An Effective Method of 3D Facial Features Segmentation

Yuan Li, Zhe Guo

of Electronics and Information
Northwestern Polytechnical University
Xi'an China

西北工業大學

Introduction

Facial features segmentation is one of the key technology fields at present in the study of face recognition. Accurate and efficient facial features extraction can lay a strong foundation for the application above. 3D face data can provide the sufficient information to represent facial structure, which provides a more solid foundation for facial region segmentation. The existing key problems in these facial features segmentation methods based on 3D information are high algorithmic complexity and low robustness.

In the paper, we present an effective method for 3D facial features segmentation. The key curvatures, such as gaussian and mean curvature vector, maximum and minimum curvature vector, are first extracted based on triangular mesh surface analysis. Then, 3D facial feature regions are roughly partitioned by using the clustering method. The optimizing segmentation result is subsequently completed under the guidance of the structural model of facial feature region which is constructed based on diverse structural characteristics of a human face.

Methods

Material:

Frontal face data in the GavabDB database [1] is adopted to conduct the segmentation experiments.

Methods:

1.Curvatures estimation on triangular mesh

The curvature distribution on 3D model can reflect geometry characteristic of the model, which can complete the 3D model segmentation perfectly by using curvature and its inferred characteristic parameters as the features of the model in [2] and [3].

2. Facial Feature Structural Model of 3D Face

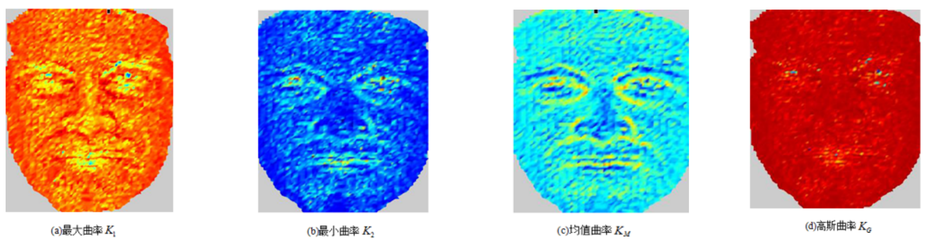
We chose *m* typical frontal 3D face models, and calculated the average model, called the average template. According to the practical condition of the above analysis based on the experimental model, we can easily establish the facial features distribution model.

3. Facial Curvature Image Segmentation

The image segmentation method based on clustering is utilized on the surface curvature description results. Mean Shift is a commonly used clustering method, and can be used for image segmentation [4]. Then clustering segmentation of multi-curvature combinations based on K-means also used which gave a good performance for the following experiments.

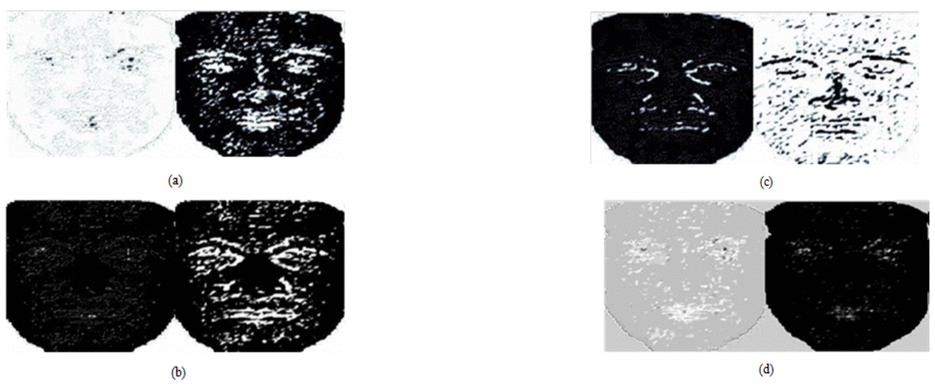
Results

A.3D Facial Curvature Feature Description Based on Triangular Mesh



(a)Maximum curvature (b) Minimum curvature (c) Mean curvature (d) Gaussian curvature

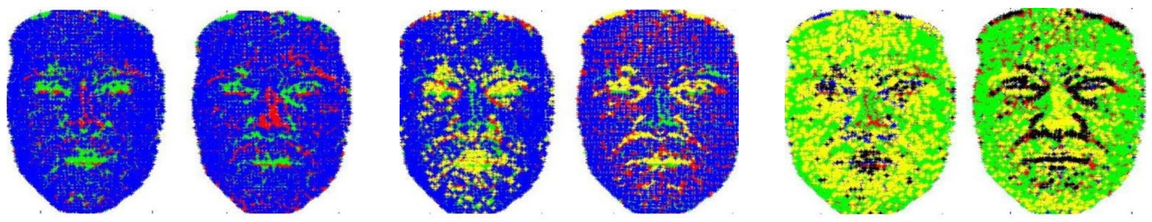
B.Segmentation Results of Curvature Clustering



(a)Maximum curvature (b) Minimum curvature (c) Mean curvature (d) Gaussian curvature

Mean Shift segmentation results (left is the smoothing image, right is the segmentation results)

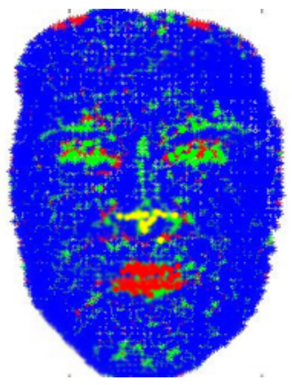
C. Clustering Segmentation Results of Multi-curvature Combinations



(a) 3 clusters (b) 4 clusters (c) 5 clusters

Left: the characteristics combination of K1, K2. Right: the characteristics combination of KM,KG

D. Optimization Results with Facial Structural Model



The optimized segmentation result of facial feature distribution model

From the Maximum-Minimum curvature characteristics segmentation results (Fig. 8), it can be found that there are still some interference noise points, and the division for the eyes, eyebrows, nose and mouth features is still obscure. As a result, the facial feature structural model built in the third section is used to optimize the segmentation results; points that fit the facial features distribution structure are kept, and others are removed. Then let the center point of each the facial feature area be the center of the cluster center, do the clustering operation again. We can obtain the final segmentation result which is shown in Fig. 9. By analyzing the segmentation results can easily see that the eye area is pigmented by green, the nasal tip area is pigmented by yellow, the area around the mouth is red, which can realize significant effective extraction of facial feature regions as expected.

Conclusions

We first estimated the performance of the qualitative and quantitative comparison of the key curvatures, such as Mean-Gaussian curvature vector and Maximum-Minimum curvature vector, through theoretical and experimental analysis based on triangular mesh surface curvature. Then, the structural model of facial feature region was built up. In terms of 3D model regions segmentation, the clustering method was used to convert to characteristics of 3D face facial features division, which is under the guidance of the previous region model associated with diverse structural characteristics of a human face, which performs the segmentation effectively. Experimental results show that the proposed method can effectively complete the regional segmentations of eyes, nose and mouth features on a 3D human face.

Bibliography

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