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A Study on Face Recognition and Reliability Improvement Using Classification Analysis Technique

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Abstract

In this study, we try to find ways to recognize face recognition more stably and to improve the effectiveness and reliability of face recognition. In order to improve the face recognition rate, a lot of data must be used, but that does not necessarily mean that the recognition rate is improved. Another criterion for improving the recognition rate can be seen that the top/bottom of the recognition rate is determined depending on how accurately or precisely the degree of classification of the data to be used is made. There are various methods for classification analysis, but in this study, classification analysis is performed using a support vector machine (SVM). In this study, feature information is extracted using a normalized image with rotation information, and then projected onto the eigenspace to investigate the relationship between the feature values through the classification analysis of SVM. Verification through classification analysis can improve the effectiveness and reliability of various recognition fields such as object recognition as well as face recognition, and will be of great help in improving recognition rates.

Keywords: *Machine Learning, SVM, PCA, Classification, Face Recognition*

1. Introduction

Research on face recognition has been in progress for a long time, and research papers are ongoing to this day. The fact that research is conducted for a long period of time means that there are difficulties in face recognition. Face recognition shows completely different recognition rates depending on the environment in which the experiment is conducted. In other words, face recognition reacts very sensitively to the experimental environment. Therefore, most of the studies up to now have been conducting research on improving the recognition rate while changing and improving these experimental environments. Recently, with the emergence of the 4th industrial revolution, core technologies that will lead the 4th industrial revolution such as artificial intelligence (AI), Big-data, and internet of things (IOT) are at the center of the general public's topic.

Among them, the Big Data Analysis (BDA) technology required for AI implementation can be used in various fields and is being used in many places. Among BDA techniques, Classification Analysis (CA), which corresponds to the field of machine learning (ML) [1,2], is also one of ML techniques [3-5], which are essential for implementing AI. CA belonging to ML includes decision tree (DT)[6-8], random forest (RF) [9-11] and

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support vector machine (SVM) [11]. There are and logistic regression analysis (LRA) [7,12,13].
In this study, feature information is extracted using a normalized image with rotational information and then projected onto the eigenspace to investigate the relationship between the feature values for differently formed clusters through SVM CA. Verification through CA can improve the effectiveness and reliability of not only face recognition [14] but also various recognition fields such as object recognition, and will be of great help in improving recognition rate.

2. Face Recognition

2.1. Face Detection

Face detection uses the average brightness when it is dark and when it is bright at the same location in consideration of the change in brightness due to the change in illumination, and removes the job through morphology calculation. Equation 1 is a method of obtaining a background model.

$$B(x) = \begin{cases} 255 \text{ if } |P_{max}(x) - I(x)| \text{ or } |P_{min}(x) - I(x)| > D(x) \\ 0 \quad \text{otherwise} \end{cases} \tag{1}$$

$P_{max}(x)$: Brightest pixels , $I(x)$: input image, $P_{min}(x)$: Darkest pixel, $D(x) = P_{max}(x) - P_{min}(x)$

2.2. Obtaining Facial Feature Information

In order to improve the face recognition rate, images of rotation information including side photos were used. Figure 1 shows some of the entire facial images used in the experiment. In order to shorten the time for face recognition, a gray image was made through a pre-processing process.

Figure 1. Part of the input video

2.3. Eigen Space

In order to construct the eigenspace, the average of all images is calculated and analysis of each image is obtained. Find the average of all images with Equation 2.

$$C = (1/N)\sum_{i=1}^{N} x_i \tag{2}$$

After finding the mean, the eigenvalues and eigenvectors are obtained using principal component analysis (PCA). After that, when projecting all the eigenvectors into the eigenspace, only the feature vectors representing each image are projected. Equation 3 expresses the unique space of the face image.

$$\frac{\sum_{i=1}^{k} \lambda_i}{\sum_{i=1}^{N} \lambda_i} \geq T_1 \quad (3)$$

The projected feature vectors are expressed as points in the eigenspace, and vectors with similar feature values are projected close to the eigenspace. That is, the closer it is, the higher the correlation between the images.

3. Classification of Support Vector Machine

Among the BDA techniques that classify big data and then use it to infer and predict the future, CA corresponding to ML is one of the ML techniques [1] that are essential to implement AI.

3.1 Machine Learning Technique

ML is one of the fields of artificial intelligence that allows machines to make decisions and infer like humans. It is a technology that gives them the ability to infer by learning data having a specific meaning (ML) [1]. ML can be divided into three categories: supervised learning (SL), unsupervised iearning (UL), and reinforcement learning (RL). First, SL finds a prediction function from specific data and predicts the result of a new input value. Second, UL learns random data by itself. Third, RL reinforces learning through errors.

In this study, the ML technique to be applied to determine whether each face can be distinguished based on the feature values extracted for face recognition is the SVM.

3.2 Overview of Support Vector Machine (SVM)

SVM is a learning method proposed by Vapnik [2] in 1995 to solve the binary pattern classification problem. It is a technique that classifies two categories by finding an optimal hyperplane using feature vectors.

SVM has excellent recognition performance and processing speed, and is applied to various fields such as face recognition, character recognition, pattern recognition, and document categorization [13]. The definition of a linear classifier (LC) that creates a hyperplane is as shown in Equation (4).

The definition of a LC that creates a hyperplane is as shown in Equation (4).

$$g(x,y) = < W.x > + \omega_0 = W^T x + \omega_0 = \sum_{i=1}^{n} \omega_i x_i + \omega_0 \quad (4)$$

The LC determines the class when the class to be classified is (+1) and (-1). if, $W^T x + \omega_0 > 0$

than, +1 class

if , $W^T x + \omega_0 < 0$ than, =1 class

here, t $W = (\omega_1, \omega_2, \ldots \omega_d)^T, x = (x_1, x_2, \ldots x_d)^T$ than, is the length of the mending foot from the center to the hyperplane.

