Age Invariant Face Recognition

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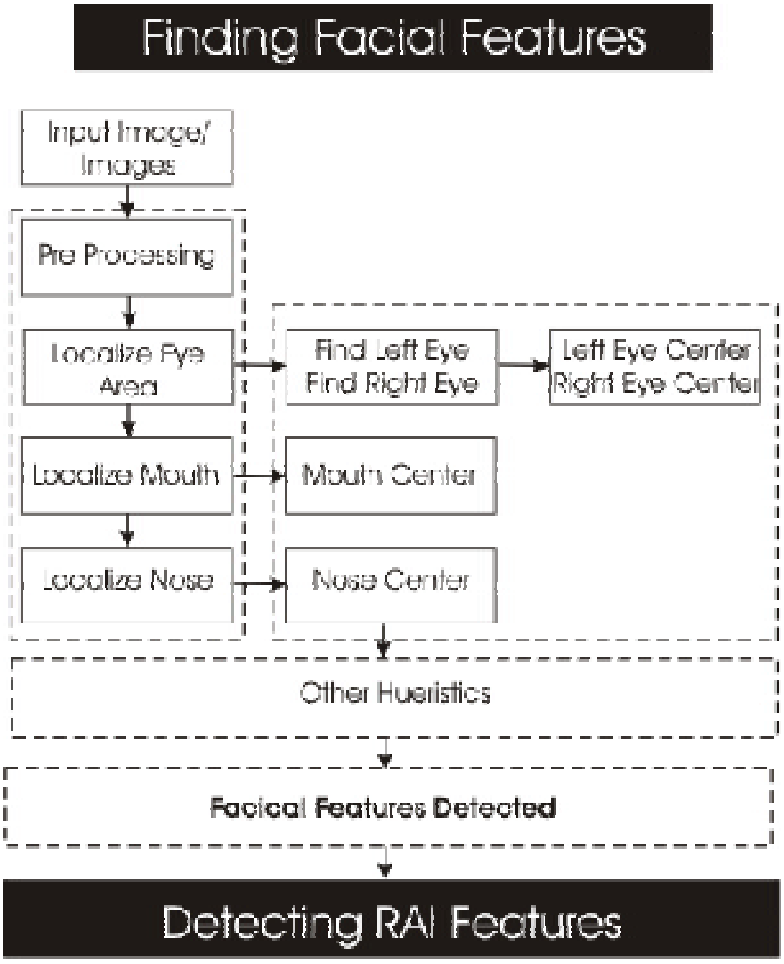
EE372 - Computer Vision and Document Processing

A. Final Block Diagram of the system



B. Detecting Facial Features

Preprocessing

1. Loading image
2. Convert to grayscale
3. Resize the input image to 64px and 256px for detailed and coarse
4. Equalize image histogram

Localize Eye Area

1. Convert to Binary image
2. Read the template
3. Perform the template matching by direct correlation
4. Extract the best template
5. Extract the position of the eyes for 256px image

Localize Mouth

1. Extract the feature image consisting of regions of the eyes, image below the eyes, vertical margins snapped to the left and right eyes – call it **imFeature**.
2. Equalize histogram
3. Morphological image reconstruction
4. Conversion to binary image
5. Removing black components connected to the boundary
6. Calculating the vertical histogram
7. Floor values less than 0.25 Max
8. Ceil values greater that 0.75 Max
9. Find the position of maximum from the top

Localize Nose

1. Extract the region below the eyes and above the mouth from **ImFeature**

Find Right/Left Eye

1. Get the eye region
2. Divide the region into two for seperate processing of each eye
3. On each part find the vertical edges
4. Take the window with the maximum vertical edges

