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Filtering Based Illumination Normalization Techniques for Face Recognition

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Abstract

The main challenge experienced by the present face recognition techniques and smooth filters are the difficulty in managing illumination. The differences in face images that are created by illumination are normally bigger compared to the differences in inter-person that is utilized to differentiate identities. However, face recognition over illumination has more uses in a lot of applications that deal with subjects that are not cooperative where the highest potential of the face recognition as a non-intrusive biometric feature can be executed and utilized. A lot of work has been put into the research and development of illumination and face recognition in the present era and a lot of critical methods have been introduced. Nevertheless, there are some concerns with face recognition and illumination that require further considerations which include the deficiencies in comprehending the sub-spaces in illumination pictures, problems with intractability in face modelling and complicated mechanisms of face surface reflections.

***Keywords**: illumination, face recognition, techniques, strategies, filters*

1. Introduction

Face recognition using different illumination is a critical challenge for applications used in real time. Many illumination filtering techniques are used and introduced by researchers to manage the issue at hand. Nevertheless, the present approaches are both archaic and do not include the crucial analysis of performance of illumination filtering techniques [1, 2]. Face recognition techniques at present include a group of functionalities that carry out the normalization of illumination and thus, handle the main challenge with the face recognition system [3].

2. Filtering of Illumination normalization Face recognition

We have explained some of the filtering of illumination normalization face recognition in this paper.

2.1. Single Scale Retinex or (SSR) algorithm

When the SSR scale lowers, it improves the local contradiction and offers a better robust compression range. However, it has some drawbacks such as the the halo artifact. On the contrary, when the SSR scale rises, the features of the color constancy would improve at the same time. Nevertheless, it is not able to contract the robust scale of an image well enough by not taking into consideration the characteristics of the image [4], since the images' ratio of compressed robust scales varies [5].

Single-Scale Retinex

The SSR form is defined according to (1),

$$R(x,y)= \log I(x,y)-\log(F(x.y)*I(x,y)), \quad (1)$$

Where R(x, y) is the Retinex output; I (x, y) is the image intensity; '*' reflects the operation of convolution; and F(x, y) is a Gaussian functionality.

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F(x, y) =K•e-(x2+y2), integral (integral (F(x, y), dx, Dy=1, (2)

Figure1. Illustration original images are in the upper rows, Images processed by SSR - the reflection functionalities are in the lower rows

2.2. Multi Scale Retinex or (MSR) algorithm

The algorithm for Multi Scale Retinex or MSR is extended from the algorithm of the SSR as suggested [6].The theory of retinex has the assumption that the perception of color is strictly dependent on the human vision system's neural structure. Reference [7, 8] introduced the retinex model for lightness computation. In order to improve the images with conditions of complex lightings, the theory of retinex, which is derived from the system of human visual, has been utilized for improvements in image contrasting. Reference [7, 9] first introduced the theory of retinex. Used Land's theory to create the SSR [8] and MSR [6]. In general, the MSR is successful in improving local contrasting and compression of a robust range. In recent times, researches have introduced methods to enhance the MSR based on the correction of color [10], natural impressions [11], and halo effect [12].

Figure 2. Show original images are in the upper rows, Images processed by MSR – the reflection functionalities are in the lower rows

2.3. Homomorphic Filtering-based Normalization (HOMO) Algorithm

Homomorphic filtering or HOMO is a popular technique for normalization whereby the image input is firstly changed into the necessary logarithm and after that into the domain for frequency [20]. After that, the components of high frequency are focused on and the components of lower frequency are decreased. Finally, the image is changed back to the spation domain utilizing the inverse Fourier transformation and hence retrieving the exponential outcome [21].

