NOVATEUR PUBLICATIONS
INTERNATIONAL JOURNAL OF INNOVATIONS IN ENGINEERING RESEARCH AND TECHNOLOGY [IJIERT]
ISSN: 2394-3696
VOLUME 3, ISSUE 6, JUNE-2016

FACE SEGMENTATION, VASCULAR FEATURE EXTRACTION AND MINUTIAE EXTRACTION FOR PERSON IDENTIFICATION USING THERMAL IMAGE

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ABSTRACT

The paper discusses the vascular feature detection of human face using thermal images and the inter process results. Here we have designed an approach to segment the face of photographed person. Then the segmented face is processed through anisotropic filter to remove noise present in it. Then we have also discussed the methods to extract blood vessel structure from the noise removed face. The results of the segmentation and of anisotropic filter are discussed. Through application of anisotropic filter noise is removed in fairly good amount and post processing becomes easy. Discussed concept of segmentation here also gives good results of segmentation. Then minutiae points were extracted on the basis of ridges and bifurcations present in blood vessels.

INTRODUCTION

Image segmentation is one of the most important work[2]] in image processing and machine recognition. Various face segmentation techniques are available but in our case background of thermal image is mostly dark and foreground i.e. face and dress of person is always bright. In such case we decided to go for localized active energy counters. Actually the localized active counter is prepared to[4] decrease the energy function i.e. the pixel intensity or characteristic of image which depends upon some image feature. Hence a function of minimum energy is designed

In the choice of filter to remove speckle noise Perona Malik[5] anisotropic diffusion filter is used. In our case we must understand the concept noise. Actually in thermal image of face of person the things are quite miscellaneous. The blood vain which is of importance to us if hotter [3] that the surrounding tissues. In spite of this when we see the image the radiance of blood vessel and the radiance of fat tissues or skin tissues is somewhat equally bright. And hence it becomes difficult to differentiate between the blood vessel and surrounding tissues. To tackle this particular issue we need to go for two criterion specified by Perona Malik[5].

MATERIALS AND METHOD

The task presented here is carried out in three steps.

1. Data or image acquisition
2. Face Segmentation
3. Pre processing
4. Blood vessel extraction
5. Post processing

6. Minutiae extraction

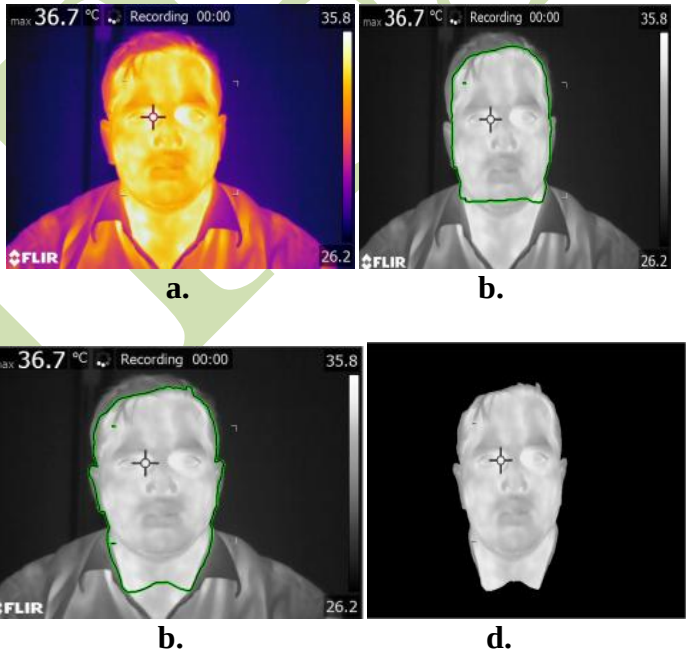
1. Data or image acquisition: The images of 5 different persons were taken by in infrared cameras under ambient condition where room temperature was around 30 degree centigrade. All the people participated this experiment were asked to stay relaxed for nearly about 30 minutes so that the blood vein temperature of all people would come normal. Then the image of image of each person was taken at a distance from 1 meter from the person facing straight.

2. Face segmentation: In this step the face of the person is segmented from rest of the image. As shown in fig 1.a. the image is actually RGB. Therefore it is first converted into gray scale. The a mask was given manually on the image approximately centered to the face of person. Then the local energies were tested using following formula[2].

```
upts = find(phi<=0);                    % interior points
vpts = find(phi>0);                     % exterior points
u = sum(I(upts))/(length(upts)+eps); % interior mean
v = sum(I(vpts))/(length(vpts)+eps); % exterior mean
```

The dual active counter [2] activated shrinks or expands based on the minimum energy criterion of pixel. It considers local minima and maxima of pixel value to decide whether to move inwards or outwards. The face region is always bright compared to background hence mostly the active counter expands outward.

