Facial Feature Detection summary

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Artificial Intelligence & Information Analysis Lab

Facial Feature Detection

- Face Description Models
- Eyes detection
- Mouth and lip detection
- DNN Facial Feature Detection
- Dynamic 3D face modeling

Problem statement

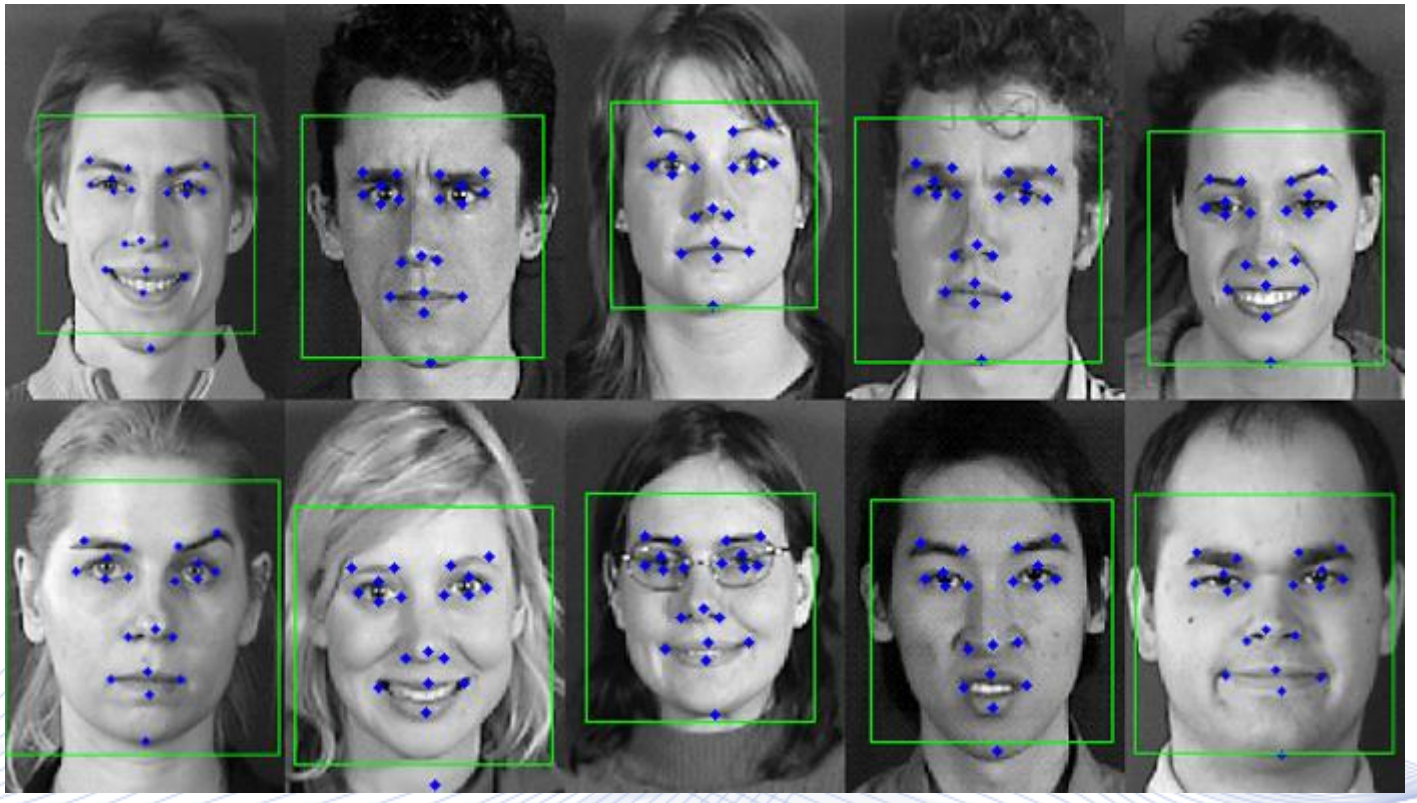
- Facial features (e.g. eyes, mouth) play a significant role in computer vision. Facial features detection and analysis follows face detection, and it is important to be done in real-time.

- While facial features detection using state-of-art techniques encounter some difficulties, the growth of deep learning and neural networks has been very useful, showing better results.

Challenges

- Facial features are different from people to people
- Different illumination conditions, positions, sizes
- Needs to be fast

