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Illumination Normalization using Eimad-housam Technique

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ABSTRACT

The problem associated with Illumination variation is one of the major problems in image processing, pattern recognition, medical image, etc; hence there is a need to handle and deal with such variations. This paper presents a novel and efficient algorithm for images illumination normalization called Eimad-Housam Technique (EHT). EHT features are derived from a general definition of texture in a local graph neighborhood. The experiment results show the effectiveness of proposed algorithm.

Key words: Local graph structure, image processing, pattern recognition, Illumination variation, local binary pattern

INTRODUCTION

In recent years, biometrics gained renewed attention and essentially based on the development of pattern recognition systems. To verify a person's identity, biometrics uses a wide range of technologies to measure and analyze his or her physiological characteristics, these characteristics features are directly extracted from measuring some part of the body. Currently biometrics technologies have been developed and being applied in security applications and everyday law enforcement, a range of technologies have been used by biometrics, optical sensors or electronic, for instance, scanning devices and cameras are used to capture images, recording sound or measuring people's characteristics. Face recognition has a significant improvement over other biometric measurements; it is a natural, nonintrusive and straightforward. As such, it became a tool of choice for a lot of security applications. With the development of cheaper and higher quality imaging technologies, face images can be easily obtained with good images quality and good technology to utilize advanced, cost-effective and much more perfect face identification systems. As researcher interesting in face recognition, many systems were developed such as face recognition using skin color segmentation (Wang and Li, 2011), intelligent system (Ishak *et al*., 2006), directional images (Khan *et al*., 2004) and frontal color face recognition (Wakaf and Saii, 2009). The assessment recognition of faces indicates that the high level of performance for the best systems to be a frontal oriented and uniformly illuminated faces (Phillips *et al*., 2003). On the other hand, identification/recognition of faces across different changes in illumination and pose has proved to be a very challenging problem (Phillips *et al*., 2003; Gross *et al*., 2001; Krishnamoorthy and Bhavani, 2007), despite the fact that the majority of works by researchers have so far paying attention on frontal identification/recognition, there is a considerable work on illumination invariant and pose invariant face identification/recognition systems. However, face recognition across pose and illumination remains a largely unsolved problem (Zhao *et al.*, 2003; Georghiades *et al.*, 2001). In this study, we addressed the illumination normalization using our devised technique.

The problem associated with Illumination variation is one of the major problems in image processing, face recognition, medical image, etc., e.g., the appearance or perceptions of faces are significantly affected by factor of illumination, together with pose variation (Gross *et al.*, 2004; Shin *et al.*, 2008). Faces can vary markedly in illumination direction and rotation in-depth and these cause occlusions and varied appearances. Changing the illumination orientation consequently produced large image variation as have been reported by Adini *et al.* (1997). Their study was comparing images of several faces portrayed with similar or diverse lighting directions. Many representations of these faces were used: grey-scale faces, faces filtered with Gabor functions, 1st and 2nd derivatives of the grey-scale faces and edge maps. Varying illumination directions for all representations were considered to contribute in larger image differences than in adjusting the identity of the face. Quite a lot of methods have been proposed in the last years for solving the variable illumination problem in face recognition contexts. The approaches to solve these illumination problems can be roughly classified into three main categories: (i) Face modelling, (ii) Normalization and (iii) Pre-processing and invariant features extraction. The drawback of the face modelling approaches is the requirement of images for building the linear subspaces. Additionally, the secularity difficulty and the fact that human faces are not perfect, Lambertian surfaces are ignored by these models as stated by Ruiz-del-Solar and Quinteros (2008) and Abusham and Kiong (2009). For normalization and pre-processing techniques, several image pre-processing algorithms are introduced to compensate and normalize illumination. Most of these algorithms do not need any training or modelling steps, knowledge of three dimensional face models or reflective surface models (Wang and Zhang, 2011; Yang and He, 2010). Numerous methods and techniques have been presented in the previous study deal with illumination normalization. Two popular methods among these techniques are Local Binary Pattern (LBP) and Gabor wavelets. In this study, a novel illumination normalization method called Eimad-Housam Technique (EHT) for face recognition is proposed. EHT is applied to the image which can efficiently and successfully get rid of the effect of uneven illumination. Then the produced images which are insensitive to illumination variations, are used for face recognition and it can be combined with different methods, such as principal component analysis, independent component analysis and Gabor wavelets (Chui, 1992; Ojala *et al.*, 1996; Wakaf and Saii, 2009). The objective of the study was to present a novel and officient algorithm for images illumination normalization.

MATERIALS AND METHODS

The basic idea behind the algorithm is to form a local graph for each pixel (called target pixel) of the input image. The graph consists of three pixels on the left side and three pixels on the right side of the target pixel. Then behind the 6 pixels there will be target pixel as shown by the white colour in the Fig. 1.

