Evaluation and Development of Strategies for Facial Features Extraction for Emotion Detection by Software

Project Presentation
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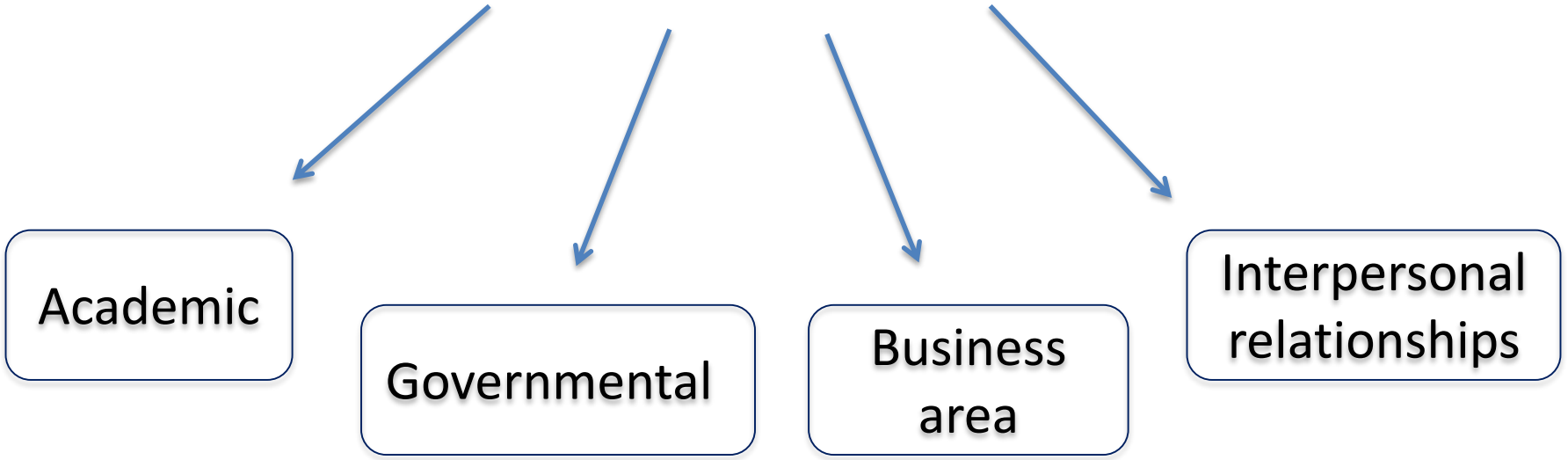
Emotion Detection

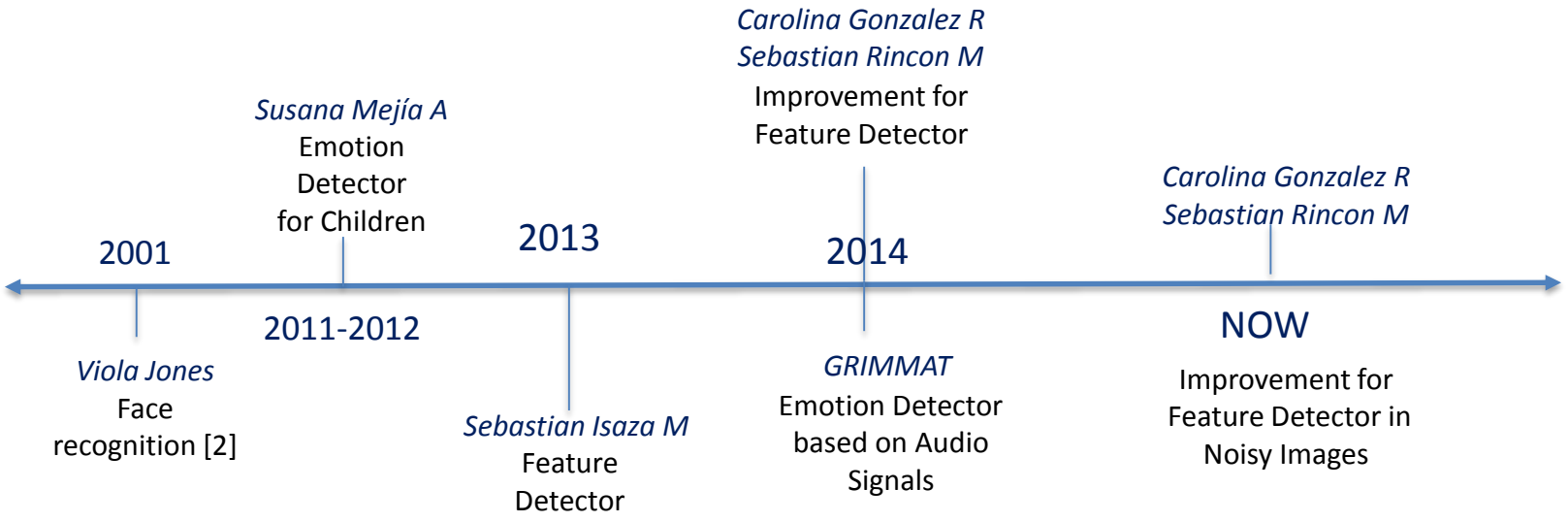
The process that aims to recognize and identify one of the six innate emotions [1], which are independent of culture, such as

