



Semantic Face Retrieval System

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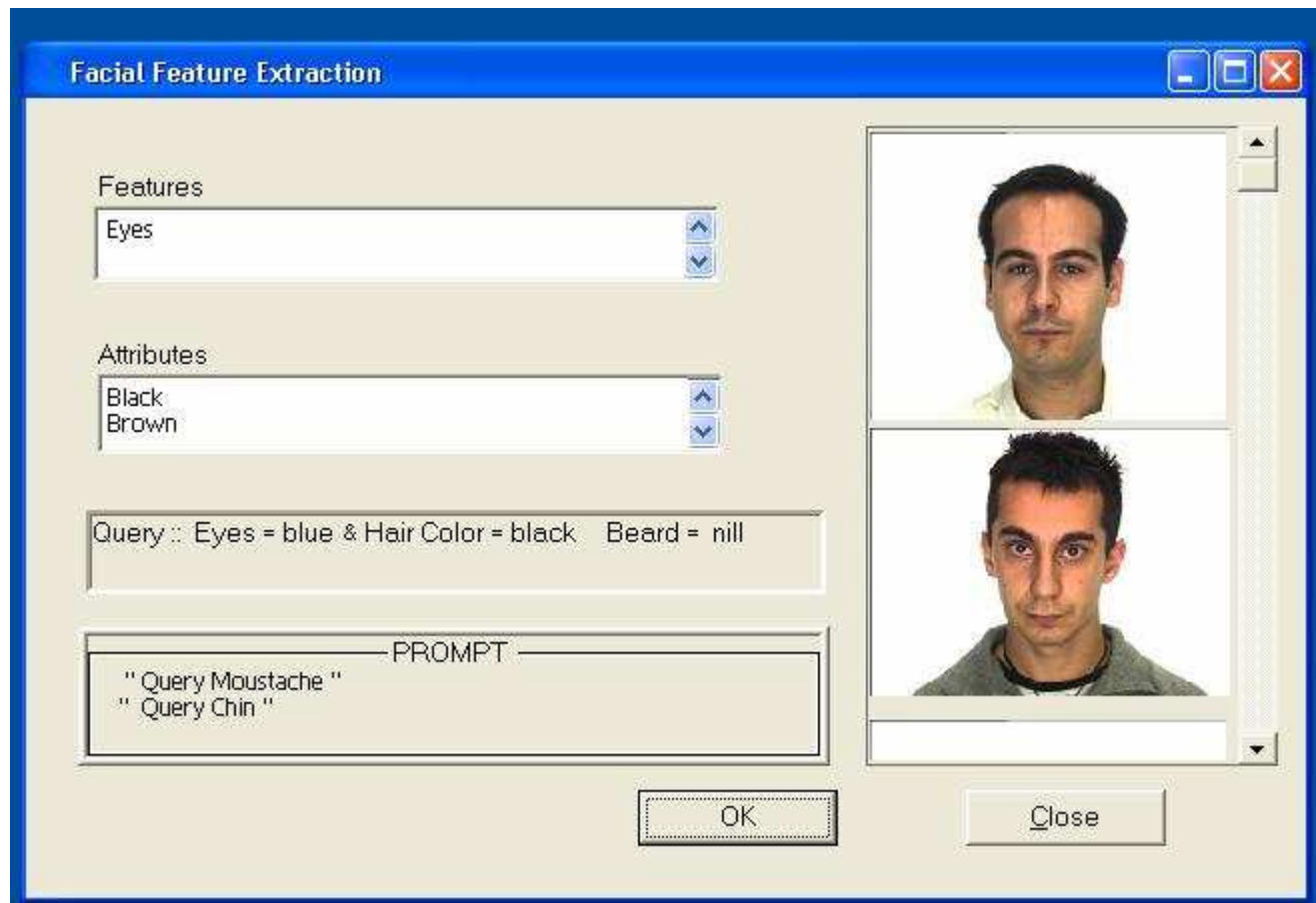


