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Automated Skin Detection using Fuzzy Logic based Pixel Matching Algorithm

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Abstract

Objectives: Skin detection is the initial process of any automatic face recognition system. One of the fore most common approaches to detect the faces in facial pictures can be done by an automatic face detection method. In this paper, a new type of facial skin detection using the combination of Fuzzy and Pixel matching algorithms is proposed. **Method/Statistical Analysis:** The proposed system has three steps. Initially, the input facial color image is transformed in to a grey scale image and then, it is sharpened using a filter. Secondly, the pixels of the different types of facial grey scale images are computed. Finally, the computed pixels are compared with the original grey scale image based on the fuzzy rules. This process is done for the first pixel to the last pixel so that all the pixels which are present in the entire image can be included in the overall process. **Findings:** The algorithm is tested for different types of facial images for both the accuracy and the time taken to complete the skin detection process. The results of the experiments reveal that an accurate skin detection rate of 94.42% for the combination of fuzzy based pixel matching along with the dimension reduction methodology. **Application/ Improvements:** Future enhancements in this work are to propose an efficient algorithm to detect the facial images of group of faces present in a single image.

Keywords: Dimension Reduction, Facial Image, Fuzzy Logic, Pixel Matching Algorithm, Skin Texture Analysis, Skin Detection

1. Introduction

The human skin texture analysis is look of skin surface. The options of the skin texture represent the changes in skin wrinkle. As a result of age factor, it is an element for skin texture changes. Image process tools are utilized in the texture analysis, since it can be done in a scanned facial image[1,2]. In the case of image process, the though there is that the images are acquired from the camera, recording parameters can affect the quality of an image. The objective of image processing is to own a decent image analysis, that should be applied to various surfaces with irregular non-periodic patterns. Within the advanced image making concept, some techniques are created to follow them. This can be obtained by selecting a collection of attributes, the gives the options that account for the change in appearance of the image[3].

Fuzzy logic is one of the foremost vital issues determination techniques that contains of the mathematical frame work to resolve the improbability of data. Fuzzy image handling is used for various pictures, their segmentation, and other options[4]. Fuzzy classifier relies on the ideas of fuzzy rules which can be used for the classification of the skin and the non skin pixels. Concerning this, several approaches of fuzzy skin detection, various fuzzy based classification and detection strategies like fuzzy logic based strategies, fuzzy interference system, modified Fuzzy C Mean algorithm, and Linear Matrix difference (LMI) Fuzzy clustering[5] where proposed by earlier researchers.In[6]planned and proposed a fuzzy based novel methodology for the process of face detection methodology. Their algorithmic rule implements the methodology on still and colored pictures. It's done by combining the skin detection methodology with matching the skin

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sample images present in a database. The skin detection can be done using the strategy of fuzzy edge location, by means of checking the image which utilizes two systems. Their method yields higher results in comparison with alternative classical skin detection algorithms.

In[1] explains concerning Fuzzy based Skin Detection and Segmentation, which provides the performance analysis of two well-known fuzzy based skin detection techniques such as fuzzy based reasoning and modified Fuzzy C-Mean. In[4] proposed a new concerning Fuzzy Classification of Human color in Color pictures, during which a fuzzy approach for the skin characterization and shading tones in shading image is exhibited[9]. It has two main steps. Initially, the choice of pictures with completely different skin tones. It is followed by various color variations. Additionally, the process tones in regard to the RGB system were used to determine the fuzzy sets because the reasoning rules enforced into the system.

The paper is summarized as follows. Section 1 depicts the detailed description of fuzzy logic and texture of the human skin and the related works done in skin detection and its analysis. Section 2 explains of the proposed methodology for skin detection using the fuzzy logic and Section 3 consist of the experimental results and Section 4 depicts the conclusion and future enhancements of the proposed work.