The manually given mask now starts operating automatically and keeps operating until we let it work for desired number of operations. Finally we get a mask equal to face of the person. Then it is just a multiplication of mask with gray scaled original image to segment the face from rest of the image.



a. **b.**

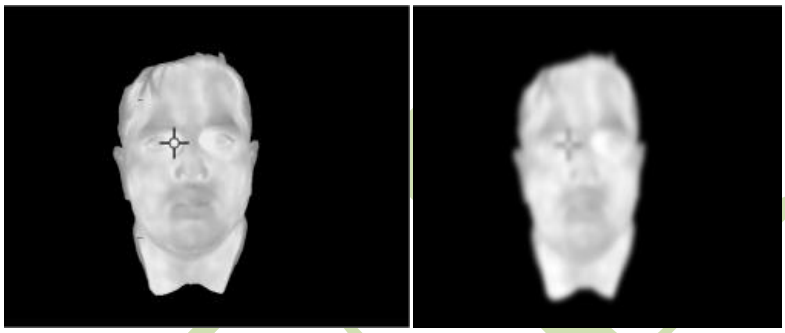
b. **d.**

fig 1 .a. original thermal image, b. contour at end of 50th iteration,c. contour at the end of 350th iteration, d. Segmented image.

In fig 1.b we can see a counter around the face and in part of neck at the end of 50th iteration. In fig1.c we can see a counter around the face and in part of neck at the end of 350th iteration. In fig.1.d we can see the segmented face from rest of the face.

PRE PROCESSING

The main problem with the segmented image is now to remove unwanted noise. So here we must understand the reason behind this noise. Actually this thermal image is giving us the thermal imprint of the face. The blood vessels in our body are hot but our human face has blood vessels as well as tissues which are also hot but at some what lesser temperature.
If you watch carefully the fig.1.d you can notice that on chick the region is white. That is due to the blood vessel as well as due to under laying tissues. So here a need of differentiating the tissues with the blood vessel arises. This task accomplished using PERONA MALIK anisotropic filter. This filter actually integrates the pixel and its neighboring pixel and finds the mean of that to calculate the respective pixel value instead of considering the original pixel value.
The output of this filter is shown in fig2.



a. **b.**

Fig 2. a. Segmented image, b. diffused image

We can see that in fig.2.a the fore ground face has more contrast. But in fig.2.b. we can find that the pixels have been diffused and hence contrast is also lowered. Here the filter spec ifications are kept as follows.

num_iter = 50
delta_t = 1/10
kappa = 200
option = 2

where num_iter are number of iteration for which filter is applied.
Delta_t is constant of integration, kappa is gradient modulus threshold that controls the conduction or diffusion.

BLOOD VESSEL EXTRACTION

After applying the filter it is now turn of extracting blood vessels. This was done by executing different procedures. Our prime objective, now remains is to find blood vessels. So first step in this is to do open hat segmentation of segmented face. For this the segmented and filtered image went through erosion process with a disc structuring element mentioned below fig. 2

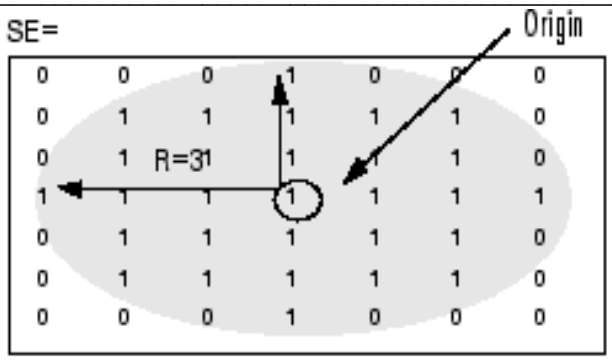
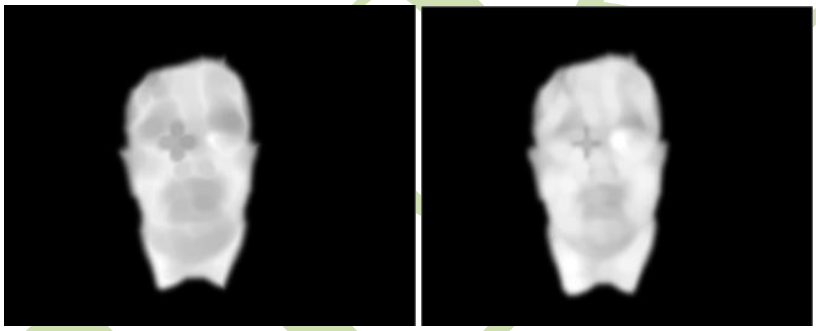
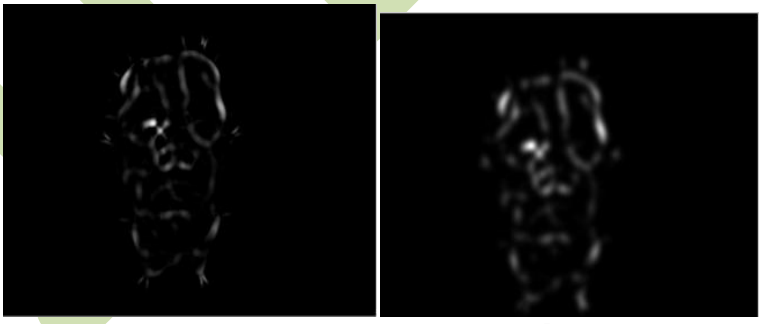


