16. Proceeding KICSS 2016 Face Recognition Using Eigenface with Naive Bayes

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Face Recognition Using Eigenface with Naive Bayes

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***Abstract*—One of the lack of eigenface for prediction the face recogniton is not good accuracy. This paper uses naive Bayes for classifying the result of eigenface feature extraction to predict the face. The normalization z-score is added for sharping the accuracy. To see the performance of proposed method, the 200 datasets are divided into data training and testing by using cross validation (*k*=10). The results show that the proposed method can predict the face image up to 70%. Moreover by adding normalization Z-Score, the accuration of prediction raise up to 89.5 % (in average).**

Keywords—Eigenface; Naive Bayes; Face Recognition, z-score

I. Introduction

The face recognition is one of biometrics recognition. Since a human has a unique face, even for identical twins, this recognition can be used as represntation of a personal recognition [1]. Face recognition can be used for security system, attendance record system and so forth.

Many researches about face recognition using eigenface have been conducted, such as by Heng et al [2] and the others [3][4][5][6]. Hang et al claim eigenface method is able to produce accuracy 73% from 3 angel of face.

In this study, predict eigenface is combined with naive Bayes. Eigenface for feature extraction, and naive Bayes is used for dataset class prediction.

II. RELATED WORK

A. Eigenface

The word “eigenface” comes from German word “eigenwert”. The German word “eigen” refers to characteristic and word “wert” refer to value. Eigenface is face recognition algorithm based on Principle Component Analysis (PCA) which was developed by Massachusetts Institute of echnology (MIT). Many researchers prefer call it the term of eigen image. This technique has been used in hand-write recognition, libs reading, voice recognition and medical imaging.

Overall eigenface algorithm is quite simple. Training and testing data of image are represented as combined flat vectors into a single matrix. Eigen value is extracted and stored in temporary file or database for each image. In order to find the distance of eigen value, each eigen value from testing data compared with database or temporary file that consists of eigen value from training data.

The idea of Eigenface was developed by Sirovich and Kirby [7]. They argued a collection of face images can be approximately reconstructed by weights for each face images. Turk and Petland decsribes some steps of eigenface wirh some Eqs (1)- Eqs(3) [8]:

1. Take all class of dataset. Each data is represented as $I_1, I_2, I_3, I_4 \dots . I_n$
2. Each data I_n transform into a vector $I^2 \times 1$. Now we have matrix of vector $r_i = I^2 \times n$.
3. Compute average of vector.

$$Y = \frac{1}{M}\sum_{i=1}^{M} r_i \quad (1)$$

4. Subtract the mean of face image.

$$Q = r_i - Y \quad (2)$$

5. Compute covariance matrix.

$$C = A^T A \quad (3)$$

Compute eigenvalue and eigenvector of C covariance matrix.

6. Keep matrix u, this matirx contain eigenvalue that sorted by bigest eigenvector.
7. Calculate the distance of eigen value by ecludian distance.

B. Naive Bayes Classifier

Naive Bayes is a classifier method which is introduced by Thomas Bayes. This method learning from data and predict class which each class have probability [9]. Bayes theorem is shown in Eq. (4)

$$(A|B) = \frac{P\,(\mathrm{B}|\mathrm{A}) * P(A)}{P(\mathrm{B})} \quad (4)$$

where $P(A)$ and $P(B)$ are probabilities of observing A and B [10]. $P\,(B|A)$ is the probability of observing event B given that A is true.

Naïve Bayes equation is represented by $P(A\,|B)$, A is a input vector that have feature and B is a class label [11]. Based on information from training data, for each combination A and B, the final probability $P(B \mid A)$ of model should be trained. With that model, testing data of A' can be declared by look for B' value by maximazing $P(A'|B')$ value. Then for classification, Naïve Bayes formula can be declared as Eq. (5)

$$P(B|A) = \frac{P(Y)\prod_{i=1}^{q} P(A_i|B)}{P(A)} \quad (5)$$

where $P(B|\,A)$ is probability data for A vector in Y class. $P(Y)$ is initial probability of Y class.

$\prod_{i=1}^{q} P(A_i|B)$ is independent probability B class from all features in A vector. Value of $P(A$ is always a fixed value so in the next calculation we just need to calculate $(B)\prod_{i=1}^{q} P(A_i|B)$ to select the max value of selected class as the result of prediction. Meanwhile, independent probability $\prod_{i=1}^{q} P(A_i|B)$ is an influence of all features from the data for each B class. Naive Bayes for continuous data can be dsecribe as Eq. (6).

$$P(x = v|c) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(v-\mu)^2}{2\sigma^2}}\,. \quad (6)$$

III. PROPOSED METHOD

This proposed method uses combining eigenface for feature extraction and naive Bayes for predict class of images dataset. The result of it needs to be normalized to increase the quality of classfying of naive Bayes. This concept can be shown in Fig. 1.

Fig. 1. The concept of proposed method

Therefore, some steps can be described as follows.