Examples



Images with bounding box around faces and facial landmarks pointed

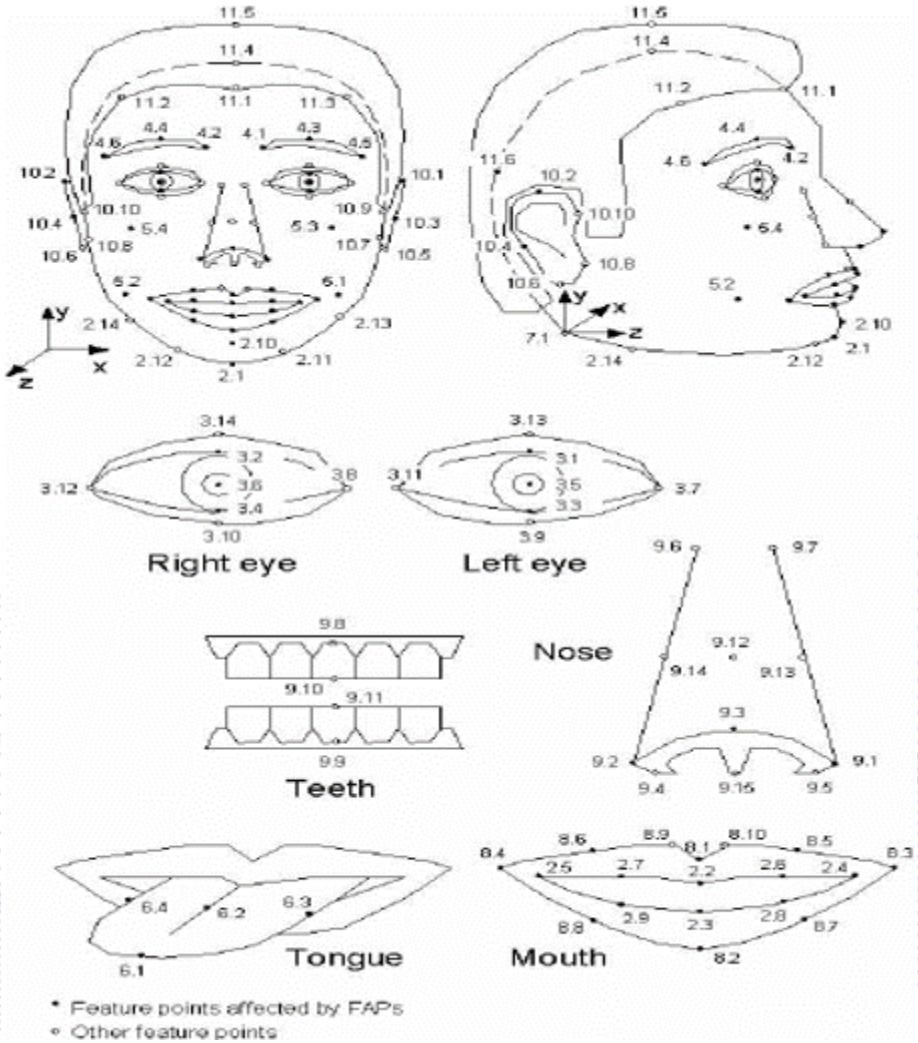
Examples

Face images having noted facial landmarks

Applications

- Human-computer interaction
- Image face tracking
- Facial expression recognition
- 3D face reconstruction
- Access control
- Surveillance systems
- Health care

Face Description Models



MPEG FDPs

Face Description Models

- **Candide**

  - CANDIDE is a face grid model using parameters, established for model-based coding of persons' faces. It can achieve fast reconstruction with low computer power.

  - CANDIDE 1 and 2 are controlled by Action Units.

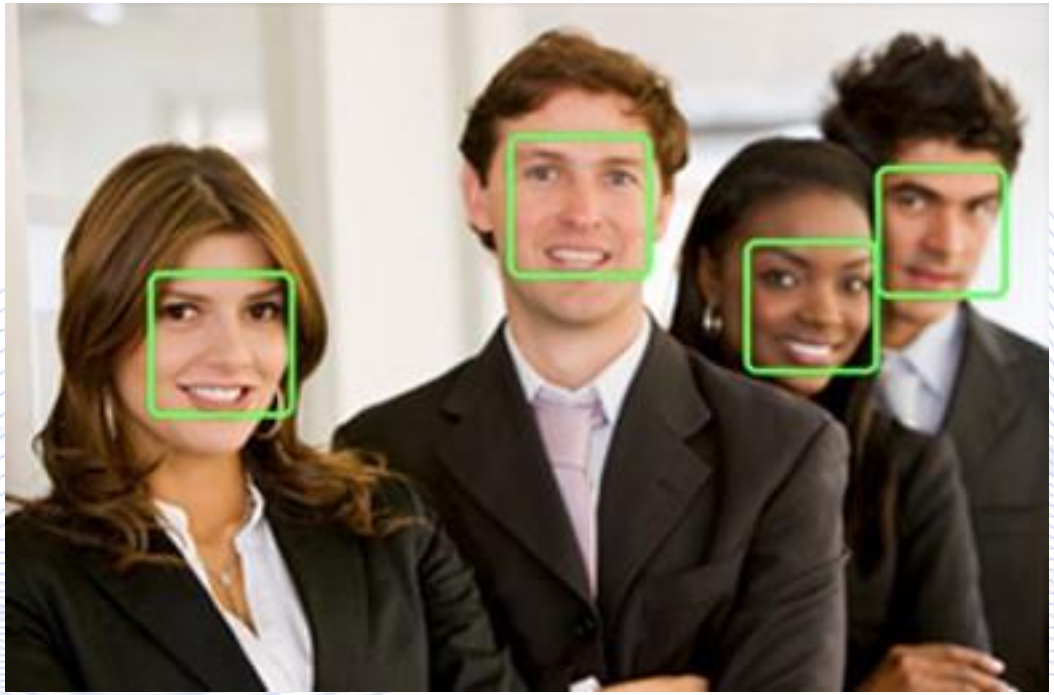
  - CANDIDE 3 was established in order to be corresponding with MPEG-4 FDPs.

Face Description Models

Candide model.

