

# NEUROMEM SMART SENSORS FOR INDUSTRY 4.0

***Trainable miniature sensors to control the quality of production and monitor the good health of production equipment***



### KEY FEATURES OF A NEUROMEM NETWORK FOR INDUSTRY 4.0

- Can learn numerous models of simple features with no penalty in speed performance
  - o NeuroMem neurons are especially good at
    - Modeling textures (for material and food inspection)
    - Verifying alignment of parts
    - Matching templates (printed materials, patterned objects)
- Can learn new examples at any time and immediately
  - To process new products
  - To adapt to new components and materials making a product
  - Production data including confidential examples of defects to recognize remain on site
- Can detect drifts and novelties
  - For predictive maintenance
  - RBF is a powerful enabler here!
- Can detect defects and anomalies
  - For quality control
  - The later can then be logged for post verification and possibly learned as a new acceptable model
  - RBF is a powerful enabler here!
- Multiple NeuroMem networks can be trained on different sensors and/or feature extractions to produce a robust decision aggregating the response of these networks (aka multiple experts)
- Small footprint and low power

## INDUSTRIAL CREDENTIALS

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### FISH INSPECTION

[https://www.general-vision.com/applications/fish\\_inspection/](https://www.general-vision.com/applications/fish_inspection/)

- Triggered inspection
- Trained by the fishermen on the boat with simple push button interface
- Output categories (Accept, Reject, Recycle) aggregate multiple attributes of the fish such correct species, acceptable size, no scratches nor wounds, acceptable positioning on the conveyer to enter the fileting machine
- Simple Feature extraction = pixel subsampling at known location
- Resulting knowledge of  $\approx 200$  models in average (200 committed neurons)
- 98% accuracy, 6 fishes per second

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### GLASS SURFACE INSPECTION

[https://www.general-vision.com/datasheet/DS\\_DDS.pdf](https://www.general-vision.com/datasheet/DS_DDS.pdf)

- In line inspection combining 36 cameras with 1 CM1K per camera (1024 neurons)
- Trained by a supervisor on the factory floor (training was done using images of 1 camera at the center of the float and the 2 edges cameras)
- Training UI was very simple: acknowledge that the entire field of view shows no defect. Automatic suggestion by the program of drifts from what is good quality, so supervisor can acknowledge or deny. Same knowledge was copied from the central camera to all the others except the 2 edges cameras trained to include classification of the edge of the glass sheet
- No feature extraction = neurons learn a 16x16 pixel values
- Resulting knowledge of  $\approx 900$  models (900 committed neurons)
- Detection of 0.1 mm<sup>2</sup> minimum defect with 86% accuracy
- Inspection at 70 msec / camera, with all camera running the same inspection in parallel.

## OTHER EXAMPLES

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### FILLING LEVEL MONITORING FOR FOAMY LIQUID

[https://www.general-vision.com/appnotes/AN\\_BottleInspection.pdf](https://www.general-vision.com/appnotes/AN_BottleInspection.pdf)

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### SURFACE INSPECTION

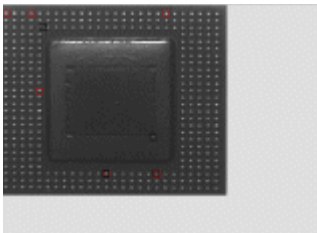
[https://www.general-vision.com/appnotes/AN\\_SurfaceInspection.pdf](https://www.general-vision.com/appnotes/AN_SurfaceInspection.pdf)

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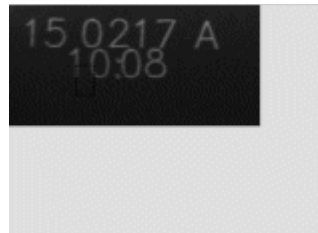
### OTHER

The following examples are delivered with the General Vision Image Knowledge Builder in the form of images, suggested annotations to start the teaching of the neurons and suggested settings such as feature extraction.

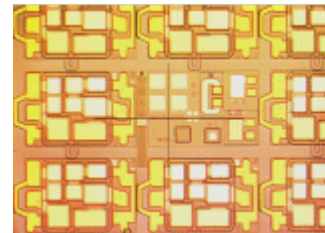
BGA inspection



Inkjet character Inspection



Wafer inspection



The NeuroMem neurons are also be used to learn and monitor signals, sounds, vibrations, temperatures, and more, whether combined or separately.