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A Review Paper on Facial Expression Recognition: Atlas Construction and Sparse Representation

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Abstract: The **human face can exhibit complex and strong changes that are both unpredictable and varying in time. Nowadays, facial expression recognition has become a emerging and research topic due to advancement in this field. In this paper, we study about many facial expression techniques, but these two techniques are most utilized for facial expression recognition. In existing method atlases are constructed using conventional group-wise registration method due to which lot of subtle and important information lost. To overcome this limitation sparse based atlas construction method and Spatio-temporal information are represented for better performance in recognition process. This paper presents a quick survey of facial expression recognition.**

Keywords**: Facial expression recognition, atlas construction, diffeomorphic image registration, sparse group-wise registration, spatial domain, temporal domain.**

I. INTRODUCTION

Automatic Facial Expression Recognition (AFER) is challenging problem with many applications. Its application include computer vision , medical image analysis, financial security, law enforcement etc. It is most powerful way that people coordinate conversion and communicate emotions and other mental cues. Facial expression analysis aims to analyze human facial expressions from videos and classify them into correct facial type, such as anger, disgust, happiness, fear, sadness and surprise. It mainly depends on two stages: 1) feature extraction ,these features are often represented in different form such as novel approaches like motion based method, motion based method and geometric features like active appearance model (AAM), 2) classifier design, support vector machine is mostly used. The aim of facial expression recognition is to estimate facial expression type from an image sequence .A facial expression sequence consist of 3 phases one or more onset, apex and offset. Here, we use spatial domain as well as temporal domain are used to guide recognition of image sequence. In spatial domain, image appearance information used to enhance recognition performance and temporal domain contains evaluation details. This paper present [1], a new way to tackle the dynamic facial recognition. The method work on two stages: 1) atlas construction stage and 2) recognition stage. In atlas construction stage, longitudinal atlas of facial expression is constructed based on sparse representation group-wise registration. Atlases is nothing but the group of images belonging to specific expression type. It can capture overall facial feature for each expression among whole population. In recognition stage, expression type is determined by comparing the corresponding query sequence with each atlas sequence, comparison conducted based on image appearance information and temporal evaluation information. In this paper, facial expression can be described by diffeomorphic motion. In atlas construction stage, diffeomorphic growth model is estimated to get image sequence. Diffeomorphic means the motion is preserved. Diffeomorphic image registration or transformation means to transform set of image into common space.

II. REVIEW ON EXISTING PAPERS/LITERATURE SURVEY

In a previous paper [2], the author proposed a new way to tackle the face recognition scheme. The entire system concentrates on group-wise deformable image registration and MRF problem .This method achieves highest recognition rate. There are two main states present in this paper. 1) From each pixel position anatomical features are selected from the facial image. These anatomical features reflect the structural property and structures in facial images such as nose, eyes and lips etc. have different shapes and sizes. To extract these anatomical features, salient scale detector is used and this detector is depends on the survival exponential entropy (SEE). 2) To perform group-wise image registration, the deformable model is converted into markov random field labeling problem. MRF labeling problem is formulated to perform group-wise registration in a hierarchical manner. This paper works on available databases: FERET, LFW, CAS-PEAL-R1, and the FRGC. This paper [3] mainly focuses on facial action units that produce facial expression. The method is used here not only to recognize facial action units but also the temporal model .from faces image sequence. The algorithm performs partical filtering to extract 15 facial points in a facial image. It also perform automatic segmentation and recognition of

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temporal segment that takes input from video or images and that convert into facial expression. These both segmentation performs on 27AUs. In this paper, a basic idea is given about how to recognize AUs and their face profile images. It does not work on full range of AUs but it detects only 27AUs alone or in combination.

The method presented in this paper [4] is automatic facial expression analysis. This paper works on automatic detection of AUs and classification of 6 basic facial expressions..It mainly focuses on three stages; Facial tracking and feature extraction, extract dynamic signals to parametric face, Machine learning methods. Machine learning methods are used for better understanding of dynamic changes in facial expression. The algorithm performs integration of facial action units AU1 toAU15 and geometric features M1 to M14 to recognize facial expression. By tracking these points from image sequence it is possible to capture motion muscles and afterword's that it is use for expression analysis. To extract dynamic signal a parametric space is constructed and features are measured in each frame. Dynamic responses of these texture feature gives the specific expression .Some classifier learners used for data classification/partitioning and all learners work differently.

