Face Detection - Integral Images and Haar-like features

Computer Vision

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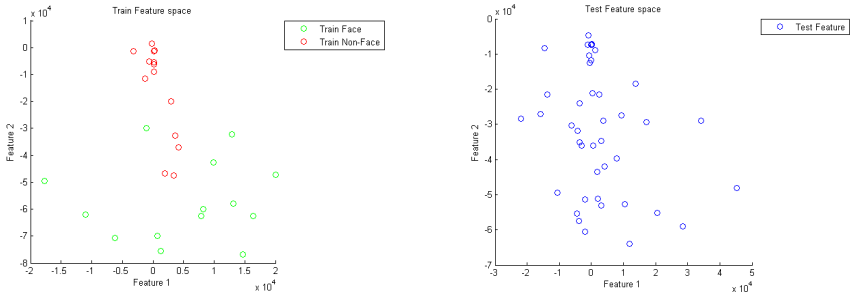
1 Exercise 1: Haar-like features and Classification

1.1 Part 1: Compute and visualize Haar-like features

- Explain the obtained 2-dimensional plot on the feature space.



(a) Training computed features labelled (b) Test computed features not labelled

Figure 1: Plots of the features obtained from the train and test windows analyzed of the train and test images.

In figure 1a we can observe than the features considered non-faces are concentrated on a zone of the future space, while the face features are distributing more spread on the feature space represented on the plot.

- Given this 2-dimensional plot, can we infer the defined Haar-like features are appropriate for face/non-face discrimination?

  From the observations on the previous plot, we can think about classifying the features using a k-nn classifier for the unlabelled test features.

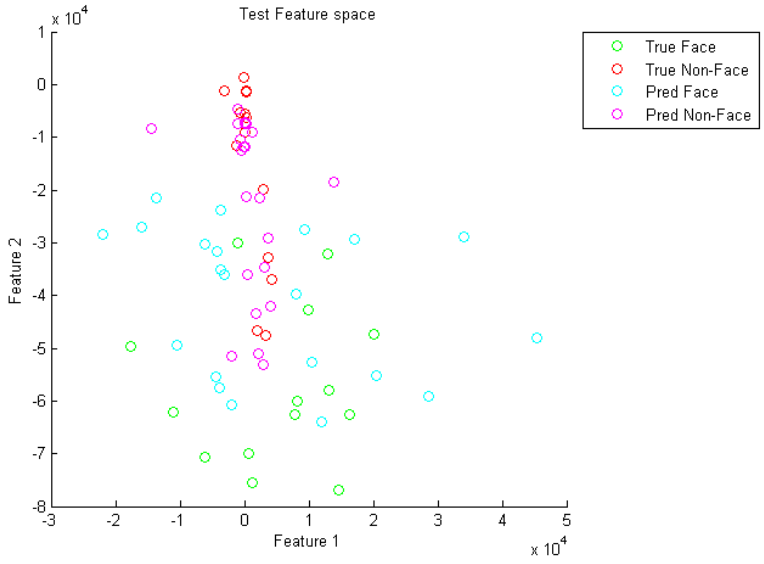


Figure 2: Testing features labelled using k-nn with the training features

In figure 2 we can observe than the features considered how the zones containing face features and non-face features become more clearly defined after introducing the test data with k-nn to the labelled feature space.

Finally we want to check if this spatial feature representation used for applying k-nn for classifying the features was a really relevant training set for being applied to our test set. So we will apply the validation step using a simple visual plot of the features predicted by k-nn on the test image.

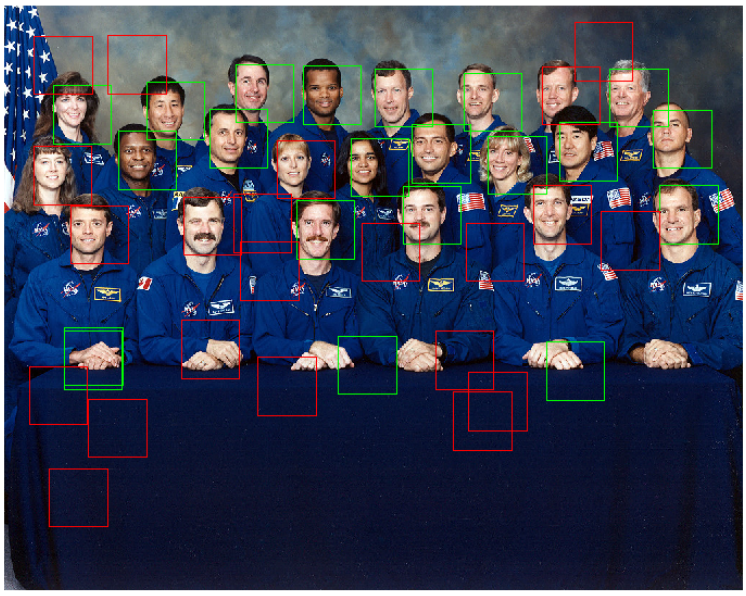


Figure 3: Testing features labelled using k-nn with the training features

In figure 3 we can observe than with just two features and few training samples, we are classifying prety well. We just have 4 false positive features, so our precision is quite high. From this observations we can say than yes, the defined Haar-like features are appropriate for face/non-face discrimination with the data used.

