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2D to 3D Image Morphing Techniques

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***Abstract*—**This paper describes the techniques of image processing used for construction of 3D face models from a 2D input. 3D models play an important role in various fields. The advances in technologies have put a greater emphasis on efficient techniques of 2D to 3D conversion. 3D models can be developed manually or automatically. Automatic construction process faces certain problems such as identification of the subtle nuances present in the features of each individual. Also presenting a model which has the natural elements of each individual requires consideration. The process can be carried out in two phases; in the initial phase a 2D input is fed as input from which a new 3D model is registered by computing one-to-one correspondence to a 3D model present in a database of 3D models. Next the naturalness of the models is taken into consideration and the unlikely appearance factor is minimized. This paper discusses about the different techniques used in 2D to 3D conversion, how well they have contributed in increasing the efficiency of the process and what future research needs to be conducted.

***Keywords*—**3D modeling techniques, facial modeling, Image registration, photogrammetry, Morphological operation, virtual imaging, facial animation, computer vision, image metamorphosis, view interpolation, view synthesis, image warping

I. INTRODUCTION

3D modeling is a complex procedure and hence demands for an automated process. While manual construction helps in achieving a higher naturalness, it becomes a tedious process when the number of models to be constructed increases. This calls for an automated process. The automated process faces certain difficulties that are listed below.

Problems faced in automated 2D to 3D modeling

- They demand high levels of expertise to avoid creation of unnatural, non face-like models.
- Identification of similar features in different faces.
- Separation of natural faces from the unnatural ones.
- Certain points such as the tip of the nose, eye corners and other less prominent portions are difficult to differentiate and require human intervention.
- Automation can be used efficiently only to determine more prominent features.

In this paper we will discuss the different types of techniques involved in 2D to 3D conversion, starting with the parametric face modeling technique followed by the view morphing and adaptive face modeling technique. We will look into each technique and understand how it is performed. We will also analyze the 3 techniques by making a comparative study.

II. PARAMETRIC FACE MODELING TECHNIQUE

It is a technique of developing 3D models in an efficient way, wherein we try to minimize problems faced during automation. In this a database of 3D models is maintained. A 2D input is taken and a one to one correspondence is done and similar 3D base models are selected from the database. Then by applying pattern classification methods the issues of variations in face models are dealt with. The morphable 3D face model is a combination of various 3D models taken from the database. By combining the similar features of 3D models and the 2D input, a regression process is performed to obtain the correct 3D model. Factors such as age, gender, weight, nose edges, eye corners etc. are all taken into consideration in order to achieve exactness and to avoid creation of unnatural faces[1][2][3][4].

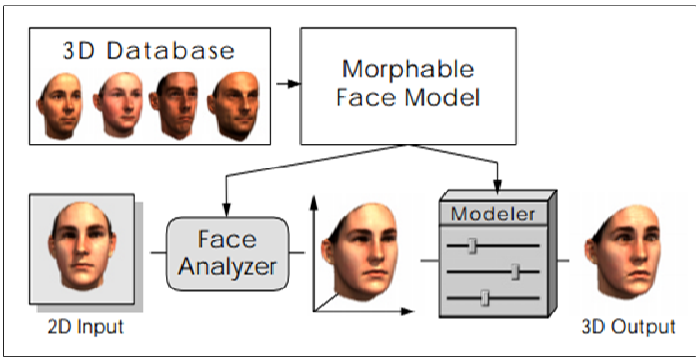

Figure 2.1: Phases involved in parametric face modeling technique [1]

Figure 2.1 shows the block diagram of parametric face modeling technique
It involves the following

a) 3D database containing predefined 3D models
b) 2D input handler which receives the 2D input
c) Face analyzer which observes the features of the 2D input
d) Modeler where 2D to 3D reconstruction takes place by taking inputs from the analyzer and the 3D database

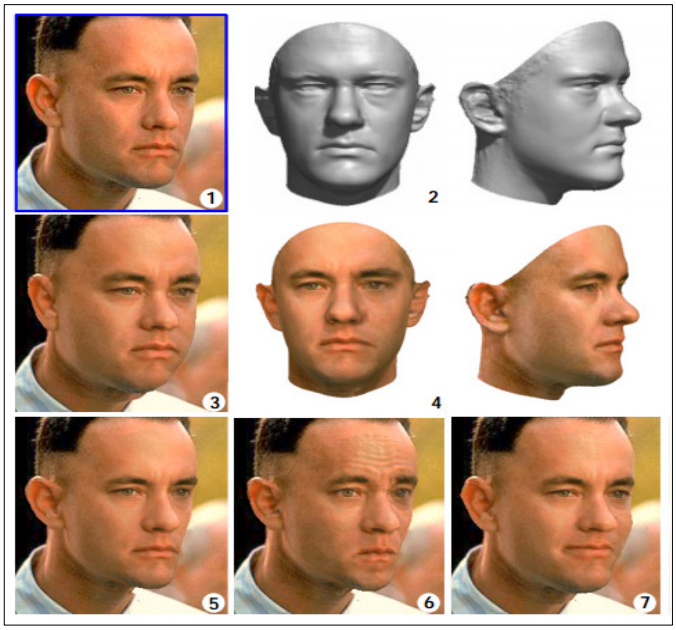

Figure 2.2 Parametric face modeling technique example [1].

