Estimation of Missing Facial Views

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Abstract

We describe a method for estimating new facial views from a single 2D face image. A model has been generated which incorporates two facial views, a frontal view and a 30 degree rotated view. Appearance models for each view of shape and texture have been combined using further principal components analysis to form a multiple view model. Presented with a novel face image in a frontal view, we can then use the multiple view model to generate an estimate of the same face as seen from a different viewpoint. The method is general and could also be applied to any object class in which the texture and shape of the constituent objects exhibits significant correlation.

1 Introduction

The problem of estimating the appearance of an object at some arbitrary angle of rotation with respect to an imaging device is well documented. The most common approach is to generate a 3D model of the object and then rotate the model to the desired angle. There are a number of ways of doing this. Blanz and Vetter [1] use a high quality 3D training set to generate a morphable model for synthesising 3D faces. Alternatively, the missing pose can be inferred from a set of 2D images without generating a 3D model. Graham and Allinson [2] have shown that this can give reasonable results. Their approach is based on the use of "virtual eigensignatures" to characterise a subject's face. Cootes et al [3] also use an eigen-face approach although they form their eigen-space differently. They make clever use of a mirror to capture two face views simultaneously. We use a similar method but unlike [3] we have an extensive training set of colour face images in which each face is captured from 7 specific viewpoints.

2 Method

2.1 Generating a Multiple View Model

The multiple view model was constructed from a training set of 200 colour female faces, a subset of a face database obtained from the Max Planck Institute. The set comprised 100 frontal view face images and 100 30 degree, rotated-view face images of the same subjects. These images were captured simultaneously using a Cyberware 3D scanner. Here we only make use of 2 face views although we are currently extending the model to include all 7 views. Simultaneous capture is important if we are to accurately capture the correlations between different facial views

The scheme for generating the model is shown below in figs 1&2. For brevity we have only shown how to construct the appearance model [4] for the frontal view. Appearance models for rotated views follow equivalent schemes.

2.2 Estimation of a Missing Facial View

Given a frontal view image of a subject from outside of the training set, we can use our model to estimate a view of the same subject's face at an angle of rotation of 30 degrees. The estimation process is described in two stages as summarised by figs 4&5. The first stage decomposes the frontal view (known) face image into its appearance model coefficients. In the second stage we use a partial projection technique to synthesize the missing view.

3. Results

Fig 6 shows the typical quality of reconstruction that can be expected from a two-view model based on 200 training images.

