ZERO-CROSSING BASED IMAGE PROJECTIONS ENCODING FOR EYE LOCALIZATION

Laura Florea, Corneliu Florea, Ruxandra Vrânceanu, Constantin Vertan

Politehnica University of Bucharest
Image Processing and Analysis Laboratory

A new feature extraction / classification framework for accurate description of the eye area.

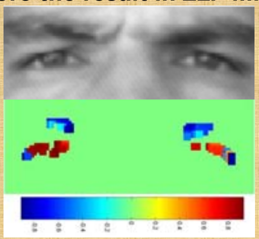
Features = Zero-crossing based Encoded image Projections (ZEP)
Classification = Multi Layer Perceptron

Advantages: fast + easy to compute + independent to scale and illumination variation.

Algorithm

Pre-processing:
- Apply Face Detector
- Scale face at 300x300
- Geometrically cut the possible left eye area and right eye area
- For speed consider only darker points

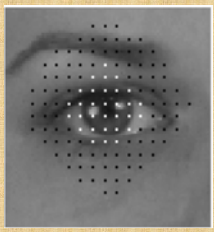
Main:
For all possible 71x71 eye patches:
- Calculate ZEP (max. 5 epoch => 60 elements)
- Test with trained MLP
- Store the result in ZEP image



Post-processing:
- Threshold ZEP image keeping results greater then 0.6*maximum as possible eye patches
- Find the geometrical center of the resulting thresholded image

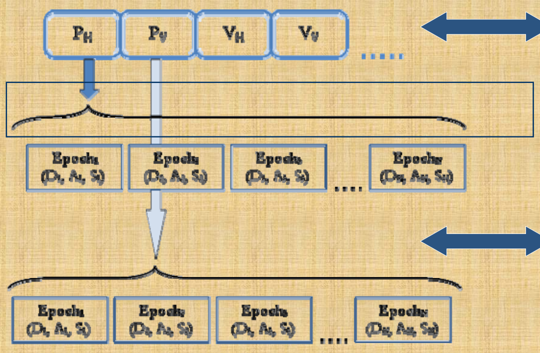
Training

- Positive examples = 10000 patches centered near the eye
- Negative examples 10000 patches centered further away from the eye (patch = 71x71 pixels)
- Calculate ZEP for each one
- Train MLP (2 layered feed–forward perceptron)



Localization of the center of the patches used as positive examples (white) and negative examples (black).

ZEP = compute/normalize projections + TESPAR encode each projection



Integral Projections (P_H, P_V)

$$P_H(j) = \frac{1}{i_2 - i_1} \sum_{i=i_1}^{i_2} F(i,j), \forall j = \overline{j_1, j_2}$$

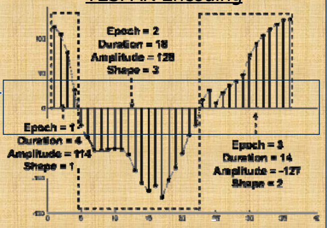
$$P_V(i) = \frac{1}{j_2 - j_1} \sum_{j=j_1}^{j_2} F(i,j), \forall i = \overline{i_1, i_2}$$

Variance Projections (V_H, V_V)

$$V_H(j) = \frac{1}{i_2 - i_1} \sum_{i=i_1}^{i_2} (F(i,j) - P_H(j))^2, \forall j = \overline{j_1, j_2}$$

$$V_V(i) = \frac{1}{j_2 - j_1} \sum_{j=j_1}^{j_2} (F(i,j) - P_V(i))^2, \forall i = \overline{i_1, i_2}$$

TESPAR Encoding



Results

Measure: $\varepsilon = \frac{\max\{\varepsilon_L, \varepsilon_R\}}{D_{eye}} < T$

ε_L, ε_R = errors between the true and the detected eye

D_{eye} = inter-ocular true distance

Public Database	T=0.1	T=0.25
Cohn Kanade	92.51%	98.97%
BioID	88.97%	98.48%
Speed less than 25 msec/frame for faces of 300x300px on an Intel i7		

Good (top) and bad (bottom) examples from Cohn Kanade database: ground truth (red) vs. detected eye (green)

Good (top) and bad (bottom) examples from BioID database: ground truth (red) vs. detected eye (green)

Conclusions

We have shown that TESPAR encoded image projections (named ZEP) are fast and efficient feature detectors. We have studied the achievable performance in the context of eye localization and tested on public and widely used databases.

Acknowledgments The work has been co-funded by the Sectoral Operational Programme Human Resources Development 2007-2013 of the Romanian Ministry of Labor, Family and Social Protection through the Financial Agreement POSDRU/89/1.5/S/62557 and POSDRU/89/1.5/S/76903.