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FACE RECOGNITION THROUGH VARIOUS FACIAL EXPRESSIONS

A.D. AITULEN, S.B. MUKHANOV, G.I. KHASSENOVA

International IT University

Abstact: *Face recognition is the main task of the problem that the developers solve, and it also attracts ordinary users, since this area is called intervention biometric modality. In this article, we proposed a new method for identification, that is, the detection (recognition) of faces with different emotions of faces. This approach consists of two elements: the first is facial expression recognition and the second is facial recognition. The method reflects two more important steps to improve the quality of face recognition when changing facial expressions. The first step to choose is specially selected characteristics that decide for the formation of the emotions of individuals, applying the approach (method) of mutual information. This action helps to effectively improve the accuracy of the classification of facial expressions, as well as reduce the size of the feature vector. In the second stage, we used the basic component analysis (PCA) to build EigenFaces for each class of facial expressions. Then, face recognition is performed by projecting the face onto the corresponding EigenFaces facial expression. The PCA technique significantly reduces the dimension of the original spaces, since face recognition is performed in the reduced EigenFaces space. An experimental study was conducted to evaluate the effectiveness of the proposed approach in terms of the accuracy of face recognition and space-time complexity.*

Keywords: *Facial Expression Recognition, Facial Recognition, Local Binary Structure (LBP), Principal Component Analysis (PCA), Mutual Information, Support Vector Machine (SVM)*

РАСПОЗНАВАНИЕ ЛИЦ ЧЕРЕЗ РАЗЛИЧНЫЕ ВЫРАЖЕНИЯ ЛИЦА

Аннотация: *Распознавание лиц является основной задачей проблемы, которую решают разработчики, а также оно привлекает простых пользователей, поскольку эта область называется интервенцией биометрической модальности. В этой статье предложен новый метод идентификации, то есть обнаружение (распознавание) лиц с разными эмоциями. Этот подход состоит из двух элементов: первое – это распознавание выражений лица и второе – распознавание лиц. Метод отражает еще два важных этапа для повышения качества распознавания при изменении выражений лица. Первый шаг – выбрать особо выделенные характеристики, отвечающие за образование эмоций лиц, применяя подход (метод) взаимной информации. Это действие помогает эффективно повысить точность классификации выражений лица, а также сократить размер вектора признаков. На втором этапе использован анализ основных компонентов (PCA) по построению EigenFaces для каждого класса выражений лица. Затем распознавание лица выполняется путем проецирования лица на соответствующее выражение лица EigenFaces. Методика PCA значительно уменьшает размерность исходных пространств, поскольку распознавание лиц выполняется в уменьшенном пространстве EigenFaces. Проведено экспериментальное исследование для оценки эффективности предложенного подхода с точки зрения точности распознавания лиц и сложности пространства-времени.*

Ключевые слова: *распознавание выражений лица, распознавание лиц, локальная двоичная структура (LBP), анализ главных компонентов (PCA), взаимная информация, машина опорных векторов (SVM)*

ӘРТҮРЛІ БЕТ ӘЛПЕТТЕРІ АРҚЫЛЫ АДАМДЫ ТАНУ

Аңдатпа: *Бет тану – әзірлеушілер шешетін басты мәселе, сонымен қатар қарапайым пайдаланушыларды тартады, өйткені бұл аймақ биометриялық араласу әдісі деп аталады. Осы* *мақалада біз сәйкестендірудің жаңа әдісін ұсындық, яғни әртүрлі эмоциялардың тұлғаларын анықтау (тану). Осы тәсіл екі элементтен тұрады: біріншісі – бет әлпетті білу, екіншісі – бет реңін тану. Бұл әдіс бет әлпетін өзгерткенде тұлғаның танылу сапасын жақсарту үшін тағы екі маңызды қадамды көрсетеді. Таңдаудың алғашқы қадамы – өзара ақпараттың тәсілін қолданатын жеке тұлғалардың эмоцияларын қалыптастыруды шешетін арнайы таңдалған сипаттамалар. Бұл әрекет бет әлпетін жіктеудің дәлдігін жақсартуға, сондай-ақ, вектордың өлшемін азайтуға көмектеседі. Екінші кезеңде біз бет белгілердің әрбір класына сәйкес EigenFaces құрастыру үшін базалық компоненттік талдауды (PCA) пайдаландық. Содан кейін бетті тану тұлғаны сәйкес EigenFaces бетінің өрнегіне шығару арқылы орындалады. PCA технологиясы түпнұсқа кеңістіктердің өлшемін едәуір азайтады, себебі бет әлпеті төмендеген EigenFaces кеңістігінде жасалады. Ғарыштық уақыттың күрделілігіне және тұлғалықтану дәлдігі тұрғысынан ұсынылған тәсілдің тиімділігін бағалау үшін эксперименталды зерттеу жүргізілді.*