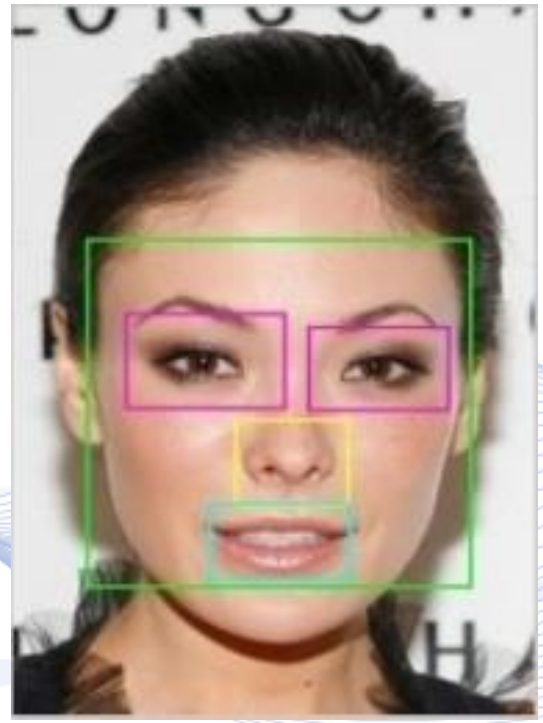
Facial Features Detection levels

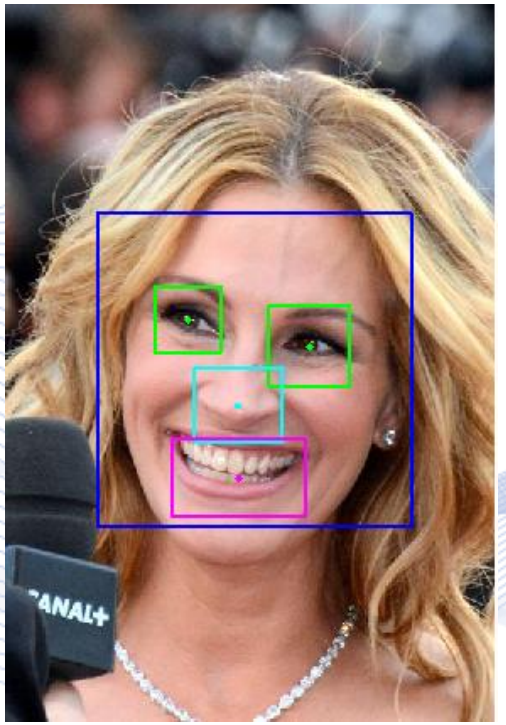
- **Face Detection**



Facial Features Detection levels

- **Facial features region detection**





Facial Features Detection levels

- Facial Features landmarks location (corners) and shape extraction.

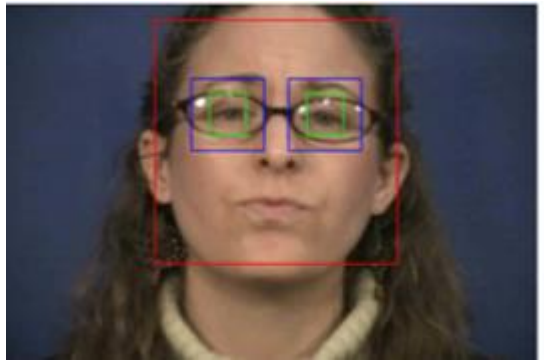
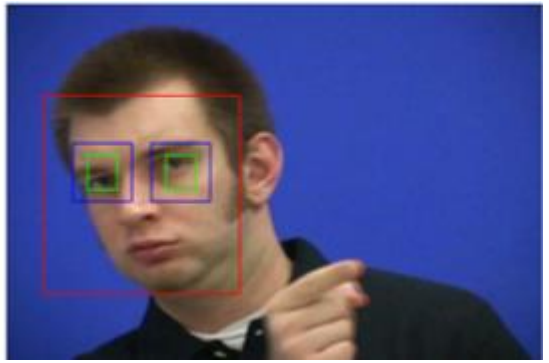
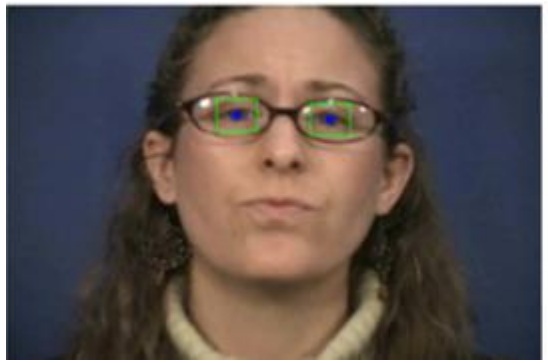
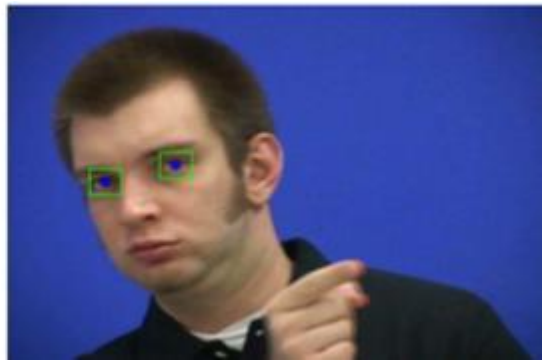
Eyes detection

- Description
  - Eyes contain the eye white (sclera), iris, pupil and eyelids
  - Iris and pupil have a circular shape
  - Eyelids give an oval shape to the eye white
  - Eye structure is crowned by the eyebrows, that are sometimes used in eye detection

Eyes detection

- Eye detection techniques filter down several eye candidate regions found in a face ROI.
- First step to eye detection is to detect the eye center, disregarding the iris position, and the bounding box of the eye area.
- In order to locate the eye windows, apriori information may be used, like searching only the upper half of a facial ROI.
- Next step to eye detection is to detect the eye shape.
- Left and right margins for each eye are provided by detecting the eye corners.

