Face Recognition of Robust Regression With Pre-Processing Using CLAHE Technique

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ABSTRACT

One of face recognition methods that has been developed to overcome the problem of illumination variation is the Robust Regression. This method uses the Histogram Equalization technique in pre-processing stage, which is used to reduce the effects of illumination factors on face images. The results of previous research show the face recognition performance of the Robust Regression method (which uses Histogram Equalization technique in the pre-processing stage) is very high. In this research, the Contrast-limited Adaptive Histogram Equalizaton (CLAHE) technique will be used in the pre-processing stage to replace the Histogram Equalization technique. The research was conducted to find out how the effect of pre-processing technique changes on face recognition performance. The empirical experiment was conducted using one of the standard face database data i.e the Extended Yale Face Database B. Based on the experimental results, the average accuracy of face recognition where in the pre-processing stage using the CLAHE technique is 98.06%. This result is better than face recognition performance using the Histogram Equalization technique at the pre-processing stage, where the average accuracy of facial recognition is 96.17%.

Keywords: ***Face Recognition, Robust Regression, Contrast-limited Adaptive Histogram Equalizaton, and Extended Yale Database B.***

1. Introduction

Among the various techniques based on biometrics, such as the introduction of fingerprints, palms, irises, retinas, ears, sounds, or behavior (gait, signature, etc.), the characteristics of face recognition systems have many advantages over others, face recognition can be done without requiring the presence of an individual's active role. This is especially useful for security and monitoring purposes.

In face recognition, the factors that cause the variation of the facial image can be categorized into 2, namely intrinsic and extrinsic factors [1]. Intrinsic factors are related to the physical features of the face. While extrinsic factors associated with the change of face image because of the interaction between light and face.

In research conducted by Abate et al [2], the variation factor of illumination is considered one of the major problems associated with reliability. Even according to research from Hu [3], illumination variations factor are more influential on face recognition than with other variations, such as position or expression factors. Especially in complex lighting conditions, this problem has not been fully solved in face recognition systems [4]. Many approaches have been developed to solve this problem. One of them is the Robust Regression [5], which shows better face recognition performance compared to a number of other approaches. Based on the results of tests conducted using several standard databases, the Robust Regression approach shows a fairly high level of accuracy. A number of test results show a better accuracy over many other face recognition approaches. However, among the results still show a less than optimal accuracy. So it is possible to do further development to get a better level of accuracy.

In the pre-processing stage, the Robust Regression method uses the Histogram Equalization technique [6], as one of the most commonly used image contrast adjustment techniques today, to normalize the face image, to increase image contrast and to reduce the variation of the face image due to the effects of illumination variations. By using Histogram Equalization technique, performance of the Robust Regression method is quite good, with average accuracy 96.17%. In this research, the Contrast-limited Adaptive Histogram Equalizaton (CLAHE) technique will be used in the pre-processing stage, replacing the Histogram Equalization technique. Implementation of this technique is expected to produce more face recognition performance than before.

2. Research Method.

1. The Robust Regression Method

The method proposed in this research is the approach developed from the previous method, namely the Robust Regression method. There are two stages in the Robust Regression approach, namely the stages of training (training) and the testing stage (testing). Similarly, the proposed method also comprises the two steps, with modifications at the pre-processing stage.

In the training phase of the proposed method, the pre-processing stage uses the Histogram Remapping technique with non-uniform distribution to normalize the illumination of the face image (image training) in overcoming the illumination variations in the image. In the previous method, this pre-processing stage uses the Histogram Equalization technique. After the pre-processing stage is done, several stages performed the same as the previous method, namely:

1) The training image image is transformed into a vector with smaller dimensions. This step alters the image originally represented as axb matrix into ab-sized vector for later down sample process so that the vector has smaller dimension. Furthermore, this small dimension vector is normalized for maximum value of 1.
2) Preparation of predictors (regressors / predictors) for each class by combining training vectors. This step aims to produce predictor variables by arranging the vectors of the training image horizontally. This predictor variable is established for each class.

