Correction of human face 3D model using 2D images

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Introduction. Currently, the processing and reconstruction of human face 3D models is used in various areas, for example, in medicine, criminalistics, etc. For instance, in medicine the 3D models of faces can be used for medical diagnostics, plastic surgery and creation of face prosthetics. In criminalistics, an actual task is the identification of personality. Among the different methods of such identification, the most convenient one is the method of face identification, because in this case the contact between the person and a measuring device is not necessary. There are many methods of identification by photos (2D) [3,5,7,8,9,10,12,15,17], but there are not always enough images to successfully identify a person. This is why a new task emerges – using a 3D model of a person's head to obtain new different images of the person. This leads to the necessity of adapting a generic 3D model of a human head to the specific person. There are different methods of creating a 3D model, based one photo [6,11,13,16] or two photos [1,2,4,14]. This work is dedicated to solving the task of creating a human face 3D model, which is adaptable to a specific person.

Problem statement and solution algorithm. As an initial 3D model of human head, a model created in a program FaceGen Modeller was selected. The model of the head contained approximately 8200 vertices or control points (Fig. 1).

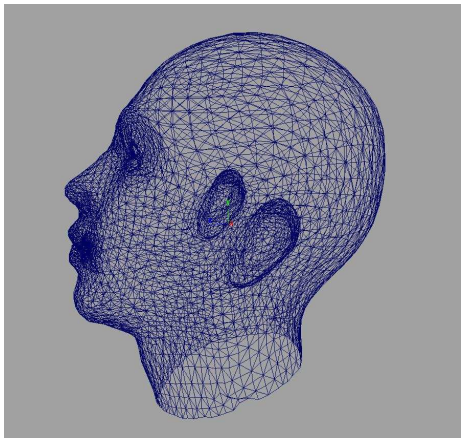

Fig. 1. Initial model

The task was to adapt this initial ED model to a specific person, using the given images (Fig. 2).

Fig. 2. Given image (full face, profile)

Problems solution algorithm. The proposed method consists of the following steps. The selection of a face fragment, that is responsible for the form and size of the nose. For this, it is primarily necessary to choose the corresponding control points of the nose. Each control point P is described by the initial coordinates x, y, z. The coordinates of the control point are transformed in accordance with the transitional matrix.

$$\begin{vmatrix} Sx & 0 & 0 \\ 0 & Sy & 0 \\ 0 & 0 & Sz \end{vmatrix}, \quad (1)$$

where: *Sx*, *Sy*, *Sz* are the coefficients of deformation (compression/decompression). Correspondingly, the transformed coordinates x', y', z' of the control point P are described as follows:

$$\begin{aligned} x' &= Sx * x; \\ y' &= Sy * y; \\ z' &= Sz * z. \end{aligned} \quad (2)$$

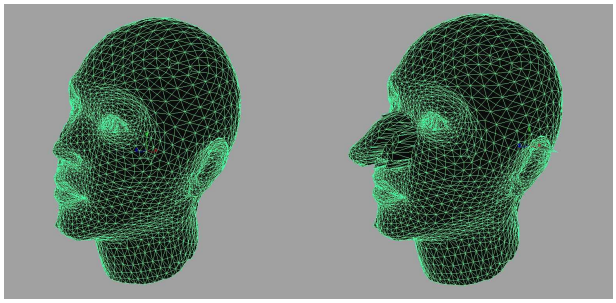

Fig. 3. Modified model (nose)

This transformation is applied to all the object's control points, which belong to the correctable area. For the proper transformation of this area, a weight coefficient is introduced. The weight of the control points on the border

of the correctable area is w=0.5, less than in the area's center w=1. In accordance to this, the transition between the correctable and uncorrectable area is smooth, without the aliasing on the borders (Fig. 3).

Similarly, the other face fragments (head form, ears, nose, mouth) are also modified to adapt to the specific person (Fig. 4).

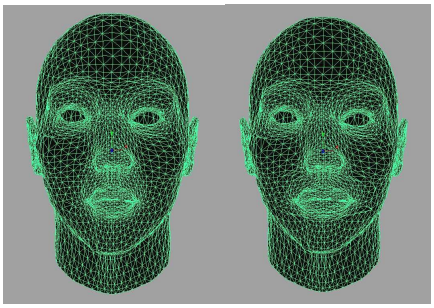

Fig. 4. Modified model (mouth)

Conclusions. The proposed algorithm allows the creation of a human's head 3D model for a specific person, using several 2D images. This, in turn, provides a possibility to extend the learning sample for the classification of new images, when there only a few images are presented. The learning sample is extended by generating images using the created human's head 3D model (by turning and changing the viewing angle of the model). Such extending of the learning sample advances the reliability of classifying new images, which were not present in the learning sample.

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The processing and reconstruction of human face 3D models is used in various areas, for example, in criminalistics, medicine. This work is dedicated to solving the task of creating a human face 3D model, which is adaptable to a specific person. Human face 3D model is adapted by transforming different face fragments (nose, mouth, ears, etc.). The proposed algorithm allows the creation of a human's head 3D model for a specific person, using several 2D images.