Human Face Identification from Profile Projection

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Abstract

This paper presents face recognition from front face. The idea is to extract the facial profile from a frontal view to provide a measurement for automatic face recognition. The profile is derived from the intensity of horizontal projection of the face image and using profile measure such χ^2 distance for face identification. Three profile projections from 4 images or more are taken for each person, average values are calculated and stored in a database file. Profile measurements are compared with other profile in the database file. Results of experiments to the faces with or without spectacles rotate head (lift, right) and different face expression show that the proposed approach is robust and efficient way of face matching.

Keywords: Face recognition, Profile projection, χ^2 distance, Horizontal projection.

Introduction

Face recognition technology has received significant attention in the past several years due to its potential for a wide variety of applications. However most of proposed face recognition systems are designed to work with frontal face images, there are several works that aimed to identify human faces from a profile view. Face recognition has become one of the most important biometric authentication technologies in past few years due to various applications. Most of proposed face recognition methods are 2D based and designed to work with frontal face images [1].

The side view of a face has excluded features available from a frontal view, which restricts their feature lists. Systems based on a frontal view have included more features, generally by including more geometrical measurements. Basing a recognition procedure on a frontal view alone rather than on a side view appears a wise choice, since a frontal view has major advantage that a much richer feature set can be available and most documents record face images only as frontal view, such as passport photographs.

In order to satisfy recognition requirements within large populations a rich feature set will be required. This cannot be achieved by just taking more geometrical measurements. It is manifest that face recognition can be based on a side view alone, but the feature set does not benefit from the richer feature set available in a front view. In order, to include the advantage of recognition based on the side view of a face within a strategy based on a front view alone, it is possible to determine a version of the profile by intensity projection of a fontal view of a face [2].

The problem of automatic human face recognition can be stated as follows: given an image of a human face, compare it with pre-stored models of a set of face images labeled with the person's identity (the training set) and report the matching result. Face identification is one-to-many process that compare an input test image against all face templates used in training; the output is the identity of the input test image. The problem of human face recognition is a complex and highly challenging one with spatial and temporal variations, e.g. illumination, pose orientation, expression, aging, head size, make-up, image obscuring (eye glass effect), disguise, and face background [3].

Extraction the profile from a frontal view

Human vision can normally infer 3-D shape correctly from a 2-D gray-level image by interpreting intensity information in the image and with some prior knowledge of the object. However, automatic inference of the 3-D shape has proven to be remarkably complex. Intensity distribution on a single 2-D monochrome image does contain the 3-D shape information of the object and some methods have been developed for obtaining depth information of the object surface.[4].

Intensity reveals the 3D shape of the object on a 2D image and the profile feature of a face is potentially available from a frontal view photograph of a face within a vertical central region of the image.

Accordingly a vertical rectangular region from the top of the forehead to the bottom of the chin along the middle of the face is defined as the face profile feature region. This region is well marked in an image using horizontal projection. The intensity variation in this region is employed to represent the profile feature of a face. As we know that the eye locate in the upper part of the face and that the pixels near the eyes are more changeful in value comparing with the other parts of face, it is a obvious that peak of this horizontal projection in the upper part can give us the Position of the profile projection.

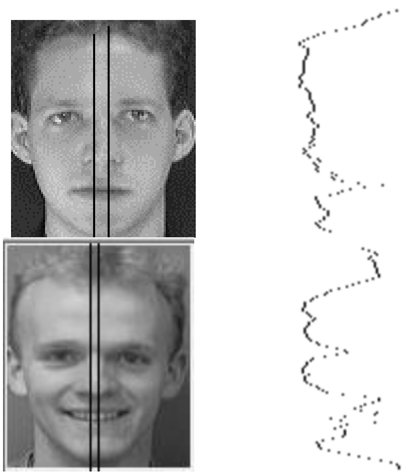

Fig.(1) Horizontal projection of frontal face.

