Face recognition using eigenfaces and the CrCb colour space

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Abstract

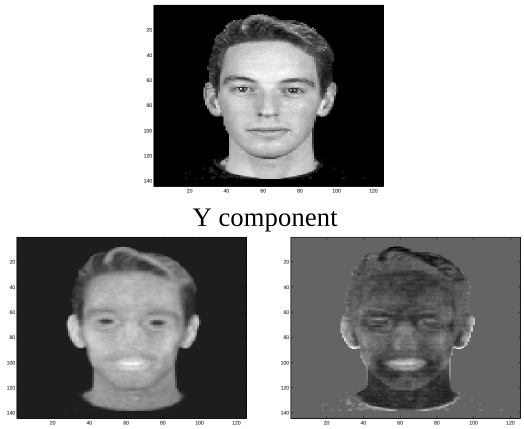
Most research on face recognition has focused on using the grey-scale intensity images for recognition. This is sensitive to changing lighting conditions. Colour is increasingly being used as a method for overcoming this sensitivity to lighting. In this paper, we investigate a simplistic method of using purely chromatic information for recognition and evaluate its performance relative to the standard eigenface technique on the XM2VTS database.

1. Introduction

Much of the research on face recognition has focused on using grey-scale images. With the increasing availability of colour images, it makes sense to investigate approaches of integrating colour information into the recognition process.

The grey-scale approach is also sensitive to lighting variations. An approach successfully used in face detection (see [1] or [2]), is to ignore the intensity information and use purely the chromatic information. Thus we are interested in investigating whether this is a sensible approach to use for face recognition.

It is not immediately obvious that this will be the case. For instance, in figure 1, we show the separate components of the YCrCb representation of the face. The person is immediately recognisable form the Y image, but the Cr and Cb components are less recognisable.



Y component

Cr component   Cb component

Figure 1: Different views of a face.

2. Experiment Design

To test the hypothesis, we constructed a test based on the XM2VTS database provided by Surrey University (see [3]). Note that we are interested in a comparison of the available information for recognition between the intensity channel and the chromatic channels. Thus we are not implementing full face recognition system.

First we need to decide on a suitable colour-space. There are several possible choices, but for the purposes of this experiment, we chose to use the YCrCb space. We wish to compare the recognition performance on the Y component against each of the Cr and Cb components and against a combination of the two chromatic components.

There are many possible approaches to face recognition. We decided to use a simple method based on eigenfaces (see [4] or [5]), using a simple nearest neighbour rule for classification and 20 eigenfaces as features.

The eigenface technique has been frequently described, so we will not provide details here. For the Cr and Cb cases, the implementation works exactly as the for the grey-scale case. For the combined case, we constructed the image vectors as a concatenation of the Cr and Cb cases, i.e. if $\boldsymbol{I}$ was the Cr component and $\boldsymbol{Q}$ the Cb component, then the CrCb representation is given by

$$\boldsymbol{C} = \begin{bmatrix} \boldsymbol{I} \\ \boldsymbol{Q} \end{bmatrix}.$$

Better results can be obtained by using considering the two components as separate experts and combining the results using an additional step, but that aspect of our system is still under development. This simplistic approach is sufficient for the purposes of this experiment.

We based our test on configuration 2 in the Lausanne protocol used in [6]. However, since we only wish to compare the performance of the different colour-space components against each other and since there are many aspects of our eigenface implementation that should be improved before we would consider it as a face recognition system, we simplified the test somewhat by ignoring the evaluation sets.

With this test design, we have 4 example images of 200 different person in the database for training and 2 more of each person for testing correct verification performance, while we have 8 images of 70 people to use as imposter claims. To normalise position, scale and rotation of the faces, we preprocessed the images using a simple ellipse-fitting scheme. This approach is not particularly accurate, but gives reasonable performance and since the images for both the intensity and chromatic tests used the same preprocessing stage, errors here, while affecting the overall performance figures, should not unduly affect the relative performance.

3. Results

We compare 4 different representations. As a baseline, we use the Y component as a measure of the grey-scale accuracy. For this case, we obtained an equal error rate of 25.5%. We plot the false acceptance rate (FAR) and the false rejection rate (FRR) are plotted in figure 2.