Түйінді сөздер: *тұлғаны тану, тұлғатану, жергілікті бинарлық құрылымы (LBP), негізгі құрамдас талдау (PCA), өзара ақпарат, тірек векторлық машинасы (SVM).*

INTRODUCTION

Face recognition attracts researchers because it provides a more natural and user-friendly system than the biometric modalities of the iris or fingerprints. In fact, the personal identification system looks more professional when the cooperation of the participant is not required. Compared to traditional identification systems, biometric identification provides more security benefits because it helps to avoid the misuse of lost or stolen personal information. The task of face recognition includes both identification and verification problems. In the identification problem, the system identifies an unknown person from a database of known people, whereas in the verification problem, the system seeks to accept or reject the claimed person. A key advantage of the computer vision system is its ability to memorize a large number of identifiers, while the capabilities of the human brain are limited. This is what led to the emergence of face recognition systems in many applications to counter crime and terrorism. Other applications include a wide range of commercial and legal applications, such as access control, video surveillance, gaming, healthcare, etc. The recognition of a real three-dimensional face from its 2D image causes major changes in different lighting, posture, expressions, accessories and etc.

In normal social interaction, a newly emerging person is mainly identified to show whether they are familiar or interpret their emotional state. In addition, from a neurophysiological study [1], it was shown that facial expression analysis and facial recognition are performed simultaneously. In fact, this study showed how some patients suffering from cognitive impairment in a person’s perception, known as prosopagnosia (Alzheimer’s) patients, managed to recognize a familiar facial expression, but did not recognize its identity. This proves that facial expressions are the correct human modality. Accordingly, most face recognition systems and imperfections on the face are due to the dissociation of people’s recognition and the definition of their emotions.

In this paper, we use the window scanning algorithm, which works as follows:

- There is a test image, a scanning window is selected, the used features are selected;
- Next, the scan window begins to move sequentially through the image in 1 cell increments of the window (for example, the size of the window itself is 24 * 24 cells);
- When scanning an image in each window, approximately 200,000 options for the location of features are calculated by changing the scale of features and their position in the scanning window;
- Scanning is performed sequentially for different scales;
- It is not the image itself that is scaled, but the scanning window (the cell size is changed);
- All found signs get to the classifier, which “makes a verdict.”

All these points describe the process of the algorithm for face recognition. In other words, window scanning is a pixel face recognition method.

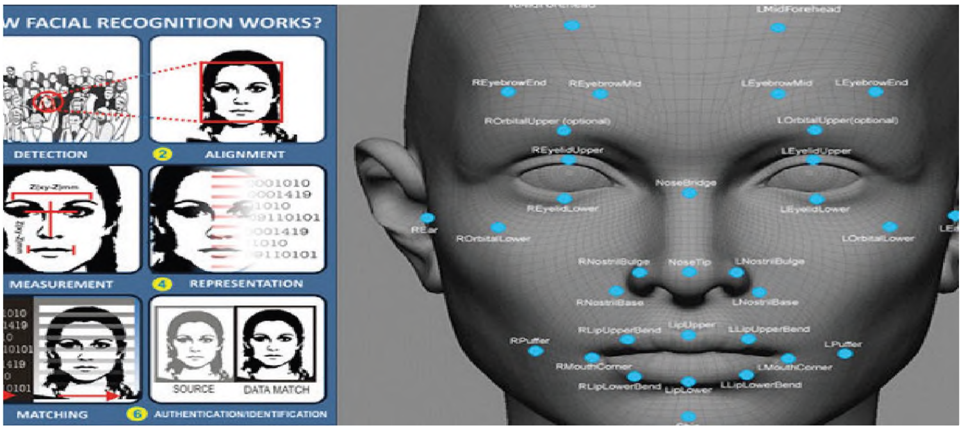

Figure 1 - Face recognition by special features

This method is applied to face recognition with various facial expressions. This method includes two main stages:

The first is facial expression recognition and the second is facial recognition. At the first stage, we examined the preliminary knowledge of psychological studies described in [1], which show that only some areas of the face are descriptive in the disclosure of expression. Therefore, a region selection strategy was applied in order to select descriptive regions that are responsible for the expression of an expression using the Mutual Information technique (statistical function of two random variables). Regarding the selection of facial features, we used the Local Binary Pattern (LBP) technique to encode micro-facial expressions. At the second stage, facial recognition was achieved using the principal component analysis method (PCA), based on psychological theories that consider face space as a metaphor for the memory of a human face [6]. In addition, the choice of the PCA method was motivated by its ability to drastically reduce the dimension of the original face space and execute them in the recognition process, as well as recalculate the newly reduced space. From the database of individuals, we built the basis vectors (eigenvectors) and then projected each face into selected prominent eigenvectors to calculate its weights. After that, each new person presented in the decomposition weights and the weight of its own face is compared with the best consistent weights through the database to identify its identity. In the proposed method, we have defined EigenFaces for each facial expression, therefore, once the expression has been identified, we simply project the face into the corresponding EigenFaces facial expression. The results of the experiment confirmed the effectiveness of the proposed approach, since it shows a good compromise between the accuracy of facial recognition and space-time complexity. The main contribution of the proposed method is to perform facial recognition and facial expression recognition as one of the associated problems, where facial expression recognition helps speed up the facial recognition process.

Works on face recognition can be traced back to the 1950s in the field of psychology and the 1960s in engineering literature [7]. Drawing on the psychological study of how people use holistic and local features to recognize a face. These works can be divided into two main approaches: a global approach and a localapproach.

GLOBAL APPROACH

In the global approach, faces are represented as arrays of pixel intensity or output signals that resemble the corresponding photoreceptor patterns in this area. Using the entire face image is a raw input recognition system and requires the provision of meaningful data for the effective presentation of the face. There are basically two ways of representing a face: a) a subspace method that includes a PCA representation and its derivatives b) an artificial intelligence method that uses raw characteristics of intensity or edges. The subspace method assumes that any set of facial images includes redundancy, which can be removed using dimension reduction methods. Such methods create a new low-dimensional space composed of a set of basis vectors. After that, each face can be reconstructed using these vectors in a new low-dimensional space. The classification stage is achieved by projecting the reconstructed image of a face onto a low-dimensional space and performing a comparison of the distances between different classes of space. Both methods of basic component analysis (PCA) and linear discriminant analysis (LDA) have been widely used as methods for reducing the dimensionality [7]. In fact, the PCA method represents information in orthogonal linear space. However, the LDA method encodes the corresponding information in a linear space, which is not essentially orthogonal. It is known that the algorithm based on the LDA method works better than the algorithm based on the PCA. However, recent work shows that these results depend on the amount of training data. In fact, the training data set is small; PCA gives better results than LDA. When a set of images of people's faces is available, a favorable trend is the use of subspace learning methods to simulate a change in the data set on a global scale.

In the methods of the parametric model [4], the parameters are estimated from the data of the image itself. Each image set is then represented using a certain parametric distribution with already estimated parameters. However, to evaluate the parameters, it is necessary that the gallery and sample sets have strong statistical correlations, which may not always be true [7]. To avoid the inconvenience of parametric methods, non-parametric model methods were introduced to represent a set of images as a linear / affine subspace of a mixture of subspace or non-linear manifolds. As for the methods of artificial intelligence, they use the stage of training, at which various artificial methods can be used, such as the neural network, the method of support vectors [4]. Some prior knowledge of pixel information and face structure data is encoded as a feature vector. In fact, the support vector machine builds a plane using a large stock criterion between two classes of examples. Due to the fact that the resulting database is large, both the learning steps and the testing steps are expensive. The Adaboost algorithm was another alternative to classifiers with a large margin proposed to solve machine learning problems. The presented algorithm by Freund and Shapir, the Adaboost algorithm, is used to select the most distinguishing LBP descriptors and provide a similarity function in the form of a linear combination of weak classifiers based on LBP descriptors. Although these methods are simple and provide important admissions, they face difficulties in changing the light, facial expression and posture that affect the appearance of the face.