- happiness
- sadness
- anger
- fear
- disgust
- surprise

APPLICATIONS

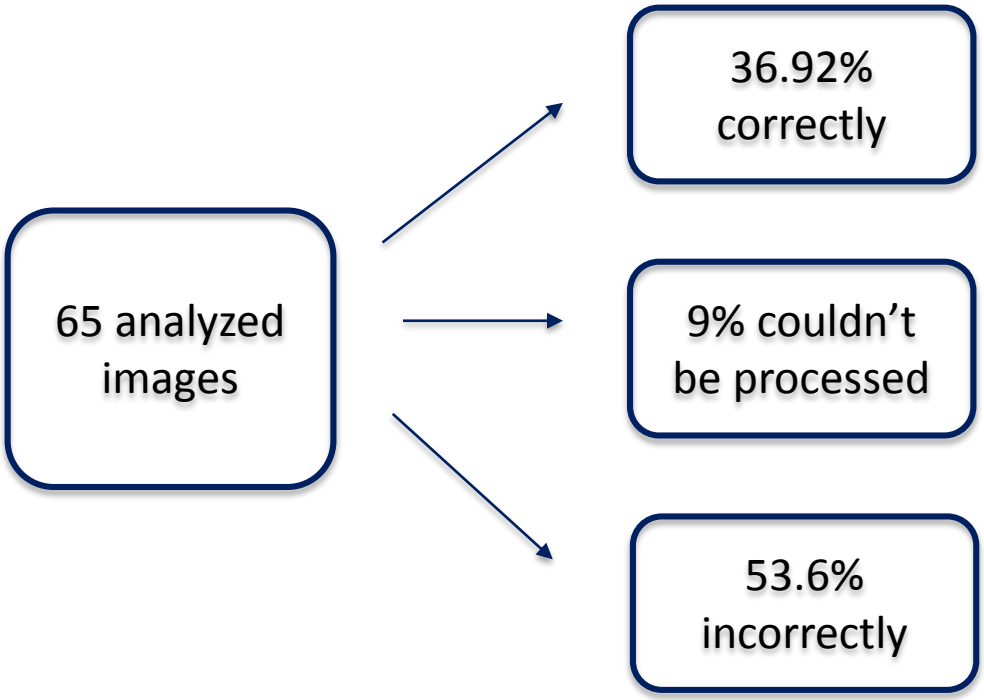


Progress



The current research will start with a compilation of information, collected from previous work of the people mentioned above. Focusing on the most promising results and untested ideas.

Base Algorithm



40% eyebrows

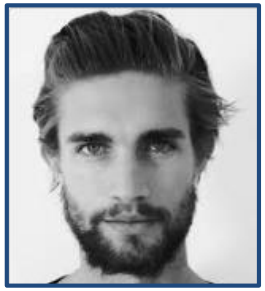
26% more than one

17% eyes

14% mouth

3% nose

Useful Concepts



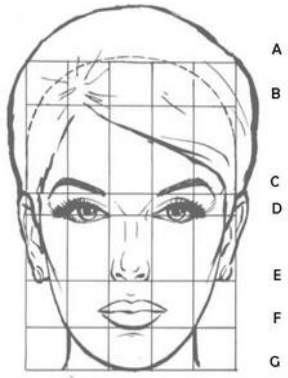
Beard

Bang

Skin tone

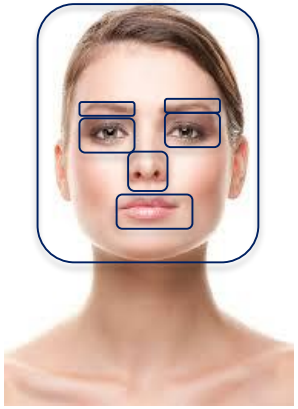
Low quality

"Noisy Images"