Classification of SVM is defined as the margin of the LC by extending the width of the LC between two classes until it meets the data point. It maps to a dimension to obtain a hyperplane that can be linearly separated. Figure 2 shows two-dimensional and three-dimensional ideas.

The figure on the left of Fig. 2 is the mapping of one-dimensional data that cannot be linearly separated into two-dimensional data by applying a variance function, and has a decision boundary that can be linearly separated. The two figures on the right are two-dimensional data mapped into three dimensions, not one-dimensional data, and a linearly separable plane can be obtained.

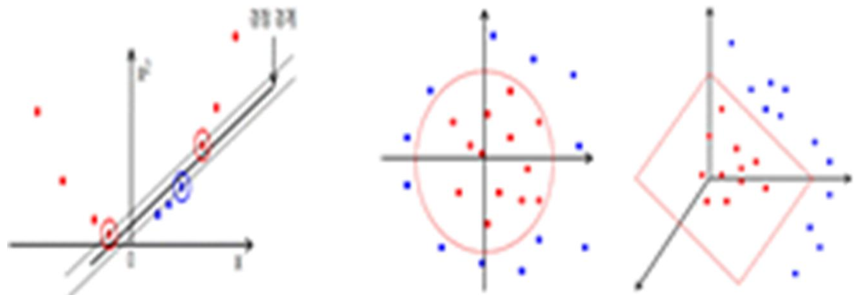

Figure 2. SVM hyperplane (2D, 3D)

3.3 Classification Analysis Experiment of SVM

In this experiment, training data was created by setting a mask for learning SVM. In addition, by applying a nonlinear SVM to the generated training data, parameter C was set to minimize all misclassified samples. Also, feature coefficients were used as training data for nonlinear SVM. Equation 5 is a case where the upper R feature coefficients are selected among all feature coefficients.

$$X_i = (d_1, \ldots, d_R, y),\ y_i \in \{face, non\ face\} \tag{5}$$

X : input image , d : distance

In addition, in SVM, a transform function that extracts a new feature is called a kernel function (KF), and the const value and gamma value are checked according to the type of the KF. In such kernel technique, there are linear technique (LT) and non-linear technique (NLT). LT selectively uses linear properties and NLT uses radial, gaussian, and polynomial properties.

As a result of CA, 80% of correct classification and 20% of misclassification of the train set were found, and 74% of correct classification and 26% of incorrect classification of the test set were found. As a result of the CA of the two groups train set and the test set participating in the experiment, there is no significant difference due to a small range between each other, so it is reliable in CA, but the classification rate as a whole can be said to be somewhat low.

The low classification rate can be seen as a result of insufficient training due to insufficient amount of total data used in the experiment rather than a mistake in the CA process through SVM. If more experimental days are used, the classification rate will increase significantly will be. Therefore, since there is no significant difference in the classification rate between train and test, the result of CA using SVM is judged to be reliable.

Table 1 shows the correct classification rate and misclassification rate by SVM's internal function calculation by classifying 35 of the total 50 data used in the experiment into a train set. As a result of classification analysis, 80% of correct classification and 20% of misclassification of train set were found.

Table 1. Result of classification analysis of input image (train)

	Classification	Misclassification	All image
train data	28	7	35
Classification rate	80%	20%	100%

Table 2 shows 15 of the total 50 data used in the experiment as a test set and shows the correct classification rate and misclassification rate by the calculation of the internal function of SVM. As a result of classification analysis, the correct classification of the train set was 74% and the incorrect classification was 26%.

Table 2. Result of classification analysis of input image (test)

	Classification	Misclassification	All image
test data	11	4	15
Classification rate	74%	26%%	100%

4. Conclusion

In the era of the 4th industrial revolution, at the time when trying to develop various technologies using AI in all fields of society, the best of consumption and the maximization of profits are being optimized. In order to obtain sophisticated BDA results, data must be well classified according to the purpose to be analyzed. From this point of view, this study went through a pre-processing process of face images for face recognition. And to improve the face recognition ra

In addition, PCA was used to speed up face recognition, and faces were recognized through the Euclidean distance of each face by extracting feature values of each face through PCA. However, in improving the face recognition rate, the recognition rate can be significantly reduced due to the overlapping phenomenon of each face existing in a similar unique space. In order to classify the feature values where the overlap problem occurs in the eigenspace more precisely, the CA method. An experiment was conducted to find out the methodology for classifying data more efficiently and stably using SVM among several CA belonging to ML techniques.

In the case of the train set by SVM in this experiment, the correct classification rate is 80%, and the misclassification rate is 20%. In the case of the test set, the correct classification rate is 74% and the misclassification rate is 26%. Through the SVM CA experiment, the degree of CA of the train set and test set was investigated. The CA rate of the SVM technique, which helped improve the recognition rate in the existing face recognition field, came out somewhat low, but this is thought to be a phenomenon that occurs because sufficient training is not performed due to the lack of data used in the experiment. If more experimental data are used, the classification rates of train set and test set will increase significantly.

Therefore, the classification was good because the total classification rates of the Classification and Misclassification of the train set and the Classification and the Misclassification of the test set did not differ significantly from each other, and the CA results were judged to be reliable.

In the future, after examining the performance using CA, which was not covered in this study, the CA performance of specific objects and other objects will be compared and analyzed. In addition, for CA, we will deal with the data participating in the experiment in a more diverse manner and check the CA rate according to the quantity by increasing the amount of data.

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