Figure 2.2 helps us to understand the parametric face modeling technique where 1 is indicative of the 2D input. 2 shows the morphable 3D model obtained by one to one correspondence process.4 shows the model achieved after regression process and 3,5,6,7 show the variations in expressions or features which can be made once the model is establish, for e.g., gaining weight(3), losing weight(4) , frowning(5), smiling(6)

III. VIEW MORPHING TECHNIQUE

Another technique that is being used extensively is view morphing. The interests in morphing techniques for producing smooth transitions between images have increasing rapidly. These techniques combine 2D interpolations of shape and color to create dramatic special effects.

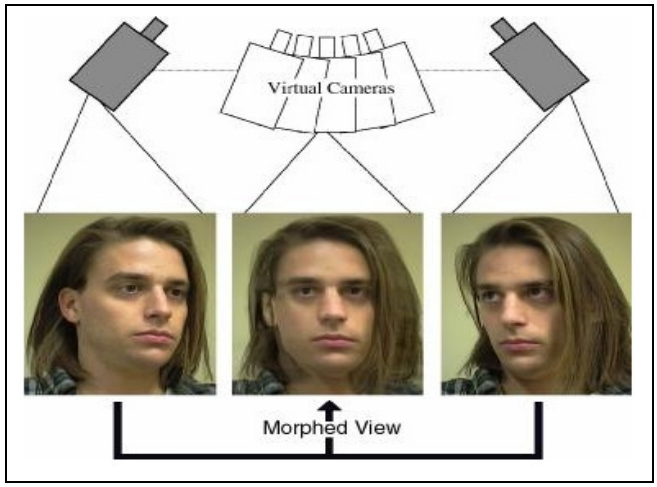

Figure 3.1. Generating a morphed view using view morphing technique [5].

Figure 3.1 shows how a 2D input from 1 angle is projected to create virtual images of the other angles. Left hand side view is given as input and after processing we obtain the central and right hand side views.

The technique of view morphing is presented in this paper. This technique takes a 2D input and is able to create images of the 2D input in all possible views i.e. left-hand side view, right-hand side view, center view etc. All these 2D viewpoints are accumulated and processed to form a comprehensive 3D model. Using basic principles of projective geometry, this paper shows a simple extension to image morphing that correctly handles 3D projective camera and scene transformations. The technique, works by pre-warping two images prior to computing a morph and then post-warping the interpolated images. Because no knowledge of 3D shape is required, the technique may be applied to photographs and drawings, as well as rendered scenes. The ability to synthesize changes both in viewpoint and image structure affords a wide variety of interesting 3D effects via simple image transformations [5][6][7].

IV. ADAPTIVE FACE MODELING TECHNIQUE

This technique focuses on reconstructing 3D faces from single 2D images; it does not require multiple cameras to capture the image simultaneously. This technique increases the representational power of the 3D model by incorporating a greater number of training samples. It uses the approach of first deforming a set of examples in the training data set. A principle component analysis (PCA) based 3D face model is adapted for each new near frontal input face image to reconstruct the 3D face shape. The

results are pretty convincing as this technique outperforms the others with a 95% confidence level.

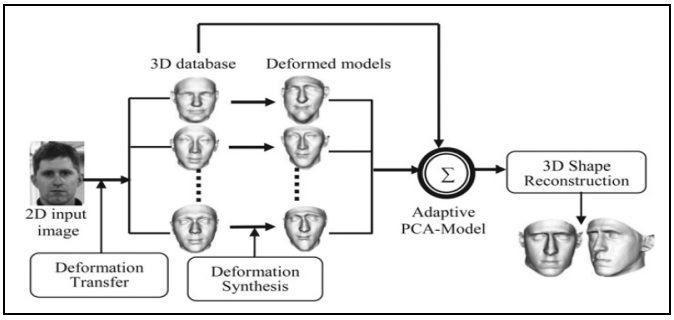

Figure 4.1: Steps involved in Adaptive 3D face modeling technique [9].

The adaptive face modeling technique mainly focuses on including deformed face models into the training database via a deformation synthesis mechanism. The main aim of this technique is to enhance the RP of this technique in comparison to the RP of a standard PCA based modeling technique. The steps involved in this technique are as follows;

- Deforming 3D exemplar faces
- Adaptive PCA model construction

The figure 4.1 shows that first a single 2D image is given as input which through a deformation transfer process. The database consists of a number of 3D face models and their corresponding deformed models. The first step is to choose 3D models for the 2D input; then deformation synthesis is done to get deformed models for each near frontal view of the 2D input. Then all the selected models are combined in an adaptive manner to reconstruct the final 3D face [8][9][10][11][12].

V. COMPARISON BETWEEN THREE TECHNIQUES

Name	Parametric face modeling technique	View Morphing technique	Adaptive face modeling technique
3D database	Yes	No	Yes
Orthographic Views	Front View	Front, RHS, LHS View	Front View
Types of 2D images	Real	Real and Virtual	Real
Deformation of models	No	No	Yes
Speed	Average	Fast	Slow
Accuracy	Average	Less accurate	Very accurate

VI. CONCLUSION AND FUTURE SCOPE

3D model development is a complicated task and involves a lot of stages. Proper implementation of these steps is essential in order to achieve a true model. In this paper we have reviewed some of the techniques which have been implemented in 2D to 3D conversion of images. The parametric face modeling technique makes use of a 2D input and a database of predefined 3D models in order to generate the required 3D model. View morphing technique on the other hand makes use of a 2D input and virtual cameras to generate different views and subsequently the 3D model. The Adaptive face modeling technique makes use of a deformation synthesis mechanism to improve the resolution power of the 3D models and to produce more accurate models. Although progress has been made future work has to be done. The techniques which have been established are good but are unable to produce the quality levels which are expected in today's world. Minute details are often missed out which should be avoided and addressed primarily in the future.

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