Facial Canon

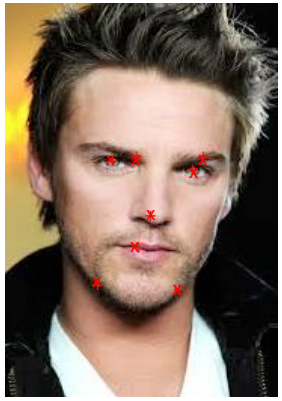
Set of proportions most people follow [3].



Partial feature detection

Establishment of feature marks

Past Results

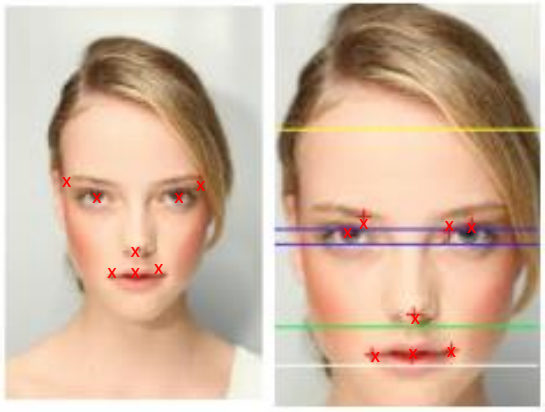


First results

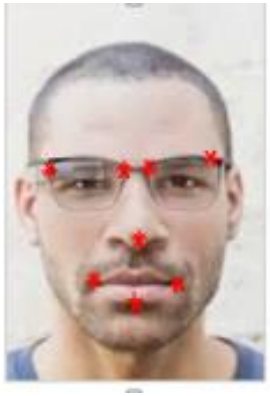
Pre processing results

Canon of proportions

Canon's proportions

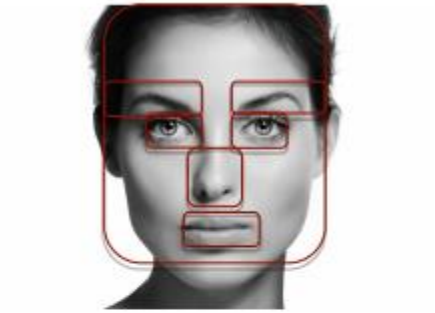


Past Results

Lack of accuracy while stablishing marks and the canon of proportions in noisy images

Past Metodology

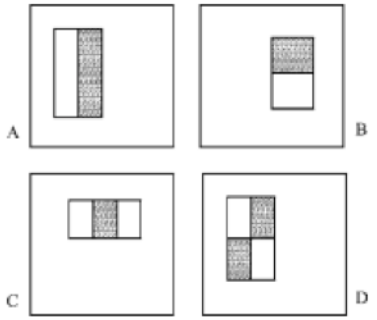




The empirical way of the canon establishment might affect the accuracy of the mark establishment and therefore the emotion detection. It also reduces the images that can be processed by the algorithm.

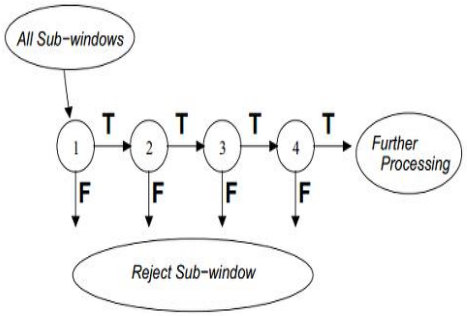
Viola Jones

Is one of the most used for real time detection, it is able to perform face and facial feature recognition in video or images [2]. The accuracy of the algorithm lies on:

- Feature extraction
- Learning and classification algorithm
- Multi-scale detection