EHT algorithm applied to the image by moving in a horizontal way to scan the whole image and the resulted normalized face image is invariant to illumination such as lighting pose and angle.

To produce the EHT for pixel (x_d, y_d) a binomial weight 2^p is assigned to each sign s $(g_d\text{-}g_n)$. These binomial weights are summed:

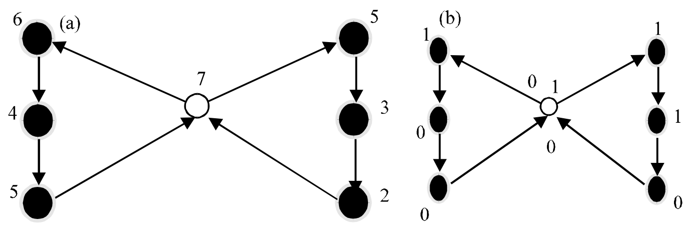

Fig. 1(a-b): Local graph structure, (a) Direction and (b) Pixels, binary

$$LGS(x_d, y_d) = \sum_{p=0}^{7} s(g_d - g_n)2^p \quad (1)$$

where:

$$s(x) = \begin{cases} 1 & x \geq 0 \\ 0 & x < 0 \end{cases}$$

where, p = 7. p = 7, 6,... 0

EHT algorithm:

- Move on the left side of the graph to produce 3 binary values from the original 6 bits
- If the move from large vertex to small vertex we assign a value = 1 to that edge
- Else we assign a value to that edge
- Loop until get back to the target pixel by finding one binary value when you get back to the target
- Move on the right side to produce 3 binary values
- Assign the new value into target pixel and then continue scanning the image

RESULTS

Eimad-Housam technique has proved to be useful in a variety of image processing and pattern recognition tasks. The basic idea is illustrated in Fig. 1: A decimal representation is obtained by taking the binary sequence as a binary number between 0 and 255. For a pixel, EHT not only accounts for its relative relationship with its neighbours but also the relationship between the pixels that form the local graph of the target pixel , while discarding the information of amplitude and this makes the resulting EHT values very insensitive to illumination intensities. The 8-bit binary series with binomial weights consequently result in 256 different patterns in total for the pixel representation.

In the initial work of face processing using EHT, can be seen in Fig. 3, is an example of new generated image from original image in Fig. 2 using EHT, a histogram of the EHTs for original image and a new generated one are illustrated in Fig. 4 consequently, histogram of EHTs image representing the distribution of 256 patterns across the face image. The advantage of EHT; Firstly it is a local measure, so EHT in a certain region will not be affected by the illumination conditions in other regions. Secondly it is a relative measure and is invariant to any monotonic

Fig. 2: Example of original image

Fig. 3: Example of new generated image from original image using EHT

transformation such as shifting, scaling or logarithm of the pixel-values. Therefore, it can be invariant to a certain range of illumination changes.

We test our method using the public ORL face database. The database consists of 400 faces from 40 persons. The faces were captured with the subjects in a straight, frontal position against a dark identical background and with acceptance for some sloping and regular change of up to 20 degrees. Image variations of five individuals in the database are illustrated in the Fig. 5.