Introduction

- **Face as soft biometric.**
- **The general description about face given by people is semantic like 'long nose', 'blue eyes, etc.**
- **The system enables retrieval of required face based on verbal descriptions of the face given by the user.**

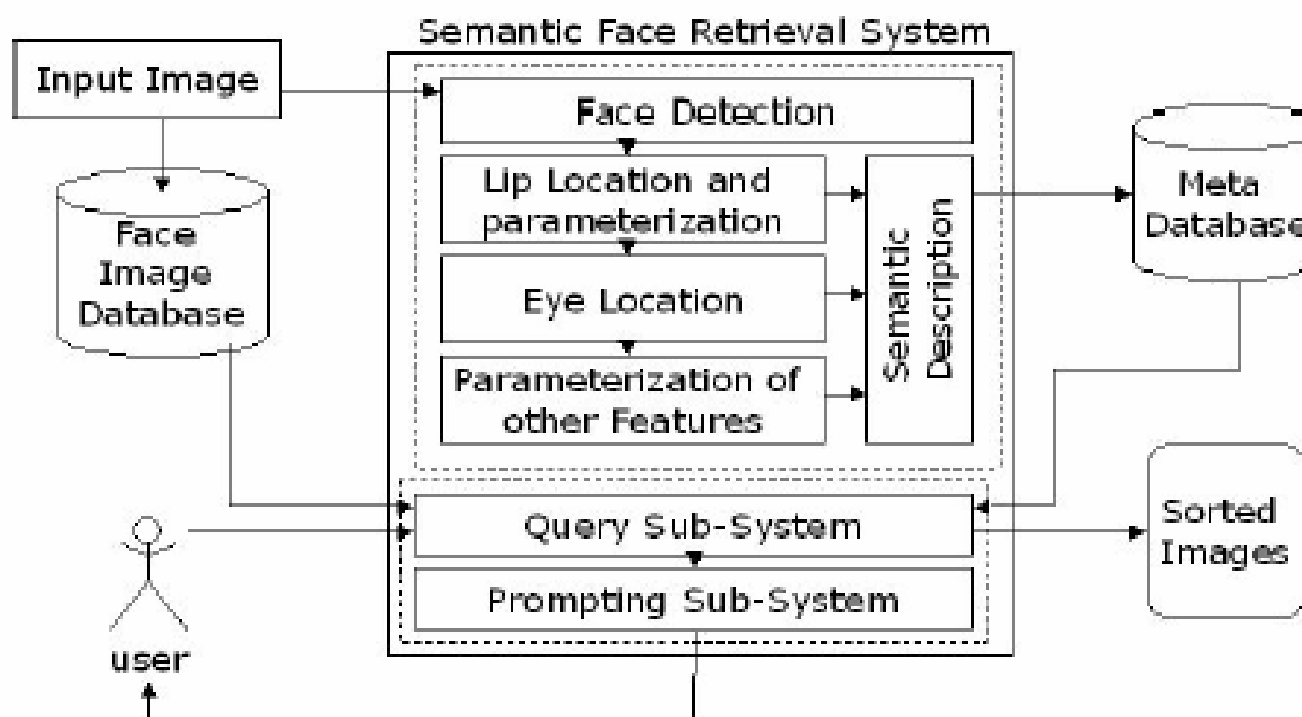


System Snapshot





System Overview





Parameterizing Facial Features

- To describe each facial feature it is first parameterized.
- Since we only need semantic descriptions we only fit the lowest order polygon for each feature that successfully describes the feature.
- Eg. Triangle for nose, rectangle for lips etc.
- Lip detection and eye detection are first carried out.
- Based on eye and lip location approximate location of all other features known.
- Further based on color vector based edge detection, all other features are located.



Lip Detection

- Approximate Lip Localization using Color based segmentation.
- But this approximate localization does not capture lip corner.
- Exact localization of lip is then performed using Histogram based object segmentation in the approximate region of the lips in the image.