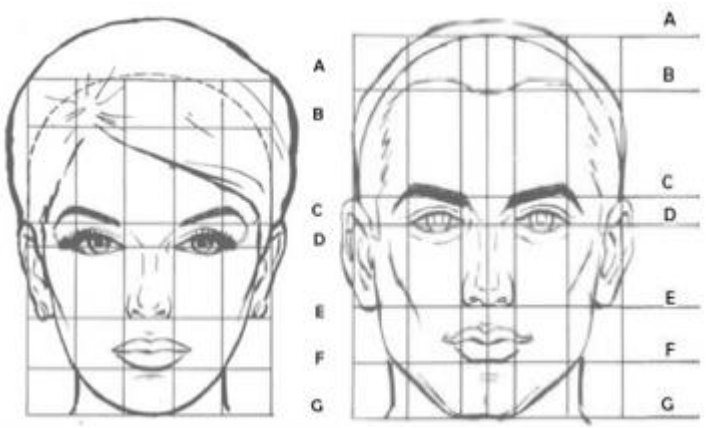
$$v_f = \sum p_w - \sum p_d.$$



Canon of Proportions

There are conditions and proportions that fit in a natural concept and morphology of the human face, that allows a standardization call the canon of proportions [3].

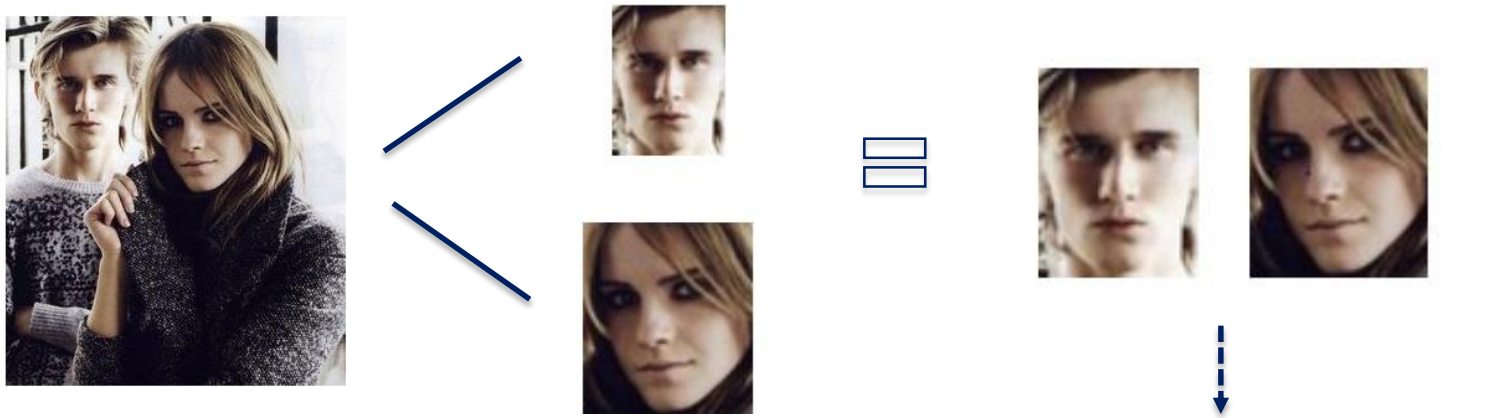
Module: mathematical proportions



A: topline of the skull
B: hairline
C: eyebrow level
D: eyes level
E: bottom of the nose
F: bottom of the lip
G: bottom of the chin

Resizing process

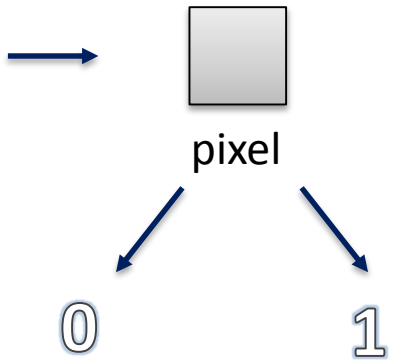
This process consists on readjusting the size of an image based on a certain criteria.



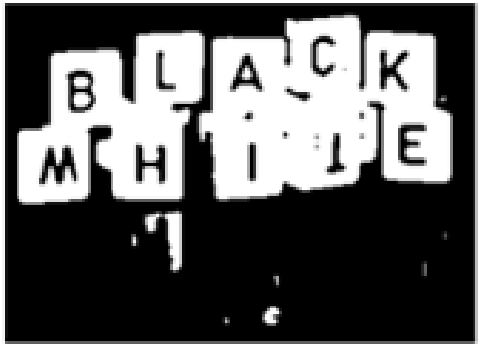
Standardizes proportions

Thresholding

Is a segmentation method. It is a nonlinear operation that converts a gray scale image into a binary image [4].



