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A SURVEY TO FACE RECOGNITION ALGORITHMS: ADVANTAGEOUS AND DISADVANTAGEOUS

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Abstract. The ways of face recognition is in such a way that one can recognize the face. Someone is using software and the aim is to recognize the specified person even after the face is changed. This essay investigates the pros and cons of some of the algorithms of methods used for recognizing face.

Keywords: *face recognition, holistic, dimension reduction, expanding educational data, local methods*

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1. Introduction

During last decades, there have been considerable elaborations on expanding recognition algorithms with full-face picture. The existing methods for recognizing the face needs several gallery (educational) pictures from each person to teach their own system in an optimum way. On the other hand, for variety of real applications to recognize face such as applying law, driving license and identifying identity by passport, there is usually only a picture of each person. This issue is called "The issue of a picture from each person" or "one-sample issue". In this case, the majority of the existing methods such as ones based on neural networks and Adaboost are likely to encounter serious problems in their performance or they might lose their recognition ability completely. On the other hand, the applied face recognition method is required to be resistant against picture variables. The main problems to which we are encountered to can be categorized as follow:

- Brightness changing problems. Most of the methods used for face recognition are based on picture content. So that, the act of recognizing gets difficult when the amount of brightness and following that, picture content changes.
- The problem of appearance change in pictures. The appearance changings can include growth of face beard, oldness and different gestures in people. Due to the changes that any of these can make in content of pictures, the system of face recognition is likely to be disorganized.

The viewing-angle problem. As we know some parts of the human beings face is omitted form the two-dimensional picture as one turns their head in different directions. This makes systems with only a recorded picture of the person from

one angle, usually front, to have problem during recognition. The face recognition algorithm is one approving or rejecting the identity of people through digital pictures as well as recognition video frames or their identity based on a confirmed identity automatically or via physiological properties [2]. Extra information like race, age, face expression or the voice of people might be used to simplify the research. The stages of face recognition through a picture include 1) face detection in picture; 2) eliciting the characteristics from faces and 3) face recognition. These stages are shown in block diagram of the Figure 1.

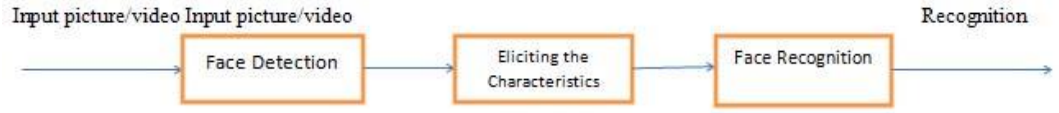


Figure 1.

In applications such as the picture on driving license, there is not the problem of the dividing and finding the part of the face due to its controlled nature. But only if there is only one picture of an airport, finding the part of face in it will be difficult. But only if we have a series of video pictures, the division will be done easily; although those video pictures have the problem of reduced quality.

2. Face recognition methods

In this section we investigate the methods to recognize face in fixed pictures. As it is obvious in figure 1, recognizing face through fixed pictures contains three steps. However applying all three steps is not necessary for such system, but investigation on any of these steps is important. The reason is that not only the techniques used for different parts should be amended, but also each of these parts will have independent applications in different parts. Dividing these parts causes each part is amended individually and gets a considerable progress.

It is worth noting that the stage of eliciting presented properties can be applied in this stage implicitly. In this section, all of the methods of recognition are investigated based on the severity of the face pictures. A lot of researchers in different fields such as psychology, pattern detection, neural networks, visual machine and computer graphic participate in the field of face recognition. That is why the literature of recognition is very vast and complicated. Sometimes a system of face recognition includes a series of different techniques that originate from different rules. Using these different techniques in different parts of the face recognition system causes not to be able to use a simple division for different face recognition methods based on use techniques to categorize and elicit the property. Therefore to gain a general category, the category of psychology is used in this investigation. In view point of psychologists, human mind may act in two ways to recognize people face recognition: paying attention to the generality of the face of one who is recognized or considering positional properties of face such as mouth, nose and eyes. Hence, the methods of face recognition are divided to three main categories [3]:

a) Holistic methods. These methods use the whole of the face as an input.
b) Positional methods. In these methods, positional properties of the face are used for recognition. There should be a lot of attention in the case of attaching general information to the positional model of the face.
c) Compound methods. These methods use face positional and general information for recognition. Due to applying simple information, these methods have better capability than individual usage of positional and holistic methods.