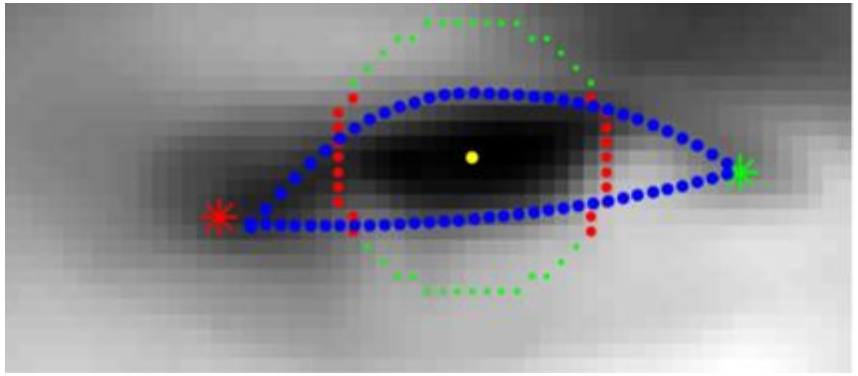
Eyes detection

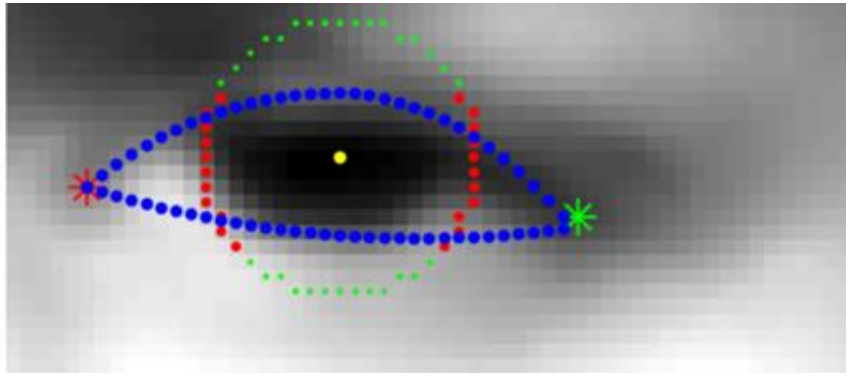





Position of the eyes

Final detection of eye center and ROI

Eyes detection





Eye shape extraction phase

Eye Detection

Training data

a) The left eye training images

b) The right eye training images

c) The length maps for the left image eye

d) The length maps for the right image eye

e)The angle maps for the left eye image

f) The angle maps for the right eye image

Mouth and lip detection

- Challenges
  - Mouth can be closed or open
  - If open, simple face models are not enough and more detailed models are needed

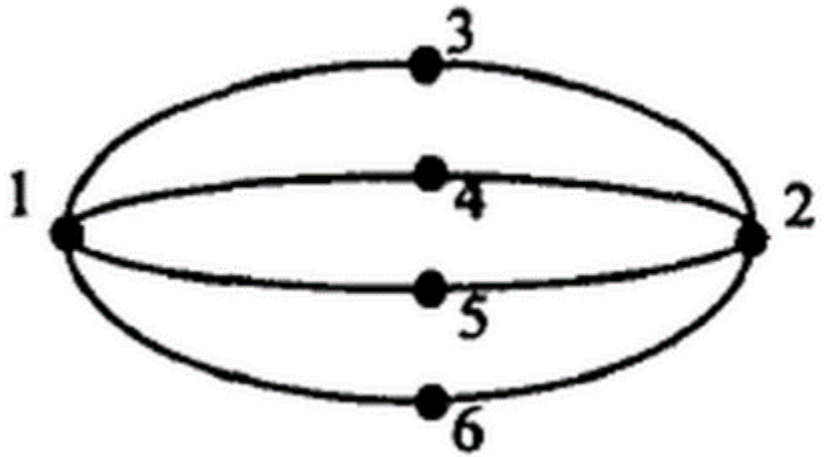
Mouth and lip detection

- Mouth detection localizes the mouth in a facial image and finds the bounding box.
- It also finds the corners of the mouth.
- Usually, the facial image is segmented based on lips color.
- Another common method is mosaic method, that leans on the fact that location and distribution of facial features are relative stable between different faces.
- Some methods detect the eyes and mouth by exploring symmetry in the face.

Lip detection

- Lip detection provides more detailed information by localizing mouth corners, the top of the higher lip and the bottom of the lower lip [5].

- Some methods localize six points on the lips, as shown below.