While the testing stage in the proposed approach, the pre-processing stage using the Histogram Remapping technique with non-uniform distribution, the same as in the training stage, to normalize the illumination of the face image (test image) in overcoming the illumination variations on the image. In the previous method, this pre-processing stage uses the Histogram Equalization technique. After the pre-processing stage is done, several stages performed the same as the previous method, namely:

1) The training image image is transformed into a vector with smaller dimensions. This step alters the image originally represented as axb matrix into ab-sized vector for later downsample process so that the vector has smaller dimension. Furthermore, this small dimension vector is normalized for maximum value of 1.
2) Predict the test image class using Huber's estimate with the smallest distance. This step is aimed at generating prediction classes for testing images, corresponding to the smallest distance between the vector image testing with a particular class prediction vector.

2. Datasets

The training data in this research used one of the standard image databases used by researchers in the field of face recognition, namely the Extended Yale Face Database B [7], which is a database developed from Yale Face Database B, with more individuals many and changes in variations of illumination. This database consists of 38 individuals and 64 illumination conditions per individual. The original image size is 168 × 192. Figure 1 shows the illumination variations on one individual on the Extended Yale Face Database B with the frontal position.

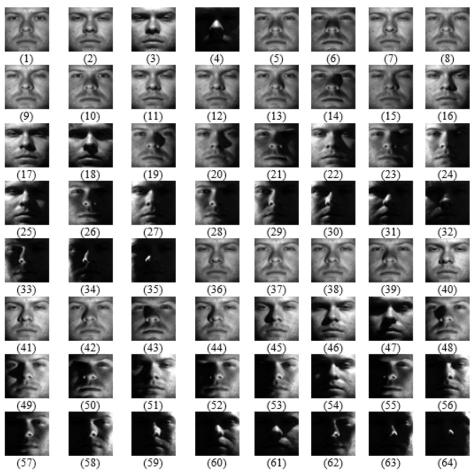

Figure 1. Illumination variations from one individual in the Extended Yale Face Database B

Experiments using this face database were performed by dividing the individual image variations into 5 subsets, as shown in Table 1. The training process was performed on subset one drawings and the testing process was performed on other subset images (subset 2-5).

The results of the proposed Robust Regression method (which uses the CLAHE technique in the pre-processing stage) will be compared with the performance of the previous method (using the Histogram Equalization technique in the pre-processing stage).

Tabel 1. Experiments Technique in the Extended Yale Face Database B

Citra *Training*	Citra *Testing*
Citra Subset 1	Citra Subset 2
Citra Subset 1	Citra Subset 3
Citra Subset 1	Citra Subset 4

3. Discussion.

This section describes the results of the trials that have been obtained in this research. The experiments were conducted in order to determine the accuracy level (percent unit) of face recognition of each experiments technique using the standard face image database (in this research using Extended Yale Face Database B). The average accuracy is calculated based on the average value of the results obtained on all test techniques. Furthermore, this research compares the results of the Robust Regression method testing using Histogram Equalization (in the pre-processing stage) with the Robust Regression method using CLAHE technique in the pre-processing stage.

Table 2. Testing Result

Evaluation Techniques	Training Images	Testing Images	Robust Regression (Preprocessing with Histeq)	Robust Regression (Preprocessing with CLAHE)
1	Subset 1	Subset 2	99,89	100,00
2	Subset 1	Subset 3	94,92	99,44
3	Subset 1	Subset 4	93,68	94,74
Average Accuracy			**96,17**	**98,06**

The experimental results are shown by table 2, where the average accuracy of the Robust Regression method using Histogram Equalization is 96.17%. While the average accuracy of Robust Regression method using CLAHE technique is 98.06%.

4. Conclusion.

Based on the results of experiments that have been done in this research, the use of Contrast-limited Adaptive Histogram Equalizaton (CLAHE) technique on Robust Regression method gives more result than using Histogram Equalization technique. In empirical experiments using Extended Yale Face Database B, the difference in accuracy is 1.89%. Although the difference is not very significant, but at least the results of this experiment show a better influence from the use of CLAHE techniques on facial recognition of the Robust Regression method.

Thus, the conclusion of this research is the use of CLAHE techniques in the pre-processing stages of the Robust Regression method, in fact giving a better effect on facial recognition performance. But the results of this study need to be tested again on other facial recognition methods, whether giving the same conclusion or different. In addition, further research can also be done by conducting trials on a number of other standard image databases to determine the extent of its conformity with the conclusions obtained in this research.

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