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Study Of Facial Expression Identification And Pose Estimation For Face Recognition

Divyanshu Dewangan[1], Shrikant Tiwari[2], Yamini Chouhan[3]

***Abstract*— Facial Expression Recognition (FER) has many useful applications, including human behavior and perceptual user interfaces. Facial Expression Recognition is one of the most leading research areas which are used for many purposes such as; specific applications include terminal and network access, sign-on (log-on) restrictions, data protection, wireless and remote access limitations, transaction security, and web security.The need for Facial Expression Recognition arises from limitations of fiducial points on face of any person which moves while changing the expression, and for Pose Estimation it arises from the limitations of feature based pose estimation where shape of the head changes due to light and different poses of head. For the detection of facial expression and head pose, the basic spatial orientation of face is described in this paper. Here combination of facial expression identification and 3D head pose estimation techniques is used where the faces are scanned and shape, intensity of image is combined and is used for facial matching. In this paper Fiducial Points and Gabor jet wavelets are used for getting the accurate land marks for the detection of face. And for detection of head pose we use multiple parametric linear subspace model (MPPLS). There are many application of face recognition using facial FER and head pose estimation such as security, communication and credit card verification to surveillance video image.**

Index Terms—3D head pose, FER, Parametric Linear Subspace Model (PPLS), Fiducial Points, Gabor Wavelets, and Face recognition.

I. INTRODUCTION

A facial recognition system using the FER and pose estimation is a computer application for automatically identifying or verifying a person from a digital image or a video frame from a video source. One of the ways to do this is by comparing selected facial features from the image and a facial database. To prevent a face mould from faking out the system, many systems now require the user to smile, blink, and move the pose of head in a way that is human before verifying. Some of the existing applications for facial recognition technology include: Journey measurement (people journey times – passenger / shopper), document control (passports, drivers' licenses), transactional authentication (credit cards, ATMs, point-of-sale), [34]. The important factors in any facial recognition application are facial expression and head pose variation because the human face has various expressions depends on situation and head can move freely. Under this assumption the human face is having various expressions like happy, smile, angry, sad, fearful, disgusted, neutral etc and the human head is limited to 3 degree of freedom (DOF) in head pose which can be characterize by pitch, roll, yaw. In this paper we are using Gabor wavelet for effective and efficient land mark detection. With the help of these wavelets it is possible to detect facial. Land marks such as eyes, lips, nose even in presence of different facial expression, optical or beard. And by using the fiducial points we can determine the various expressions. In next section we will describe about various techniques for head pose estimation with their advantages and disadvantages.

II. THE BASICS OF HEAD POSES

Estimating the head pose is crucial since it usually coincides with the gaze direction. Furthermore, head pose estimation is also essential for analyzing complex meaningful gestures such as pointing gestures or head nodding and shaking. Under this assumption the human head is limited to 3 degree of freedom (DOF) in head pose which can be characterize by pitch, roll, yaw.

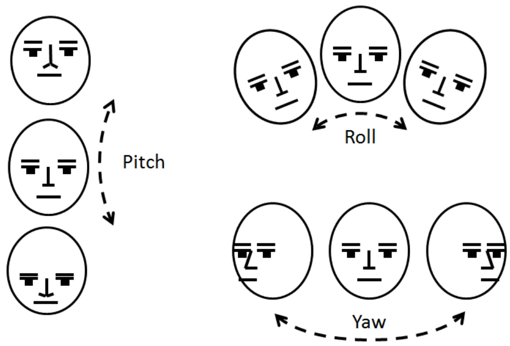

Fig: 1 Complete description of orientation through movements.

Yaw is the angle when moving the head left ↔ right (rotation around Y-axis). Pitch is up and down (rotation around X-axis). Roll, which we usually don't experience, is when you tilt your head (rotation around Z-axis).

II. TYPES OF POSE ESTIMATION TECHNIQUES

There are many types pose estimation technique having its own advantages on disadvantages .Some of the successful approaches towards pose-invariant face recognition are:

- **Multi-view approach**: This approach is based on the multi-view gallery, which consists of multiple views of various poses for each known person.
- **Single-view approach**: The pose invariance is achieved by representing each known person by a facial image with a fixed canonical head pose and by transforming each test image to the canonical pose.
- **Piecewise Linear Subspace Method:** This method describes an arbitrary facial image a linear combination of a small number of orthonormal principal components (PCs) learned from training samples.