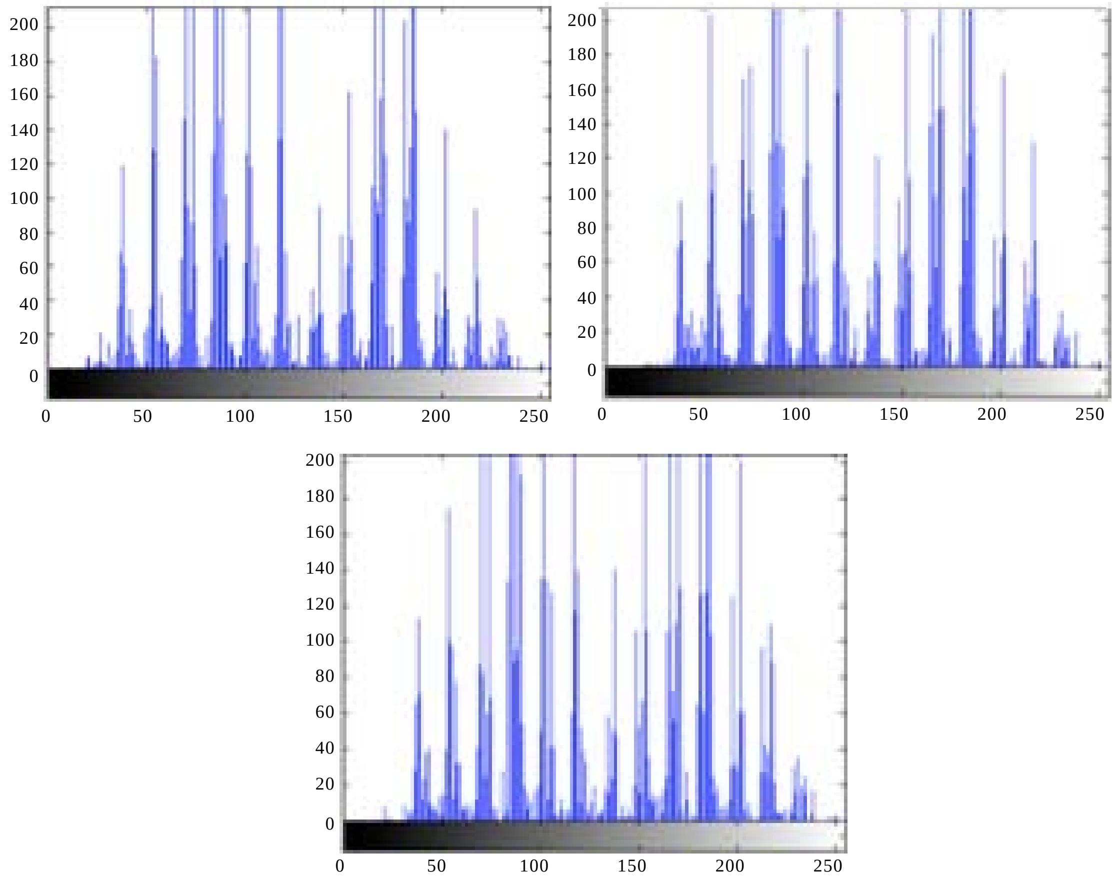

Fig. 4: Histogram of new generated image using EHT

Fig. 5: Sample of five individuals from ORL database

To assess the performance of the three proposed method on face recognition. Eighty subjects have taken for our experiments, 320 images for training and the remaining 20 images for testing, first both methods E-H were applied to find the histograms for the entire training set, for testing, the histogram of test image is calculated and then find the between the training images histograms and histogram of test image by applying the correlation functions which it compares two histograms.

The recognition rates obtained on ORL with the algorithm is shown in Table 1 and 2, respectively.

The similarity results for the proposed method is shown in Table 2.

The algorithm is also tested on our database (Fig. 6) where the database contains 100 images for 10 subject then 80 images used training and 20 images for testing the results as shown in Table 3 and 4.

Table 1: Recognition rate with ORL database

Method	E-H (%)
Recognition rate	91.25

Table 2: Similarity rate

Subjects	Testing image	Index	Recognition
1	1	16	0.9933
	2	16	0.9899
2	1	19	0.9875
	2	18	0.9897
3	1	32	0.9883
	2	29	0.9905
4	1	35	0.9946
	2	36	0.9937
5	1	48	0.9922
	2	48	0.9897

Table 3: Recognition rate

Subjects	Testing image	Index	Recognition
1	1	7	0.9969
	2	5	0.9963
2	1	9	0.9973
	2	9	0.9972
3	1	24	0.9975
	2	21	0.9967
4	1	25	0.9911
	2	27	0.9898
5	1	39	0.9959
	2	38	0.9926

Table 4: Recognition rate of our own database

Method	E-H(%)
Recognition rate	100

Fig. 6: Sample of our own database

DISCUSSION

In this study we attempted to apply a new concept by using graph techniques to assign a weight for a given pixel to form a binary code. The main advantage behind this concept is that we do not only consider the relationship of one pixel with its neighbour but in-fact we consider the relationship between the pixels that form the local graph of the target pixel. The other advantage of the proposed method is its computation time as shown, the method is quite fast and it can be easily used in mobile phone for face recognition because cell phone requires less memory and computation.

This method can easily be combined with other methods such as principal component analysis, linear discriminant analysis and independent component analysis and can easily kernelized by using different kernels functions.

On the other hand, the false recognitions reported in ORL database are caused by the rotation hence in this case the problem can be solved by applying in-plane rotation as suggested by Huang *et al*. (2007) where the alignment is achieved by aligning one image at a time and then minimize the total sum of the entropy.

CONCLUSIONS

This study presents a novel and efficient algorithm for images illumination normalization call Eimad-Housam (EHT) the features of local graph structure are derived from a general definition of texture in a local graph neighborhood. The advantages of EHT over other local methods it's invariant to illumination changes, computational efficiency and fast so that it can be easily applied in real-time system. EHT assigns weight for target pixels by considering not only the relationship of one pixel to its neighbours but also the relationship between the pixels that form the local graph of the target pixel; this feature is unique to EHT and lead to improve the image appearance and subsequently the recognition performance. This is especially applicable for faces from which the photos are taken under different lighting conditions. Important regions for feature extraction are those with the eyes and the mouth.

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