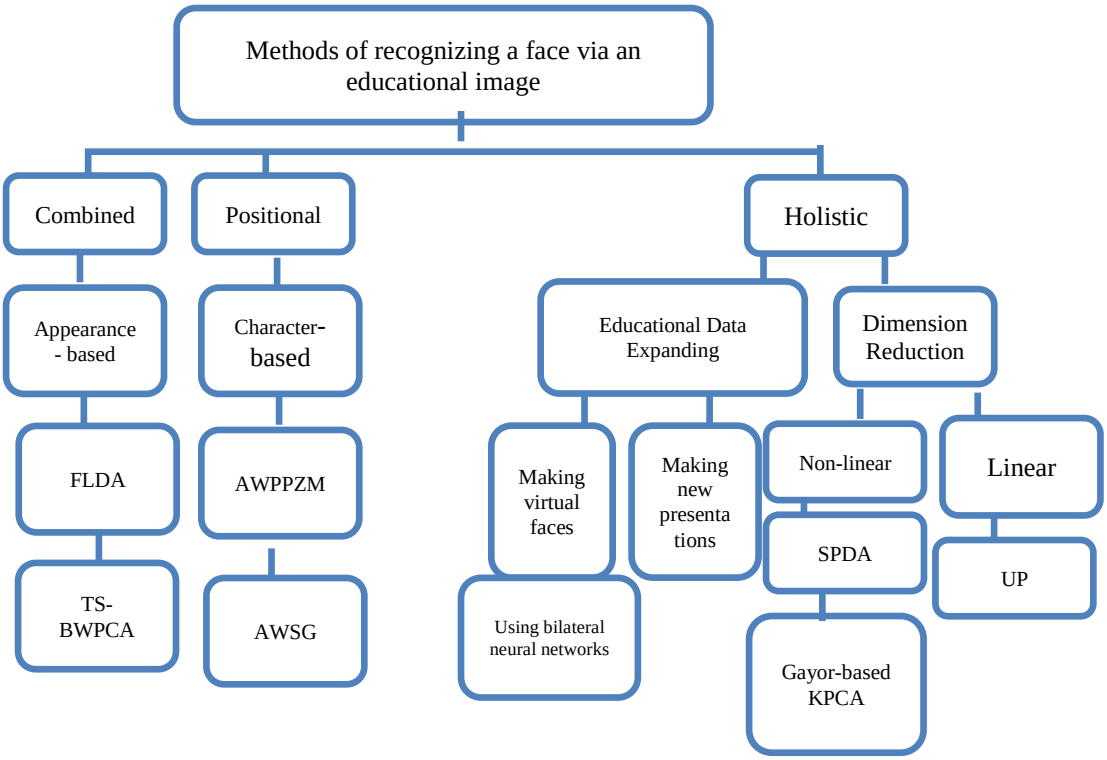


Figure 2. Categorizing face recognition methods with an educational picture.

Holistic Methods

In these methods, each face is defined via vectors with high dimensions in that any of the indicators related to it show the amount of pixel brightness. Using this method of showing, at first the whole information regarding face texture and form are stored for recognition and secondly, more general aspects related to positional descriptions are considered. Albeit, there are some disadvantages with this method that ought to be regarded recognizing a picture of an individuals. At first the problem of high dimension and shortage of data is likely to be more complicated and since there is only a vector for each category, eliciting the intra-network features via ordinary methods of pattern cognition is almost impossible. Two methods are suggested for solving this problem. First problem is that most of the possible information is elicited through high dimensions or common methods such as Principal Component Analysis are used. The second method is combining

the previous information to make new presentations for existing faces as well as elevation of the series of educational data.

