



# **A Probabilistic Approach to Semantic Face Retrieval**



## A Quick Recap

- **A Enrollment Sub-System.**
  - Lip localization
  - Eye localization
  - Detection of other Features
- **A Query Sub-System.**
  - Bayesian Inference
- **A Prompting sub-system.**
  - Entropy



## Restrictions of the Method

- **Restricted to color databases.**
- **Enrollment system results depend on lip and eye detection and most errors occur here.**
- **Obtaining probability of features based on semantic description.**



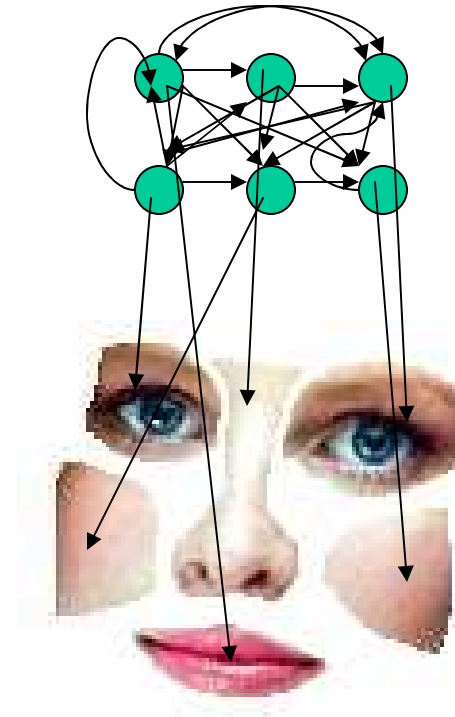
## **Improving the Enrollment Sub-system**

- **Detecting a feature must not solely depend on localizing another.**
- **Yet localizing one feature must aid in detecting others.**

**Convert from heuristic method to probabilistic one.**



## Graphical Model



Simultaneously detect features

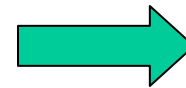
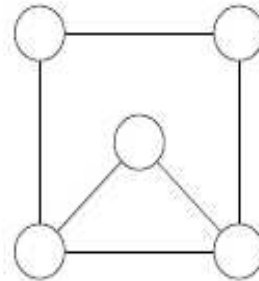
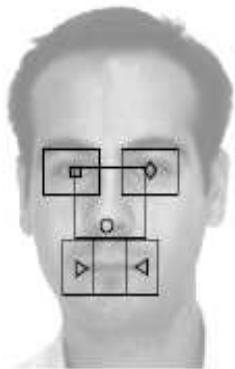


## Graphical Model

- Face is modeled using latent variables.
- The latent variables generate the observed data.
- The observed data can be extracted from the image to be PCA co-efficients, shape descriptors etc.
- The way the latent variables are connected show the probabilistic relation between parts.



## PCA Based Model<sub>[1]</sub>

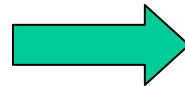
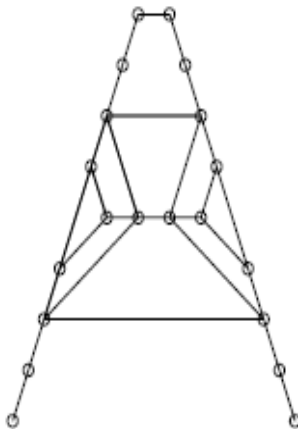


- PCA of the blocks containing the control points are taken as the observed data.
- Belief propagation between nodes is non-parametric.



## Model Based on Shape Descriptor<sup>[2]</sup>

- Define shape descriptor  $Q = [q_1, q_2, \dots, q_n]$
- Each point  $q_i$  (node) connect to all other nodes that affect it. This forms the Graphical model.





## General Framework

- **Latent variable for control points remain same irrespective of the form of observed data modeled.**
- **Hence we must be able to design a model that can take in only the information available and model best with that information.**
- **We get multiple evidence for same latent variable.**



## **Advantages**

- **Can work with color as well as grey scale images**
- **Since all features are simultaneously detected and finding one helps finding others, better results expected.**
- **A more rigorous and correct way of including prior knowledge about face.**
- **Can handle occlusions, deformations in component shapes.**



## References

1. "Nonparametric Belief Propagation" E. Sudderth, A. Ihler, W. Freeman, and A. Willsky. CVPR, June 2003.
2. "Shape Matching with Belief Propagation: Using Dynamic Quantization to Accomodate Occlusion and Clutter", James M. Coughlan and Huiying Shen. To appear in GMBV (Generative-Model Mased Vision) 2004, in conjunction with CVPR 2004.
3. R. Dahyot, P. Charbonnier and F. Heitz "A Bayesian approach to object detection using probabilistic appearance-based models", Pattern Analysis and Applications, Vol. 7, No 3, Dec. 2004, pp. 317-332.
4. A.M. Martinez , "Face Image Retrieval Using HMMs", Proceedings of IEEE CVPR'99 (Workshop on Content-Based Access of Images and Video Libraries), 1999
5. J. Coughlan and S. Ferreira. "Finding Deformable Shapes using Loopy Belief Propagation." The Seventh European Conference on Computer Vision (ECCV '02). pp. 453-468. Copenhagen, Denmark. May 2002.