Eyes Center - $y_{eyeleft}$, $y_{eyeright}$, $x_{eyeleft}$, $x_{eyeright}$

1. Convert to Binary image with a low threshold as the darkest regions are the eyes
2. Perform morphological operation - image opening with a square structuring element of 5x5 pixels
3. Perform morphological operation - image dilation with a square structuring element of 5x5 pixels
4. Find the horizontal histogram
5. Ceil values greater that 0.75 Max
6. Find the position of the weighted average of the histogram – this gives us y_{eyes}
7. On the column of y_{eyes} find the weighted average of the intensity values – this gives us x_{eyes}

Mouth Center - y_{mouth}, x_{mouth}

1. Convert to Binary image with a low threshold as the darkest regions is the Mouth Line
2. Removing black components connected to the boundary
3. The average of the first pixel from the left and right gives the y_{mouth} and x_{mouth}

Nose Center - y_{nose}, x_{nose}

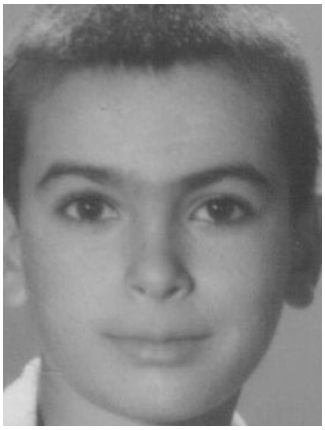
1. Read the nose template
2. Perform the template matching by direct correlation
3. Extract the best template
4. Extract the position of the center of the template in the region with the best match – y_{nose}, x_{nose}

Other Heuristics

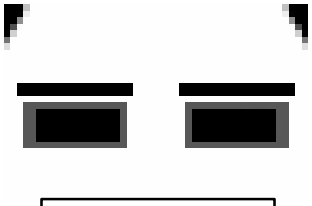
1. Find the axis of symmetry by the mean of the nose template

Results

Input Images

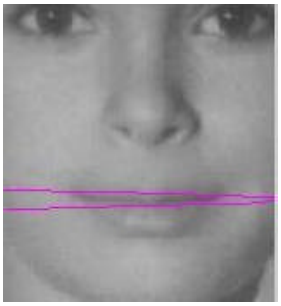
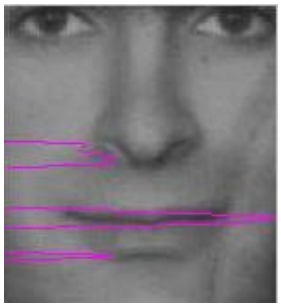



Locating Eye Area



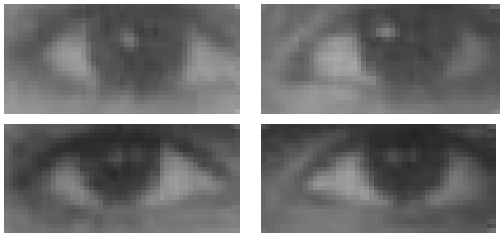

Imfeature


Localize Mouth

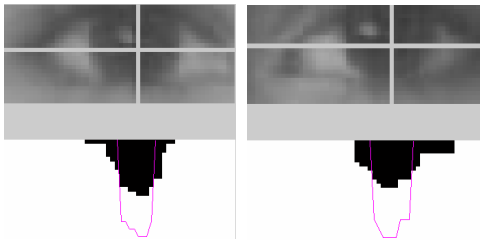
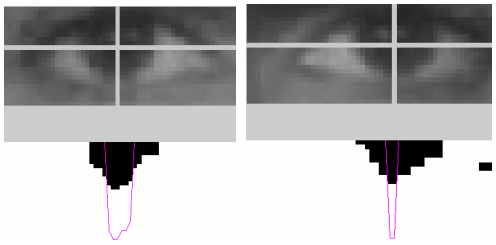