Mouth and lip detection

Face and mouth within bounding boxes, and mouth of both persons extracted

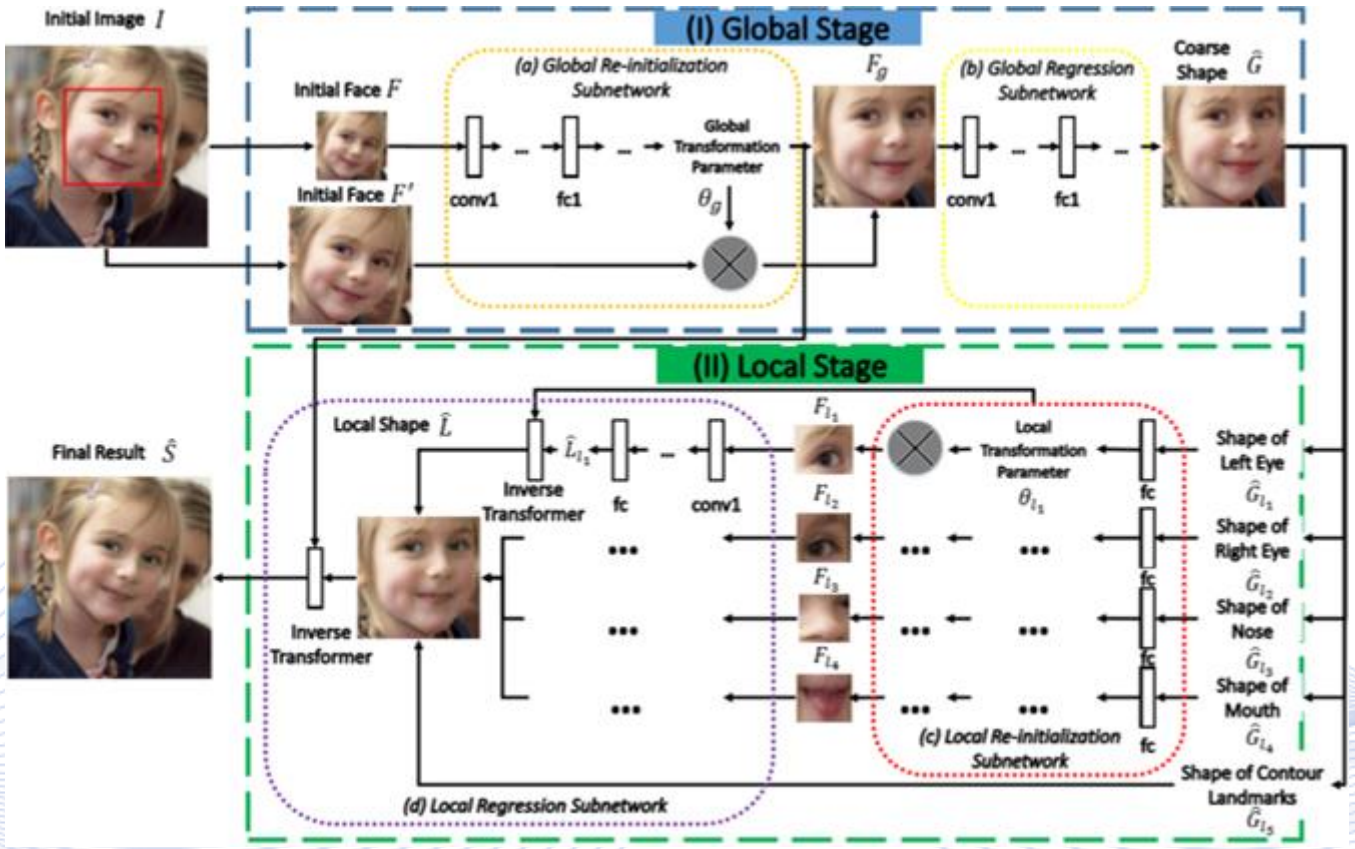
Eyebrows detection

- Detecting face and eyes precisely, means the position of the remaining landmarks is relatively known.
- Thus, it is easy for eyebrows to be detected.
- The eyebrows in the x axis is confining, while in the y axes do not differ. The eyebrows are different colored regarding the skin, thus it is effortless to find them by looking for non-skin color in the area over the eyes.

