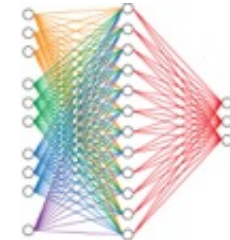
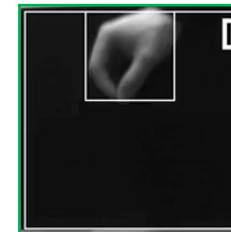
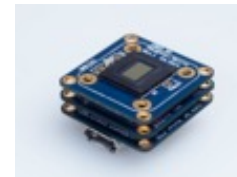


Vision & Industry 4.0: Towards smarter sensors

Dr. Amina Chebira

Vision Embedded Systems, CSEM SA

October 4th, 2016





- Perception and vision
- Smarter sensors
 - Recognition applications
 - More miniaturization, more low power ... and more and more **machine learning**
 - Metrology applications
 - Deep integration: the chips can measure ... but **they can also make decisions**

Perception and vision

Why vision ?

- Generic solution: **1 image = many possible interpretations** (defined by the context)
 - Quality control/ Objects detection and **classification**
 - Understand an unknown environment
 - **Metrology**
- Approach: A robust extraction of **essential features for real-time, low-cost systems**
- Today, costs and performances of vision systems open up new possibilities in many industrial fields



Nature found solutions before engineers ...

From biology ...

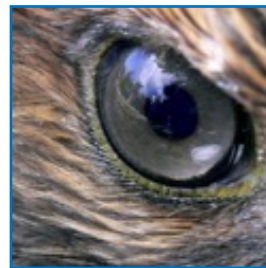
- Vision systems perfectly **adapted to the environment** and to the **“tasks”**
- Optimal combination of **feature extraction** and **neuro-computing**



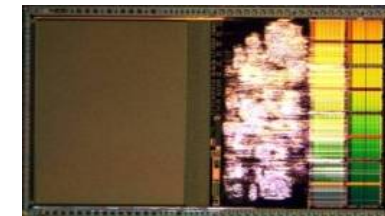
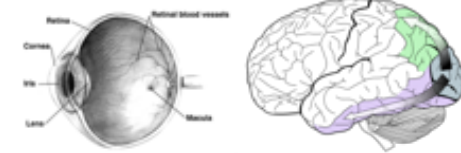
Musca domestica



Jumping spider



Hawk



SoC (System on Chip)

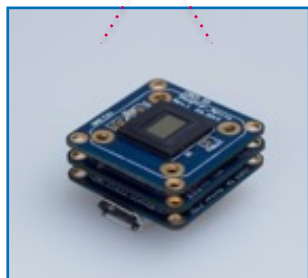
... to processing

- **Dedicated processors** for **computing**
- Neural networks for **feature extraction**

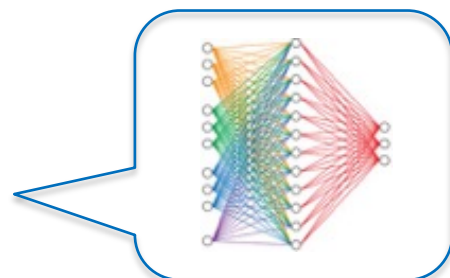
“Biology is too important to leave it to biologists”

