Face Recognition

- ▸ Using a NeuroMem trainable neural network and
- ▸ Image Knowledge Builder software for training and validation

Which face recognition?

- **Possible objectives**
  - Tracking faces in images and video
    - https://youtu.be/5khZepM5e20
  - Identifying an individual (cooperative or not)
    - https://youtu.be/-3PrRaHCoeU
  - Analyzing facial expressions
    - https://youtu.be/6ursWKumuQ0
- **Possible variability**
  - Size, position
  - Viewing angle
  - Illumination conditions

Face Detection Trial

Using the Simplest Feature: pixel sampling

Simple trial

1. Annotate the face of all 11 players
2. Extract subsample of their face (normalized, monochrome, resulting in a vector of 256 length)
3. Broadcast to the neurons

| NeuronID	Context	Model	Category	Active IF
0	1		1	2577
1	1		1	2714
2	1		1	3296
3	1		1	3356
4	1		1	2964
5	1		1	2931
6	1		1	3370

The faces of 6 players are sufficient to model the decision space. This knowledge also works satisfactorily on new players

See on next page

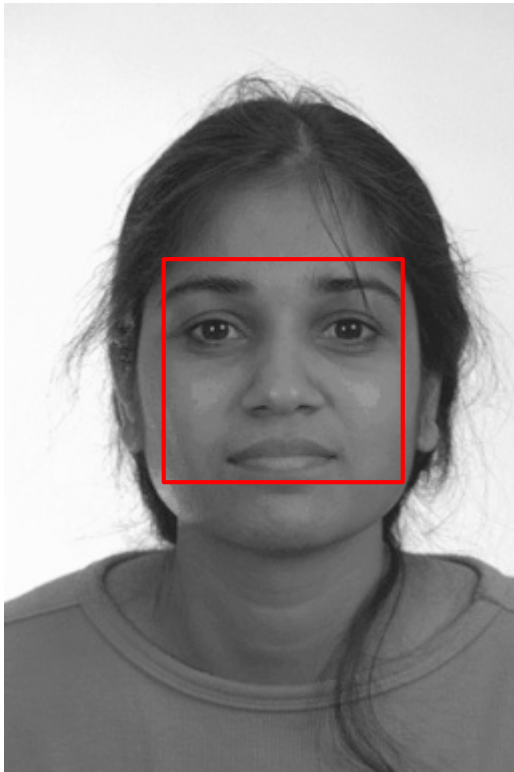Similar scale, BUT different lighting and complexions

Testing at different scales, the knowledge also works on samples from the Ferret DB and images collected from a webcam . No false positive!
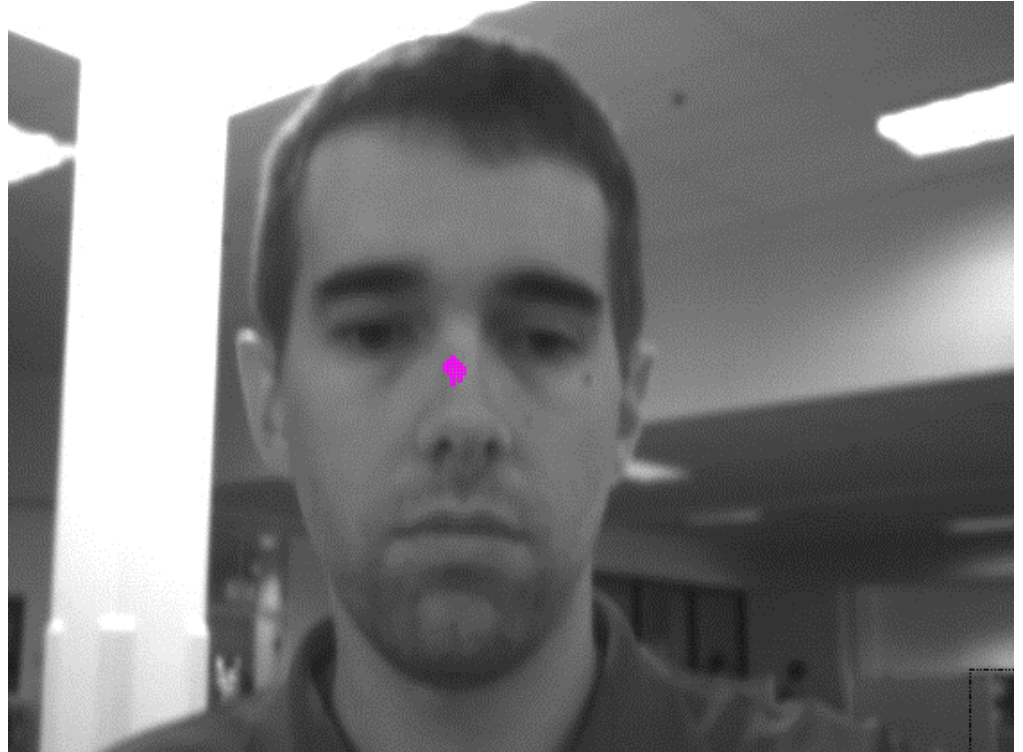
Learning with iconic approach
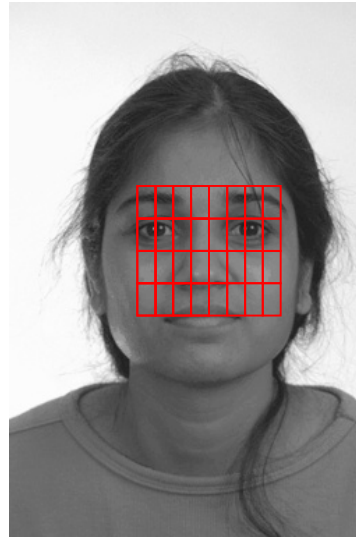
**Good Example
(limited to discriminant area)**

