A Face Detection in low resolution blurred images using Supers Resolution and Mixed Gaussian Color Models

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ABSTRACT

Due to the limitation of current capturing technique, we often get low resolution(LR) blurred images. In this paper we propose one algorithm which first do restoration on blurred image and remove the blur. Than we apply Super Resolution(SR) algorithm on the newly low resolution image and get upscaled image. After getting this image we do Face detection using Mixed Gaussian color model. Experimental results show that whole algorithm is quite practical and faster in comparison to the techniques such as neural networks and other techniques.

Keywords: Restoration, Super Resolution, Face detection, Mixed Gaussian color model, Adaptive threshold, Morphological operations, Template matching.

I. INTRODUCTION

Super Resolution is a process of producing a high spatial resolution image from one or more LR observation. It includes an alias free up sampling of the image thereby increasing the maximum spatial frequency and removing the degradations that arises during the image capture like blur and noise. In SR, typically, the LR images represent different “looks” at the same scene.[1] That is, LR images are sub sampled (aliased) as well as shifted with sub pixel precision. If the LR images are shifted by integer units, then each image contains the same information, and thus there is no new information that can be used to reconstruct an HR image. If the LR images have different sub pixel shifts from each other and if aliasing is present, then each image cannot be obtained from the others. Here new information contained in each LR image can be exploited to obtain an HR image. if we combine these LR images, SR image reconstruction is possible. Super resolution image reconstruction from multiple snapshots provides far more detail information than any interpolated image from a single snapshot.

An image restoration is one related problem to SR techniques, which is a well-established area in image processing applications [2]. The goal of image restoration is to recover a degraded (e.g., blurred, noisy) image, but it does not change the size of image. Actually, restoration and SR reconstruction are closely related theoretically and SR reconstruction can be considered as a second-generation problem of image restoration. One more problem related to SR reconstruction is image interpolation that has been used to increase the size of a single image.

Human face detection is the fundamental problem in computer vision.. What face detection do is, Given a single image, the ideal face detection should identify and locate all faces regardless of its three-dimensional position, orientation, and lighting conditions. There are mainly four different face detection techniques available now 1. knowledge-based methods 2. feature invariant approaches 3. template matching methods and 4. appearance based methods. Detailed descriptions of algorithms and representative works for face detection in a single image within the above four categories can be found in [3],[4].

This paper is organized as follows. In Section II, We introduce our new proposed algorithm for detecting face from low resolution blurred image, in Section III we have shown experimental results and its discussion and finally section IV consists of conclusion.

II. PROPOSED ALGORITHM

A) Super Resolution using wavelet based interpolation [5].

The up-sampling method for super resolution is summarized in the following steps:

i). Initialize a matrix I'_{DWT} of dimensions $2m \times 2n$ with all its elements as zeros.
ii). Set the original image to a matrix I of dimension $m \times n$.
iii). Multiply I by the scale factor $\boldsymbol{s}$ to produce a matrix I_{LL}. Replace the top-left quadrant of I'_{DWT} by I_{LL}.
iv). Apply the high-pass wavelet filter (without down-sampling) in each row of I followed by the low-pass filter in each column. Set alternate rows and columns of the resulting matrix to zeros to produce a matrix I_{HL}. Replace the top-right quadrant of the matrix I'_{DWT} by this I_{HL}.
v). Apply the low-pass wavelet filter (without down-sampling) in each row of I followed by the high-pass filter in each column. Set alternate rows and columns of the resulting matrix to zeros to produce a matrix I_{LH} Replace the bottom-left quadrant of matrix I'_{DWT} by this I_{LH}.
vi). Apply the inverse DWT on matrix I'_{DWT} to produce I'.

The diagrammatic view of whole algorithm is as given in figure 1.