Original image



Global threshold

Adaptive Thresholding

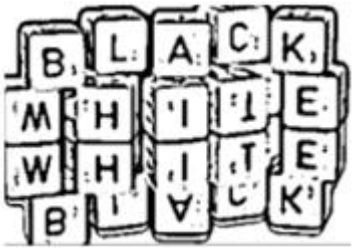
Is a variation of the global thresholding, the threshold value is dynamic or local [4].

This procedure is performed with a convolution with a Gaussian window.

Properties:

- The pixels' weight decreases compared to the center.
- The farthest pixels are the most insignificant
- Preserves low frequencies and removes the high ones

Original image



Adaptive thresholding

Parameters:

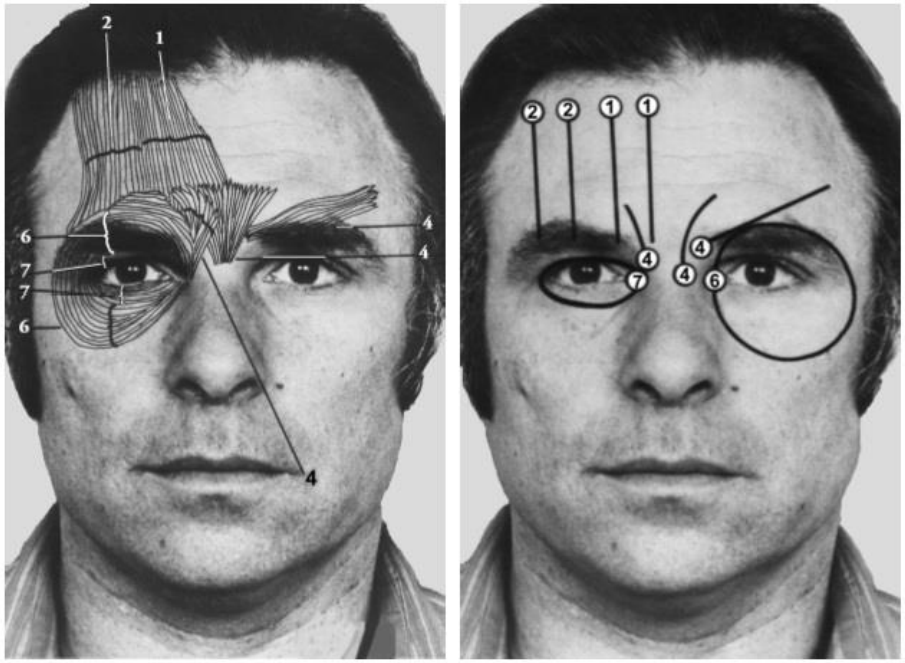
(size  , σ)

Hough Circle Transform

$$x = x_{center} + rcos(\theta),$$
$$y = y_{center} + rsen(\theta).$$

It is used to determine parameters triplets as: $(x_{center}, y_{center}, r)$ to describe each circle which center falls in the perimeter above described [5].

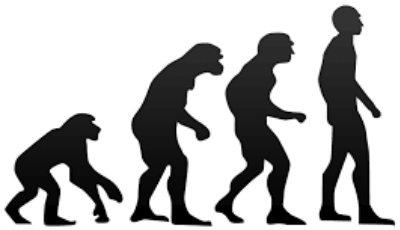
FACS (Facial Action Coding System)



- Validated emotion coding system.
- It was first designed to taxonomize human movements.
- It assigns each facial movement an Action Unit (AU), it can be interpreted as the smallest visible units of muscular activity in the face [6].

Genetic Algorithm

- Genetic algorithms are an example of adaptive heuristic methods, which are commonly used to solve search and optimization problems.
- Genetic algorithms are based on genetic processes, living organisms follow .



Similarly to what happens in nature, genetic algorithms are based on a population of solutions, each of those solutions have a given value, representing the individual's chance to reproduce [7].

