Efficiency of Face Recognition System Using Local Binary Pattern and CLAHE on color skin person

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Abstract: *Facial recognition is widely used as identification. the reason for this choice of facial recognition is its simplicity of implementation and its non-invasive feature while providing an acceptance result. Beside its popularity, facial recognition still facing many accuracy issues. Popular method, eigenface, still having problem recognizing a skin color person in variable ambient lighting. This research focuses on implementing image enhancement on pre-processing to equalize image contrast. By using the contrast-limited adaptive histogram equalization, an improvement in face detection rate will be achieved. While the local binary model, which replaces the eigenfaces method, is used to increase the accuracy of face identification even with a small amount of face samples during training.*

Keywords: *Face recognition, Face Detection, eigenface, local binary pattern, contrast limited adaptive histogram equalization, CLAHE,*

1. Introduction

Face recognition is known as a popular method as automatic identification system due to its non-invasive and simplicity characteristic, and acceptable recognition accuracy. Face recognition, on the other hand, still facing many issue on its recognition accuracy due to environment condition, especially ambient illumination. This paper will perform several approaches to increase face recognition accuracy of color skin person.

2. Face Recognition System

Face recognition system can be broken down into two main importance stage. Face detection to located face inside the image/frame will be the first step. Once face is located, the face will be cropped and identify its identity [1].

2.1 Face Detection

Face detection is an important supporting part on recognition process. Before it can beidentified, at first the face in image should be located. Unlike human eye and brain, computer cannot see a visual object like human did. Computer will see object as a binary's strings. Image will be scan byte after byte [2]. Every feature will be translated to digital world as a digital feature. Viola-Jones introduced Haarlike feature to be used by computer to detect face(5). These features combination will be used as filter to eliminate non face object. By cascading many types of filter (each with different features combination) will lead to face detection.

Unfortunately, this method still vulnerable on variation on ambient illumination and it need the face to be in frontal face to the camera.

2.2 Face recognition

Before the system have the capability to identify face identity, first it need be trained. Training is performed by giving a known dataset (face image and its identity). Once it is trained, the system can identify the face in a given image by comparing the face with the training data. The highest matching score and above the pre-determined threshold, will be consider as the identity [2].

Many algorithms available to be used as face recognition. One of them is eigenface. Based on PCA, it generates a set of eigenface based on the training data. Then each identity will be assigned a set of weighing factor, that correspond to each eigenface to generate the training image. By comparing this weighing factor set to the database, it will identify face identity[3]. Unfortunately this algorithm is not that robust. Variation on ambient illumination and pose, and small number on training datawill lead to low accuracy.

3. Image Enhancement

A fail face detection can be considered due to poor image exposure quality. To increase image quality, system need to apply some image enhancement process. This image enhancement is needed to adjust image contrast. An alternative technique for contrast

enhancement which has been widely used is histogram equalization.

3.1 Histogram Equalization

In this method [4], the intensity value in the image is altered such that the resulting image has a constant intensity histogram. This transformation may be accomplished by the use of the cumulative distribution function of the pixel intensities as the intensity remapping function.

Such image utilize the available display level well, but because the contrast enhancement is based on the statistics of the entire image, some levels will be used for the depiction of parts of the image which are diagnostically unimportant, such as the background.

3.2 Adaptive Histogram Equalization

Adaptive histogram equalization (AHE) attempts to overcome the limitations of global histogram equalization by providing most of the desired information in a single image which can be produced without manual intervention [5] [6].

In this technique, the contrast mapping applied to a particular pixel is is a function of the intensity values immediately surrounding the pixel. For each pixel in the image, a region centered about a pixel, called its contextual region, is assigned. The intensity values in that region are used to calculate a histogram equalization mapping which is then applied to the pixel in question. The result is an image which mapping applied to each pixel is different and its adaptive to the local distribution of pixel intensities rather than the global distribution of pixel in image. Thus hidden features of the image is more visible.

3.3 Contrast Limiting Adaptive Histogram Equalization

The enhancement on adaptive histogram equalization sometime too strong that two major problems can arise: noisy amplification in “flat” regions of the image and “rign” aritifacts at strong edge.

In[7] [8] Contrast limiting adaptive histogram equalization (CLAHE) was designed to improve AHE performance, by prevent the over amplification of noise. This is achieved by limiting the contrast enhancement of AHE. The contrast. The contrast amplification in the vicinity of a given pixel value is given by the slope of the transformation function. This is proportional to the slope of the neighborhood cumulative distribution function (CDF) and therefore to the value of the histogram at that pixel value.

CLAHE limits the amplification by clipping the histogram at a predefined value before computing the CDF. This limits the slope of the CDF and therefore of the transformation function. The value at which the histogram is clipped, the so-called clip limit, depends on the normalization of the histogram and thereby on the size of the neighborhood region. Common values limit the resulting amplification to between 3 and 4 times the histogram mean value.