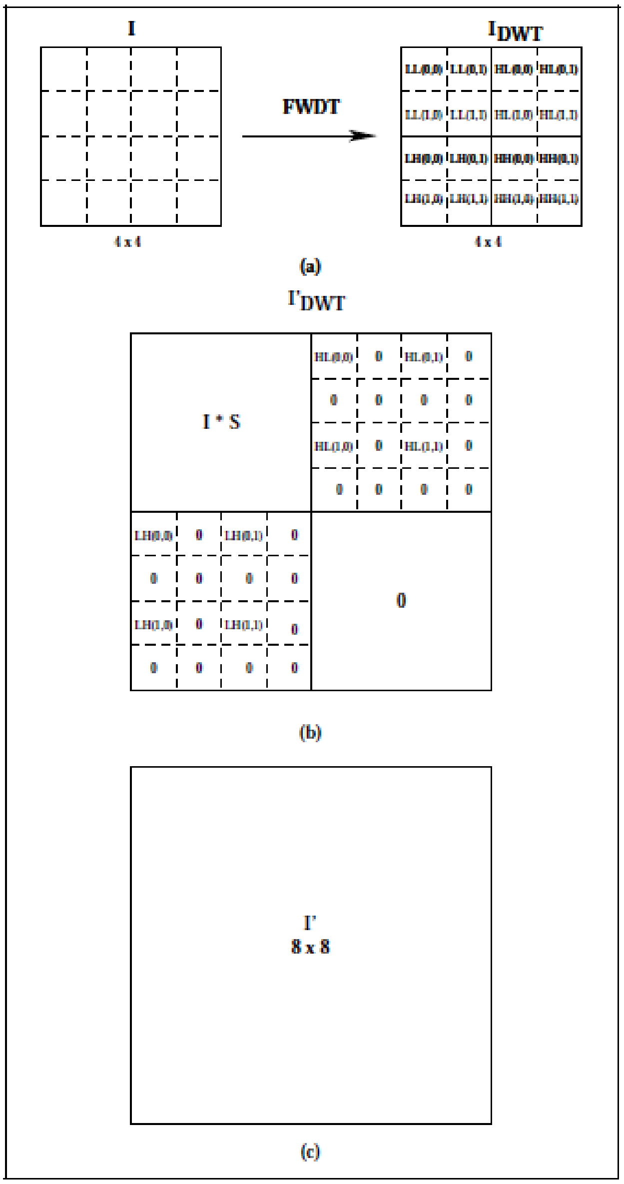

Figure 1. DWT based image upsampling

B) Face detection algorithm

The use of Color information can be used for detecting face and in recent years it is used a lot. Most publications [3,4,6,7] have shown that color is a powerful descriptor that has practical use in the extraction of the face detection.

In many research papers it is assume that chrominance components are independent of the luminance component of skin-tone color [8,9]. In fact, the skin-tone color is non-linearly dependent on luminance. Rein-Lien Hsu found that although skin colors of different people appear to vary over a wide range, they differ less in chrominance than brightness, specially the skin colors from a compact area in the YCbCr plane. And they nonlinearly transform the YCbCr space to make skin cluster luma independent [6]. Skin-colors and clothes colors locate at the same range in the YCbCr, plane therefore clothes cannot be segmented from face areas.

The likelihood ratio of skin color areas is calculated based on mixture model. Let p(x, y) be the pixel value in the image, then the skin color detection technique can be written as formula (1).

$$p(x,y) \in \text{skin}\ ;\ p(x,y) \sim \frac{(e^{(p(x,y)} - \mu_{CbCr})^2/(2 * \sigma^2_{CbCr})}{(\sqrt{2\Pi}\sigma_{CbCr})}$$

$$\text{and}\quad \frac{(e^{(p(x,y)} - \mu_{YIQ})^2/(2 * \sigma^2_{YIQ})}{(\sqrt{2\Pi}\,\sigma_{YIQ})}$$

$$p(x,y) \in \text{non-skin area};\quad \text{Otherwise} \qquad (1)$$

Skin Segmentation

Thresholding process is used to segment the skin region from the rest of the image. A fixed threshold value is not good to process different images of different people with different skin color,. So an adaptive thresholding process is required to find the optimal threshold value. The adaptive thresholding is based on the observation that the stepping the threshold value down may increase the segmented regions. The threshold value at which the minimum increase is observed while stepping down the stepping down the threshold value will be the optimal threshold. The following stages are used to remove those pixels, which do not belong to the facial regions.

Detection of Skin regions

It is necessary to determine the number of skin regions in the image to determine the frontal human face. An 8-connected neighborhood is used to label the skin regions [12].

(a) Number of holes inside a region

We can use Euler number of region to calculate number of holes present in given image.

$$E = C - H \qquad (2)$$

Where
E:The Euler number
C:The number of connected components
H: The number of holes in a region.