Shi Tomasi Algorithm

Based on Harris Corner detector algorithm. It basically finds the difference in intensity for a displacement of (u, v) in all directions [8].

$$E(u,v) = \sum_{x,y} w(x,y)[I(x+u, y+v) - I(x,y)]^2.$$

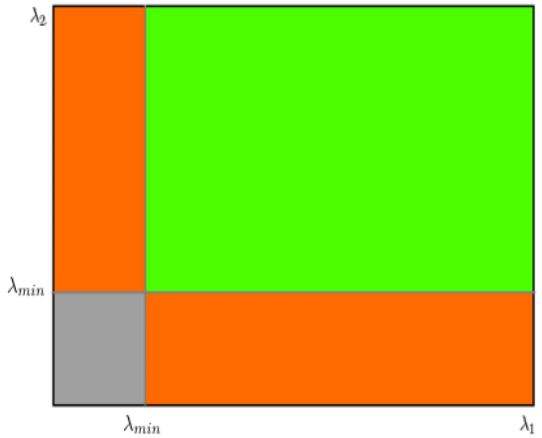
Window function is a rectangular window which gives weights to pixels underneath. Applying Taylor expansion we get:

$$E(u,v) \approx [u \quad v\,]\, M \begin{bmatrix} u \\ v \end{bmatrix}, \qquad \text{where,} \qquad M = \sum_{x,y} w(x,y) \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix}.$$

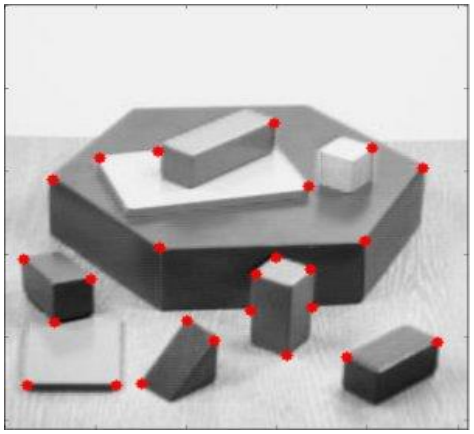
Shi Tomasi Algorithm

I_x and I_y are image derivatives in x and y directions respectively. The scoring function in Shi Tomasi is given by:

$$R = \min(\lambda_1, \lambda_2).$$



Here is an example of the algorithm implemented.

