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A Simple Algorithm for 3D Face Reconstruction Model

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Abstract

We propose a simpler and faster method to construct 3D face model. First, we extract ASM face features and get the depth face image with Kinect. Then, we describe the depth face image with OpenGL in three-dimension coordinate. Owing to the dropped depth information in face edge, we use CANDIDE-3 face model as basic face skeleton to remedy the distortive profile. Here, we match the CANDIDE-3 face model and front face image with the coordinate of ASM feature points. After we get an incomplete 3D face, we need to fill the data to the empty part of side face. According to the skeleton coordinate of face model, we extend the edge information for each row in profile face with the edge pixel in side face till the end edge of face model. Because the repaired 3D face still retains many texture information of original front face image, we can easily achieve a satisfied result with any rotation angle from 0 to ±90 degree.

Keyword: CANDIDE-3, ASM, Kinect, 3D face

1. Introduction

3D face reconstruction methods can be categorized into the following ways: laser scanning, Stripe generator, Stereoscopy, Video sequence and Image reconstruction (Lee & Thalmann, 2000). Among these methods image reconstruction is the most simple, low cost and low consumption time. Image reconstruction usually needs one front and one side face to construct 3D face model (Liu, Su, Yuan & Zhu, 2006) and even only uses one front face to reach the goal.

Liu et al (Liu et al, 2006) sets up a feature set database including three face parts which are extracted with ASM and then combines to a basic 3D face model. Due to these face feature parts are consecutive in a 3D face model, this method will cause discontinuity among these face blocks after 3D face model deformed.

Heo et al (Heo, Park & Savvides, 2008) use a single 2D facial image and propose a method of feature points extraction and analysis from non-frontal face image based on EM

(Expectation-maximization) algorithm. And use a basic 3D face model to create 3D facial images. However, non-frontal face feature information is somewhat insufficient. The feature points obscured must be used to guess the future approach to estimate.

Lai et al (Lai & Wang, 2006) using a 2D face image, 16 feature points manually selected, and a variable facial feature model (Eigen head). They also propose a new 3D face correction algorithm. Then comparison single 2D face with 3D feature face model deformed repeatedly and normalizes all the results to reconstruct 3D face model. However, due to the number of feature points is too less, it results in similarity of models reduced.

Gao et al (Gao et al, 2005) proposed a method of single frontal face image for 3D face reconstruction that using a system to select feature points automatically. And also propose a method of mapping guessingly to fill the texture information of profile that can't be obtained from the front face. However, this method uses only one human face model-based for 3D face reconstruction. If the real facial characteristics are different from the basic human face model too large (such as a square face with a round face differences), it will increase the time of model deformed.

Breuer et al (Breuer, Blanz, Kim, Kienzle & Scholkopf, 2008) proposed a method of automation 3D face reconstruction from 2D facial image or video based on SVM. This method uses SVM to detect the position of the face and gets the information. They calculate whether influence of angle on face, and use estimate method to calculate angle if it is. Selecting characteristics information is which part of the face by using Gaussian distribution. Then use a 3D face model-based and combine with the characteristics information to reconstruct 3D face model. But its methods on the same 2D face model, according to the different angle of the original face, there may result in reconstructing completely different model.

Basri et al (Basri & Hassner, 2006) proposed to estimate its depth information based on posture or shape in 2D image. This method will divide image in different blocks and compare to single object database (such as: hands, fingers or face, etc.) respectively. Then use its algorithm to estimate the depth of the information in 2D images. This method can also be used on 3D face reconstruction, but the goal is to reconstruct the shape and depth. Due to there is no details of feature points, so this method is poor on the performance characteristics. The 3D face model similarity is lower, too.

Gong et al (Gong, Wang & Xiong, 2009) proposed a method of 3D face reconstruction based on TDF (Ternary Deformation Framework). It uses the relationship between feature points of eyes, nose and mouth to calculate the pose of the 2D face image by linear regression. This method simulated 3D face pose have better results. But it due to the feature points too less, and no feature points of the contour of face. So the reconstruction of 3D face image is difference between the areas of the contour of face.