LOCAL APPROACH

The local approach was the main strategy used by early facial recognition systems [2]. The hypothesis underlying this approach is that the facial recognition system is completely damaged when facial features are edited or spatially reorganized. In fact, local features such as eyes, nose, and mouth are detected before performing face recognition. Then, for the structure classifier, the positions of facial features and local geometric statistics and / or appearance statistics are provided [6]. Methods within this approach can be classified into two classes: geometric methods and structural methods. In geometric methods, some heuristic rules that include angles, distances, and areas are used to determine the distribution of facial features. It calculates the distance and angles between the corners of the eyes, the width of the head, the distance between the eyes and from the eyes to the mouth, etc. [5]. Authors Ahonen, T., & H.A.P.M. identified facial features as points in one form, for which objectively significant and reproducible biological analogues exist in all other forms of the data set. The most commonly used facial features are on the tip of the nose, the corners of the eyes and mouth, the center of the iris, the tip of the chin, nostrils and eyebrows. Indeed, the method of scale invariant feature transformation (SIFT) [4] was used to detect the characteristic points of the face on eight different perceived facial images. Later, accelerated robust functions (SURF) were introduced for face recognition. In [3], the authors used Gabor wavelets to detect key points. Then these points are clustered by the k-means algorithm. A comparison of individuals was performed using chi-square statistics. In structural methods, geometry consisted in a complete model of structures. As an illustration, we can provide a technique for comparing elastic graphs that simulates the relative positions of points in a structural model. In fact, each node in the graph defines one point on the face, and its arcs are weighted considering the expected distances between the facial features. To assess the similarity of local facial features, some templates are used. Since potential deformations are mainly based on points of facial features (for example, the corners of the eyes distort much more than the tip of the nose), you can add some specific information about the positions of facial features.

PROPOSED APPROACH

In this paper, we proposed a global approach to facial recognition with various facial expressions. The proposed approach consists of two main stages: facial expression recognition and facial recognition. In fact, at the first stage, we defined a class of facial expressions, applying the LBP operator to the most discriminating areas. Based on the last step, we projected the face onto the identified class of expressions using the PCA technique. In the Figure 2 it is obviously describes the proposed approach.

Facial expression recognition

For any automated face analysis system, face detection is usually the first step to take. It is designed to determine the position and size of the faces in the image. Using the face detector Violas [7], we automatically determined the areas of the face in the image. The face is then converted to an image level in grayscale, changed to a resolution of 64 × 64 pixels, and then pre-processed by histogram alignment to increase the overall image contrast and reduce the effect of uneven illumination. In addition, we used an elliptical mask to get rid of hair, background, neck and all noisy objects that may appear with the detected face. Before recognizing a person, we focused on identifying his emotions in order to speed up the comparison in the next stage of face recognition. In fact, the proposed approach to the recognition of facial expressions is based on the study of psychology, which showed that only some of the facial muscles are responsible for the appearance of facial expressions. These facial muscles are located around the mouth, nose and eyes [1], which proves that most expressive areas for facial expression are around certain areas of the face. Based on the results of this psychology, we used the Mutual Information method to select the most discriminating areas responsible for the expression of the expression. Belowit is the emotion recognition algorithm (Figure 3).

CONCLUSION

This article presented a robust face recognition system for achieving accurate face recog-