- **Biased Manifold Embedding (BME):** The **BME** framework is pivoted on the ideology of using the pose angle information of the face images to compute a biased neighborhood of each point in the feature space, before determining the low-dimensional embedding.
- **Appearance-based techniques:** This technique uses the whole sub image containing the face. Most of them concentrate on face detection and consider the pose estimation problem as a classification problem. The range of head orientations is divided into a limited number of classes and classifiers for each class are trained.
- **Model-based approaches**: Model-based approaches for head pose estimation use a geometric model of the face.

IV. FACIAL EXPRESSION IDENTIFICATION

The recovery of facial activities in image sequence is an important and challenging problem. In recent years, plenty of computer vision techniques have been developed to track or recognize facial activities in three levels. First, in the bottom level, facial feature tracking, which usual detects and tracks prominent facial feature points (i.e., the facial landmarks) surrounding facial components (i.e., mouth, eyebrow, etc.), captures the detailed face shape information. Second, facial actions recognition, i.e., recognize facial Action Units (AUs) defined in the Facial Action Coding System (FACS), try to recognize some meaningful facial activities (i.e., lid tightener, eyebrow raiser, etc.). In the top level, facial expression analysis attempts to recognize facial expressions that represent the human emotional states.

V. RELATED WORKS IN FACIAL EXPRESSION IDENTIFICATION

Here the introduction of the related works in Facial Expression Identification like Facial Feature Tracking, Expression or Action Units Recognition and Simultaneous Facial Activity Tracking and Recognition is given.

A. Facial Feature Tracking

Facial feature points or Fiducial Points are used to encode the critical information about shape of the face and face shape deformation. Accurate location and tracking of fiducial points are essential in the applications such as computer graphics, animation, etc. The facial feature points recognising technologies are classified into two categories: model free and model-based tracking algorithms. Model free approaches are general purpose point trackers without the prior knowledge of the object. Each feature point is usually detected and tracked individually by performing a local search for the best matching position. However, the model free methods are susceptible to the inevitable tracking errors due to the aperture problem, noise, and occlusion. Model based methods, such as Active Shape Model (ASM), Active Appearance Model (AAM), Direct Appearance Model (DAM), etc., on the other hand, focus on explicitly modelling the shape of the objects.

B. Expression / Action Units Recognition

Facial expression recognition systems usually try to recognize either six expressions or the AUs. Over the past decades, there has been extensive research on facial expression analysis. Current methods in this area can be grouped into two categories: image-based methods and model-based methods. Image-based approaches, which focus on recognizing facial actions by observing the representative facial appearance changes, usually try to classify expression or AUs independently and statically. This kind of method usually consists of two key stages. First, various facial features, such as optical flow explicit feature measurement (e.g., length of wrinkles and degree of eye opening), Haar features, Local Binary Patterns (LBP) features, independent component analysis (ICA), feature points, Gabor wavelets, etc., are extracted to represent the facial gestures or facial movements. Given the extracted facial features, the expression/AUs are identified by recognition engines, such as Neural Networks, Support Vector Machines (SVM), rule-based approach, AdaBoost classifiers, Sparse Representation (SR) classifiers etc.

C. Simultaneous Facial Feature Tracking

The idea of combining tracking with recognition has been attempted before, such as simultaneous facial feature tracking and expression recognition and integrating face tracking with video coding. However, in most of these works, the interaction between facial feature tracking and facial expression recognition is one-way, i.e., facial feature tracking results are fed to facial expression recognition. There is no feedback from the recognition results to facial feature tracking. Most recently, Dornaika *et al*. And Chen & Ji improved the facial feature tracking performance by involving the facial expression recognition results.

VI. PROPOSED METHODOLOGY

We learn classifiers for the individual facial features using AdaBoost which is a supervised learning algorithm. Boosting refers to the concept of building a strong, highly accurate classifier by combining weak, not very accurate classifiers. In this work, we apply the adaptive boosting variant of the algorithm AdaBoost which was proposed by Freund and Schapire.