From the above information, we can know that 3D face reconstruction of image-based has three main steps: (1) feature point extraction (2) model selection (3) 3D model deformation. The following will propose method in this paper.

2. Proposed Method

We propose a method to quickly build 3D face models. In this chapter, we will introduce the three steps as following. The flow chart of the proposed method is shown in Fig.1.

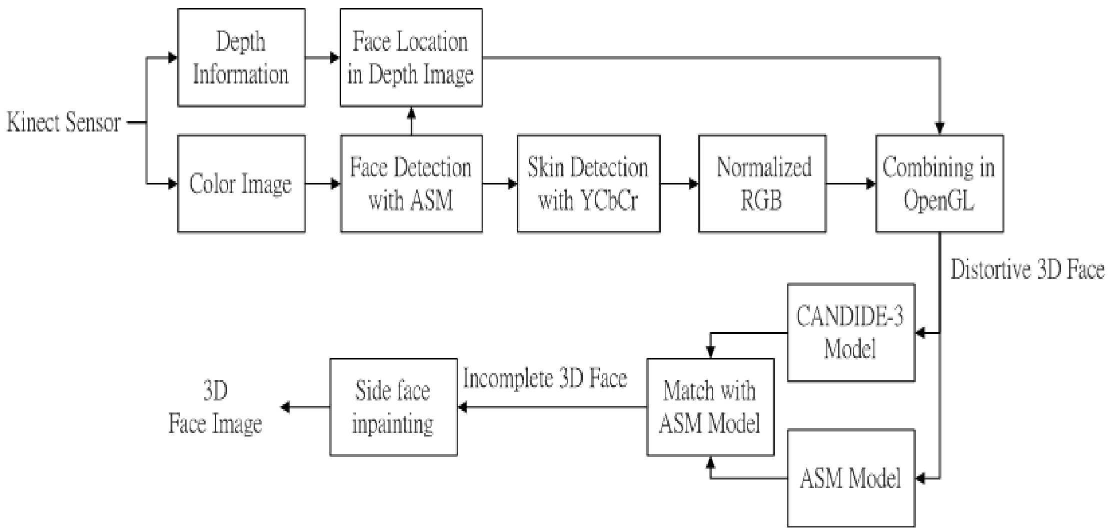


Fig.1: Flow chart of the proposed method

2.1 Extracting Face Information

First, face detection is performed with ASM and these locations of face feature are extracted and also correspond to depth image. Thus, we get the face skeleton both in color and depth image. Then, we distinguish skin color with YCbCr and keep the face component in both images.

$$\begin{aligned} Y &= 0.299R + 0.587G + 0.114B \\ cb &= 0.564(B - Y) \\ cr &= 0.713(R - Y) \end{aligned} \tag{1}$$