Max Delbrück

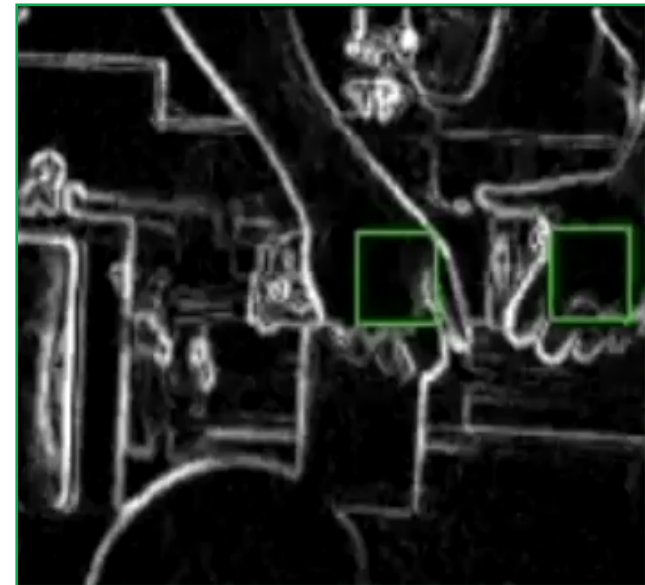
Hand detection for security



Vision In Package



Classifier



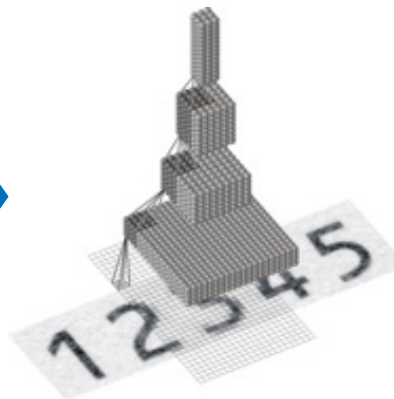
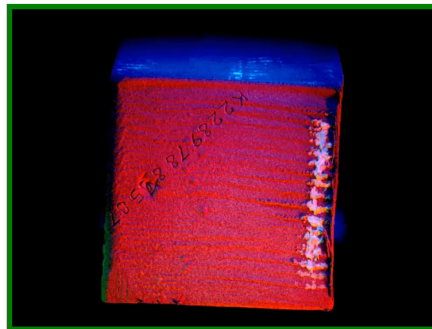
Answer: "hand, or no hand"