Let an input image be defined by a discrete function f (x, y). Then, a horizontal projection at a point x of that function is a summary of all magnitudes in the x^{th} column.

Mathematically one can define the horizontal projection as:

$$Px(X) = \sum_{j=0}^{h-1} f(x,j) \quad \text{...} (1)$$

where w, h are dimensions of the image, f(x,j) is 2D function ,where x and j are spatial coordinate, and f is a light intensity at that point . j=0,1,2,3,4……..h-1.

After located the profile area by using horizontal projection. This projection reflects the relation between the peaks and valleys of intensity with the face profile feature.

The profile can be regarded as a histogram where the discrete value of x-axis describes the bin number and y-axis depicts the count of corresponding bin. Accordingly the profile is represented explicitly with respect to x: : profile: y =f(x).

There are many standard ways of comparing two histograms. The χ^2 distance is used to identification between two profile projections, represented explicitly.

$$x^2: D_{x^2}(f,g) = \int_{-\infty}^{\infty} \frac{(f-g)*(f-g)}{(f+g)} \quad \text{..................} (2)$$

$$x^2: D_{x^2}(f,g) = \sum_{k=0}^{n} \frac{(f-g)*(f-g)}{(f+g)} \quad \text{.............} (3)$$

Assuming f and g are two profiles projection, and each element in f has been Corresponding to g ,k = 0,1,2,3,4 …….n where n is number of profile projection points [5].

Data

The database which contains a set of faces taken between April 1992 & April 1994 at Olivetti Research Laboratory in Cambridge (ORL), U.K are considered [6] There are different images of 40 (male and female) distinct subject. For some subjects, the images were taken at different times. There is variation in facial expression (open/close eyes, smiling/non-smiling), and facial details (glasses/no glasses). All the image were taken against a dark homogeneous background with subjects in an upright frontal position, with tolerance for some tilting and rotation. The images are 256 gray levels with resolution of 92x112 pixels. Examples of these images are shown in Fig.(2).

Fig.(2) Examples of ORL database.

Experimental Results

In this section, the experimental results of our algorithm are demonstrated the image of the ORL database, a well-known free database of faces, to do the experiments. In this database, there are completely photographs of 40 persons, of which each one has 4 various views. The 4 views in different poses .All faces in this database are presented by images in gray-level with the size of 92x112 pixels.

For each face three pictures are taken and profile projection are extracted. The χ^2 distance is calculated to each projection and average value from these profile projection are stored as a database file to compare it with other profile picture. Fig.(3) show the profile projection of three pictures for same person and average value, which are stored in database file. Also, Fig.(4) shows profile projection of different seven persons, which can be used for identify between faces.

The χ^2 distance is calculated for five person as shown in Table (1). The threshold value is selected to identify the face. The threshold value of this work is (Th=279), as shows in Fig.(5).

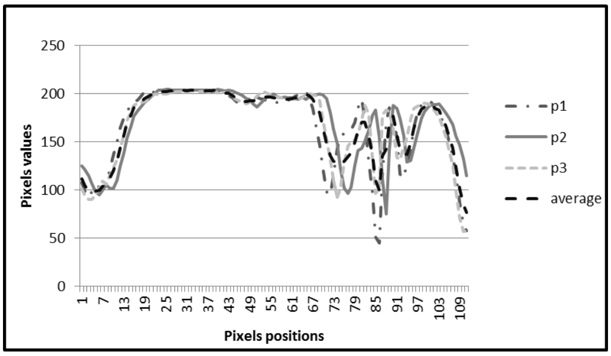

Fig.(3) Profile projections for three images and average value of same person.

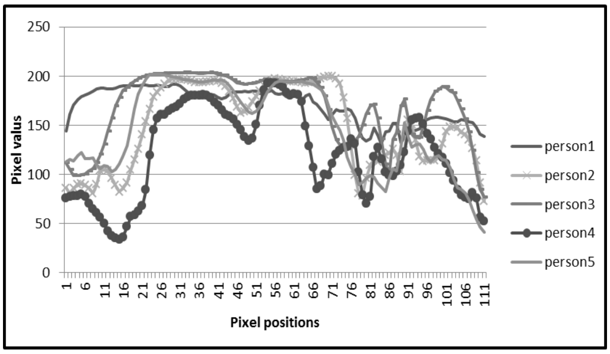

Fig.(4) Profile projections for different persons.

