Creating Face Models from Vague Mental Images

Irene Albrecht Volker Blanz Jörg Haber Hans-Peter Seidel

MPI Informatik, Saarbrücken, Germany

Abstract. We present a novel approach to create plausible 3D face models from vague recollections or incomplete descriptions, such as those given by eyewitnesses in police investigations. Our algorithm for navigating face space is based on a 3D morphable model. It exploits correlation between different facial features learned from a database, and uses a set of attribute constraints that restrict the face to a residual subspace. Faces are manipulated by intuitive parameters or by importing facial elements from a database. To avoid exposure to confusingly different faces, each face in the database is mapped to the residual subspace defined by the constraints.

Introduction. Creating pictures of faces from mental images is relevant not only in law enforcement, but also in art and design, where virtual characters are created from the artist's imagination. In both cases, the *source person* is usually not able to give a complete description of the *target face*.

Our approach takes into account correlations among facial features based on human anatomy and ethnicity. Using these correlations, unspecified parts of the target face are automatically completed to yield a coherent 3D face model. Our system makes the most plausible prediction, given the information provided by the user.

System Overview. The system starts with an *average face*. Updates of individual facial features may affect the whole face due to correlations among the features and the overall face shape. In cases where only little is remembered of the target face, exploiting these correlations may add significantly to the faithfulness of the reconstruction. On the other hand, if the user knows exactly what detail should be changed without influencing any other facial attributes, he can restrict the effect of editing operations to a local area.

Affine transformations may be applied to the face globally or locally. The majority of editing operations involve *facial attributes*, e.g. slitted–round eyes, thin–full lips, etc., which can be modified on a continuous scale using sliders. If the user wants a specific value for a facial attribute to remain untouched by further editing operations, he can add the current setting of this attribute to a list of constraints. In addition, the user may also select the desired features from a database of example faces. To add hair, we render the 3D face model into photographs of hair styles [Blanz et al. 2004].

Learning-based Face Modeling. Based on a morphable model of 3D faces [Blanz and Vetter 1999], facial attributes are learned

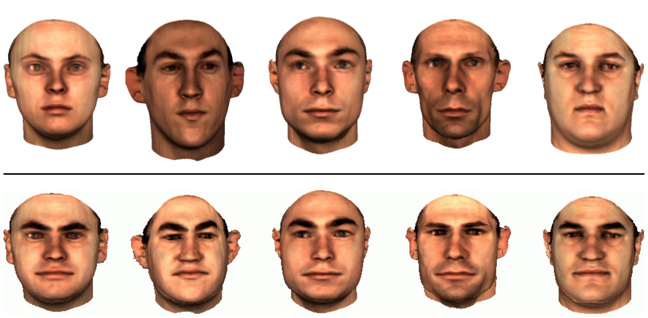
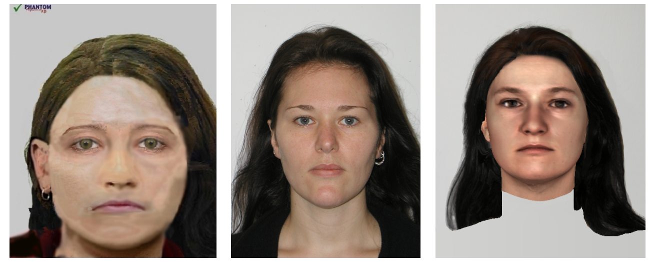


Figure 1: Applying constraints to example faces. Top row: original faces. Bottom row: transformed faces with common settings for skin color, obesity, mouth width, and eyebrow bushiness.



PHANTOM photograph our system

Figure 2: Composites created from the same person's description.

from sample vectors with attribute values assigned by the user. Since attributes are correlated, several attributes may affect the same facial characteristics. Therefore we allow the user to restrict subsequent modifications to the residual subspace of shapes and textures. These constraints can be applied to the model face and to all faces in the database, see Figure 1.

We propose a new strategy to extend the database of faces available for the 3D modeling process to a different population without collecting more 3D scans. For this, we use photographs of new faces and reconstruct their 3D shape.

User Study. To evaluate our system, we conducted a user study involving four source persons and two target persons unknown to them. Each target person was shown face-to-face to two source persons for 60 seconds. All source persons participated in reconstructing the target faces using both our system and the PHANTOM PROFESSIONALxp© system [UNIDAS 2005]. The sources described the target faces to the operators of the systems and provided feedback during the process. A forensic artist created images of the target faces using the PHANTOM system, where a face is assembled from parts of faces in a database and then imported into an image editing system for post-processing. Each composite image was created in 2–3 hours. Our system was operated by computer scientists. It took 1.5–2 hours to create each target face model. A comparison of results created with both our and the commercial PHANTOM system is shown in Figure 2.

For both target faces, the forensic artist considered a reconstruction with our system the best. One source favored the PHANTOM system, while all others felt more comfortable with our system. The sources appreciated that our system provided meaningful parameters for face manipulation and that it allowed them to inspect the faces from different angles.

Conclusions. Due to the underlying statistical model, our system supports the user in the difficult task of bringing his mental image to the screen without restraining him. For overall editing operations, the program presents the most probable solution while leaving the user the freedom to override this result.

References

BLANZ, V., AND VETTER, T. 1999. A Morphable Model for the Synthesis of 3D Faces. In *Computer Graphics (SIGGRAPH '99)*, 187–194.

BLANZ, V., SCHERBAUM, K., VETTER, T., AND SEIDEL, H.-P. 2004. Exchanging Faces in Images. In *Comp. Graph. Forum (Eurographics 2004)*, vol. 23, 669–676.

UNIDAS, 2005. PHANTOM PROFESSIONALxp©. `http://www.unidas.com/html/phantome.html`.