Product identification in machine-to-machine systems



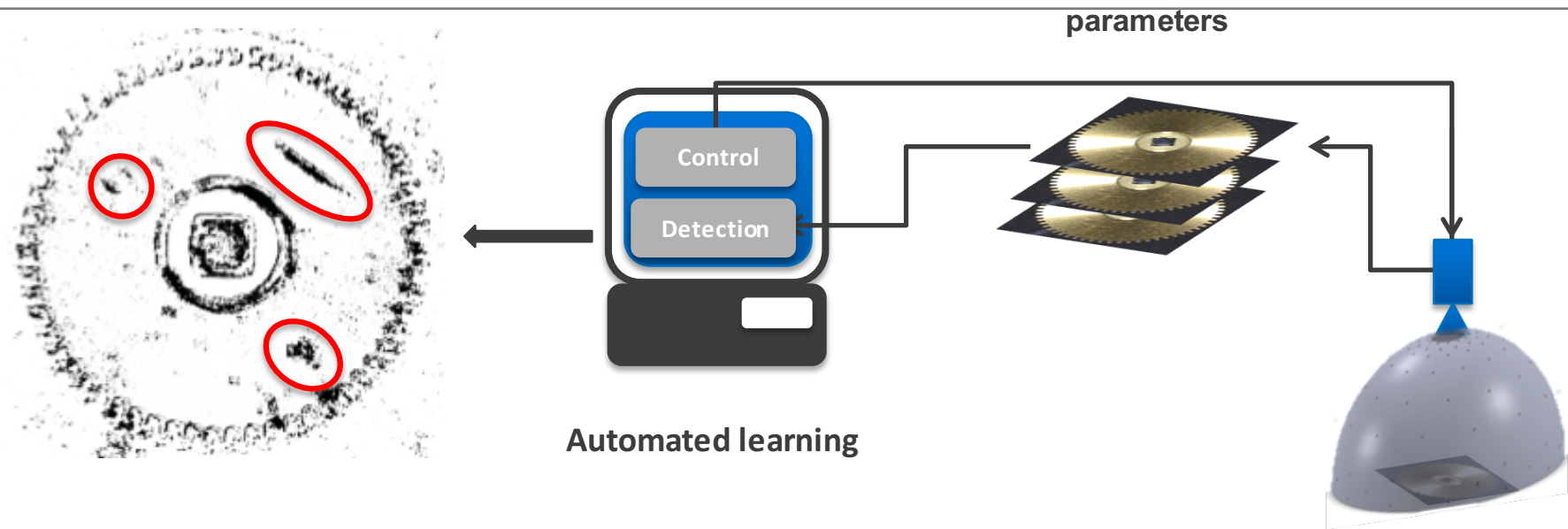
OCR in extreme conditions

- How can we achieve 99.99% of recognition?
- Embossing extraction (3D) with a convolutional neural network



Product ID Number

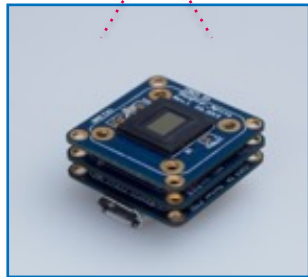
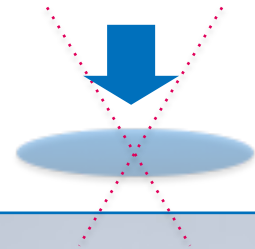
Identification & classification for quality control



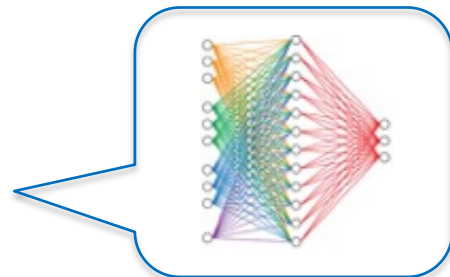
NN defect identification & localization

- Acquisition system **tailored to the product**
- **Detection & localization of defects (classes) in real time**
- Classes recognition & statistical analysis (size, ...)
- **Suitable for quality control in production or in lab**

Face recognition & landmark localization

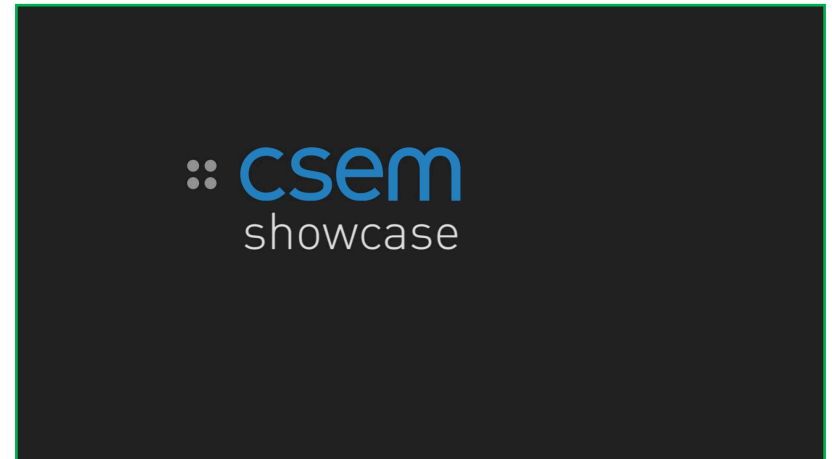


Vision In Package



Classifier

- Access control
- Machine personalization
- Environment & energy management

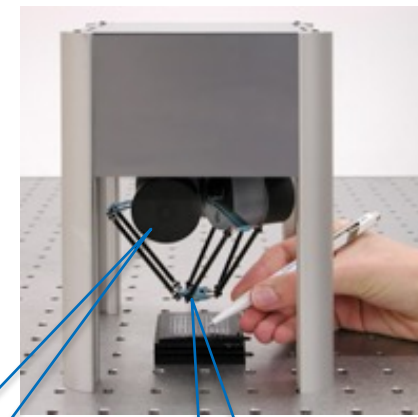
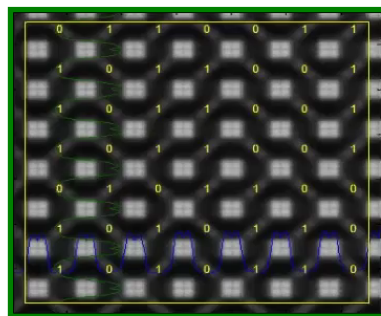