Dimension Reduction

Dimension reduction methods are divided into two linear and non-linear categories.

a) *Linear methods*

Space linear analysis in that the space of features related to the linear form of face are regarded through some dimensions, are likely to be used for the applications of face recognition. This is more due to the effectiveness and applicability of the calculations for eliciting the features and their presentation. Different factors are supposed to make different levels and hence, varieties of features are there in light of the produced space.

Principal Component Analysis. It makes a series of columns perpendicular to each other that preserve the direction of the maximum variance in educational data. The coefficient of main analysis in light of the new space is not correlated. Analyzing the main feature can preserve the general space of the picture and it is optimum for presentation and reconstruction.

Figure 3. The average picture on the left that is followed by seven biggest special faces [6]

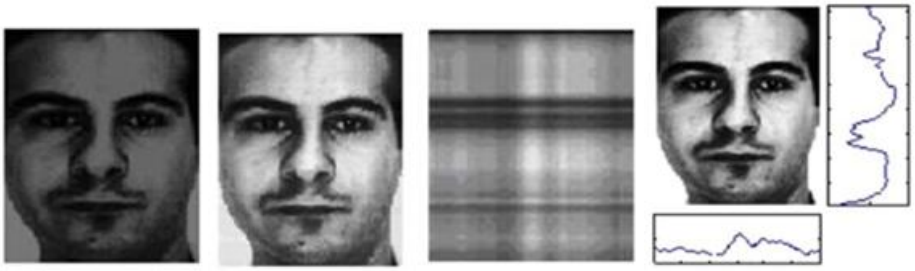
2D-PCA. Instead of using one-dimensional vectors, it works based on two-dimensional ones and covariance matrix is gained directly from the picture matrix. The size of this covariance matrix is very smaller than the gained one through PCA. Therefore, evaluation of the covariance matrix accuracy is easier and to gain vectors, less time is needed.

$(PC)^{2A}$. In a case that only a picture of an individual is reached, the common methods are not effective for specific faces. Hence, generalizing these methods for more stable withstanding seems inevitable. $(PC)^{2A}$ method is for reinforcing the information of presented face space. Considering the amount of pixel brightness in vector of (x,y) equal to I(x,y), the horizontal and vertical picture equal

$$HI(x) = \sum_{y=1}^{n} I(x,y) \quad (1)$$

$$HI(y) = \sum_{x=1}^{n} I(x,y) \quad (2)$$

Using these two pictures, a new picture of the individual is made and this new picture is to reinforce the information combined with the original picture. After this pre-processing, the non-useful information gets vanished and the more useful ones get more prominent. Then the common method for specific faces is operated on pictures. This method has three to five percent elevation in face recognition accuracy of an individual in comparison to common specific faces on FERET database [1].



D c b a

Figure 4. A series of sample picture in (Pc) ^{2A}. a) The original picture and their horizontal and vertical profiles; b)first step projection; c) The combination of picture and first step projection; d) The picture combined with second step [7].

E (PC) ^{2A}. The amended form of (Pc) ^{2A} method is E (PC) ^{2A}. The original idea for amending this method is one with nth degree pictures. The results show that the amended method is more effective than the main method. Both methods try to reinforce the information using chaos the educational picture. Another similar method is introduced under the name of Single Vector Decomposition (SVD) [7]. The reviewed methods solve the problem of each individual in an indirect way and changes of head state and head angle, brightness and gesture are not hinted explicitly. The possibility of having destroyed and diminished images taken from ID cards seems to be high that it causes weakness in process of recognition. There is a system to solve this problem. The idea of this method is producing new images, imitating original damaged images. Imitation takes place via Noise model using three Noise parameters to control contrast, brightness and Gaussian lure. The writers used 137 scanned ID card images with 300 dpi to test their method. The amount of error in this trial is about 1.32 % and this method has considerably increased the similarity between produced images and the educational ones.