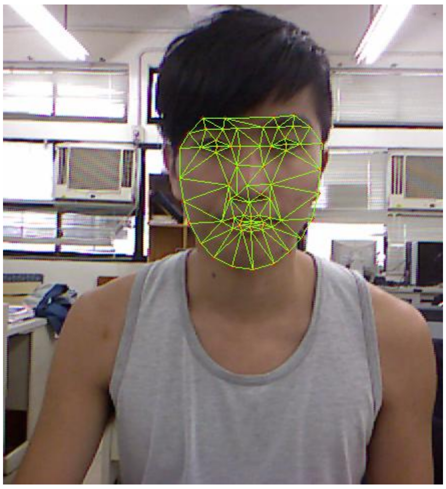


Fig.2: ASM example

(a)Result of Ycbcr (b)Keep the face area

Fig.3: The result of Ycbcr detecting

(a)R image (b)G image (c)B image

Fig.4: R, G, B image after dividing

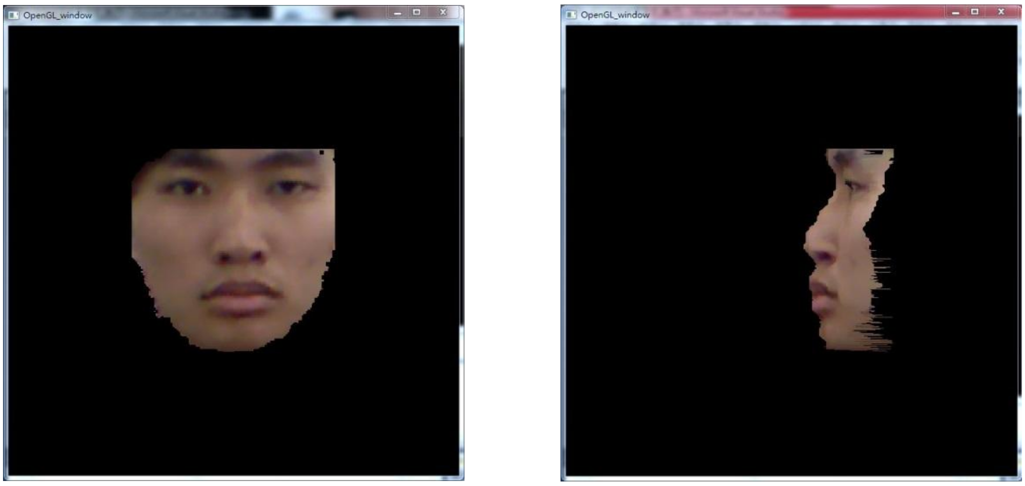
2.2 Drawing in OpenGL

In this step we describe the depth face image with OpenGL in three-dimension coordinate. We normalize the R, G, B values to use in OpenGL, i.e. R, G, B value divided by 256 as formula (2). Owing to the dropped depth information in face edge, we use CANDIDE-3 face model as basic face skeleton to remedy the distortive profile. Here, we match the CANDIDE-3 face model and front face image with the coordinate of ASM feature points.

RGB normalization:

$$\begin{aligned} NR &= OR / 256 \\ NG &= OG / 256 \\ NB &= OB / 256 \end{aligned} \tag{2}$$

Where NR, NG, NB are normalization RGB and OR, OG, OB are original RGB.

