Low-Cost Intelligent Vision Systems for Smart Lighting Applications

Engin Türetken

Swissphotonics, Dübendorf

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'Truly' Smart Lighting

Adaptive	⟷	Fixed-response
Self-decision-making	⟷	Centralized decisions
Built-in intelligence	⟷	Intelligence on the cloud
Autonomous	⟷	Dependent
Data-driven	⟷	Human model-based

Cost

Reliability

Autonomy

Flexibility

Vision Approach

The Vision-in-Package (VIP) Prototyping Platform

- Miniature complete vision system

- Off-the-shelf components

- Small form factor (16 x 16 x 8 mm)

- Real-Time OS tailored for vision applications

- ARM Cortex M series processors

- Low-power consumption

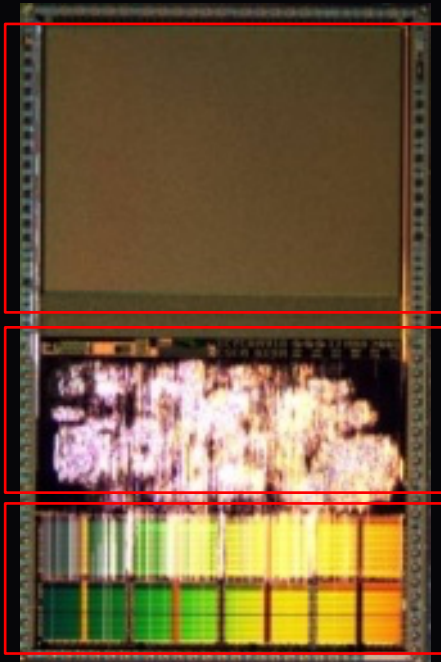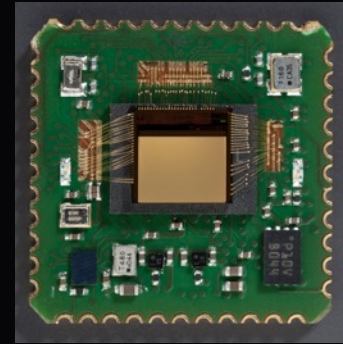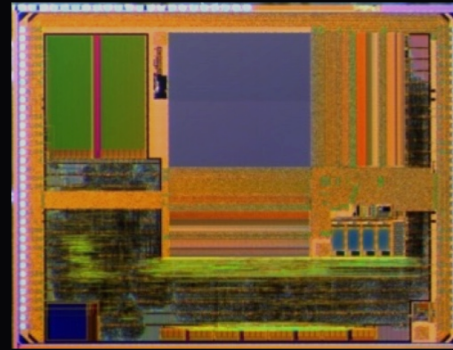- Extensions: GPIO, I2C, SPI, analog etc.