Fisher Linear Discriminant Analysis. The Fisher Linear Discriminant Analysis can be regarded as a generalization of the specific faces. In this method, the aim is to find discriminating subspaces. Given only an image of each person due to distribution between the classes, the failure is inevitable. There is a method to solve this problem. The information of other people inside the class is used in suggested method.

Locality Preserving Projection (LPP). On variety of databases, it is better than Independent Component Analysis (ICA). But this results in only feasible when several samples of each person are reachable. Otherwise, this LPP face has identical performance level comparing ICA.

UP [8]. In this method a new way of eliciting named uniform pursuit (UP) is used. The main idea of this method is that the majority of the errors are because of confusion among faces very similar to each other. Hence, using the samples with the close classes in that their centers are far from each other, the risk of recognition can be reduced. Specially, UP method is followed in original whitened ICA. Projections with handful of dimension can reduce the positional confusions among similar faces.

b) *Non-linear methods*

Non-linear methods used for recognition with an educational image are presented beneath:

Kernel Principal Component Analysis (KPCA) [9]. According to Cover, non-linear separable patterns in input subspace are very likely to be separable linear faces if the non-linear input space to the specific space could be converted with higher dimension. In order to convert a non-linear ø, input space of R^N can be written with a specific space with more dimension of F:

$$\varphi : R^N \to F \tag{3}$$

$$Y \to \varphi(Y) \tag{4}$$

The primary motivation of KPCA was that performing ICA in a space with more dimensions can gain higher statistics features of input variables. To solve the problem of high expenses of covariance matrix calculation in specific space with high dimension, the nuclear tricks could be used that via using nuclear function , input space multiplying in input space is reduced [10, 11].

$$k(Y_i, Y_j) = (\varphi(Y_i).\varphi(Y_j)) \tag{5}$$

Using this method, it could be shown that applying ICA in space of converting by k function is possible. In practical using of face recognition, three classes of nuclear functions are used massively [10] that are nuclear- polynomial, nuclear-Gaussian and nuclear-sigmoid. In [12] nuclear-polynomial are prolonged in such a way that contain polynomial models with Fractional Power Polynomial (FPP), if $0<d<1$ for instance, there might be a more authentic applicability.

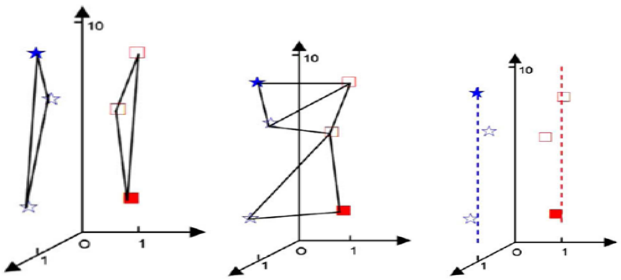
Gabor-oriented KPCA with double nonlinear format [9]. In this method, at first we use violet Gabor to elicit face expression features. Then, a double nonlinear format method is suggested to convert input features not only considering input features but also considers a mask for emphasizing the famous specific parts of face. After that, the method of analyzing KPCA is used for face recognition.

SPDA [13]. Majority of the methods for dimension reduction, such as LDA, have been successful in face recognition field but they could not be used directly to recognize face with an educational image.