**Bad example
 (includes background)**

(c) General Vision Inc.

Subsampling ➜ ratio invariant

Same vector is obtained if the number of blocks inside the ROI remains constant.

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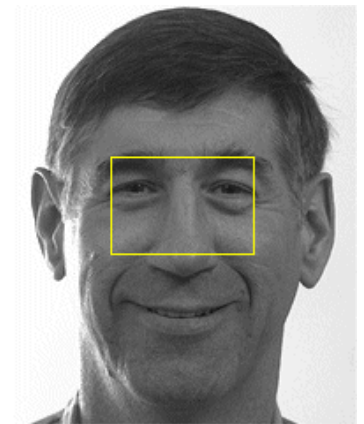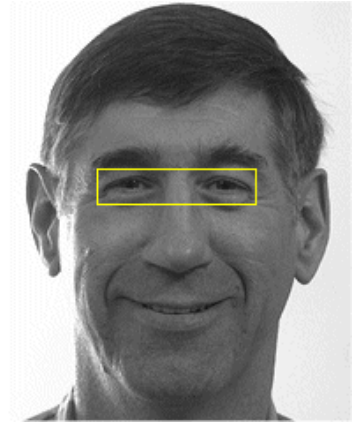# Subsample…scale invariance

Zoom 1

use a feature invariant to scale…

Feature extraction

Same vector is obtained for
Zoom 1 and Zoom 4 if
- Region Width / Block Width = constant
- Region Height/ Block Height = constant