Table (1)
χ^2 distances of five persons.

	person 1	*person 2*	*person 3*	*person 4*	*person 5*
person 1	***278***	868.977	522	2000.5	873.893
person 2	693.8	***221***	783.47	858.08	680.8
person 3	693.82	1007.954	***164.078***	1700.54	698.59
person 4	1797.69	899.6	1851.54	***98.66***	883.35
person 5	964.1	686.36	765.92	1001.43	***226.96***

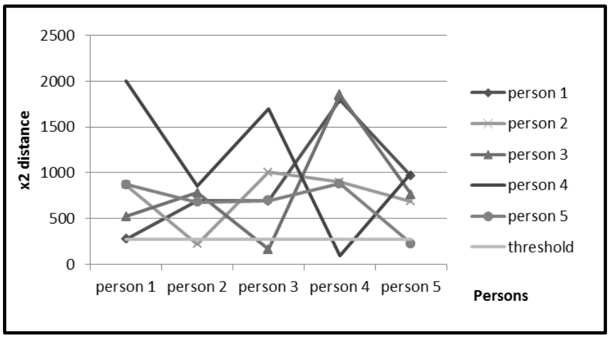

Fig.(5) The χ^2 distance of 5 persons with threshold value.

As show from the table above that minimum value of (χ^2) distance represented the match between faces. This work are implemented with VB6 on Core2 Due 2.2 Hz laptop .The speed would likely improvement considerably by using C program.

The experiment was done by using all faces with or without spectacles which concerns 160 faces images and 40 persons. The success rate of proposed algorithm for all 160 faces is 97.5%. Fig.(6) shows examples of the images for which the proposed algorithm couldn't correctly detect the profile projection area. Because the intensity of light isn't homogenous for all face, therefore this algorithm is failed to detect the profile projection accurately.

Also, the algorithm succeeds to identify the variety of light intensity and change hair style as shown in Fig.(7).

Fig.(6) Example of faces failed to extract profile projection.

Fig.(7) Images with change hair style and light density.

Conclusion and Future Work

The face recognition method from profile projection is reported in this paper. The proposed algorithm is to extract profile projection from face image. Images for each person is taken with different poses. Average value is calculated for each known person and stored in database file so; it can be used to compare with unknown faces using χ^2 distance.

The proposed method has tested by 160 images (male and female, beard or without beard, glass or without glass, change hair, verity light density, black and white, young and old) from ORL database. Experimental results show that this method works well with the faces. The matching accuracy is 97.5%.

The proposed method doesn't work so well for faces with side limitation, the future work will be concentrated on improving the detection accuracy for profile projection.

Future work will concentrate to improve the detection of project projection if face is side limitation. Furthermore, Algorithm will test using images of twin persons.

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الخلاصة

يقدم هذا البحث طريقة لتمييز الوجوه عن طريق صورة امامية .حيث يتم ايجاد المسقط الجانبي للوجه عن طريق المسقط الافقي للوجه وتحديد منطقة العينين. وعن طريق المسقط الجانبي يتم حساب بعض القيم العددية ليتم تمييز الوجوه. وبعد استخلاص المسقط الجانبي وباستخدام المسافة س٢ للتمييز ما بين الوجوه. يتم اخذ اربعة صور او اكثر لكل شخص وبتعابير للوجه مختلفة وحركة الوجه وبتغيير الاضاءة وخزن المعدل الحسابي في ملف حيث يتم مقارنته مع صورة غير معروفة وقد تم ادخال ١٦٠ صورة ولأشخاص مختلفين وكانت نسبه النجاح ٩٧,٥%.