Fig 1

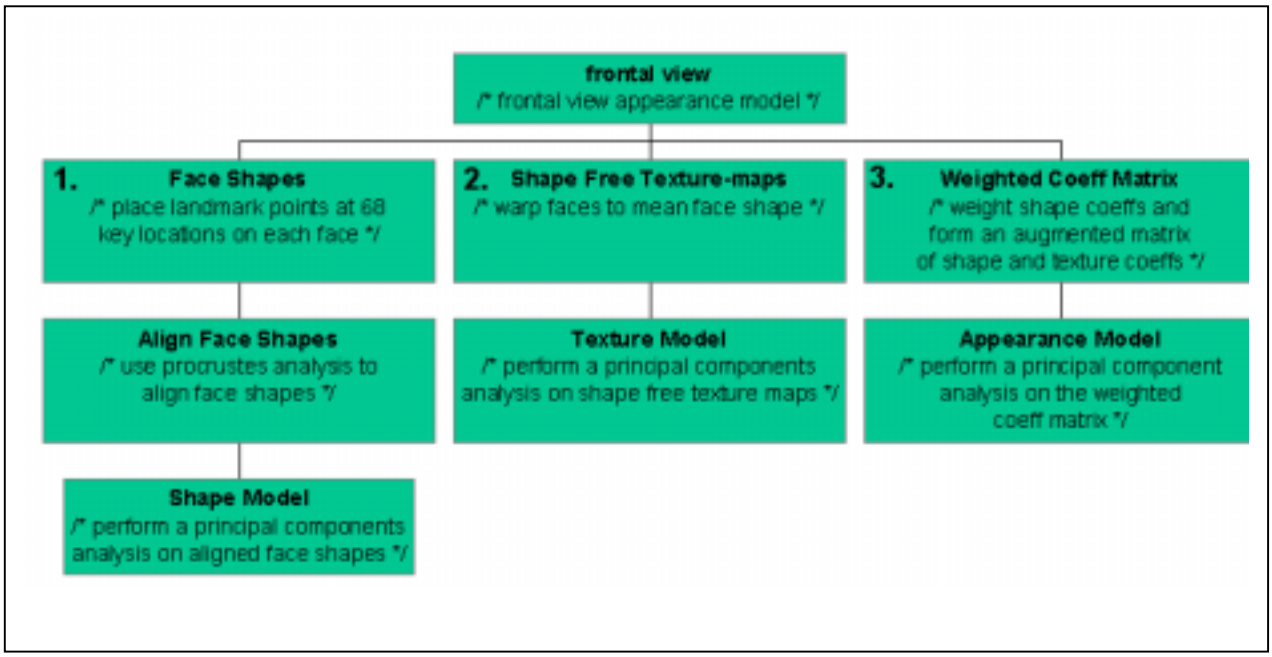


Fig 2

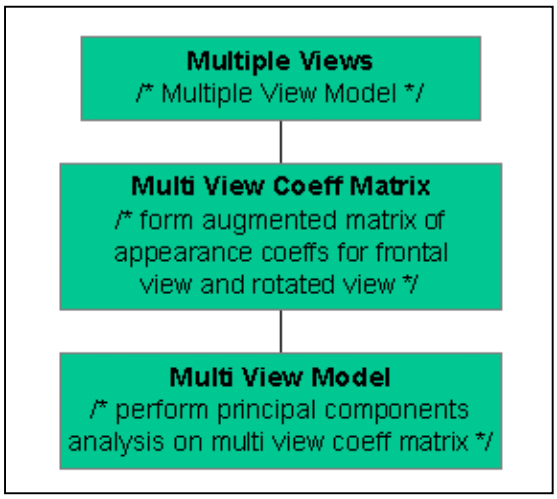


Fig 3

Fig 4

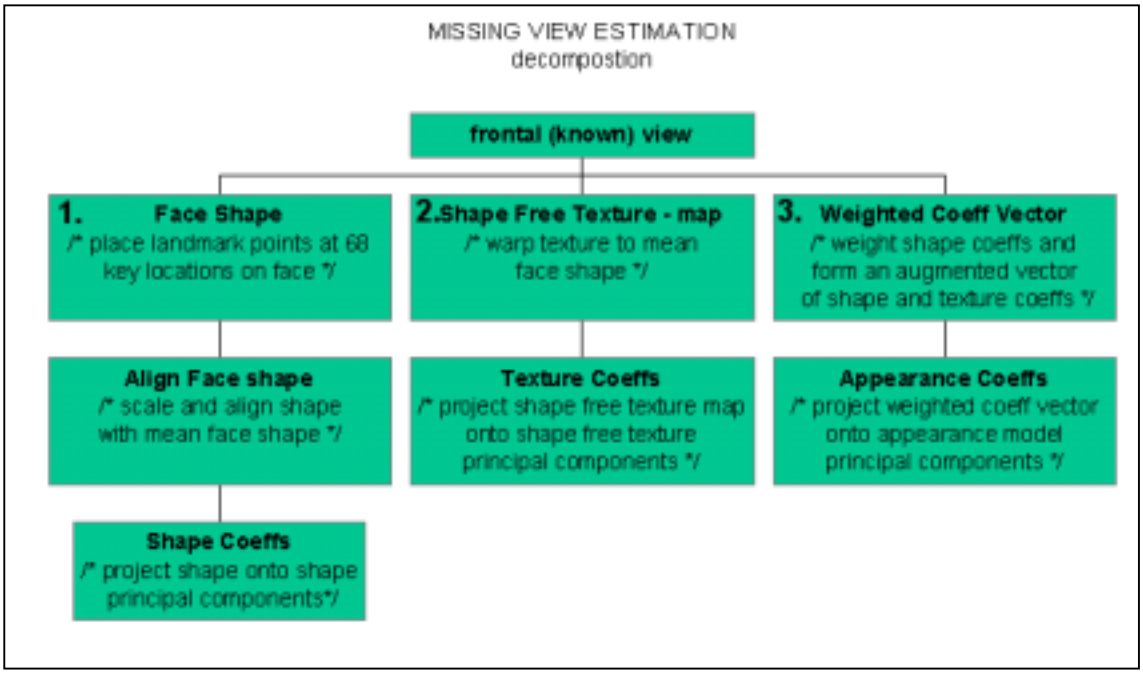
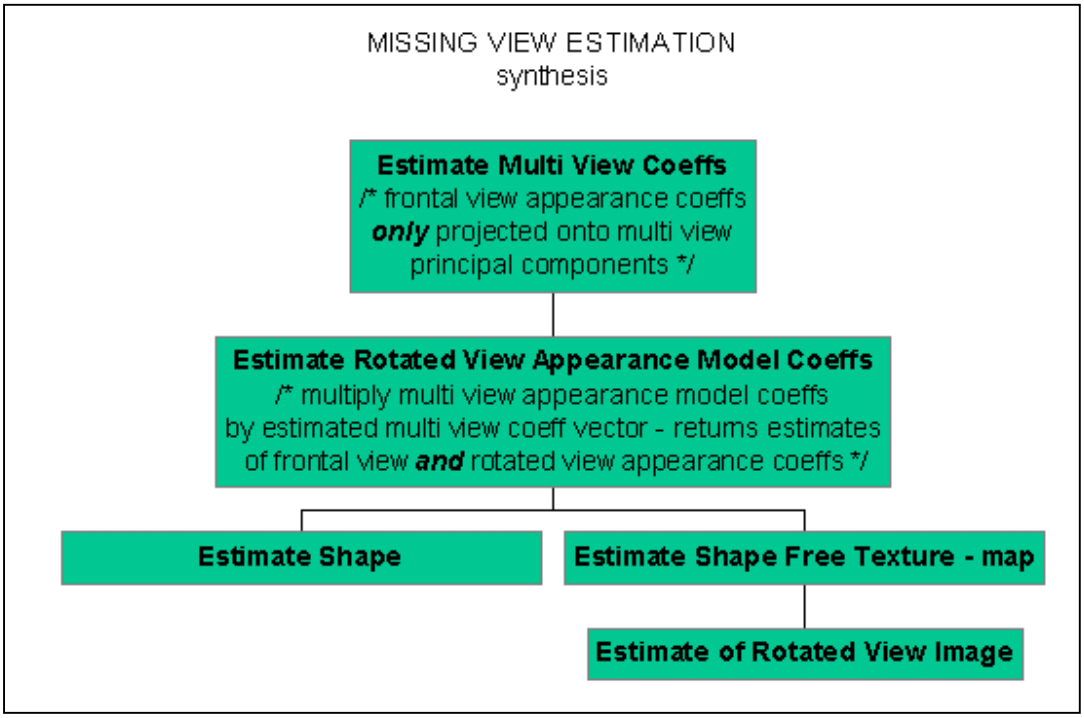