Zoom 4

(c) General Vision Inc.
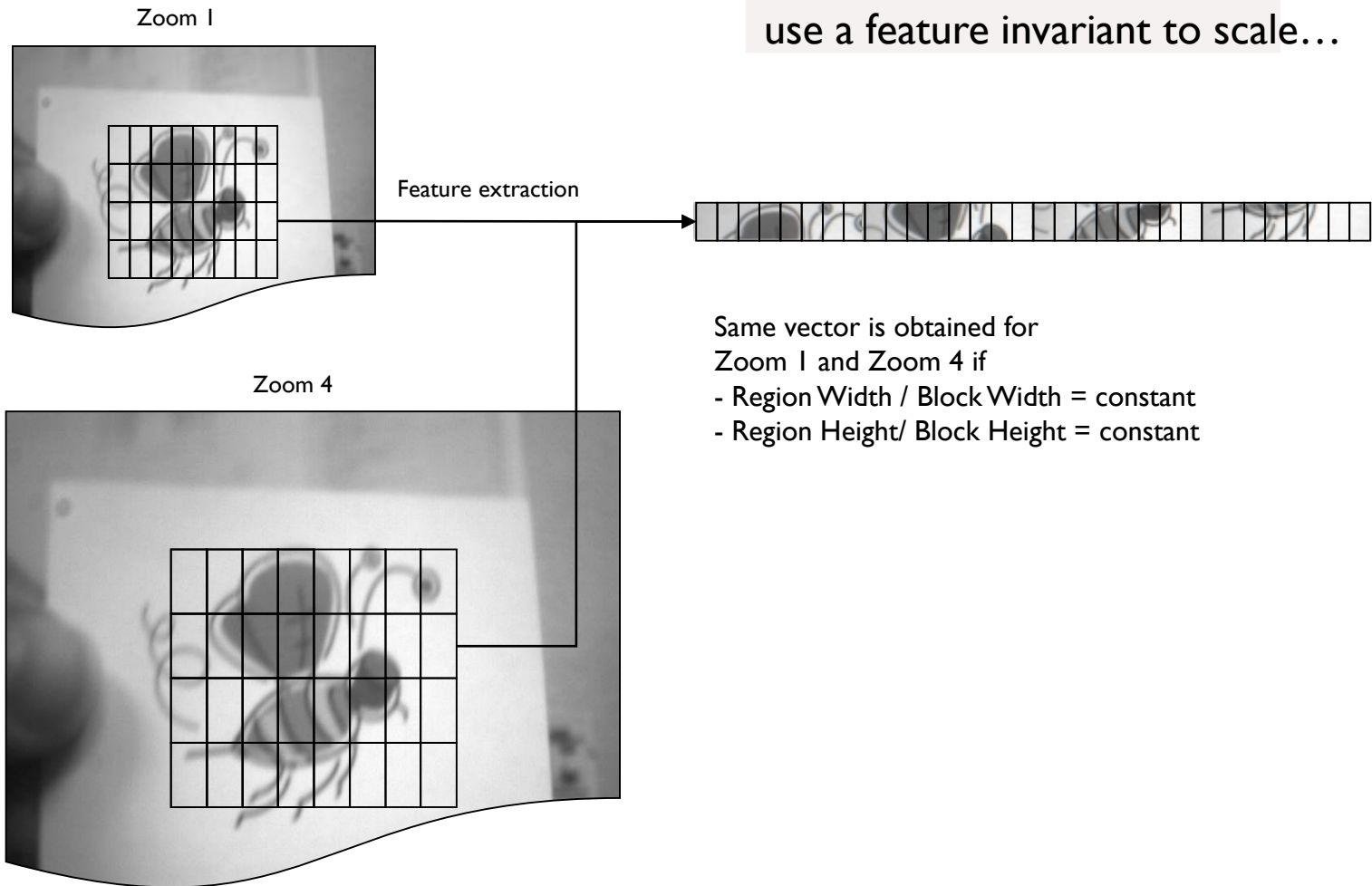
For more robustess
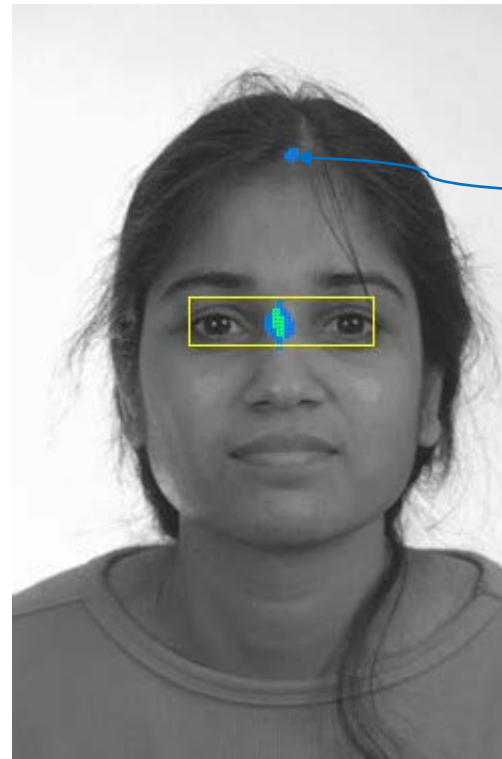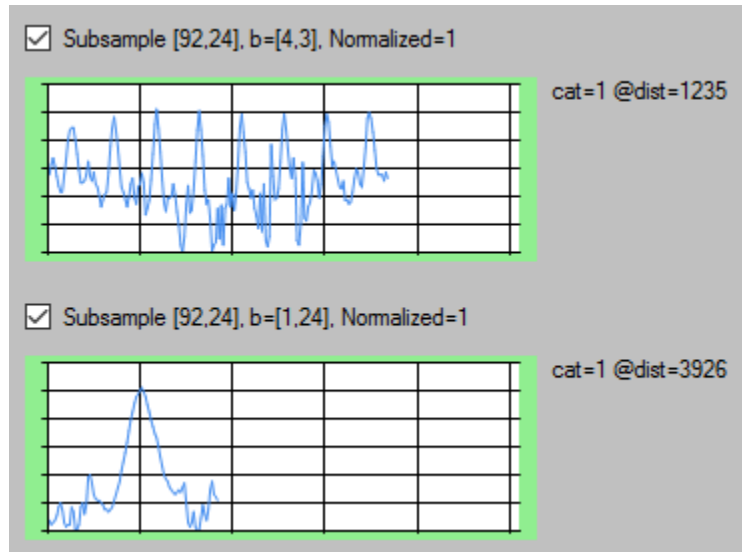
▸ Subsample multiple regions per face to generate redundancy