Eye Detection

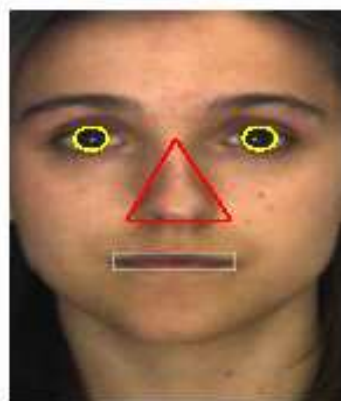
- Traditionally done using hough transform based circle detection.
- The radius of eyes in image varies.
- Method not robust.
- We can use prior knowledge about the distribution of the radius of eye in image by using probabilistic approach.
- The accumulator value is converted into probability by dividing by $2\pi r$.
- The probability distribution of radius of eye in image is got manually.

$$P(\text{point}_i) = \sum_{j=1}^5 (P(\text{point}_i | r_j) P(r_j))$$

where $P(\text{point}_i | r_j) = \frac{\text{Accumulator}(\text{point}_i, r_j)}{2\pi r_j}$ and $r_{1..5} = [9..13]$.



Facial Feature Detection



Feature	Type
Spectacles, Beard , Mustache, Long Hair and Balding	Discrete (yes/no)
Hair Color	Discrete (Black/Brown/Blonde)
Nose Width, Length and Size, Lip Width and Thickness, Face Length, Darkness of Skin and Eyebrow Thickness	Continuous



Query Sub-system

- Pruning results in sensitivity to noise.
- Bayesian inference for sorting query results

$$P(\text{face}_k | f_i = d_j) = \frac{P(f_i = d_j | \text{face}_k) P(\text{face}_k)}{\sum P(f_i = d_j | \text{face}_k) P(\text{face}_k)}$$

Where f_i refers to facial feature i and d_j refers to description j of the feature.



Prompting Sub-system

- Prompt the feature that is most discriminative. This is the most entropic feature.
- The entropy of Hs_i of the i^{th} attribute is given by

$$Hs_i = - \sum_{j=1}^m P(f_i = d_j | P(\text{face})) \log_2(P(f_i = d_j | P(\text{face})))$$

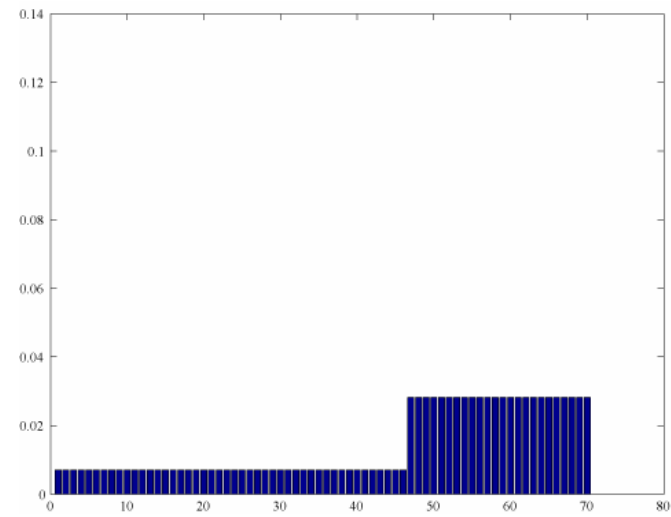
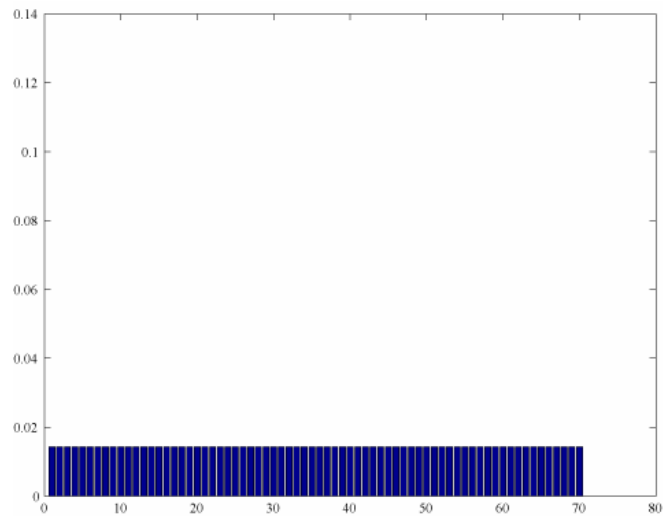
Where
$$P(f_i = d_j | P(\text{face})) = \frac{\sum_{k: f_{i,k} = d_j} P(\text{face}_k)}{\sum_{p=1}^n P(\text{face}_p)}$$