Fig. 3. Structuring element

Then this eroded image undergoes dilation operation with the same structuring element. To achieve open top hat segmentation this newly dilated image is subtracted from original face segmented and filtered image. The result obtained is the blood vessel structure. But these vessels obtained have speckle noise which is to be removed. To do so we again pass this result through PERONA MALIK anisotropic filter. All these results are shown in following figures.



a. **b.**



c. **d.**

fig 4. a. Eroded image, b. dilation followed by erosion, c. open hat segmented image, d. diffused image.

POST PROCESSING

The blood vessels obtained so far are in gray scale. For our further processing of minutia extraction we need them to convert to binary image. So it was done by using MATLAB defined function. Then skeletonization was done by inbuilt thinning morphological operator. The results are shown below**.**

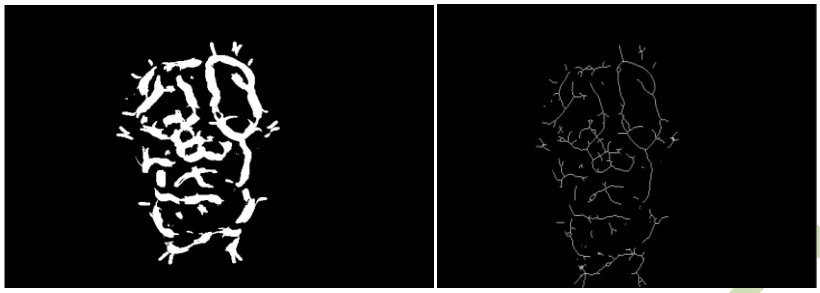


Fig 5. a. Binary image, b. thinned image

MINUTIAE EXTRACTION

The vascular structure so derived was then processed further to obtain minutia. The ridges and bifurcation were found by summing the adjacent values of pixel and the averaging it further. The following fig. 6 [3] shows the concept.

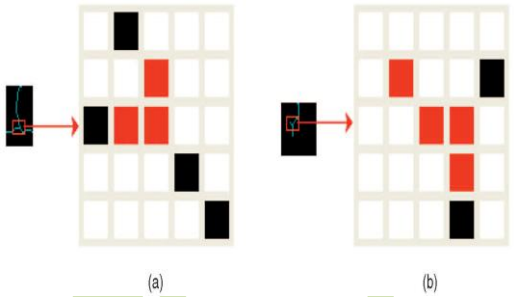


Fig. 6 Bifurcation and ridge ending

The minutiae extracted results are shown below.

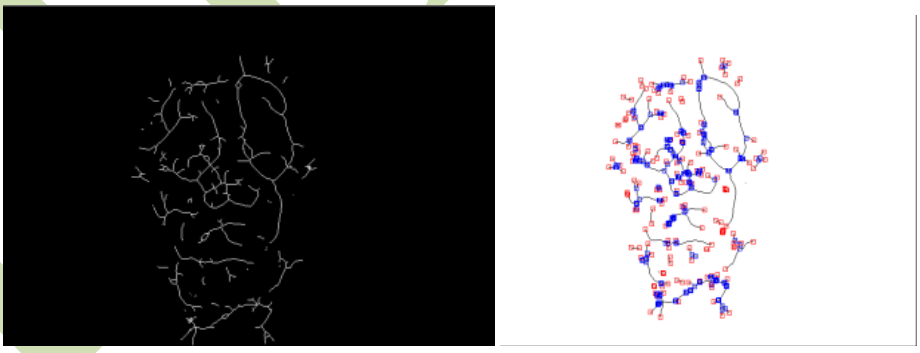


Fig. 7 a. Thinned image , Minutiae extracted image

CONCLUSION

The results of above experiment were satisfactory. The dual active counter approach to segment the face gave us fairly good results. The choice of this approach over other algorithms was its capacity to find the contrast region over dark background. The limitation

of this algorithm is the manual masking and manual iterations only. Further the open hat segmentation could properly give us the required blood vessel structure. The result had to be passed though diffusion filter to remove speckle noise. The diffusion filter output with different parameter was tried and after doing trial and error we confirmed the specified values.

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