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2D Face Recognition across Pose and Illumination Variations

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ABSTRACT: This paper describes a face recognition framework that is capable of processing images across pose and illumination. The main objective of this paper is to build automatic face recognition systems. This paper consists of three main sections for face recognition framework. The first section is to build the gallery images of faces along with three landmark points. The second section deals the illumination variation. The last section handles the pose variation. Stereo matching method handles the pose and expression variation problems.

KEYWORDS: Face recognition, pose, illumination, stereo matching.

I. INTRODUCTION

Face recognition is a very active research area specializing on how to recognize faces within images or videos. Face recognition compliments face detection. Face detection is the process of finding a 'face' within images or videos and face recognition is the process of matching the detected 'face' to one of many faces known to the system. One of the key problems in face recognition is to handle the pose variation conditions. To handle the pose variation several approaches are used [24], [15], [17], and [8].

Handling rotation in depth and broad lighting changes together with personal appearance changes is one of the main challenges of face recognition. Even under good conditions, however, accuracy needs to be improved.

There are two predominant approaches to the face recognition problem: geometric (feature based) and photometric (view based). There are various face recognition techniques applied by many researchers, three of which have been well studied in face recognition literature: Principal Component Analysis [26], Elastic Bunch Graph Matching [29], and Linear Discriminant Analysis [31].

Zhao et al. [30] presented an extensive literature survey of machine recognition of human faces and a brief review of related psychological studies. This paper organizes the recent developments in face recognition techniques using still images and face recognition based on video.

Wiskott et al. [29] recognizes the face by using Elastic Bunch Graph Matching (EBGM). The EBGM system is based on the Dynamic Link Architecture. Only magnitudes of the coefficients were used for matching and recognition. The total numbers of feature points are 4 to 7. It was robust to alignment issues but the feature points are manually clicked.

Beymer and Poggio [4] addressed the problem of face recognition across pose when only one view of each person is available. One example view is given and they generate virtual views by the use of prior knowledge of faces at different poses. Parallel deformation and linear class techniques are used to rotate the novel face in depth. Correspondences were determined using optical flow between the two images.

Gross et al. [15] presented an approach for face recognition across pose and illumination. They presented two successful appearance-based algorithms namely eigen light fields and Bayesian face sub regions. In eigen-light fields, all face pixels are treated equally. The appearance based algorithms directly use the pixel intensity values in an image of the object as the features on which to base the recognition decision.

Blanzz and Vetter [5] presented a method for face recognition across variations in pose, ranging from frontal to profile views, and across a wide range of illumination. It includes cast shadows and specular reflections. The feature points are selected manually.

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In this paper the problem of face recognition under pose, expression, and illumination variations is handled. The problem of face recognition from a single 2D face image with pose variation and illumination based on stereo matching method and normalization is mainly focused. A gallery of 2D images of faces is built with three landmark points before recognition. For the test image, generate four corresponding landmark points. Using the landmark points compare the test image and trained images. The image similarity is formed by using matching cost by running the stereo matching algorithm on the image pair. Recognize the probe with the gallery image that produces the lowest matching cost.

This method works well for large pose variation. The effect of variation in the illumination conditions in particular, which causes dramatic changes in face appearance is one of those challenging problems that a particular face recognition system needs to face. This paper overcomes the problem of illumination variations.

The rest of this paper is arranged as follows: the features are explained in section 2. The proposed face recognition system under poses and illumination is described in section 3. The experimental results given by applying the proposed technique is presented in section 4. The conclusion will be given in the last section.

Fig. 1 Three landmarks for one of the gallery images.

II. FEATURES

There are many motivations for using features rather than the pixels directly. The feature-based system operates for detecting facial landmarks from neutral and pose variation images was designed. Before computing the similarities between faces, the face images need to be aligned. To do this, first generate the landmark points of the eyes, mouth and nose. The three landmark points are generated for each image available in the training dataset. The fourth landmark point is known as stero. It creates a 3*3 filter over the image and extracts the facial features and calculates the distance between the test image and training images.

III.FACE RECOGNITION METHOD

There are several different stereo matching algorithms are explained in [9]. Efficient stereo algorithm supports the good correspondences between two images. Even though several methods might be suitable for face recognition but dynamic programming based algorithm is used for 2D face images. The stereo algorithm finds the set of correspondences that maximize the cost function subject to ordering and uniqueness constraints. In stereo algorithm, the matching is performed on individual pixel intensities. Stereo algorithms need to determine the set of correspondences between features in two images. In Criminisi et al. [10] which has been developed for video conferencing applications. It is not obvious that it will work for the large changes in viewpoint that can occur in face recognition, but we will show that it does. The important point of stereo matching is to provide good correspondences over the image. When many matches have similar costs, matching is ambiguous. One weakness of dynamic programming stereo algorithms is that, when matching is ambiguous, it can be difficult to produce correspondences that are consistent across scan lines. Selecting the right match is difficult, but important for good reconstructions. Since the cost of a matching is used in selecting the right matching is unimportant in this case.