2. Proposed Methodology

In this planned skin detection method, the input facial image is given towards the system. The given input skin texture might or might not contains the diseases as noise. The given image is currently processed by filtering process. The filtering is a method that accustomed take away the impurities and noise from the given image. The filtering technique is employed since to scale back the impurities completely therefore on get the clear image texture. For this method, a median filter is employed. Resolution of the extracted region will be high. During this case, application of the matching algorithms is impractical. Hence, the overall size of the input image should be reduced. It is done by scaling process that is the method of resizing a digital image through ever-changing its constituent resolution. To reduce the image size, a method called as down sampling is done. Throughout this method, new pixel values for the overall area can be obtained through interpolation of the recent ones. This leads to higher matching between the pictures from completely different categories and consequently ends up in the rise of an error. Hence the scaling process is needed. This is then followed by a grayscale conversion within which the colour image is converted to a grayscale image. The algorithm for changing the colour image in to gray scale is shown in Section 3.1. This is then followed by the pixel matching algorithm, to seek out the similarity between the skin textures. The closest pixels were clustered based on the similarity between their pixels. The similar pixels were then clustered and arranged using the fuzzy logic. The rule is shown in Figure 1. The diagram for the planned design is given as follows

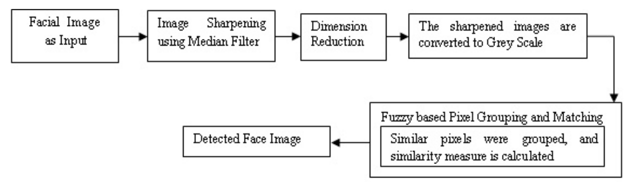

Figure 1. Architecture design of proposed method.

2.1 Image Filtering

Filtering may be a part of image sharpening that is employed to boost the overall details including the edges present within the image that are relevant to the usage. Additionally, filtering can even be used to eliminate the unwanted components of noise. Medical pictures sometimes contain salt and pepper noise. These noises are there because of the presence of minute grey scale variation within the image. Median filtering is a successful technique used image sharpening and also for removing the impulse noise[10]. Median filter is a commonly used method. It provides the exact noise-reduction skills, with essentially less blurring than other linear smoothing filters. Here, the median method was performed by considering a 3×3 windowing operator over the entire image[11].

2.2 Grey Scale Conversions

The proposed methodology works on grey scale image since it is based on grey and white pixels and its matching. For this process, the filtered image is given ad input towards the grey scale conversion algorithm in Figure 2. The filtered image can be further converted in to gray scale for the further process. The Algorithm is as follows: Algorithm for converting grey scale:

Step.1 Scan the color facial colour image

Step 2 Take the first color pixel from the scanned image and store it in Temp_color pixel

Figure 2. Original, filtered and its grey scale converted facial image.

Step.3 If Temp_color pixel = (rgb (240,230,180)) then Set Temp_color pixel = color (grey)

Step.4 If Temp_color pixel = color (grey) then goto

Step 5 else Set Temp_color pixel = color (black)

Step.6 Repeat from Step 1 to Step 4until all the pixels are scanned in the image.

Step.7 End

2.3 Dimension Reduction

Reducing the dimension of an image can be obtained using the dimension reduction method. This method will reduce the dimension of the overall image and will further reduce the time taken for the overall processing and memory. It also improves the overall accuracy of the proposed algorithm used for the purpose of facial skin detection. Linear Discriminant Analysis (LDA) is a well-known dimension reduction technique[12]. The LDA is commonly used for the methods which involves feature extraction. The LDA incorporates the overall class information of the pixels. Creation of a matrix is only difference between Principal Component Analysis and LDA. The LDA uses the classes d of all the pixelsis as follows

$$C_d = \sum_{i=1}^{d}\sum_{j=1}^{o}\left[\left(x_j - \delta_i\right)^{-1}\left(x_j - \delta_i\right)\right] \quad (1)$$

Where, o is the number of objects present with in the class, is the mean of the ith class, x is the pixel number and d is the class of all the objects present in the image.

The main objective of employing this LDA is to reduce the overall dimension of the image without changing the pixel information as well as to reduce the time taken for the overall processing.