SPDA [13]. Most of the methods for classic dimension reduction, such has LDA in the field of face recognition have been successful but they cannot be used directly in face recognition via an educational image. Semi-Supervised Dimensionality Reduction (SSDR) method which is based on graph is a practical strategy to solve this problem. Although most of the existing algorithms for SSDR are similar to positional-oriented Semi Supervised Discriminant Analysis and they totally suffer from the following: 1) they need to an abundant number of non-labeled educational samples to estimate Manifold structure. 2) They make a close modeling of data geometrical structure with the nearest neighborhood in that it cannot gain sufficient discriminating information in a space with high face dimension. 3) Basic Neighborhood Graph (which is data-dependent regulator) is made for all samples via neighborhood with the same amount.

To solve these problems in this method, a SSDR method based on graph under name of Sparsity Preserving Discriminant Analysis (SPDA) is suggested

with potential capabilities coming in the following: 1) Graph is made by SPDA and therefore, the positional structure of data is shown automatically rather than being defined manually. 2) Given the power of discriminating, SPDA can enhance the recognition affectivity in a considerable way. 3) An Ensemble could be used to accelerate making graph.



a) Data distribution b) Graph for SDA c) Graph for SPDA

Extending the educational data

Another principal way to solve the problem of each image taken from any individual using general features is maximizing educational data. Since choosing an optimum presentation enhancing the recognition affectivity is not a simple job, all of their advantages are going to be used using combining the variety of presentations. The method of Representational Oriented Component Analysis (ROCA) is likely to be used in this case. The image-oriented chaos is another way to make new presentations. In this method, the horizontal and vertical error limit is defined and whenever there is a change in the horizontal and vertical vector of defined limitation, a new presentation is made [7].

Other methods to be mentioned here are E $(PC)^2$ and chaos with isolated vector. Theoretically, there could be made as many images as possible via making chaos among images with n degree. But the problem existing in these methods is that these produced images are very dependent to the primary images and hence they cannot be used as new educational images [7].

c) *Making virtual images*

Ideally, virtual samples should be completely distinct and presentable. These images occupy a specified space of the face and they are special representatives of face changes. One of the possible methods is to achieve sufficient information of the images taken from other people in those states. A simple method to make image is using geometrical conversions such as turning and size change on the original image. A similar method to this is one wherein a mirror image is used to solve the problem of coverage of half of the face.

Other complicated methods to produce virtual images in order to solve the problem of face recognition in uncontrolled settings providing the changing state and lighting are presented. It is expected to improve a recognition system via providing a sample face and producing different states of generalizing. A method of combining information is the way of changing face is when face to face change

takes place. This information could be achieved form a massive data base containing other faces.

A computational method named Linear Classes is introduced to make virtual faces. Their idea is to learn specific changes using other people in that class and applying these changes on a new face to make a virtual face.

The face produced by bilateral neural networks [1]. In this method, the bilateral neural networks are used, inspired from neo-cortex function model and this updatable model has been used on variety of figures and different facial expressions. In order to increase the tutorial sample size, in neural classes the Manifold estimation is used adopting full-face virtual views in test database.

Positional methods being used for recognizing face are better methods than holistic ones due to following reasons. 1) In this methods, faces with some vectors with lower dimensions are introduced instead of a vector with higher dimensions. Therefore, the above mentioned problem respecting dimension is pre-solved. 2) Due to their different parts, positional methods have more adaptability and the features concerned to each class is recognized easily. 3) Different features of face cause the variability of the classifiers. In spite of these advantages, the general combination of the face is vital for face recognition. Generally speaking, there are two ways to gain this goal. The first method is using graph. So that each node represents a positional feature and edges represent the spatial feature between these two nodes. Therefore the face recognition becomes the issue of adaptation. Another method considers combination of the general information and classifying method. In some of the methods, different classifying ways are adopted to calculate the amount of similarity among the abundant used features and eventually the scores attained form the different classifiers are added to each other and the final decision is made.

3. Conclusion and future works

This survey has assessed and compared some of the common methods in processing the images. Each of those methods has their own pros and cons and one them ought to be selected based on improvement and proposed disadvantages. One of the future works is going to investigate above mentioned algorithms more precisely and based on some other parameters.

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