A. Stereo Matching

In Stereo matching algorithm, the matching is performed on the individual pixel intensities. The objective of stereo matching is to calculate the matching between two images. Matching is performed in two scan lines (rows of each face). The two scan lines are denoted as l1, l2, the cost of matching the two scan lines are cost (l1, l2). Each step involves the transition from one point to another in four planes. The four planes (or cost matrices) called C_{Lo}, C_{Lm}, C_{Ro}, and C_{Rm}.. Points are accounted for by matching (m) and occlusions (o) in the left (L) and right (R) images.

The cost of matching the two scan lines l1 and l2, denoted cost (l1, l2) is C_{Ro} (l-1, r-1). The optimal matching solution is $\sum = \{C_{Lo}, C_{Lm}, C_{Ro}, C_{Rm}\}$. The optimal matching between a given two lines $I_{1,i}$ and $I_{2,I}$ has $|I_{1,i}| + |I_{2,I}|$. It has the ability to match multiple pixels in one scan line to one pixel in another. This is done by concatenating several consecutive CLm (or CRm) in the word that encodes the solution. The algorithm accounts for exactly one pixel in one image with each step taken. The optimal matching is not having any use its cost and its length are used to normalize it.

B. Rectification and Matching Costs

While matching we do not know which image is left and which image is right. Hence, both options are tried. So rectification is necessary this means that keep one image as it is and flip other image and vice versa.

Some normalization strategy is needed for finding the matching cost.

$$\text{cost}(I1, I2) = \frac{\sum_{i=1}^{n} cost(I1,i, I2,i)}{\sum_{i=1}^{n} |I1,i| + |I2,i|} \quad (1)$$

This formula calculates the average cost per match made over all scan lines. The rectification strategy will be of the following. This rectification is used to calculate the similarity between probe and gallery images.

$$\text{similarity}(I1, I2) = min \begin{cases} \text{cost}(\text{rectify}(I1, I2)), \\ \text{cost}(\text{rectify}(I2, I1)), \\ \text{cost}(\text{rectify}(\text{flip}(I1), I2)), \\ \text{cost}(\text{rectify}(I2, \text{flip}(I1))). \end{cases} \quad (2)$$

The flip produces the left-right reflection of the image and also it adjusts the hand-clicked positions of the four points. Finally the recognition is performed by matching a probe image to the gallery images. Flip is helpful when two views see mainly different sides of the face; flip approximates a rotation about the y axis that creates a virtual view so that the same side of the face is visible in both images.

C. Illumination Handling

The illumination problem is quite difficult. The changes induced by illumination are often larger than the difference between individuals then there is a chance of false identification. The proposed system handled illumination problem by normalization.

IV. EXPERIMENTAL RESULTS

The proposed system is implemented using an IDL program where it is evaluated for recognizing the image. The performance of the algorithm is evaluated on several real images. These pictures are the most widely used standard test images used for face recognition algorithms. The image contains a nice mixture of detail, flat regions, shading and texture that do a good job of testing various image processing algorithms. These are still in the industry standard for tests. These images are used for many image processing researches.

Fig. 2 Training images

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Fig. 3 Landmarks for one of the training images

Fig. 4 Test image

Fig. 5 Landmarks for Test image

Fig. 6 Matched image

A. Recognition Rate

To evaluate the performance of the face recognition techniques several performance metrics are available. I use the recognition rate to analyses the performance.

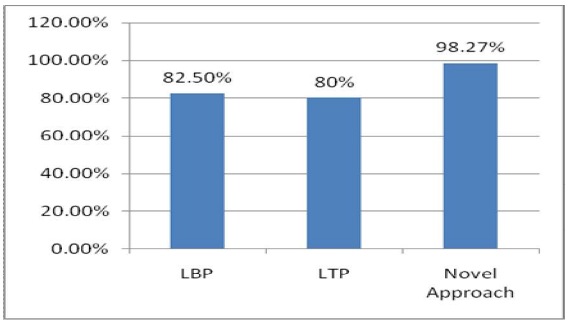
$$RR = \left(\frac{NumberOfCorrectlyIdentifiedFaces}{TotalNumberOfFaces}\right) * 100$$

The RR values for the various face recognition methods are given below.

Table. 1 Performance analysis of RR value

Method	Recognition Rate
LBP	82.50%
LTP	80.00%
Novel Approach	98.27%

B. Performance analysis of various face recognition techniques



V. CONCLUSION

This project has presented a simple, general method for face recognition with pose, expression variations based on stereo matching. Illumination changes are also handled by normalization. It uses stereo matching for face recognition across pose and show that this method exhibits excellent performance when compared to existing methods. This method is very simple. This method is much more accurate than the previous methods. The advantage of this project is its automatic face recognition system. In future, the multimodal biometric system can be used. For example, face and

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fingerprint, face and palm print, face and iris, face and speech, and face, fingerprint, and hand geometry. Face videos can also be considered. Identification of more challenging pose variations can be handled.

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