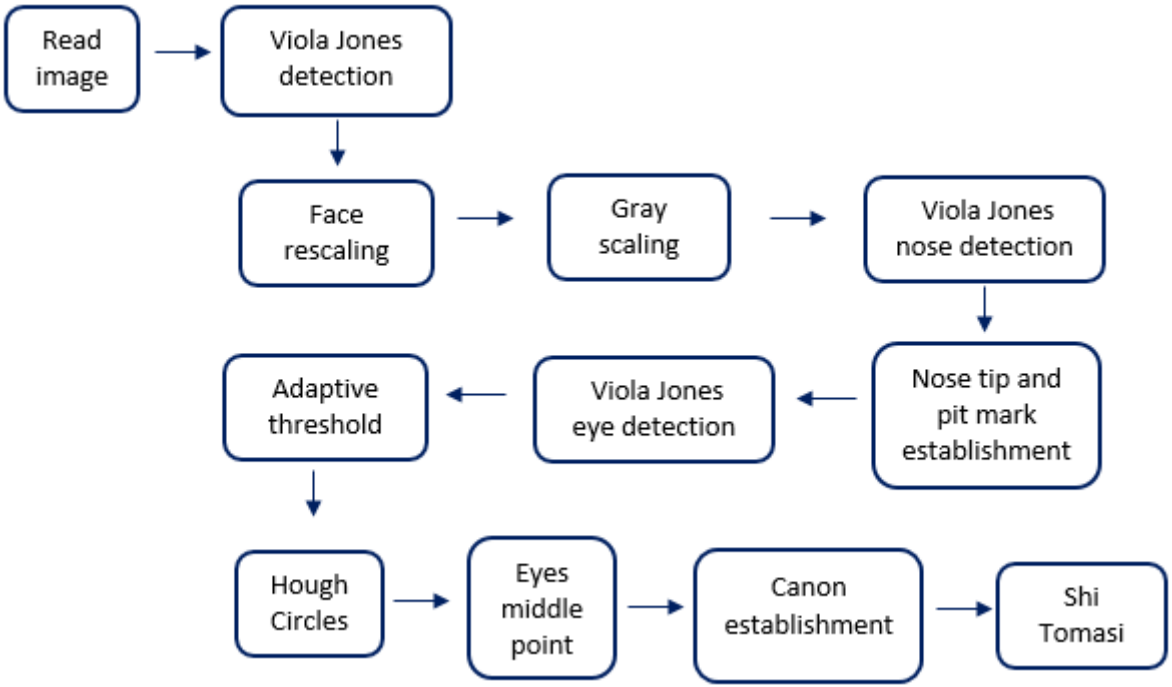


Objectives

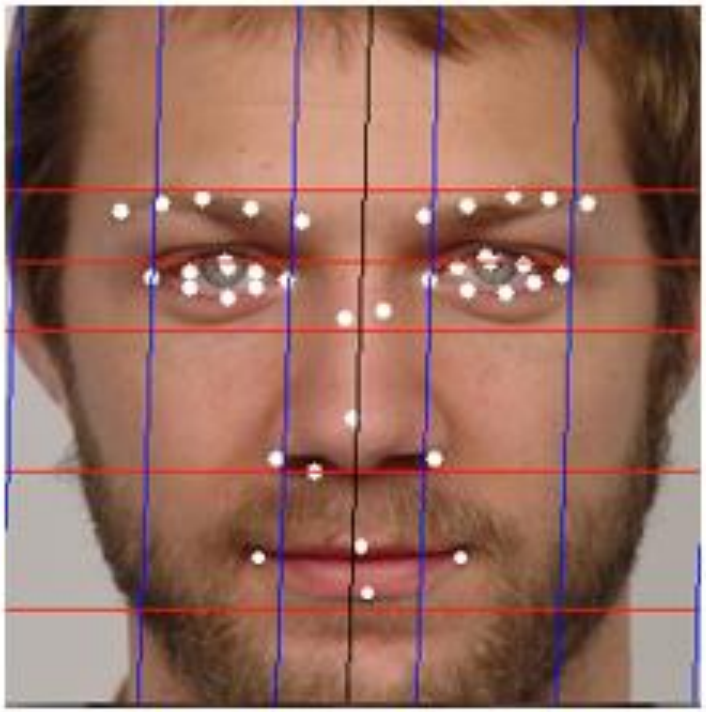
To improve the methodology used in the previous research practice, seeking for a more robust algorithm to extract features from noisy images.

- To study optical processing techniques to approach the problem of features extraction.
- To study different pre-processing techniques for images, in order to strengthen the algorithm.
- To use filters in images, to minimize the noises that difficult the feature extraction and therefore the emotion detection.
- To verify whether different features can be treated as noise.

Proposed algorithm



Results I



Achieve the objectives:

- ✓ The canon follows the inclination of the face
- ✓ The marks where stablished in the accurate places
- ✓ More marks where established
- ✓ The beard that is consider noise, did not affect the results

☆ The accuracy of the algorithm in noisy images is the result of the use of the adaptive threshold

Difficulties

The algorithm lack automation; the parameters of several functions where adjusted manually

- ☆ Adaptive Threshold

Viola Jones detection algorithm in Python did not follow our purposes

↓

FACS images; which are necessary to validate the proposed algorithm

Genetic Algorithm

The target of the genetic algorithm is to minimize

Cost function:

$$E = \sum_{i=1}^{n} \sqrt[2]{(x - x_{est})^2 - (y - y_{est})^2}.$$

Algorithm 1 Pseudocode Genetic Algorithm

```
Read(Nparents ,Nchildren,Ngenerations)
while Ngenerations and Convergence condition do
   parents=selection(generations)
   children=crossover(parents)
   if mutation=true then
      children=mutation(children)
   end if
   generation= parents + children
end while
solution= best(generation)
return  solution
```

Results II

Global threshold

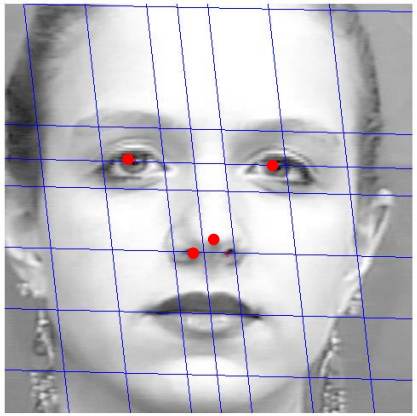
Block size	Weighted mean	Threshold
7	6.2272	0.3070

