of your vision pipelines and NimbleAI technology.