Input to the AdaBoost algorithm is a set of labeled (positive/ negative) training examples (x_n, y_n), n = 1, . . .N, where each x_n is an example and y_n is a boolean value indicating whether x_n is a positive or negative example. In each round t = 1, . . . , T, the algorithm computes a distribution D_t over the training examples. Then, AdaBoost selects a weak classifier ht: X! {0, 1} that best separates the positive and the negative examples with respect to the current distribution D_t. Based on the error of the classifier, the weights of the examples are updated. The idea is to modify the distribution D_t by decreasing the weights of correctly classified examples and increasing the weights of misclassified examples. In this way, in the next round the algorithm is forced to concentrate on the difficult examples which have been incorrectly classified before. The final strong classifier h is a weighted majority vote of the T best weak classifiers. The weight of a hypothesis h_t is larger the smaller its error ϵ_t is.

• Input: Set of labeled examples $(x_1, y_1), \dots, (x_N, y_N)$, where y_n = 1 for positive examples and y_n = 0 for negative examples.

• Let m be the number of negatives examples and l be the number of positive examples. Initialize the weights $w_{1,n}$ = $1/_{2m}$, $1/_{2l}$ depending on the value of y_n.
• For t = 1, T:

1) Normalize the weights to get a probability distribution Dt on the training set
$D_t(i) = {w_{1,n}}/{\sum_{n=1}^{N} w_{t,n}}$

2) Generate a weak classifier h_j for each feature f_j .

3) Determine the error ϵ_j of classifier h_j with respect to
D_t: $\epsilon_j = \sum_{n=1}^{N}(w_{1,n}) \, |h_j(x_n) - y_n|$

4) Choose the classifier h_j with the lowest error ϵ_j and set $(h_t, \epsilon_t) = (h_j, \epsilon_j)$.

5) Update the weights $w_{t+1,n} = w_{t,n}\, \beta_t^{1-e_n}$, where
$\beta_t = {\epsilon_t}/{1-\epsilon_t}$

and e_n= 0, if example x_n is classified correctly by h_t and 1, otherwise.

- The final strong classifier is given by:
h(x)= 1, if $\sum_{t=1}^{T} log \frac{1}{\beta_t} h_t(x) \geq \frac{1}{2} \sum_{t=1}^{T} log \frac{1}{\beta_t}$

VII. RESULT

In this paper we have studied two different techniques of face recognition. The Facial Expression Identification and Pose Estimation for Face Recognition. By using these two techniques we are going to develop a new software which can recognize the face of the person irrespective of the his head poses and facial expressions. For facial expressions we are considering the face feature points also known as fiducial points of the human face. Variations in these feature points will enable us to judge about the expression. For head poses there are some ways on which the head moves, these positions are under pitch, roll and yaw. The proposed technique for head pose we are using is ADABOOST Algorithm. The integrated technique will give the desired result. At any head pose and in any facial expression the software will recognize the actual face of the human.

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Mr. Divyanshu Dewangan *has completed his B.E. in Computer Science & Engineering Branch in 2009 with 1st division from Chhatrapati Shivaji Institute of Technology, Durg, Chhatisgarh Swami Vivekananda Technical University, Bhilai). He is pursuing M.E. in Computer Techonology and Application from Shankaracharya Group of Institution, Bhilai in year 2014.*

Dr.Shrikant Tiwari*, currently working toward as Assistant Professor in Department of Computer Science & Engineering (CSE) at Shri Shankaracharya Group of Institutions (SSGI), Junwani, Bhilai, Distt. Chattisgarh (India). He received his Ph.D. in Department of Computer Engineering from the Indian Institute of Technology (Banaras Hindu University), Varanasi, (India) in 2012 and M. Tech. in Computer Science and Technology from University of Mysore (India) in 2009. He has over 35 publications in refereed journals, book chapters and conferences. His research interests include Biometrics, Pattern Recognition, Computational Intelligence, and Computer Vision. Dr. Tiwari is a member of IET, IETE, ISTE, CSI, IAENG, IACSIT, GERA and SCIEI.*

Ms. Yamini chouhan *is working as a Assistant Professor in Shankaracharya Group of Institutions Bhilai(C.G.). She has completed her B.E. in Computer Science & Engineering Branch in 2007 with 1st division from Chouksey engineering college Bilaspur(Guru Gashi Das University Bilaspur). She has completed her M.E. in Computer Techonology and Application from Shankaracharya Group of Institution, Bhilai in year 2013.*