- More than 1'000'000 training images (offline)

Metrology: Extract positions from images

The spaceCoder technology is based on shadow imaging

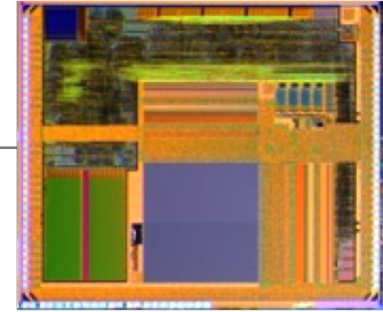
- A light source projects the shadow of a well-designed pattern onto a vision sensor
- The processing of the shadow image assesses the 3D position of the light source



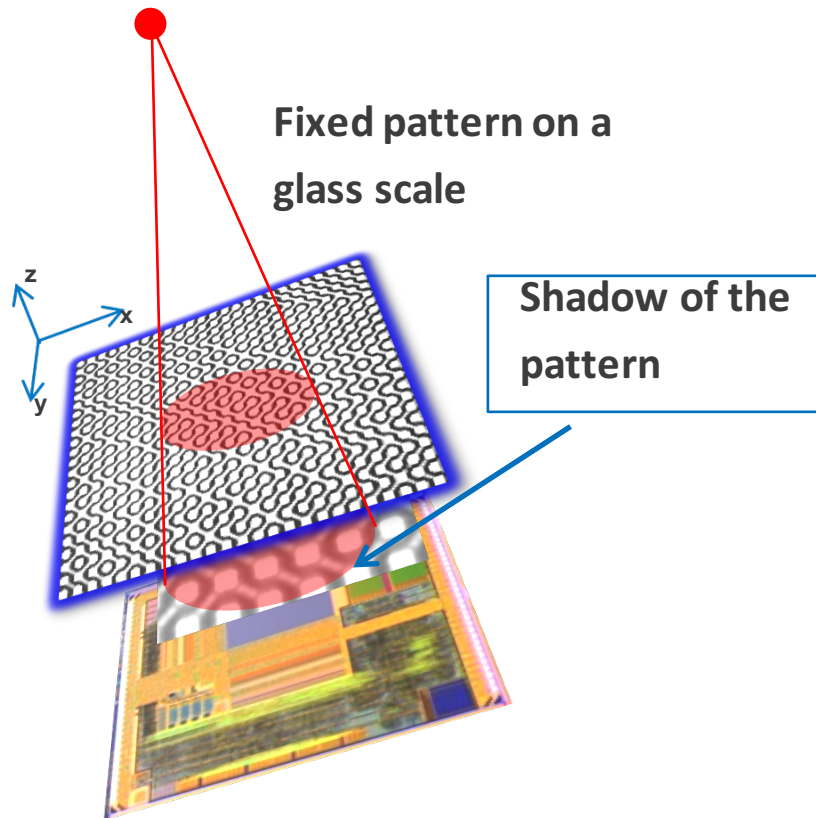
Absolute
Nanometric
Encoders

Force
Position
Probes

Absolute 1 to 6 DOF measurement



Moving light source $p = f(x, y, z, \alpha_x, \beta_y, \gamma_z)$



spaceCoder ASIC

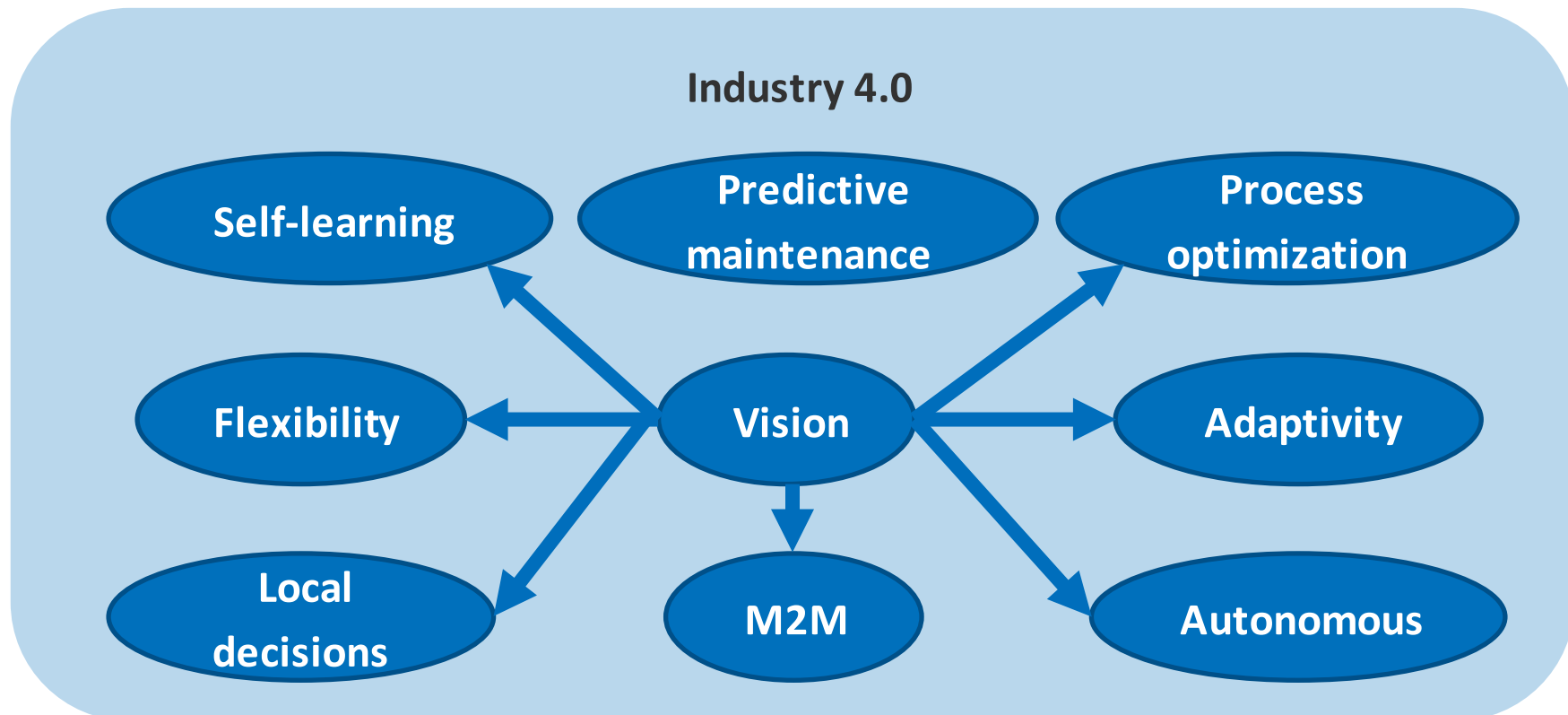
Main benefits

- **Absolute position** of the light source
- Small volume (size of a **sugar cube**)
- **Multi-axes** $x, y, z, \alpha_x, \beta_y, \gamma_z$ 6 degrees of freedom measurements
- Precision down to **5 nm** (x, y)
and 100 nm (z)
- Sampling rate up to **200 KHz** (for 2D)



Vision systems: Ubiquitous in robotics and automation

- ... it will give **more and more freedom** to the machines
- ... it will allow **more complex decisional tasks**
- ... it will open the **interactions in unknown environments**



Thank you for your attention

<http://csem.ch/vision>