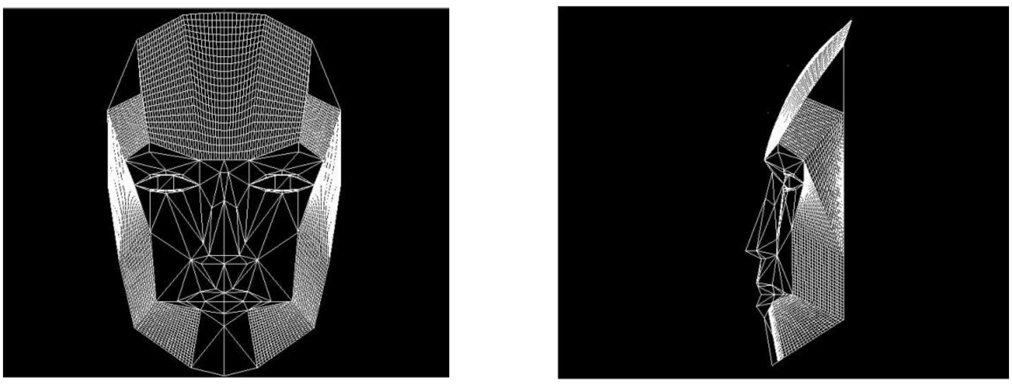


(a) front face (b) side face

Fig.5: Show the 3D face model in OpenGL

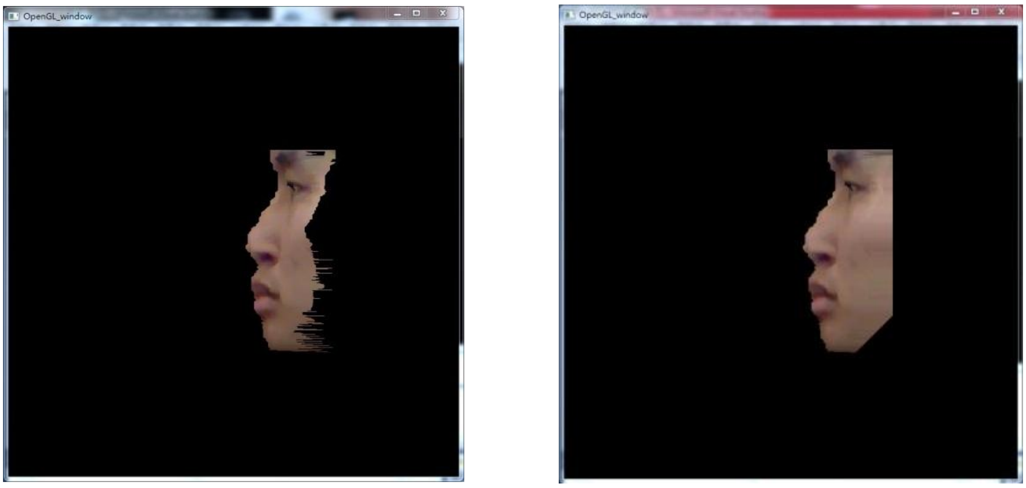
2.3 Side Face Inpainting

After we get an incomplete 3D face, we need to fill the data to the empty part of side face. According to the skeleton coordinate of face model, we extend the edge information for each row in profile face with the edge pixel in side face till the end edge of face model.



(a) front face (b) side face

Fig.6: CANDIDE-3 face model-based



(a) Incomplete face (b) Repairing face

Fig.7: Repair side face result

3. Experimental Result

The experimental environment is indoor. The depth image is captured using Microsoft Kinect. Experimental platform is Window 7 (32 bits), CPU is Intel(R) Core(TM)i5-4670 CPU @ 3.40GHz, RAM is 4.00GB, and the development tools we use are Visual C++ 10.0, OpenCV243, OpenGL and OpenNI2.

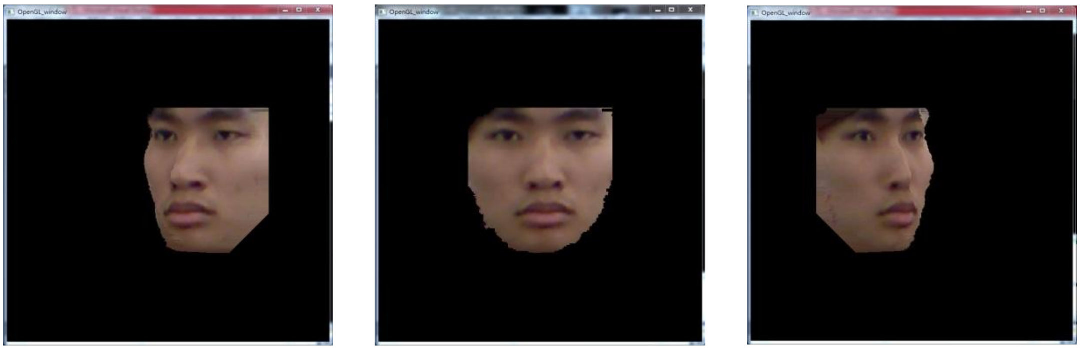
In the experiment, we show the result of 3D image we created by the method we proposed in a variation angle in fig.9, and compare to the original face shown in fig.8.

In Fig.9,(a) and (c) are the side face that angle is 90°.(d) and (f) are the face that angle is 45°. (e) is the front face. (g)-(i) are the variation of angle of elevation, and (b) is the face of angle of depression. As the fig.9 we can prove that the method we propose in this paper can create the 3D images similar to the original face.

(a)left side face (b)front face (c)right side face

Fig.8: Original face

(a) (b) (c)



(d) (e) (f)

(g) (h) (i)

Fig.9: 3D image we created in a variation angle.

4. Conclusion and Future Work

This paper proposes a method to quickly create 3D face model by a single front face image. Color and depth information captured by Kinect are combined with CANDIDE-3 face model based to repair profile information. Finally show the 3D face model in OpenGL three-dimensional space.

In the future we hope to increase the amount of database, and can match a variety of face recognition method of comparison.

5. Acknowledgement

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6. References

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