▸ Automatic multi-scaling

▸ Extend to a multiple keypoints approach

  ▸ Learn and identify eyes, nose, mouth, profile

  ▸ Verify their spatial relationship for positive recognition

Example #1

2 features to train 2 sub-networks ➜

Subsample [92,24], b=[4,3], Normalized=1
cat=1 @dist=1235

Subsample [92,24], b=[1,24], Normalized=1
cat=1 @dist=3926

Blue= any location recognized by either sub-networks

Green= location recognized by the 2 sub-networks at the minimum → No false hit

(c) General Vision Inc.

Anurag Person Identification trial with NeuroMem

Defense Research & Development Organization, India

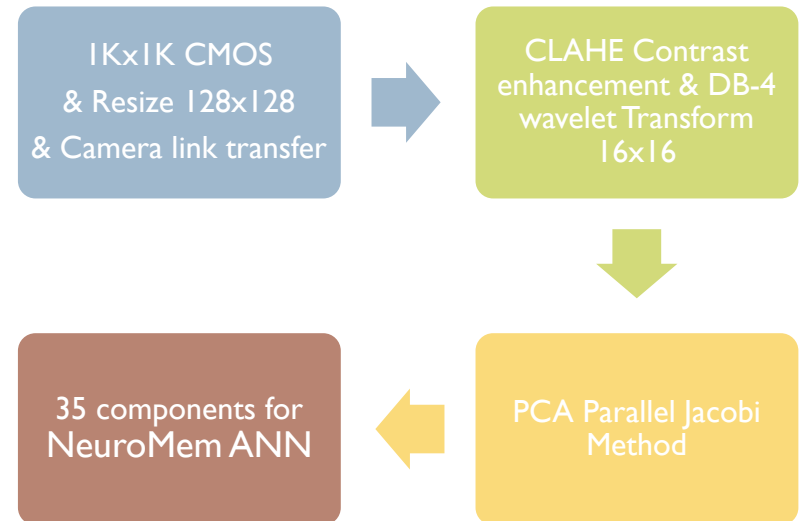Santu Sardar & K. Ananda Babu Scientist

2011: Software simulation
IEEE paper "Face Recognition using the NeuroMem neural network"
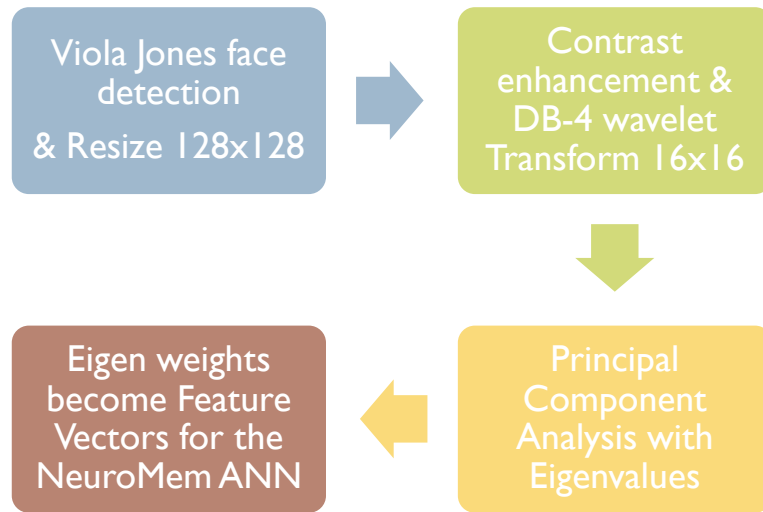
2014: Hardware development
IEEE paper "Hardware Implementation of Real-Time, High Performance, RCE-NN based Face Recognition System"

Viola Jones face detection & Resize 128x128

→

Contrast enhancement & DB-4 wavelet Transform 16x16

↓

Eigen weights become Feature Vectors for the NeuroMem ANN

←

Principal Component Analysis with Eigenvalues

> 98% accuracy

1Kx1K CMOS & Resize 128x128 & Camera link transfer

→

CLAHE Contrast enhancement & DB-4 wavelet Transform 16x16

↓

35 components for NeuroMem ANN

←

PCA Parallel Jacobi Method

18 ms per image

verified with multiple standard databases