A FACE SPECIFIC SIMILARITY MEASURE FOR IMAGE CODING AND SYNTHESIS

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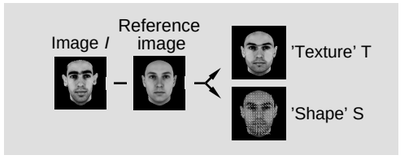
1 INTRODUCTION

What are the contributions of different face regions when judging similarity of faces? Vetter and Troje (1997) introduced a correspondance−based face coding system, in which the image imformation is split into texture information and shape information. By applying a Principal Component Analysis (PCA) on the separate texture and shape, a basis to code any other face can be found.



To code an image *I* it is written as a linear combination of many different textures and shapes:

$$I(\alpha_i, \beta_i) \quad \begin{cases} \sum \alpha_i T_i \\ \sum \beta_i S_i \end{cases}$$

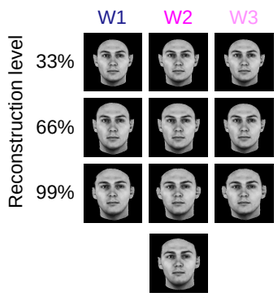
2 WEIGHTING OF THE SHAPE SPACE

To develop a coding scheme that reflects human similarity perception, we introduced a specific weighting of the shape space.

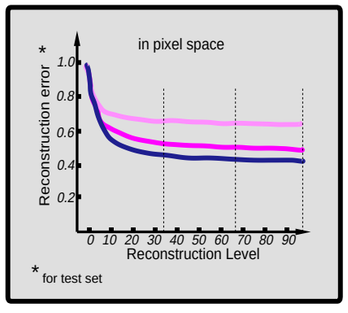
We yielded the following weightings by filtering the Reference face image with a Sobel filter and applying different thresholding oper−ations afterwards.

3 RECONSTRUCTION

Reconstruction examples:



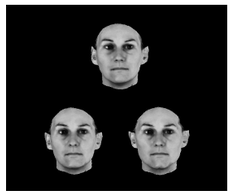
Reconstruction error (L2−error):



In pixel space the reconstruction error of the W1 weighting is less than that of the W2 and W3 weighting.

4 EXPERIMENT 1

Which of the three weightings meets our perception of similarity?



In a 2AFC paradigm subjects were shown three faces at a time: the top face was the original face. The subjects assessed which of the lower two faces was more similar to the top face.

Case 1: In 25% of the trials the original face was shown together with a reconstruction. Originals were only compared with reconstructions on the highest reconstruction level (i.e. 99%).

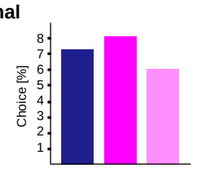
Case 2: In 75% of the trials two reconstructions were shown. Reconstructions were compared on all reconstruction levels within each level (e.g. 33%−33%).

The display time was unlimited until the subjects responded. They were instructed to perform the task as fast and accurately as possible.

RESULTS

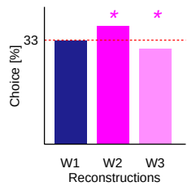
Case 1: Trials where one of the lower two faces was the original

- Subjects were able to select the original face in 78% of the cases.
- When subjects failed to select the original, they favored the reconstruction with weighting W2. ($F(2,18)=3{,}415$; $p=0.055$)

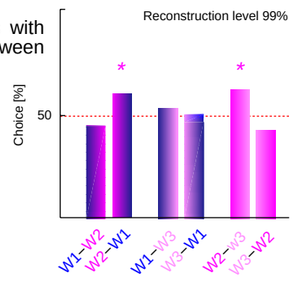


Case 2: Trials where both faces were reconstructions

- Over all reconstruction levels the choice of reconstructions W2 and W3 deviated significantly from chance. This effect started at the 66% reconstruction level.



- The choice preference depends on the shown alternative:
  S's could distinguish between reconstructions with weighting W1−W2 and W2−W3 but not between W1−W3.



W1−W2: Choice of W1 with W2 as alternative.

5 EXPERIMENT 2

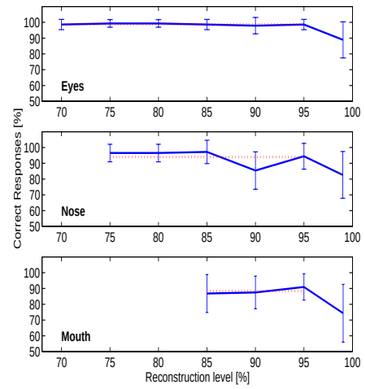
How important are the different face regions ?

After we determined the relevant regions for similarity judgements we measured the threshold of the just noticeable difference (JND) between the reconstructed and original regions.
The face regions determined in Exp.1 with weighting W2 were tested in three blocks. We performed an individual PCA for each region (i.e. on eyes, nose, and mouth) and then reconstructed each region with increasing numbers of Principal Components. These reconstructed regions were embedded in the original face.

In a similar experimental setup as above subjects had to indicate which of the lower two faces was the original. The subjects were told which region was tested. The presentation duration was 2 s.

RESULTS

- The first Principal Component for the different face regions reflects different levels of reconstruction.
- The subjects were able to choose the original face for all reconstruction levels. Only for the highest reconstruction level their correct responses dropped below 75%.
- The subjects showed similar sensitivities to the different face regions.
- The ability of the subjects to differentiate between reconstruction and original decreased only for the highest reconstruction level. But only for the eye and mouth region this was significant.



6 SUMMARY

- To achieve a high similarity between the original and a reconstructed face image it is not necessary to reconstruct all pixels in the face.
- Face regions which can be easily extracted by a filter operation (i.e.the eyes, nose, mouth, and contour region) are perceptually important face regions.
- We did not find any sensitivity differences for these face regions.
- Face images reconstructed with the W2 weighting produced perceiveable image improvement over W1 and W3 reconstructed face images.

The coding efficiency for face images is largely improved by a selective weighting.

An automatic face image quality assessment could be improved by using this specific weighting instead of the L2−error in pixel space.

7 REFERENCES

T. Vetter and N. Troje (1997) Separation of texture and shape in images of faces for image coding and synthesis. J Opt Soc Am A, Vol. 14 (9), p.2152−2161.

I. Craw and P. Cameron (1991) Parameterizing Image for Recognition and Reconstruction. Proceedings of the British Machine Vision Conference, p.367−370.