2.4 Fuzzy Based Pixel Grouping and Matching Algorithm

In this work, a completely unique approach of mixing the Fuzzy logic and Pixel grouping and Matching algorithmic rule is developed. Fuzzy based Image Analysis could be aform of many-valued logic; it manages thinking that's inexact rather than matured and corrects[13]. Fuzzy logic could be a kind of multivalent reason during which the reality values of variables are outlined as any complex quantity between zero and one. The Fuzzy management Systems are a development of logic that permit for terribly precise management of robotic systems. The Fuzzy set is that the foundation of an instability hypothesis, associated a device for each linguistics and numerical framework. In this work, the image is scanned from the first pixel to the last pixel. Initially, the set of six pixels are taken in to consideration. Here, the fuzzy rules are applied to check whether the pixel is a grey or black. Since the image is converted in to grey scale, it has only black and grey pixels. If the pixel is black, then skip the first set of six pixels and go to the seventh pixel. If the pixel is grey, group all the pixels in to one and change it to white. The above process is repeated until all the complete pixels are read and changed. The proposed algorithm for Fuzzy based pixel grouping and matching is shown below:

Algorithm for Fuzzy based Pixel Grouping and Matching

Step.1 Set P_1 = six pixels, (Scan the image from the first pixel)

Step.2 if P_1= black. Skip to the seventh pixel until grey pixel appears.

Step.3 if P_1 = grey

Step.4 Group the pixels and change it to white
Step.5 Check the seventh pixel
Step.6 Set P_2 = seventh pixel
Step.7 if P_2 = black,
Step.8 Go to step 2
Step.9 Else, go to step 5
Step.10 Repeat the process till last pixel
Step.11 End

3. Experimental Analysis

The implementation work is performed using Matlab programming. The input face image is given towards the proposed system. Then it's filtered using the median based most frequently used filtering method in order to get rid of the impurities and noise present in the image. The noise free image is currently, modified in to gray scale image using the grey scale conversion algorithm. Then the Fuzzy based pixel matching and grouping between the adjacent pixels are done. Now, the similarity between the pixels are calculated and sorted based on fuzzy rules. The performance metrics is shown in equation one, two and three respectively.

The objective of this comparison is to measure the accuracy of proposed skin detection algorithm based on sensitivity, specificity, and accuracy using equations[5,3,8] are shown in Table 1.

$$\text{Sensitivity} = \frac{TP}{TP + FN} \tag{2}$$

$$\text{Specificity} = \frac{TN}{TN + FP} \tag{3}$$

$$\text{Accuracy} = \frac{TP + TN}{TP + FN + TN + FP} \tag{4}$$

Where, True Positive (TP) is that the number of non-skin pixels known properly by the system, False Positive (FP) is that the number of skin pixels nodules labeled as non-skin pixels, True Negative (TN) is that the number of skin pixels known exactly as skin pixels by the methodology and False Negative (FN) is that the number of non-skin structures labeled by the strategy as skin pixels. The following table shows the performance metrics calculated for a few in put pictures. The Specificity, Sensitivity and Accuracy of the image is calculated. Table 1 depicts the performance analysis of the proposed methodology.

Table 1. Specificity, Sensitivity and Accuracy of the proposed methodology for different Images

Image	Specificity (%)	Sensitivity (%)	Accuracy (%)
Image 1	94.24%	91.31%	93.12%
Image 2	97.51%	91.81%	96.50%
Image 3	96.24%	89.67%	91.67%
Image 4	98.56%	94.75%	95.49%
Image 5	94.15%	93.12%	95.35%
Average	96.14%	92.13%	94.42%

The time taken to process the overall algorithm is also computed in order to find the efficiency of the proposed methodology. It is shown in Table 2.

Figure 3 shows the step by step process of skin detection. From the original image, the skin detection is performed by Noise detection, Dimension reduction,

Table 2. Execution time taken for two types of images (in seconds)

Facial Image	Without Dimension Reduction		With dimension reduction	
	Time Taken for Existing Method (In Seconds)	Time Taken for Proposed Method (In Seconds)	Time Taken for Existing Method (In Seconds)	Time Taken for Proposed Method (In Seconds)
Image 1	468	304	547	224
Image 2	338	327	629	481
Image 3	666	537	827	421
Image 4	659	445	582	223