Nose detection

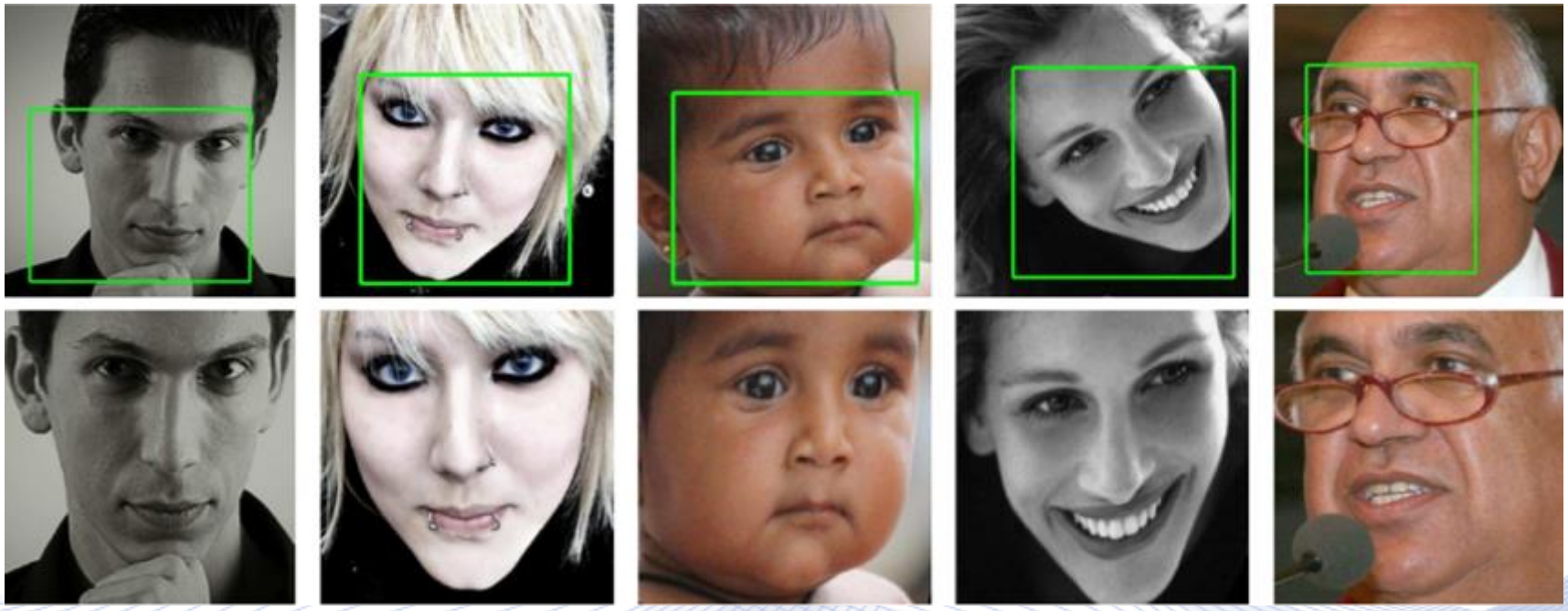
- The nose position is also easy to find, because the nose is not deformable.
- Although, obtaining the nose contour is quite difficult.
- The nose is meant to be between the two eyes on the x axis and beneath those regarding the y axis. Thus, the nose area is located beneath the lower eye lid and among the eyes.

DNN Facial Feature detection



Pipeline of the proposed architecture

DNN Facial Feature detection

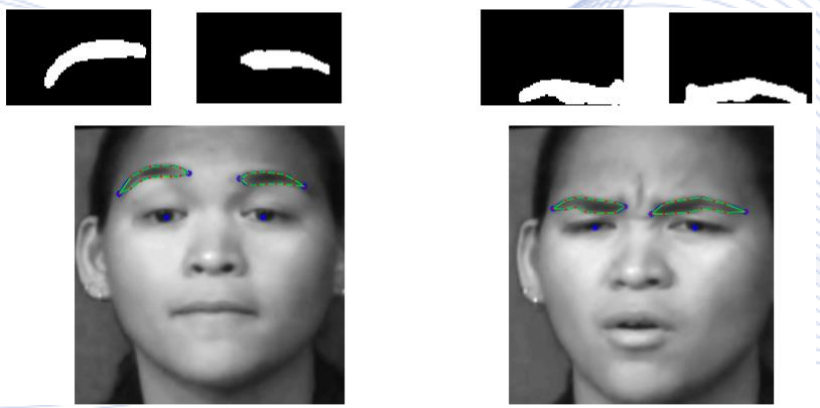


Initial face images with bounding boxes and the output images

DNN Facial Feature detection

- The pixels over the eye area that does not qualify the color model $N(\mu_c, \Sigma_c)$, are delimited first.

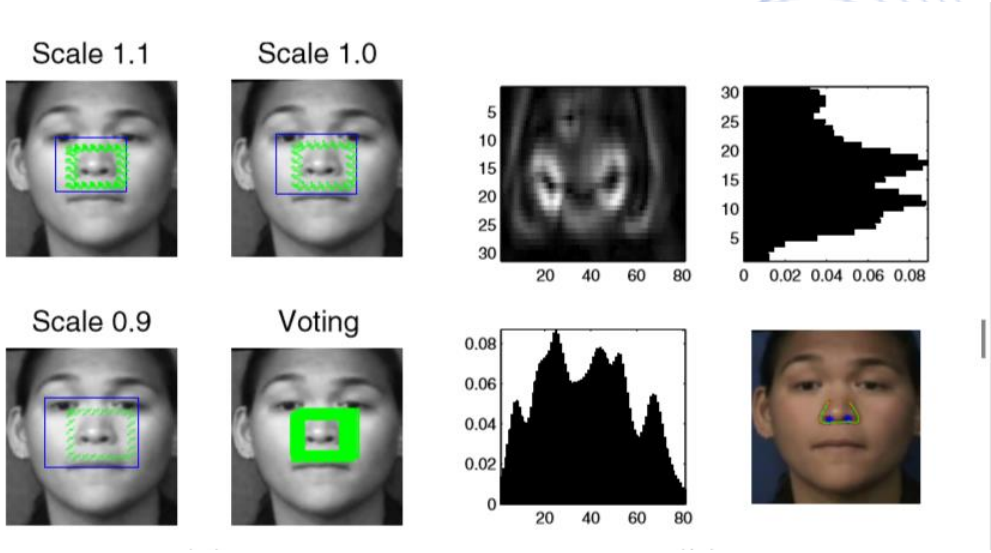
- Considering the rest of the pixels, those with highest gradient in each column are saved as contingent eyebrows.