The number of connected components is set to 1 since one skin region will be considered at a time. The number of holes is, then:

$$H = 1 - E \qquad (3)$$

(b) Center of mass

The center of the area in binary image is the same as the center of the mass.Below equations 4 and 5 can be used to compute it.

$$\bar{X} = (1/A) * \sum_{i=1}^{n} \sum_{j=1}^{n} j * B[i, j] \quad (4)$$

$$\bar{Y} = (1/A) * \sum_{i=1}^{n} \sum_{j=1}^{n} i * B[i, j] \quad (5)$$

where
A: Area in pixels of the region
B: The matrix of size [n x m] representation of the region

(c) ***Orientation***

There will be higher matching if the template face is rotated in the right angle. The orientation of the axis of the elongation will determine the orientation of the region.
The angle of inclination (theta) is given by:

$$\theta = (1/2) \operatorname{atan} (b / (a-c))$$

where

$$a = \sum_{i=1}^{n} \sum_{j=1}^{m} (x'_{ij})^2 B[i,j]$$

$$b = 2\sum_{i=1}^{n} \sum_{j=1}^{m} (x'_{ij}) (x'_{ij}) (B[i,j])$$

$$a = \sum_{i=1}^{n} \sum_{j=1}^{m} (y'_{i,j})^2 B[i,j]$$

$$\bar{X}' = x - x$$

$$\bar{Y}' = y - y \quad (6)$$

(d) ***Width and height of the region***

The regions with holes are filled out to avoid problems when holes are encountered. Now it is necessary to determine the height and width by moving 4 pointers: one from the left, right, top and bottom of the image. If a pixel is found with a value other than 0, the pointer is stopped and this is the coordinate of a boundary. With the help of the 4 values, the height of the facial region is computed by subtracting the bottom and top values and the width is computed by subtracting the right and the left values.

(e) ***Region ratio***

To have less misses however, it is found that a minimum good value is 0.8. Ratio values below 0.8 do not suggest a face since human faces are oriented vertically. The ratio should also have an upper limit. This is determined by analyzing the results in our experiments that a good upper limit should be around 1.6.

Template matching

One of the most important characteristics of this method is that it uses a human face template to take the final decision of determining if a skin region represents a face. The template is chosen by averaging 16 frontal view faces of males and females wearing no glasses and having no facial hair. The template used is shown in figure 2. Template face (model) is used to verify the existence of faces in skin regions. The template face has to be positioned and rotated in the same coordinates as the skin regions image. The template face is resized according to the height and the width of the region of the region computed. The resized template face is rotated to –theta, so that it is aligned in the same direction as the skin region. The center of the rotated template face is computed. Then the cross-correlation between the part of the image corresponding to the skin region and the template face is computed. The coordinates of the frontal face image are determined and a rectangle is drawn in the gray scale image.

Figure 2 : Template face to verify the presence of faces in skin regions

Steps for the proposed algorithm are as below.

Step 1 : Give one low resolution and blurred image.
Step 2 : Restoration is performed in order to remove the blur and noise present in the image.
Step 3 : To achieve further noise reduction soft thresolding is applied, where as the image is deblurred using Iterative Blind Deconvolution Algorithm (IBD) .
Step 4 : Apply super resolution algorithm as explained in section II(A).
Step 5 : Apply mixed Gaussian skin color on newly SR image.
Step 6 : Do the skin segmentation.
Step 7 : Count the number of skin region present in given image.
Step 8 : If Holes are >= 1 than do template matching or else we can conclude that we don't have any face present in given image.
Step 9 : Display the face which is detected in step 8.

III. EXPERIMENTAL RESULTS AND DISCUSSIONS

In this paper we have select two blurred images and we have apply our proposed algorithm on these images and we get good results. We can apply other super resolution algorithm and we can improve the result. The experimental results are shown in figure 3.

Figure 3 : Experimental Results

IV. CONCLUSION

All present face detection algorithm work on high quality image but not good with low resolution blurred images. So in this paper we apply the concept of Super Resolution and we combine this concept with mixed Gaussian skin color model to detect the face. We propose one algorithm and we have shown experimental results also and we can say using and combining different SR techniques and Face detection techniques we can do face detection in low resolution and blurred images and we can get good results.

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