1. Take all class of dataset. The images on Fig. (2) are taken as dataset.
2. Transform dataset of RGB image into grayscale as shown Fig. (3) as represented $(I_1, I_2, I_3, I_4 \dots . I_n)$

Fig. 2. Images datasets RGB

Fig. 3. Grayscale Images of Figure 2.

3. Each data I_n transform into a vector $I^2 \times 1$. Now we have matrix of vector $r_i = I^2 \times n$.
4. Compute average of vector as Eq. (1).
5. Subtract the mean of face imageas Eq. (2).
6. Compute covariance matrix as Eq. (3).
7. Compute eigenvalue and eigenvector of C covariance matrix.
8. Keep matrix u, this matirx contain eigenvalue that sorted by bigest eigenvector.
9. Normalize matrix u that contains eigenvalue using Z-Score.
10. On this step, length of principal component on matrix u can be cut. The result can be found as Fig. 4.
11. Split each class of data becomes 10 k-fold (Cross Validation).
12. Find standard deviation and average from training dataset.
13. Find average from testing dataset.
14. Compute using naive Bayes algorithm as Eq. (6)
15. Matching class predict and class testing using confusion matrix.

Fig. 4. *Images* after principal component

On PEF, Z-*score* is used for measure distance of data point from the mean in standard deviation. This *Z-score* will be used after finishing eigenface.

IV. RESULTS AND ANALYSIS

The maximal value of Principal Component (PC) is set 22500 (as long as feature on data we use). Our data consists 20 class and each classes has 10 data thus there are 200 data which dimension of image is 150 x 150 pixels. Image acquisition using digital camera, then crop and resize to 150 x 150 pixels. Each image consists the centered face image with various face expression. We conducted some various PC from 100-2200 with increasing 100. Table 1 shows the result acurarcy with Z score and without Z score.

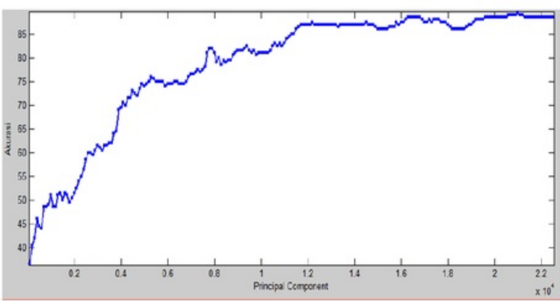

Fig. 5. Accuracy 0-2250 PC with Z-score

Figure 5 presents accuracy each principal component (pc) 100 until 2250. Highest accuracy using Z-Score on prediction of eigenface 88,5%. Lowest accuracy using Z-Sore on predict eigenface 36,5% . Best accuracy acquired on pc 2100.

Our experiment is trying to apply PEF and add Z-Score in face recognition resulted accuracy 89.5% on PC 2100. But if we used without Z-Score from PEF we get worse then we apply Z-Score as shown Table 1 and Fig. 6.

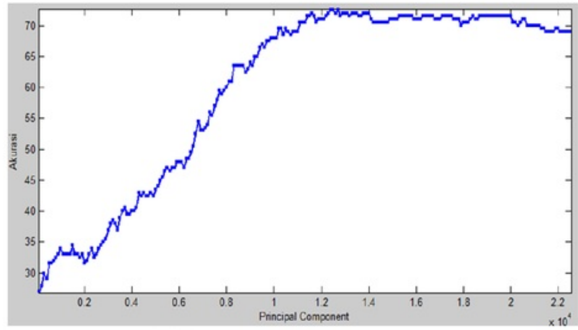

Fig. 6. Accuracy 0-2250 PC without Z-score

TABLE I. ACCURACY USING AND WITHOUST Z-SCORE

PC	Accuracy	
	Using Z-Score	Without Z-Score
100	36.5	27
500	44.5	31.5
1000	51	34
2000	51.5	31.5
5000	74	43.5
10000	81	68
15000	86	71
20000	88.5	71.5
22500	88.5	69

Highest accuracy without Z-Score on prediction of eigenface 70%. Lowest accuracy using Z-Sore on predict eigenface 27%. Best accuracy acquired on pc 2100. Comparison result can be shown on Table. 2

TABLE II. COMPARISON RESULT

Category	Without Z-Score	Use Z-Score
Best Accuracy on PC 21000	70%	89,50%
Accuracy on PC 100	27%	36,50%
Accuracy on PC 22500 (Max PC)	69%	88,5
Accuracy on PC 7700	59,50%	82%

This experimen resulted peak of the best accuracy is on pc 21000 with accuracy 89,5% if use Z-score and 70% without Zscore.

V. CONLUSION

This result shows that PEF is able to recognize the face. From 200 images of 20 different person, the accuracy prediction using PEF and Naïve Bayes is about 70%. By using Z-Score, the prediction grows up until 89.5 %. For feature, this method can be applied on real application such as security, absence on office and so forth.

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