III. EXPERIMENTAL RESULTS

The experimental results are shown in this section. We apply the method to face segmentation. Both the images in ORL Database of Faces and the general real images are used to be segmented. Our experiments are implemented in Matlab 7.8 on a 3.2 GHz Intel Pentium 4 PC.

We apply our model to face segmentation. The face images in the ORL Database of Faces are used to be segmented. The first row in Fig. 3 shows the original image and the results of the SBGFRLS method proposed in [4]. The second row shows the results using our method and the last three is the results after the post-processing.

Figure 3. Comparisons of the SBGFRLS method and our method in face segmentation. The first row: the original images and the results of SBGFRLS method. The second row: the original results of our method and the results after the post-processing.

We set $\beta_1 = 0.87, \beta_2 = 0.97, \beta_3 = 0.94$ respectively in the above three images. Our model can segment more than one object so the background whose intensity is more close to the cheek is segmented, like the areas on the top of the image. For this problems, noted that among all the segmented areas the face area is the biggest one, so we can do the post-processing to delete the unrelated areas which are all smaller than the face areas. We compute the number of the pixels who are connected in the image and only preserve the biggest area. The final result is shown in the last row from which we can see that the segmented region includes nearly all the main parts of the face except few ears are missed. From Fig. 3, we can see that our method can get better results than the SBGFRLS method. Also, we only add one parameter in the original SPF function and it is only a coefficient, so the computational complexity does not increase much.

More results are shown in Fig. 4. From the result we can see that the faces are all segmented presicesly and completely.

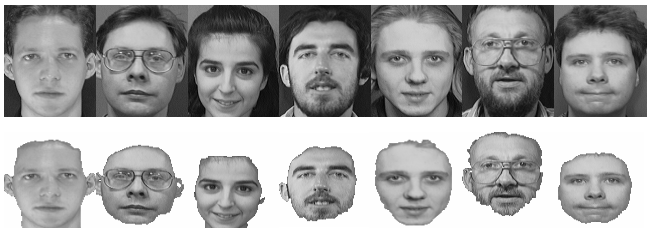

Figure 4. The results of face segmentation in the images from the ORL Database of Faces. The first row shows the origianl image and the second row shows the result.

Finally, we apply our model into the real image. The results are shown in Fig.5. From the result we can see that the area under the face whose intensity is more close to the face is also included in the segmented result. Though it cannot be avoided, it is worth nothing that from the result we can also know the position of the face and how many faces are in the image. In addition, because there is more than one face in the image, we set a threshold to delete the unrelated areas instead of conserving the biggest one. If the threshold is set bigger, the incomplete face will be removed and otherwise it will be remained in the result as shown in Fig. 5.

Figure 5. The result of segmentation in real image. The left one is the original image and the right one is the segmented image.

IV. CONCLUSION

In this paper, we proposed the VPSPF function which improves the SPF function and according to the VPSPF function modified the equation of level set evolution. It has the advantages which the SBGFRLS method demonstrates, like the effectiveness and efficiency. Moreover, the proposed method avoids the drawbacks of the SBGFRLS method that the images intensities should not meet a specific requirement. Experiment on synthetic image proves the advantage of our method. Experiments on the face images show that our method can not only segment the images in the database but also segment the general images which have more than one face. This shows that our method is effective and robust in face segmentation.

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