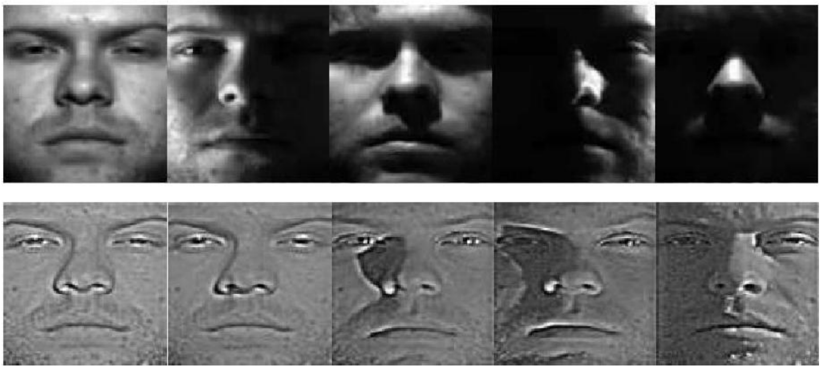

Figure 3. Illustration original images are in the upper rows, Images processed by HOMO - the reflection functionalities are in the lower rows

The component of illumination is located close to the central two-dimensional Fourier that changes the image's logarithm. However, the component of reflectance is situated further in the outer region of the Fourier spectrum's two dimension. In general, the illumination and component of reflectance are not directly separated in Fourier's space [14]. An appropraiate divide for the components is dependent on the suitable parameters of filter of the homomorphic. Normally, the parameters are adjusted accordingly by utilizing the experiences of the researcher. Adelmann [14] in his research utilized homomorphic filtering with various parameter settings and the most suitable setting was chosen for more processing works. Reference [15] chose a static group of values for the homomorphic parameters according to their experiences in utilizing the algorithm for looking for the homomorphic filtering. According to [16], there are various values for this kind of filter where they have tested the parameters and the most suitable is selected. Methods for selecting parameters in all the techniques depend on their dataset. Nevertheless, [17] suggested that a selection method for choosing the homomorphic parameter should be made according to the global contrast factors (GCF) [18], which is not reliant on any databases.

2.4. Isotropic Diffusion-based Normalization Algorithm

The algorithm known as the isotropic diffusion-based normalization or IS utilizes isotropic smoothening of the image to calculate the functionality of the luminance. It reflects the simplified r-variant of the technique of anisotropic diffusion-based normalization as suggested by Brajovic and Gross [19].

The algorithm for anisotropic diffusion (AD) is popular for the feature of illumination invariant removal of the face image. The function of the algorithm for the anisotropic diffusion is dependent on the conduction functionality and measure of discontinuity [20]. Nevertheless, in the conventional algorithm of the anisotropic diffusion, the discontinuity measurement normally takes on the in-homogeneity or space gradient [21, 35].

In the model known as the Lambertian convex surface, the face image is reflected as revealed below:

$$I(x, y) = R(x, y)\, L(x, y). \tag{3}$$

According to (3), R(x, y) is usually the reflection of the scene and L (x, y) usually represents the illumination. Thus, the normalization of illumination for verifying the face can be achieved by.

Calculation the illumination L(x, y). The L(x, y) cannot be calculated from the I(x, y) because of the ill- posed position. It is commonly assumed that R(x, y) differs quicker than the L(x, y). Therefore, in most of the approcahes, R(x, y) is retrieved by considering the variance between the images's I(x, y) logarithm and its smoothening version that is the approximation of L(x, y). The logarithmic functionality gets rid of the noises and causes the measurement to be easily done. This classification is known as the generic quotient image. The fundamental diagram of the method for generic quotient image is revealed in Figure 4.

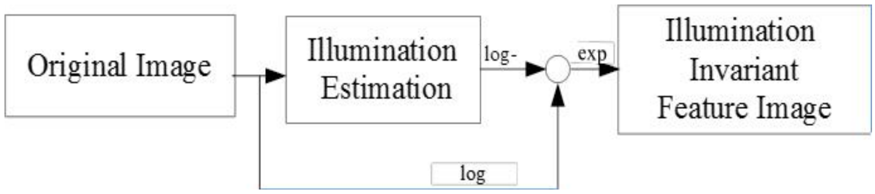

Figure 4. Basic diagram of generic quotient image method

The main highlight of generic quotient image is on the method to calculate the illumination L (x, y) using image I (x, y).