That way, CLAHE has more flexibility in choosing the local histogram mapping function. By selecting the clipping level of the histogram, undesired noise amplification can be reduced.

4. Face Matching

Many face matching algorithm has been developed to do face recogntion. The popular one is eigenface.

4.1 EigenFace

In [9] Eigenface, based on PCA, is the most simple efficient face recognition algorithm. PCA converts each training image into vector matrices and do the processing in this vector form. PCA then generates K eigenfaces from M images in training set, where K<M so it reduces the number of images to be recognized from M to K.

Each image in training set is a proportion form of features from K eigenfaces. This proportion in fact is the weighting factor that related to each eigenfaces to generate the image back. Then each image in training set can be represented by a weighting factor.

Image matching then can be accomplished by comparing this weighting vector. The main advantage by using this PCA method is the amount of data that needed to identify a face could be reduce to 1/1000th of the data set

4.2 FisherFace

Based on Linear Discriminant Analysis (LDA), fisherface is another statistical that widely used to reduced dimension and classification. LDA consider grouping of data. Fisherface then maximize the ratio of data spread between class to the data spreads interclass. The idea is data from the same class will be tightly grouping.

But both eigenface and fisherface need a lot of training data to achieved acceptable accuracy. And both methods cannot accommodate different illumination and pose [10].

4.3 Local Binary Pattern

In [11] [12] Local Binary Pattern (LBP) is focused on locale features extraction on an image. The idea is not to look the whole image as “high” dimension vector, but only states the locale features of an object.

This LBP technique will define local structure by comparing each pixel against its neighborhood. Take one pixel in the center of the neighborhood, any pixel on its neighborhood that has lower value will be set as 0, and the rest will be set as 1. By aligning the value, clockwise from the top left of the neighborhood, a set of binary data will be generated for each neighborhood. This method will result on fine details of an image.

5. Experiments and Results

Two approach is used on designing more robust face recognition. To increase face detection rate, when no face is detected, the image will be reprocessed using CLAHE and then undergo another face detection. Eigenface, fisherface, and LBP will be compared on their recognition accuracy

a. Face detection result

On face detection step, the test is performed to analyze CLAHE's performance to increase detection rate. Prior to embed CLAHE on face detection process, the clipping factor in CLAHE need to be determined first. To get the optimum value of this clipping factor, another face detection test need to be performed by varying its clipping factor. The clipping factor was varied from 0 to 0.5. The test result that 0.02 is the optimum value for clipping factor.

Using 50 images on controlled area and pose variation, LBP and Viola-Jones method will be used to do face detection both with conventional and CLAHE pre-processing. The testing result is displayed on Table 1.

Another testing on 35 images on uncontrolled condition and pose variation using both LBP and Viola-Jones method for the face detection. Again, both are performed with conventional and CLAHE application. The result is displayed on Table 2.

Table 1: *face detection performance on controlled area*

Method	Non-CLAHE	CLAHE
LBP	70%	85%
Viola-Jones	75%	87%

Table 2: *Face detection on uncontrolled area*

Method	Non-CLAHE	CLAHE
LBP	20%	40%
Viola-Jones	39%	55%

On both result, Viola-Jones method is better on face detection. And CLAHE application is proved to increase face detection rate.

b. Face recognition result

Face recognition test was conducted using eigenface, fisherface, and LBP methods. As another type of matching algorithms, these three methods also need threshold value to be used. To determine the optimum threshold value for each method, another face recognition test need to be performed by varying its threshold. Eigenface and fisherface have threshold distance range test on 10 – 4990, while LBP has threshold value range on 1- 499.

Based on the test result, it was decided to use value of 4100 for eigenface threshold and a value of 3500 for fisherface threshold. While LBP has an optimum value 100. These value will be used for this face recognition test.

Ours face database is used to test this face recognition. This database contain 100 person each with 4 different pose. 4 set of data can be generated for each pose with 100 person images.

Table 3: Image from dataset

Lighting 1 Lighting 2 Lighting 3 lighting

A normal pose is chosen as the training data set. Then the three-face recognition will be used to identify each image on every set. On completion the face recognition process, another one set is used as the training data set. And face recognition process is repeated.

Table 4: *face recognition result in our database*

	ACCURACY %		
Training set	Eigenface	Fisherface	LBP
1	65	67	85
2	65	68	87
3	67	70	90
4	70	75	92

The testing result on the fact that the LBP method is result on better accuracy rate even with small number of databases.

6. Conclusion

Better face recognition can be achieved by doing some pre-processed-on detection and using better algorithm on the recognition side.

CLAHE application is proved to increase the detection rate on various illumination condition.

LBP is proved to have higher recognition accuracy on different pose and small number of training data set.

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