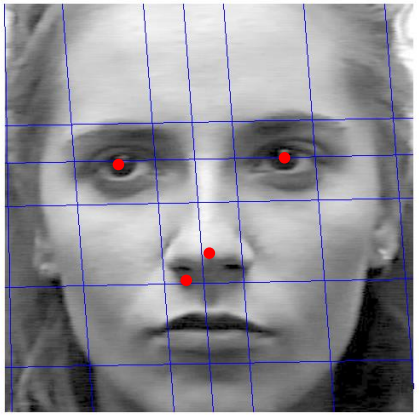
Adaptive threshold

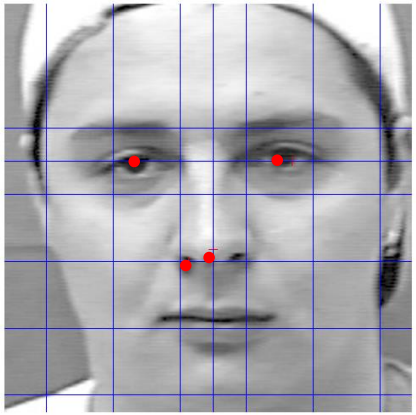
Original FACS image

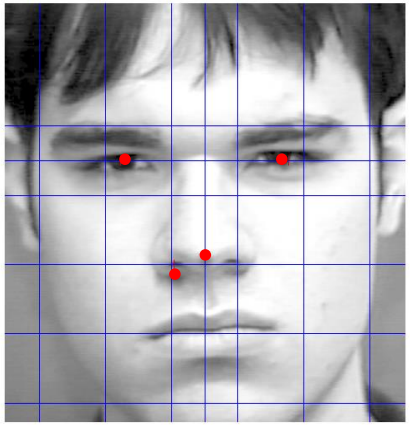
Lightning correction function

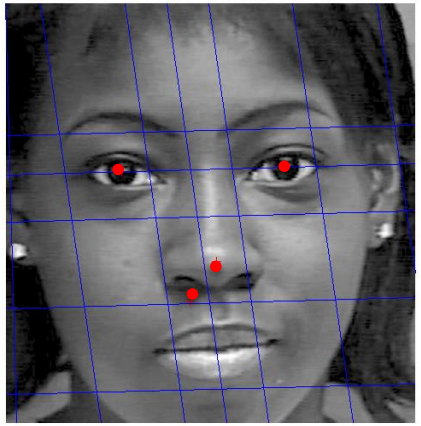
Final Results











Conclusions

- The result obtained in Python fulfills the objective of the present investigation.
- The detection algorithm (Viola Jones) along with the canon of proportions are the base of the marks establishment process.
- Optical processing is an useful tool to treat noisy images and the feature detection process.
- The parameters obtained with the genetic algorithm gives accurate results.
- The lighting correction improves the performance of the detection algorithm.

Future Work

- Implement the genetic algorithm to estimate the parameters of the other functions.
- Evaluate the performance of a detection algorithm different from Viola Jones
- Evaluate different canons of proportions depending on the features of the face to be processed

References

[1] NeuroWikia, "Bases neurobiologicas de las emociones," 2013.

[2] Viola, P., & Jones, M. J. (2004). Robust real-time face detection. International journal of computer vision, 57(2), 137-154.

[3] Ricketts, R. (2002). La divina proporción. Goldstein R. Odontología estética, principios, comunicación, métodos terapéuticos. 193-21

[4] Docs.opencv.org, 'Miscellaneous Image Transformations — OpenCV 2.4.11.0 documentation', 2015. [Online]. Available: http://docs.opencv.org/2.4.11/modules/imgproc/doc/miscellaneous_transformations.html.

[5] Docs.opencv.org, 'Hough Line Transform — OpenCV 2.4.11.0 documentation', 2015. [Online]. Available: http://docs.opencv.org/doc/tutorials/imgproc/imgtrans/hough_lines/hough_lines.html.

[6] Ekman, P., & Friesen, W. V. (1977). Facial action coding system.

[7] M. Mitchell, An introduction to genetic algorithms. MIT press, 1998.

[8] Opencv-python-tutroals.readthedocs.org, 'Shi-Tomasi Corner Detector & Good Features to Track — OpenCV-Python Tutorials 1 documentation', 2015. [Online]. Available: http://opencv-python-tutroals.readthedocs.org/en/latest/py_tutorials/py_feature2d/py_shi_tomasi/py_shi_tomasi.html.

Thank you!