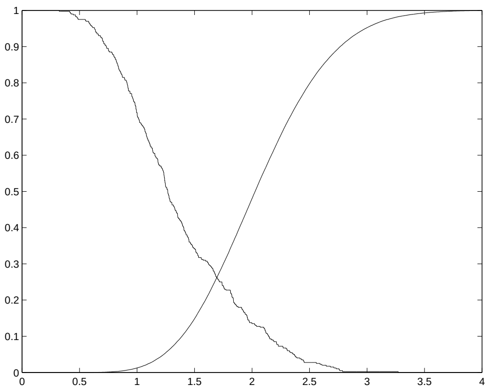


Figure 2: FAR and FRR for Y component.

Using the Cr component, we achieved a equal error rate of 27%. The FAR and FRR curves are plotted in figure 3.

Using the Cb component, the equal error rate was 30%. The results are plotted in figure 4.

Using both, we achieve a equal error rate of 26.5%. This is only a marginal improvement over the Cr case. This suggests that a more intelligent method of combining the information in the two components is needed. The results are plotted in figure 5.

4. Conclusions

We get similar results between the different chromatic choices. The grey-scale intensity choice is more accurate than any of the chromatic choices, but not by a significant margin. We can conclude that there is sufficient information in the chromatic section of the image for recognition, so we should be able to design a reasonable recognition system using only chromatic information. In this case, it would appear that the choice of Cr component provides more information than the Cb component, which agrees with the visual intuition from figure 1. Further work is obviously needed on the comparing the different possible chromatic spaces to determine the best choice.

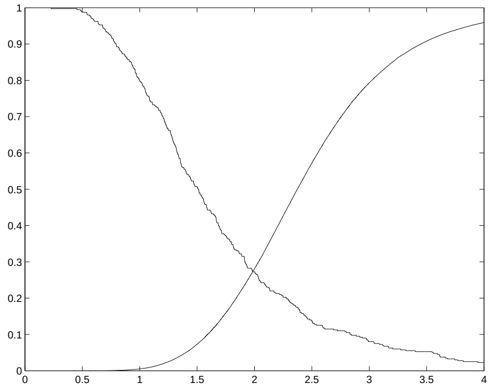


Figure 3: FAR and FRR for Cr component.

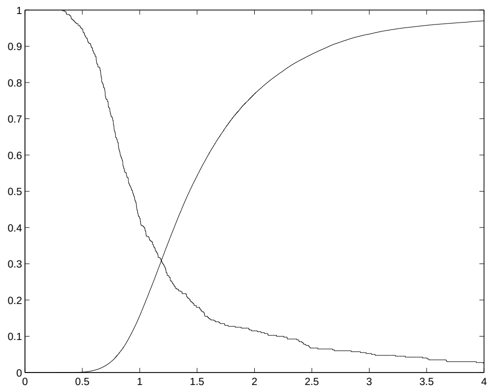


Figure 4: FAR and FRR for Cb component.

While chromatic information help avoid problems with light variation, we can expect that other problems, such as changing hair colour, will become more pronounced. The extent to which the using a chromatic representation affects the sensitivity of the system to changing light conditions is a area we still need to investigate further.

It should be emphasised that this is merely a proof of concept study. Considerably better results than been reported for the grey-scale eigenface case, however, our simplistic image normalisation system and the simple decision rule used are unsuited to a true recognition system (as demonstrated by the results). Future work will focus on improving these aspects. We also need to evaluate our system on the full Lausanne protocol test.

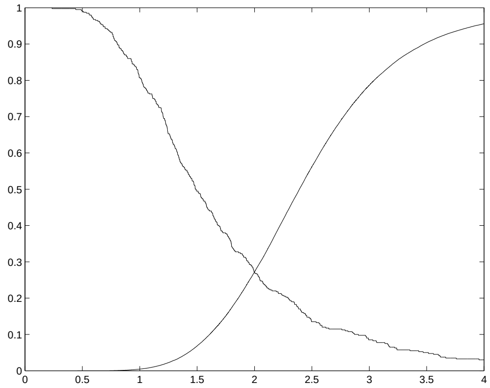


Figure 5: FAR and FRR for CrCb components.

5. References

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