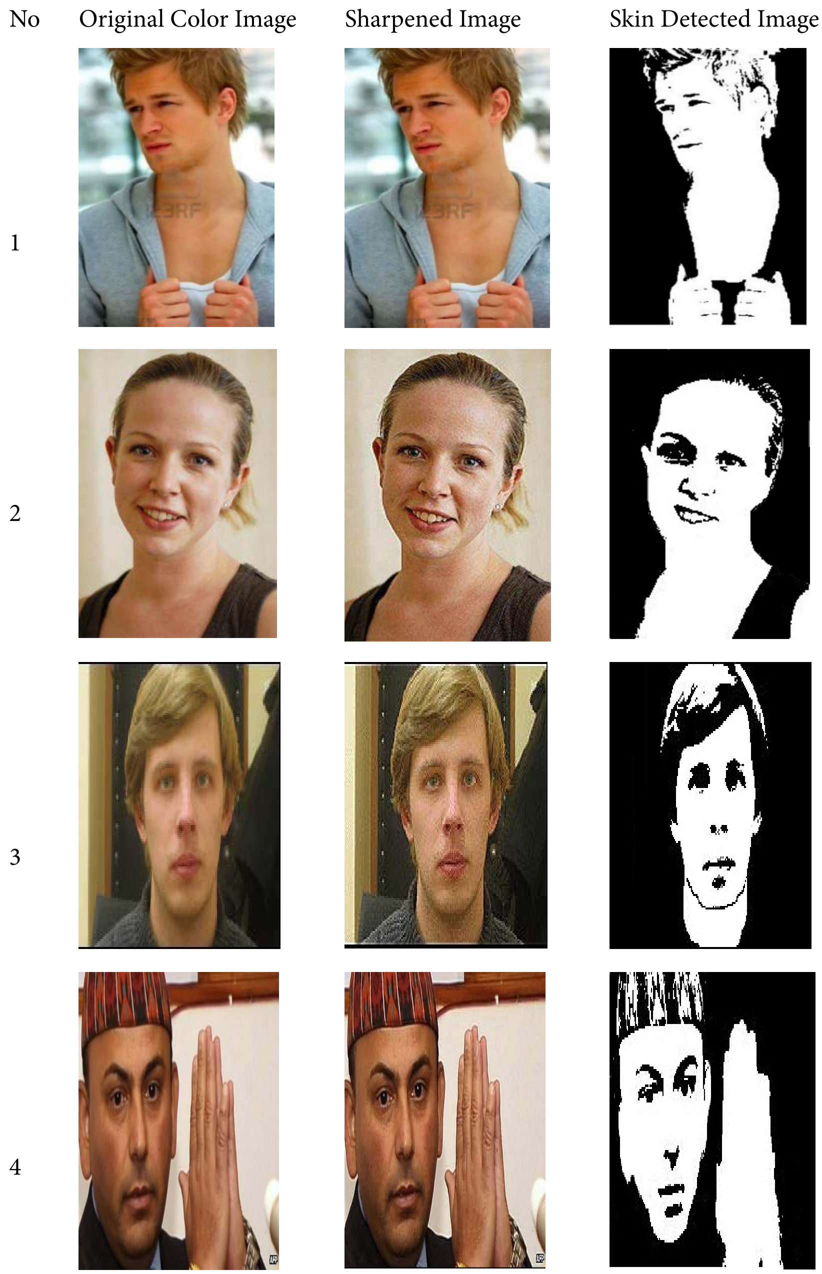

Figure 3. Original, sharpened facial image and its skin detected results.

Grey scale conversion and at last, the skin image detection.

4. Conclusion and Future Enhancements

A unique skin detection technique is planned for detecting the skin more effectively. Initially, the given image is preprocessed by a filtering process. Then the preprocessed image is converted towards a grayscale image since the grey scale functions present within the image differentiates the feel of a picture by changing it. The converted image is then computed for grouping the similar pixels, it's grouped and therefore the similarity measure is calculated. The image performance metrics is employed to obtain the performance of the planned methodology. From the performance metrics analyzed, the obtained skin pictures are clear. The distinction of the image doesn't vary during a large scale, so the image distortion is low. From the experimental results shows higher than, it is explicit that the planned technique will offer an efficient mechanism in identifying the skin. Future enhancements in this work are to propose an efficient algorithm to detect the facial images of group of faces present in a single image.

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