MISSING VIEW ESTIMATION
decompostion
frontal (known) view
1. Face Shape
/* place landmark points at 68 key locations on face */
2.Shape Free Texture - map
/* warp texture to mean face shape */
3. Weighted Coeff Vector
/* weight shape coeffs and form an augmented vector of shape and texture coeffs */
Align Face shape
/* scale and align shape with mean face shape */
Texture Coeffs
/* project shape free texture map onto shape free texture principal components */
Appearance Coeffs
/* project weighted coeff vector onto appearance model principal components */
Shape Coeffs
/* project shape onto shape principal components*/

Fig 5


MISSING VIEW ESTIMATION
synthesis
Estimate Multi View Coeffs
/* frontal view appearance coeffs only projected onto multi view principal components */
Estimate Rotated View Appearance Model Coeffs
/* multiply multi view appearance model coeffs by estimated multi view coeff vector - returns estimates of frontal view and rotated view appearance coeffs */
Estimate Shape
Estimate Shape Free Texture - map
Estimate of Rotated View Image

References:

[1] Volker Blanz and Thomas Vetter, *A Morphable Model For The Synthesis Of 3D Faces*, SIGGRAPH'99 Conference Proceedings, pp. 187-194

[2] D. Graham, N. Allinson, *Face Recognition from Unfamiliar Views: Subspace Methods and Pose Dependency*. In 3rd International Conference on Automatic Face and Gesture Recognition 1998, pp. 348-353, Japan 1998

[3] T.F. Cootes, G.V. Wheeler, K.N. Walker, C.J. Taylor, *Coupled View Active Appearance Models*, BMVC 2000, vol. 1, pp. 52-61

[4] T.F. Cootes, G.J. Edwards, and C.J. Taylor, *Active Appearance models*. In H. Burkhardt and B. Neumann, editors, 5th European Conference on Computer Vision, volume 2, pp. 484-498. Springer, Berlin, 1998.