- Bluetooth, micro-SD card, IMU …

The Vision-in-Package (VIP) Prototyping Platform
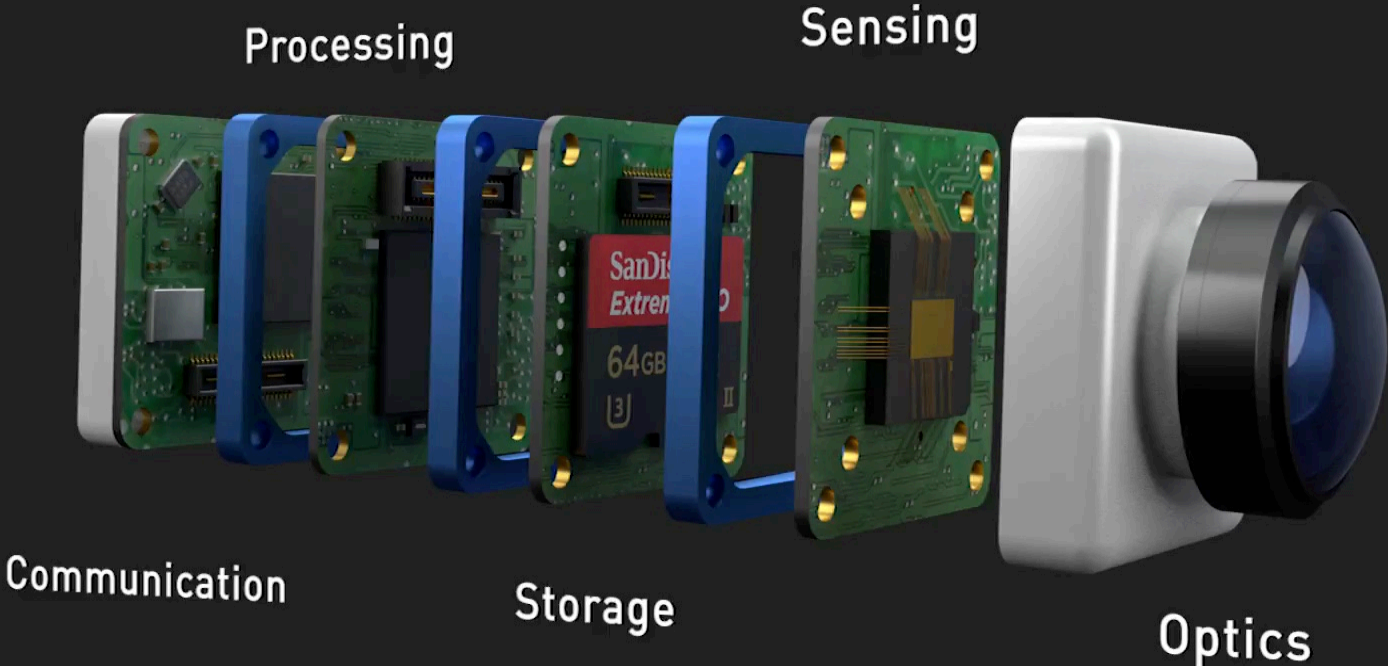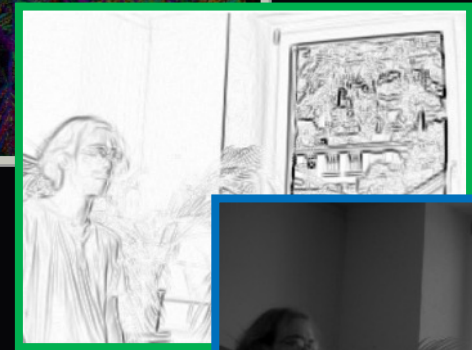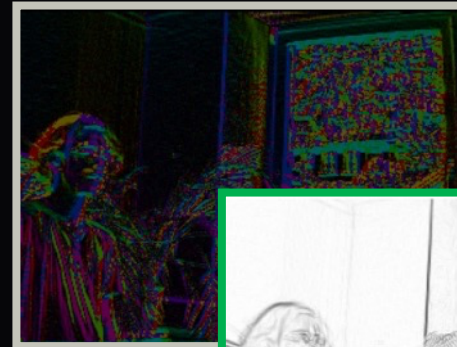
Industrial Custom ASICs