Localize Nose

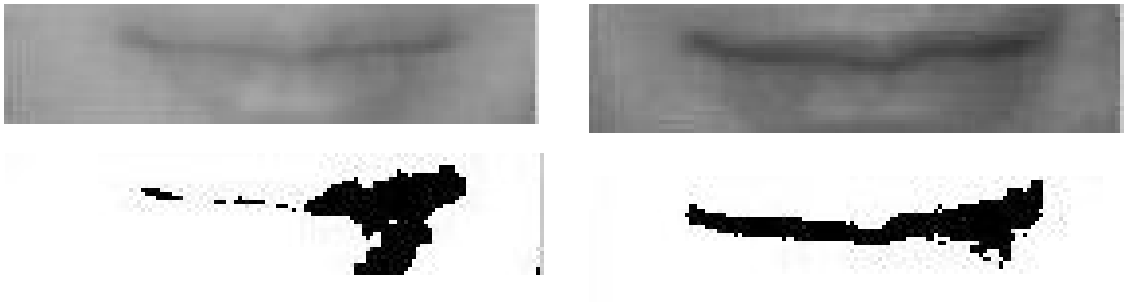

Find Left/Right Eye



Eyes center

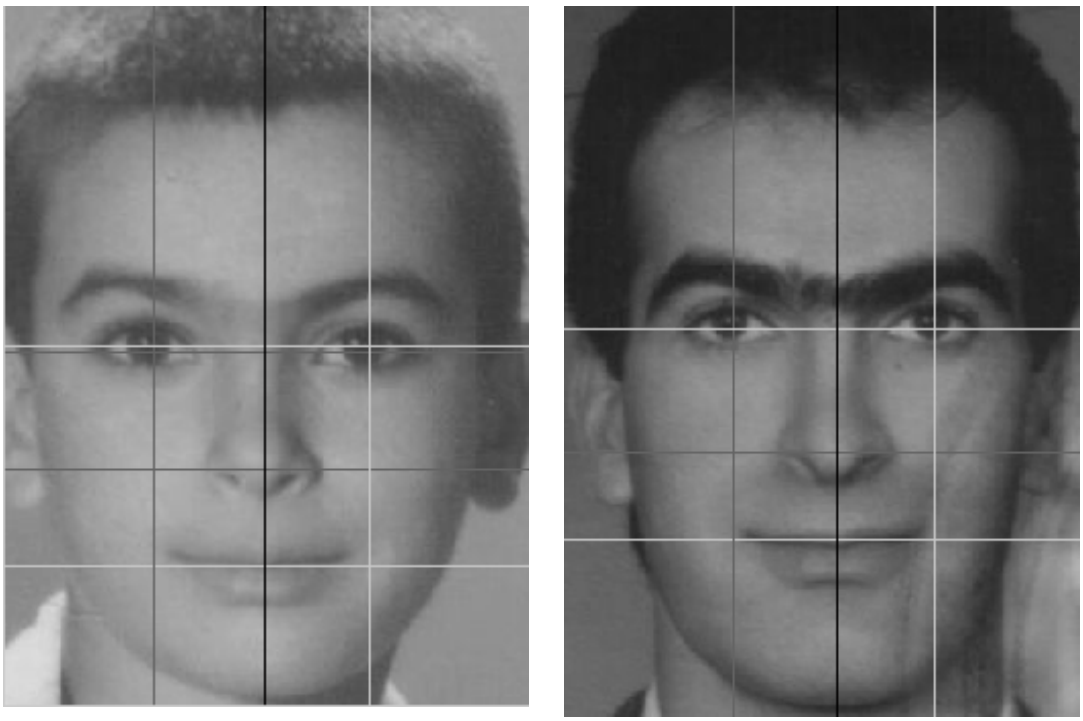
Mouth Center



Nose Center

Nose Template

Final



ALGORITHM for FACE MATCHING

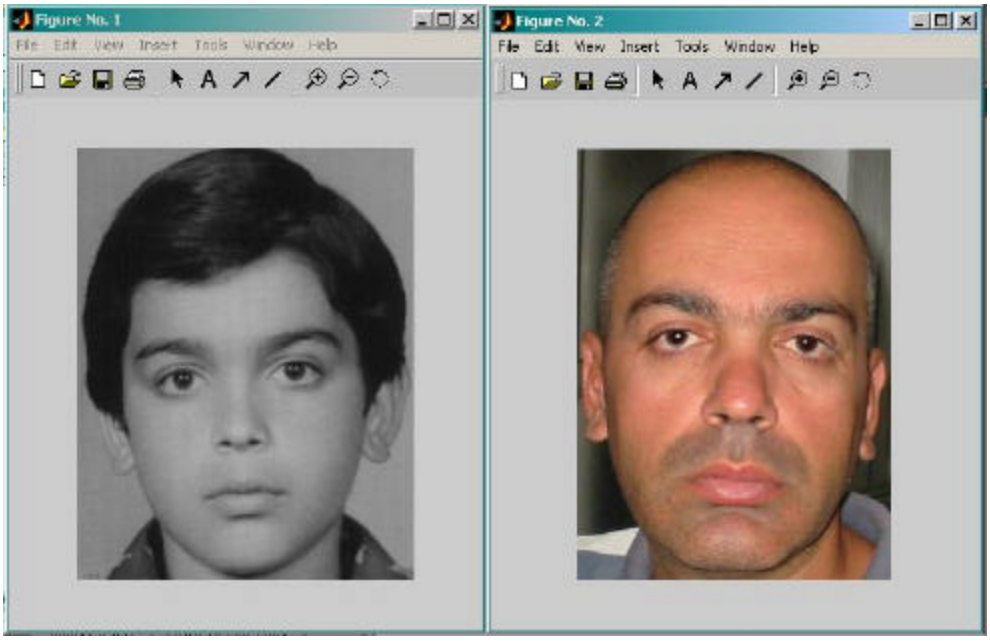
1. Identify and obtain the six points on the face.
2. Reduce this set of points to four by taking the average value for two pairs (distance between eye centres and nose and distance between eye centres and lips centre)
3. For any two pair of faces, find the difference between all the features to get a difference vector.
4. Multiply this vector by a predetermined weight vector.
5. Take the minimum mismatch value.
6. Add to it the second most mismatch value (multiplied by 2)
7. Compare this mismatch value with all the faces.
8. Give the face with the minimum mismatch as the output.

The optimised value of the weight vector is [100 2 0.5 1.3].
The minimum distance method (with variable weights) did not give desired results.

RESULTS

Some interesting results were obtained when we tried to do the age invariant age recognition.

- A database of 6 adult and 6 child images was used.
- For a match of an adult image with all the child images in the database, 4 out of 6 images could be matched successfully.
- For a match of a child image with all the adult images in the database,again 4 out of 6 images could be matched successfully.
- There was no usefulness of the distance between eyes for face recognition.
- Most useful feature (definitely a RAI feature) seems to be the distance between the lips and nose.
- Another important feature is the distance between the lips and eyes.
- In our database, their was a mismatch for pairs number 2 and 4. Rest all matched in both the directions.
- Even though the database was very small, there seems to be a very good possibility of a successful age-invariant matching technique to be possible using feature analysis.



Most likely match with image number 6 with a match values of 0.035333

All the match values:

0.0680 0.0405 0.1288 0.0502 0.0695 0.0353

FUTURE POSSIBILITIES

There seems to be a definite possibility for further extension of the work. We have already shown that certain measures taken from the features of the face show a high match with the face at a different age.

Some possibilities that arise from our work :

- Get more features from the image. More features will improve the match. Other possible features can be eyebrows, ears, shape of face, etc.
- Improve the accuracy of match. A better and more accurate determination of feature location would help in getting the numerical measures more accurately. This would in turn improve our reliability.
- Try a intra-feature match rather than taking inter-feature measures. This would involve considering shapes, sizes and aspect ratios of the features already extracted. A promising feature would be eyes. A direct template matching can be tried on the eyes.
- An automatic face correction algorithm can be implemented to correct and reorient certain images which are not usable directly.
- A good way of testing the reliability of the system and even to get an idea of the reliable features, would be to match the faces of the same individual at the same age. This would eliminate a lot of unreliable and weak performing features.