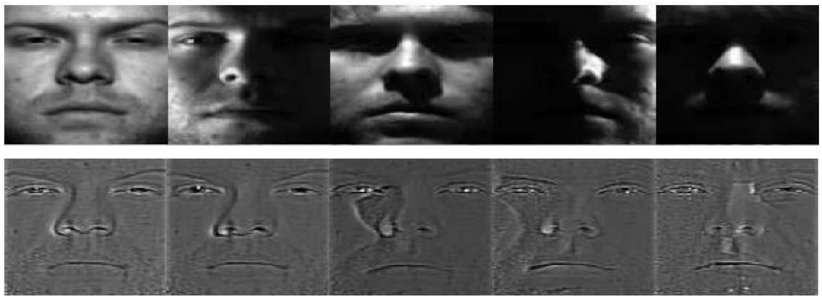

Figure 5. Illustration original images are in the upper rows, Images processed by Isotropic Diffusion-based - the reflection functionalities are in the lower rows.

2.5. Adaptive Non-Local Means Based Technique for Normalization

The technique known as the Aadaptive Non-Local Means based normalization (ANL) was introduced by ˇ Struc and Paveˇsiˇc [22, 34]. This technique utilizes the algorithm for adaptive non-local means de-noising to measure the functionality of luminance and to calculate the reflectance after that. The Adaptive Non Local Means Filter with a Mixture of Wavelet is just like the NLM filtering however, the smoothening parameter is adapted locally as expressed in:

$$\sigma_{2} = \min(d(R_i, R_j)) \forall \neq i and R = \mu - \Psi(\mu) \quad (4)$$

Whereby the distance is measured from a volume R that is inputted as the subtraction of the original noisy volume u and the low pass filtered volume $\psi(\mu)$. It was discovered experimentally that the distance minimally required in this situation is about the same as s2 because of the removed information of low frequency and the applying of the minimal operator [23, 24].

This approach is simple and has two critical advantages. It lets the same patches with a similar structure to be discovered but with a varied mean level compensating for the intensity in the homogeneity that normally exists in the data [25, 26]. However, the noise variance's overestimation will be minimal in situations that have with unique patches in the search database [34]. Therefore, the adaptive filtering will establish the parameter h2 similar to the minimal distance calculation as referred to in Equation (4).

Figure 6: Illustration original images are in the upper rows, Images processed by ANL- the reflection functionalities are in the lower row

3. Comparisons

Table 1 demonstrates pros and cons of illumination filters. In Table 1 different techniques are compared in term of performance and accuracy.

Table 1. Advantage and disadvantaage of illumination filters in face Recognition

ALGORITHM	ADVANTAGE	DISADVANTAGE	REFERENCE
SSR	1. The scale of an SSR increases, its color reliabilityfeatures improve.	1.Includes halo artifacts 2. SSRs have differentdynamic range compression. Characteristics according tothe scale. 3.The SSR does not rungood tonal execution	[5,27]
MSR	1. Works effectivelywithimages that are grayscale.	1.Histogram equalization isutilized to improve the colorof the images. This mayresult in a change in the color scale causing the artifacts and having animbalance in the color ofthe images.	[28,28]
HOMO	1.The features cause the linkwith the low frequency of the image with illumination and the high frequenc with reflection.	1. Discrete feature in attractive aspects betweencontiguous discrete scalesthat may not be found at theoutput.	[16,31]
ISOTROPIC	1.Is able to preserve edges ofimage and is able to reducenoise at the same time.	1.It is insensitive toorientation and symmetric,resulting in blurred edges.	[21,32]
Adaptive non-local	1. The applications that includesegmentation, Relaxometry, ortractography might make useof the improved data that iscreatedafter applying theproposed filtering.	1. This technique does notreduce the difficulty of thealgorithm significantly while only decreasing slightly the accuracy offiltering.	[26,33]

4. Conclusion

Given the critical challenge in face recognition, researchers have used an extensive manner of illumination variations in the works of pattern recognition and computer vision. Several techniques were portrayed that tolerated and/or compensated the variations in the image caused by changes of illumination. Nevertheless, gaining illumination in face recognition is still a huge challenge that needs continuous effort and attention. This study had carried out an extensive survey and included techniques that have recently introduced.

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