(m is the total number of values the attribute can take and f_{ik} represents feature i of face k .)



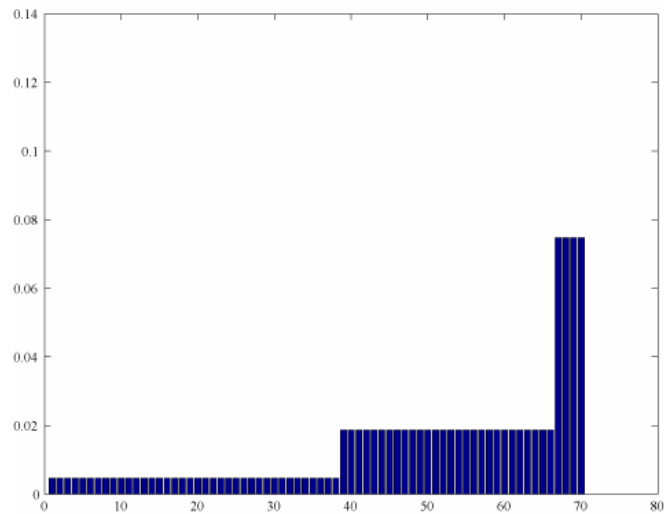
Query = []

Query = [spex = 1]

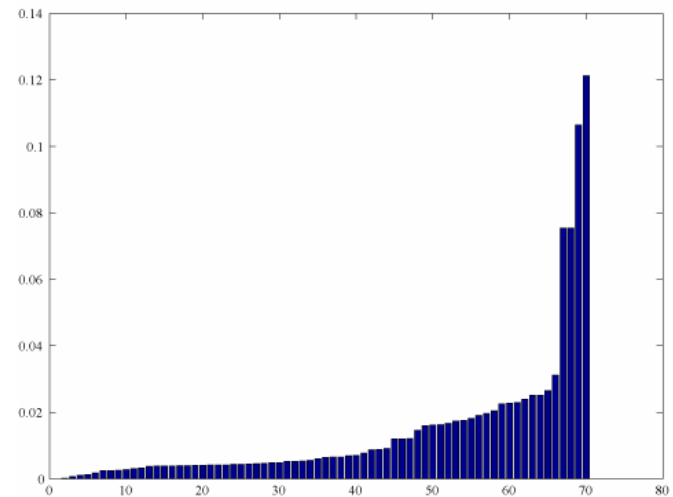




Query = [spex = 1 & mustache = 1]



Query = [spex = 1 & mustache = 1
& nose = 'large']





Performance Analysis

Feature	Number of False Accepts	Number of False Rejects
Spectacles	1	2
Mustache	2	4
Beard	4	0
Long Hair	2	8
Balding	1	0

-	Top 5	Top 10	Top 15
Avarage No. of Queries	6.64	4.59	2.72



Advantages and Applications

- **We have developed a probabilistic and interactive verbal face query system.**
- **The system is robust to noise and error by user.**
- **The system prompts the user with right questions about facial features to make the query more efficient.**
- **The system helps query based on the semantic features which is generally the kind of descriptions given by users.**
- **The system can be used for suspect identification by witnesses.**
- **It can be used for surveillance in public places to identify criminals based on description.**



FutureWork

- **To include prior knowledge about face into the facial feature detection system in a more rigorous way using bayesian inference.**
- **Extend the application to video surveillance.**
- **Inculcate pose invariance and illumination invariance.**



References

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