- **Combined visual sensing and AI in a single package**

- **Reduced costs**

- **Improved speed, power efficiency**

Digital HDR imager
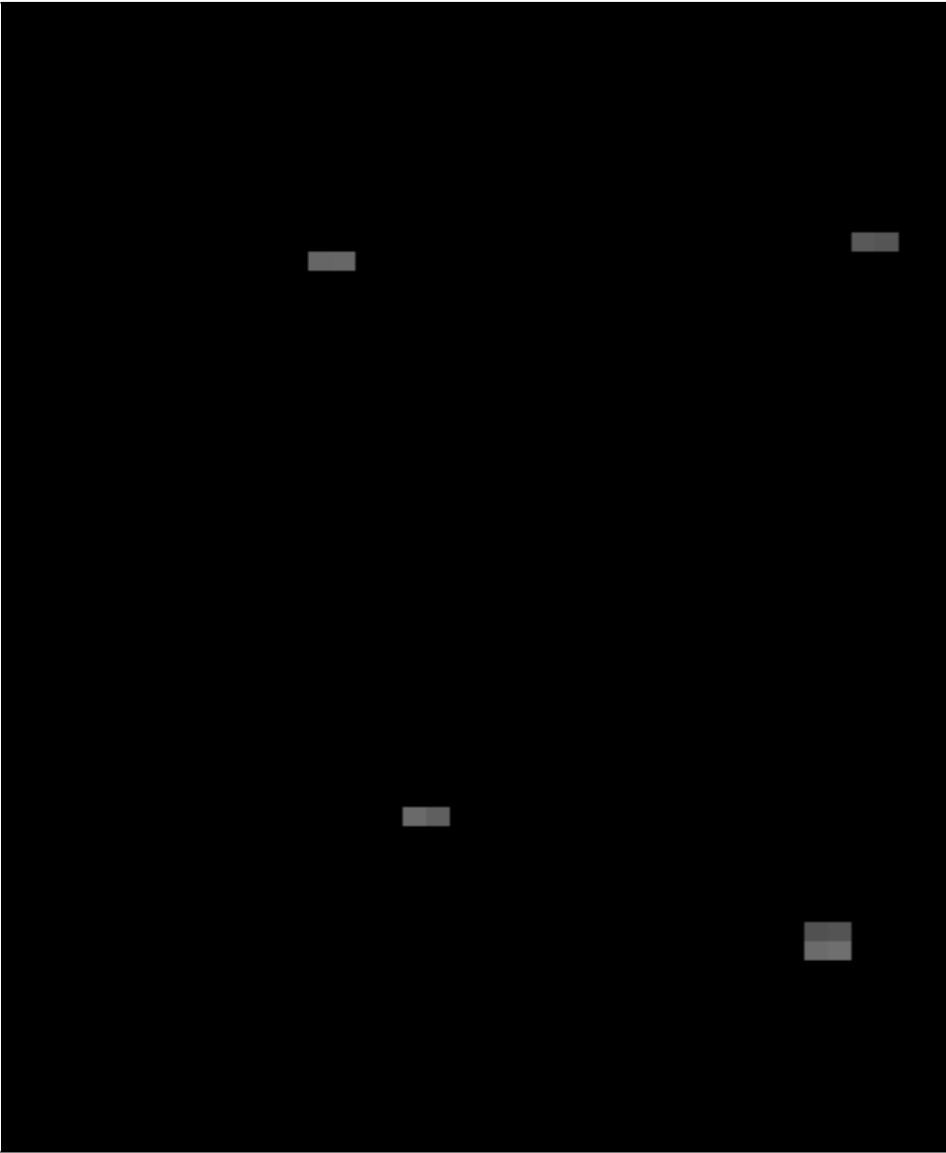
DSP neural-net system

Memory blocks

Person Detection

- **Challenging problem and prerequisite for counting, tracking, occupancy analysis ...**

- **Adapting lighting for effective utilization of the environment: health, productivity, energy ...**

- **Applications extend far beyond: heating, space optim., security ...**
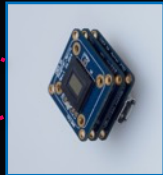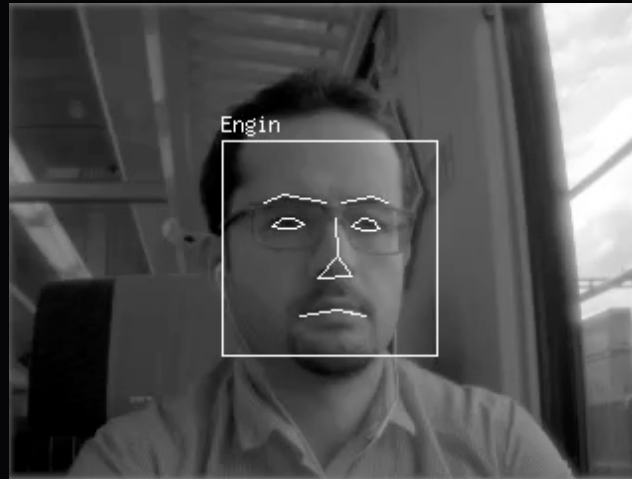

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Person Detection

Person Identification

- Smallest facial recognition system

- Low-power consumption

- Real-time performance

- Tiny memory footprint

- Instant registration of faces

- Stand-alone software

Answer: Roger Federer

| VIP | Face Detection | Facial Landmark Localization | Normalization | Recognition |

Attention Analysis

- People detection and identification answer where and who.