DNN Facial Feature detection

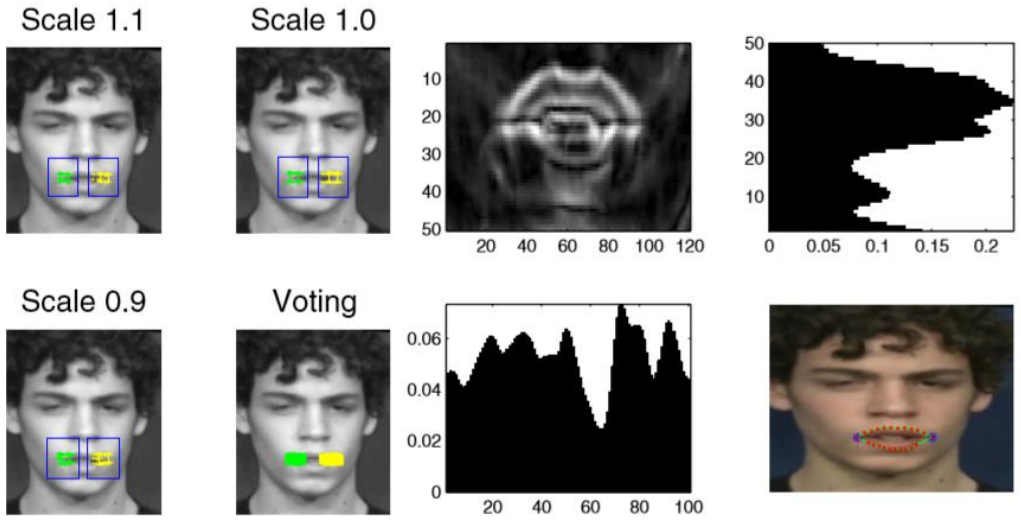
- Regarding the nose, a classifier based on the same method is trained, that produces a bounding box for the nose area.

- The nose contour is extracted by finding the image gradient and develop its projection onto the x and y axes.



DNN Facial Feature detection

- For mouth detection, the skin color is used again.
- Three features are extracted, which are verged at values T_s, T_h and T_g before being blend into a single mask response.



DNN Facial Feature detection

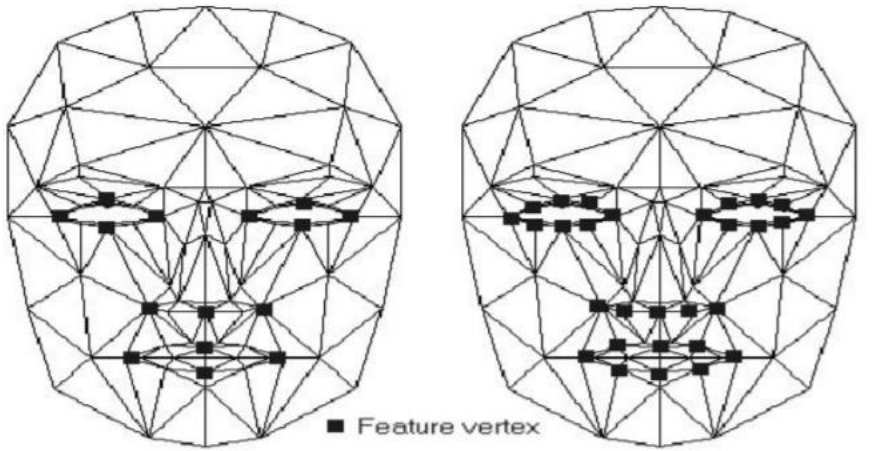
- A Gaussian model $N(\mu_d, \sigma_d)$ is matched to the outcome.
- The edge points with distance $|d|$ bigger than T_d pixels are excluded, with T_d considered as the bigger one of 10 and $2\sigma_d$. The fitting procedure is followed again for the enduring points.
- The last points are the chin detection.

Dynamic modeling of 3D face

- Method [4] uses a couple of frontal and profile view pictures of a human's face.
- Firstly, 2D facial features are generated from view images, after that their coordinates are computed
- The images that align and after that locally convert the facial vertices of the generic 3D model generate the coordinates of the particular points

Dynamic 3D face modeling

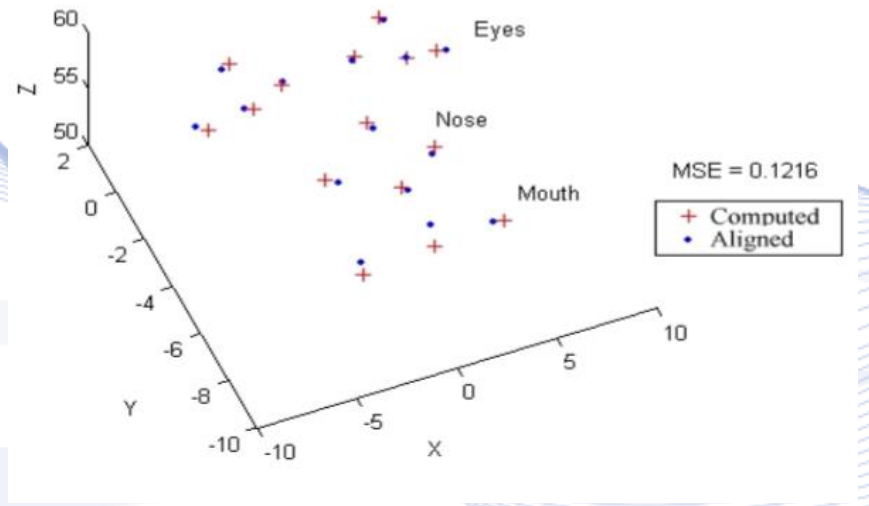
- First comes the global adjustment using the computed 15 landmark points, (x_I, y_I, z_I), and the matching 15 model vertices point, (x_M, y_M, z_M), represented below in (a).