1.2 Part 2: Classification in the feature space

- Is the result good enough? Explain your response.

		True	
		Face	Non-Face
Predicted	Face	17	4
	Non-Face	**6**	15

Table 1: Confusion matrix obtained using 2 features for the Face/Non-face detection obtained from evaluating figure 3.

In table 1 we can observe than, with just two features and few training samples, we are loosing too many true faces, and we would consider a it a "good enough" result if the recall was maximum. The face detection problem is usually an unbalanced problem, and we can't afford having false negatives on the confusion matrices of the methods being used.

So I would conclude than it's **not** "good enough", even considering the lack of training samples and the lack of features used.

2 Exercise 2: Haar-like features and Classification

- Is the result better? Explain your response.

  Yes, the result has actually passed from a non-acceptable result (even for obtaining a partial solution), to a 100% perfect result, for our initial problem on the used data, without any misclassified testing sample.

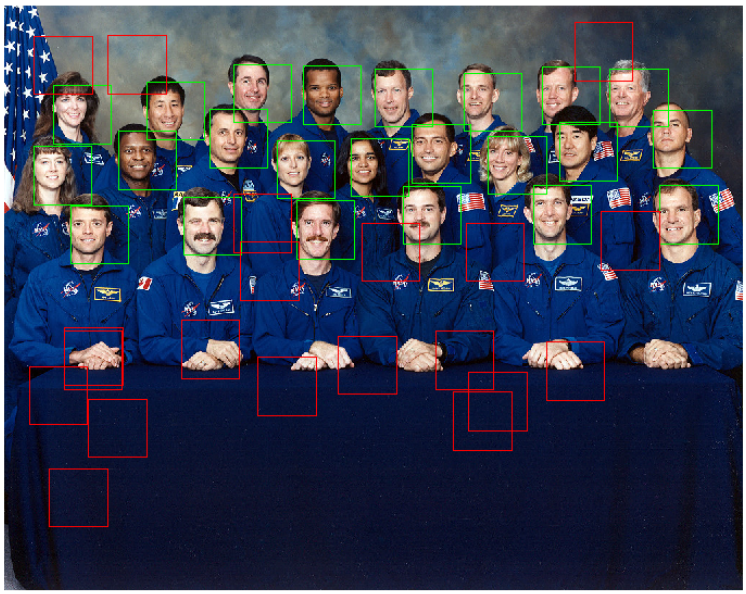


Figure 4: Testing features labelled using k-nn with the training features

In figure 4 we can observe than with 6 features we obtain 100% accuracy on the testing image windows. So from increasing the number of features now we can say that we are able to solve perfectly well the face/non-face classification problem using features and a k-nn (k-1) classifier, on the given data.

3 Exercise 3: Apply and evaluate Viola & Jones method on a video

- Is the Viola & Jones method detecting faces in the video frames?

  Yes, it is detecting faces in the video.

(a) Video frame with a detected face from person a

(b) Video frame with a detected face from person b

(c) Video frame with a detected face from person c

(d) Video frame with a detected face from person d

Figure 5: Examples of faces detected from different people on the video used.

In figure 5 we can observe how, indeed, Viola & Jones method is detecting faces in the video frames. Even if they are very different or have very extreme expressions.

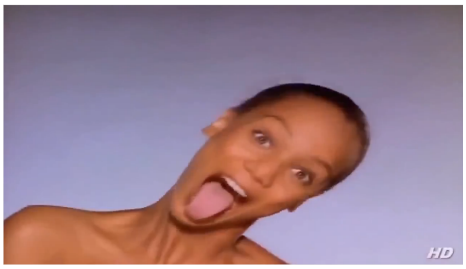
- When is the Viola & Jones method not able to detect the faces? Explain your response.

  After analysing the video we have distinguished some different cases on which Viola & Jones method is not able to detect the faces.

  1 Lateral faces, as we can see on figures figure 6a and figure 6c.

  2 Rotated faces, as we can see on figures figure 6b and figure 6d.

(a) Video frame with a non detected face from person a



(b) Video frame with a non detected face from person b

(c) Video frame with a non detected face from person c

(d) Video frame with a non detected face from person d

Figure 6: Examples of faces not being detected from the people, selected in for previous question, of the video used.

From this cases presented in figure 6, and after analysing the whole video, we concluded that Viola & Jones method is only detecting frontal faces on the video. So any turned or twisted, rotated face can't be detected by this method.