Preprocessing of 2.5D facial images from stereo camera

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Abstract

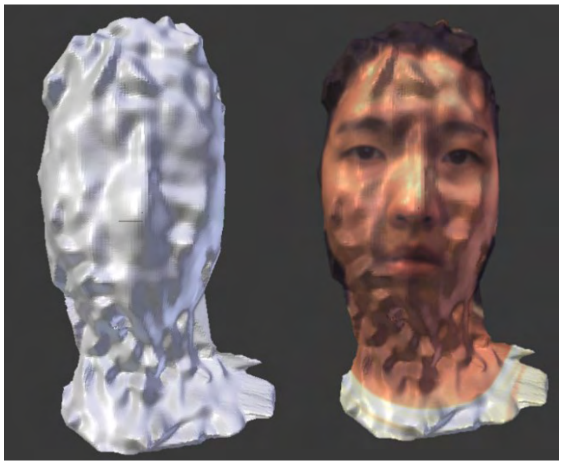
Geometrical features such as Gaussian and mean curvatures are widely utilized for 3D face recognition as they characterize the intrinsic properties of a 3D surface. Artifacts such as holes and spikes decrease the quality of a 2.5D mesh, making it difficult for face analysis and recognition. In this paper, we are implementing preprocessing techniques to remove holes, reduce surface noise. This will also reduce computational complexity.

1. Introduction

Over the past few decades, face recognition technologies have made much progress with 2D images. However, there are still many open challenges such as pose, illumination and expression variations [1]. With the advancement of 3D acquisition systems, face recognition based on 3D information is much in highlights to resolve the challenges faced by 2D face recognition systems.

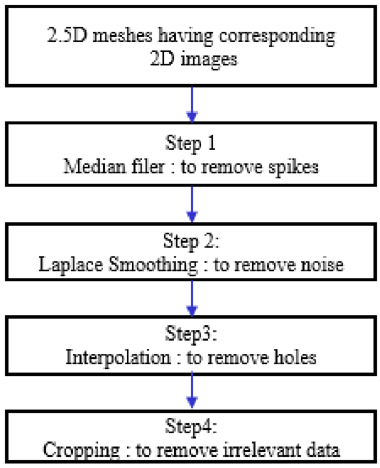
Several 3D face recognition approaches have been proposed using data acquired by 2.5D cameras rather than 3D. This is because range cameras and 3D laser scanner devices are highly expensive and difficult to install for face recognition. Compared to 3D scanners which collects data from a 360° scan, 2.5D stereoscopic cameras collects range and texture data from 180° scan. These cameras are much appealing in real world applications because of their affordability and ease of installation. Therefore, in this paper we use a stereoscopic camera system which acquires 2.5D images as it is portable, cheap and compact enough to be installed.

Most of the 3D face recognition techniques are dependent on the geometrical features of the facial scan which is sensitive to surface noise and other external factors. Even under ideal lighting conditions it is common for artifacts like spikes and holes to appear in eyes, specular facial regions and facial hair regions (eyebrows, mustache or beard) as shown in Fig. 1. Thus, we implemented various preprocessing techniques to remove the artifacts. After preprocessing all the 2.5D meshes were cropped and aligned to find optimal correspondence between gallery and probe. We took 50 facial scans from stereoscopic camera overall and applied our procedure step by step as shown in Fig. 2.



(A) (B)

(Figure 1) Results of ideal lighting condition without textures (A) and with textures (B)



(Figure 2) Flow chart showing steps of preprocessing procedure

2. Mesh Preprocessing

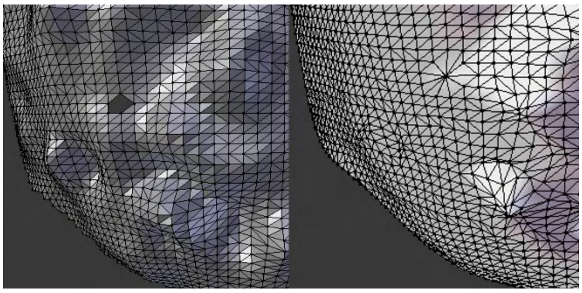
Preprocessing of 3D facial scans [2] is an essential step in 3D face recognition, where 3D mesh quality is influenced by noise, holes and irrelevant data. Preprocessing of 2.5D meshes is important when geometrical features are used in recognition. Median filter technique has been used to remove spikes in the 2.5D scans [3]. Then Laplacian smoothing was employed to reduce surface noise. Afterwards localized holes were filled by simply interpolating (x,y,z) coordinates based on surrounding points. All the 50 facial scans were cropped [4], smoothed and filtered by the techniques mentioned above and shown in Figure 1.

3. Experimental Results

Following are the results of applying preprocessing techniques to the 2.5D facial scans from stereoscopy camera. In Fig. 3 the difference of applying Laplacian smoothing [5] to the facial scan is clearly distinguishable. The surface noise that had rough impact on the 3D mesh surface is smoothened, making the curvatures smoother than before.

The second type of artifacts that are often present on 3D facial scans are holes. Holes are mainly originated in the regions which absorbs more light. Discontinuities caused by errors in enrollment stage like these can be localized and filled by various methods. We have used interpolation based on surrounding points of x,y,z coordinates. Fig 6. Shows

(Figure 3) Images before and after implementing Laplacian smoothing



(Figure 4) Filling up holes: before interpolation (left) and after interpolation (right)

The final result of applying all the preprocessing techniques along with the cropping and alignment is shown in Fig. 5.

(Figure 5) Final 2.5D images: Original 2.5D scan (left), processed 2.5D scan (right)

5. Conclusion

The algorithm implemented preprocessing techniques that reduced surface noise, aligned meshes, and decreased the number of polygons in a mesh. Thus, reducing computational complexity and increasing model quality without removing fine details on facial surface. Our other contribution is noise reduction to control smoothness of the curvature on facial surfaces. The preprocessing algorithm preserved the surface topology as well as surface boundary.

6. References

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