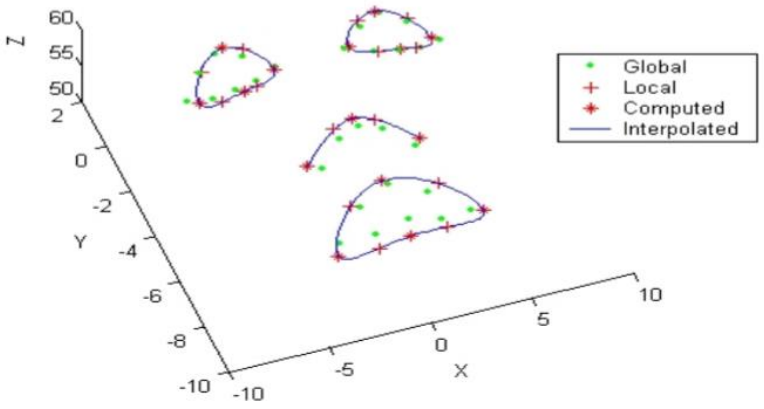


(a) Global alignment vertices. (b) Local deformation vertices.

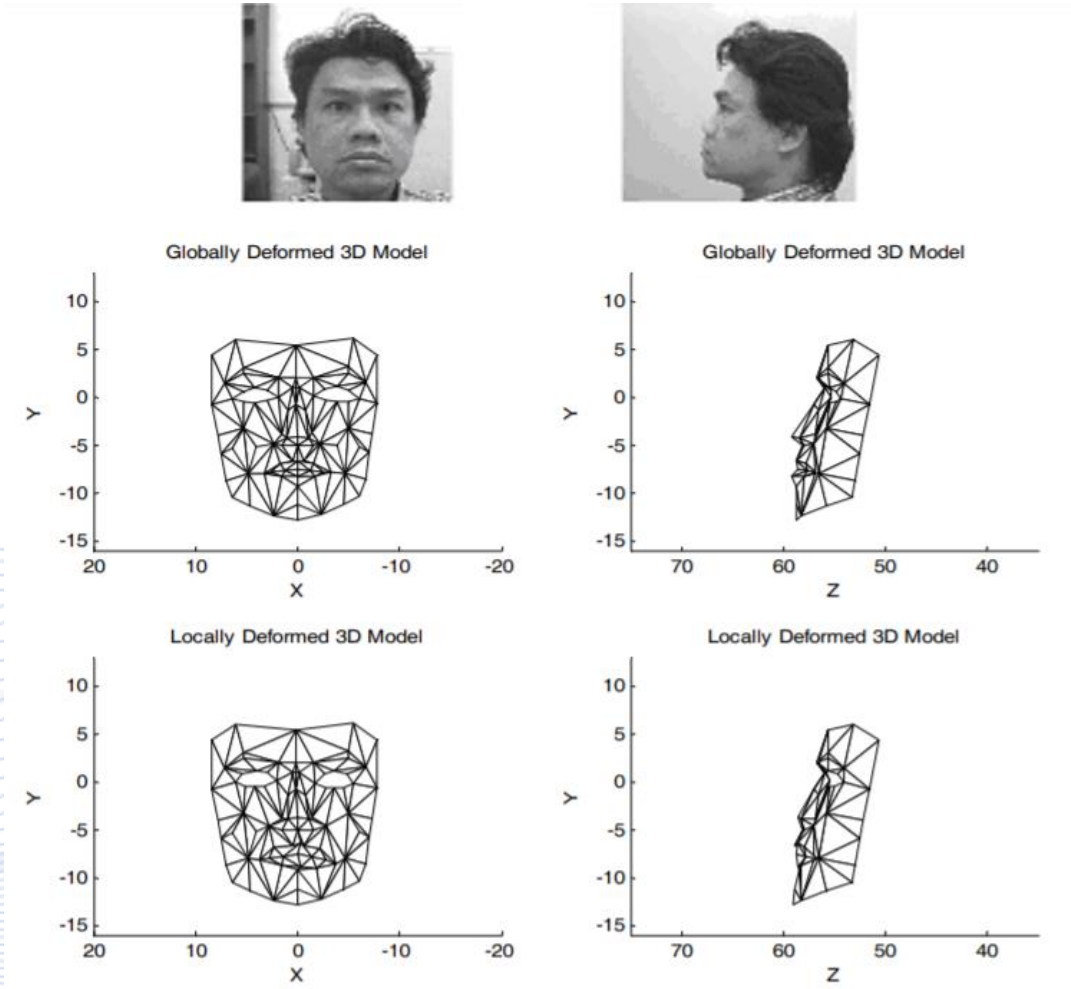
Dynamic 3D face modeling

- Those coordinates correspond to the shortest Euclidean distance among the 14 additional model's vertices (x_a, y_a, z_a) and the interpolated points (x_i, y_i, z_i)





Dynamic 3D face modeling



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Q & A

Thank you very much for your attention!

More material in
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