- Knowing the direction of attention help decide where the light should fall (direction) and at what strength.

- Eye-gaze tracking can allow this fine-grained control.

- Directional optimization of lighting can reduce eye fatigue and improve psychology.
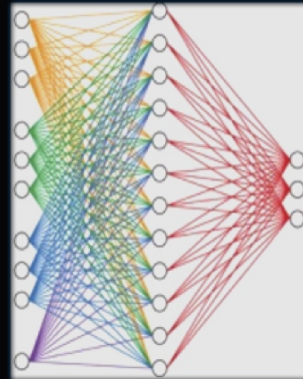
Assessment of Alertness

- Facial analysis can be used to assess the level of alertness.

- Examples can be drawn from the automotive industry (i.e., estimation of drowsiness and fatigue).

- In smart lighting, the technology can be used to create a favorable environment depending on user preferences and time.
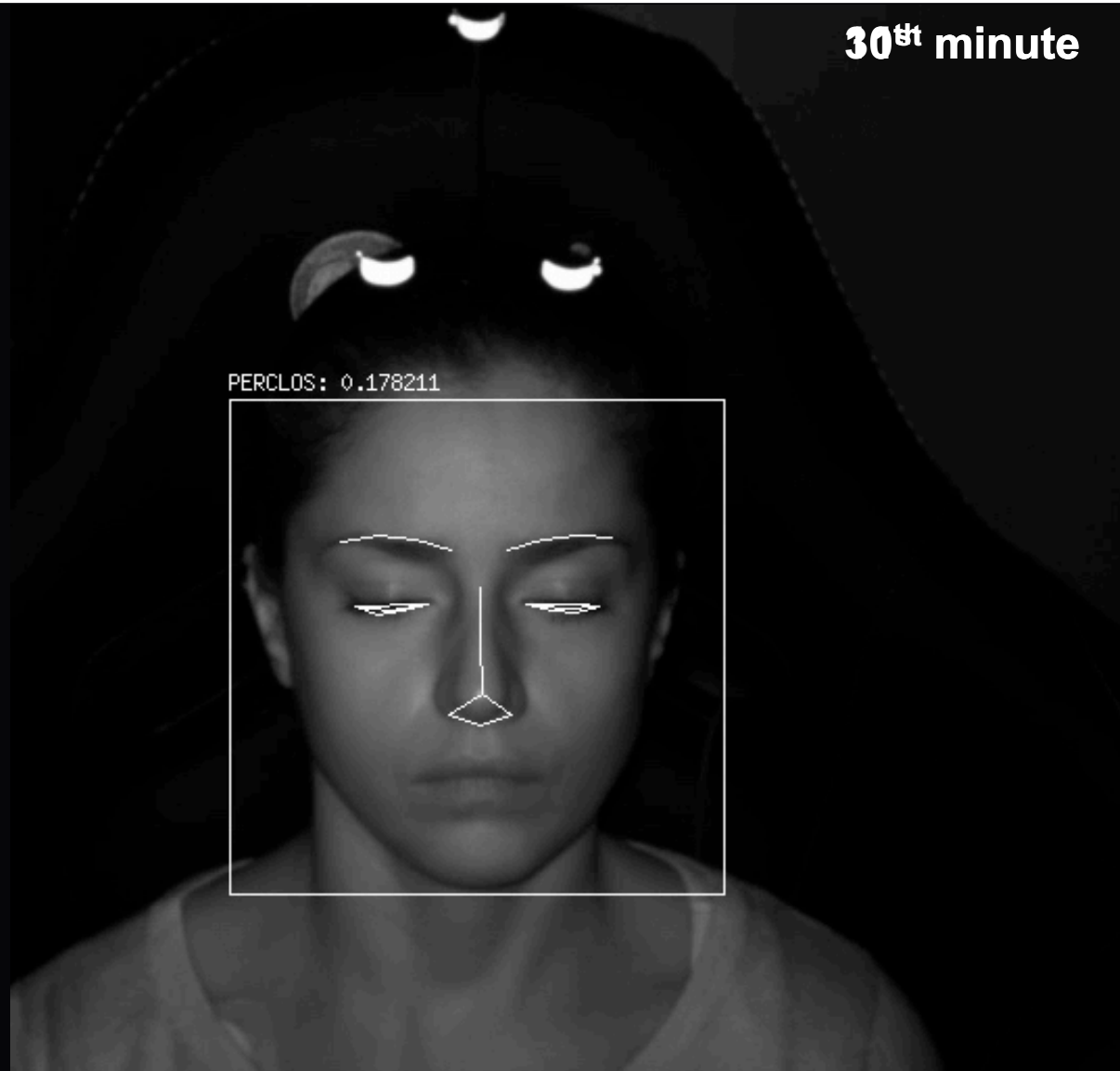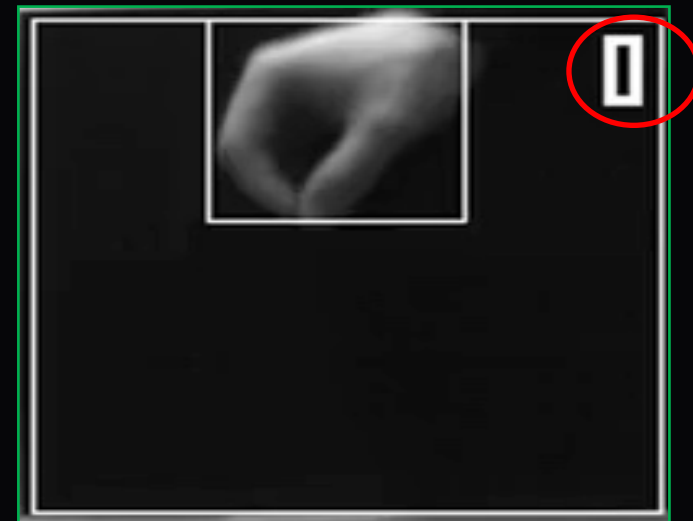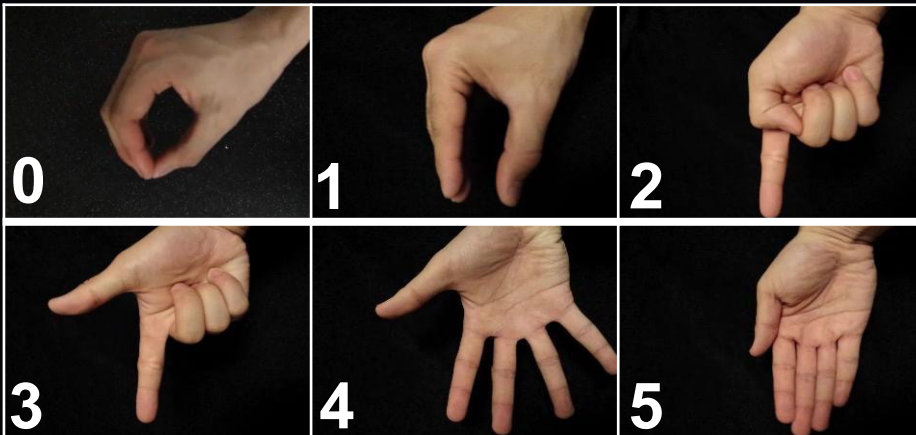
Human Interaction

VIP

Classifier

Training Data with Gesture Labels

0 1 2

3 4 5

The dataset is taken from the work of Song et al., "In-air Gestures Around Unmodified Mobile Devices", 2014.

Detection: hand / not hand

Recognition: Gesture id

Vision-Based Human-Centric Smart Lighting

Detect

Identify

Martha

Analyse

Interact