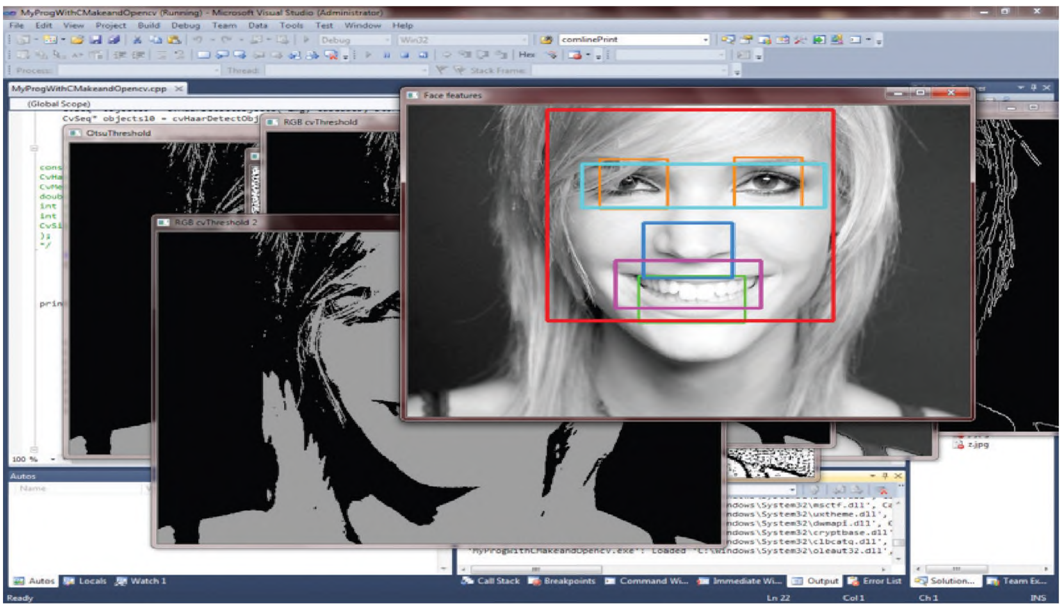

Figure 2 - Image Processing and Finding Local Features

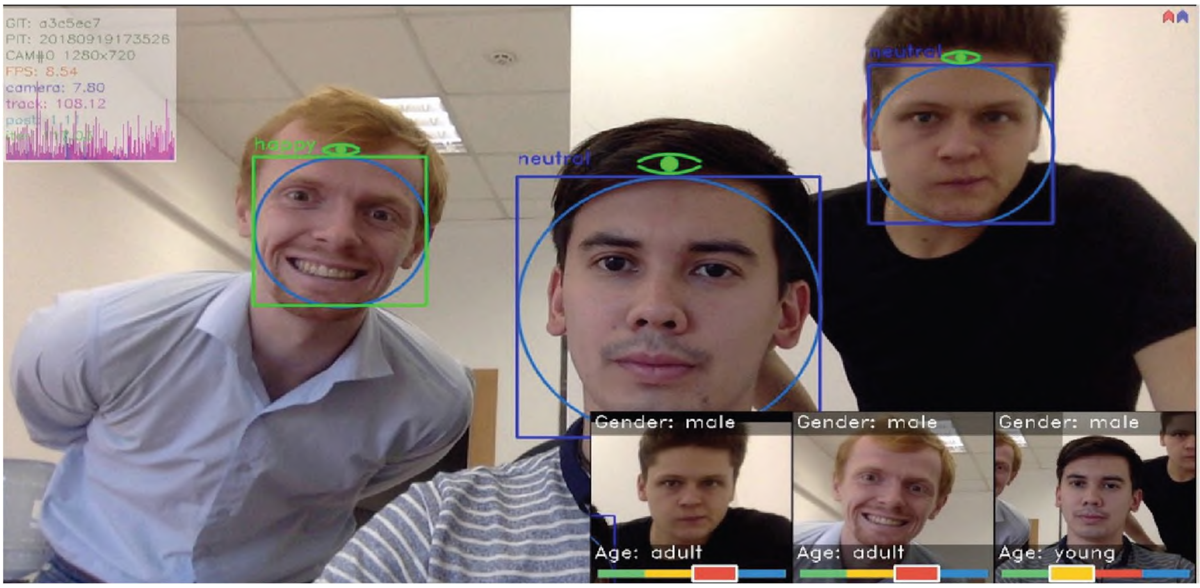

Figure 3 - Recognizing Emotions

nition with variations in facial expressions. The proposed approach simultaneously performs facial recognition and facial expression. In fact, we chose discriminatory areas that are sensitive to the appearance of facial expressions, and coded micro facial expression patterns using the LBP operator in selected areas. This procedure helps to reduce the size of the vector feature and improves the accuracy of the expression. We then created the EigenFace for each class of facial expressions using the PCA technique. After we defined the facial expression class, we projected the face onto the corresponding EigenFace facial expression to identify it. Experimental studies were conducted on the two most relevant databases for the analysis of facial expressions: the KANADE database and the JAFFE database. The results achieved showed the importance of using the facial expression step to perform the face recognition task without affecting the space-time complexity of the algorithm. Indeed, we managed to achieve good face recognition rates while significantly reducing execution time.

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