The proposed project [5] concentrated on Lipschitz embedding and expression manifold. A new way is used for tracking and recognizing facial emotions. System flow works in both embedded space and image space. In the image space, track some feature points from input video and also perform manifold Lipschitz. Lipschitz embedding is used to track 58 landmark points along with facial feature contour. In the embedded space, probabilistic model and embedded vector is used for expression recognition. In this paper, similar expressions are combined together in neighborhood on manifold and it became a path of emotions on manifold. Using a mixed model facial features are clustered. For cluster each, some ASM techniques are propagated in low dimensional space due to which avoids incorrect matching. This paper [6] mainly focuses on local binary pattern, local features and facial representation. This technique is much effective for because of local binary pattern features. Vector machine classifier is used to improve the boosted LBP feature, which gives best expression recognition.LBP features describe appearance information that helps to expression recognition. A basic LBP operatator select 3×3 neghiourhood of each pixel and 256bin histogram .The center pixel of the pattern was surrounded by 8 neighbouring pixels in 8possible directions.In this paper circular LBP is used to formed the 2p local binary pattern for texture description. Disadvantages of this paper are, it works only with static images. And they do not consider temporal information and head pose variation. They will consider dynamic images in their future work as well as temporal information. Facial expression recognition is done effectively by using dynamic image rather than static image. This paper [7] works on volume local binary pattern (VLBP). It is an extension of local binary pattern widely used in texture analysis.

In this paper [8], a new way is use to tackle the expression recognition. The method works with diffeomorphic matching. The basic step of facial expression recognition is to select landmark points from different images by using some automatic methods. Here, the author uses the rigid registration algorithm. By using diffeomorphic matching, the distance is calculated between all landmark sets. The geodesic distance is more effective to classify a query image using K-nearest classifier rather than Euclidian distance. Multidimensional scaling is used to recognize the structure of data as well as to find configuration of points.

Table 1:Comparision Table

Name of method	Peformance	Disadvantage
Local Binary Pattern for expression recogntion	Better recognition than gabor filter bank	Color information is not included.
Dimensional Prinencipal Component Analysis	Recognition rate is higher than PCA	Storage requirement is higher than PCA
Low Dimentional Principal Component Analysis	Recognition rate is low	Only single factor can be varied.
automatic recognition of facial action units	Gives average recognition rate	cannot recognize the full range of facial behavior
Local Binary Pattern	Recogniton rate is low with static images	Dynamic images are not included.

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Group-wise Registration method	Peformance is good	Lot of subtle information lost due to naïve mean operation

III. SYSTEM DEVELOPMENT

System architecture 3.1 shows overall structure of proposed method. There are two main Stages atlas construction and Recognition stage. This architecture shows all subprocess that are Feture extraction, testing,classification etc. Here, given a query facial image, estimate the correct facial expression type, such as anger, disgust, happiness, sadness, fear or surprise. The facial expression image sequence or dataset contains not only image appearance information in the spatial domain, but also evolution details in the temporal domain. The image appearance information together with the expression evolution information can further enhance recognition performance.

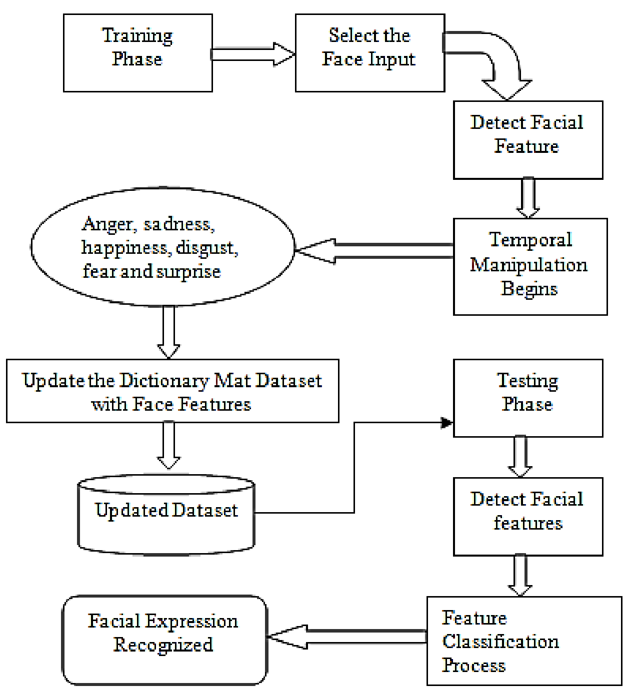

Figure 3. 1: System Architecture Design

Although the dynamic information provided is useful, there are challenges regarding how to capture this information reliably and robustly. For instance, a facial expression sequence normally constitutes of one or more onset, apex and offset phases. In order to capture temporal information and make temporal information of training and query sequences comparable, correspondences between different temporal phases need to be established. Finally in recognition stage, expression type is determined by comparing the corresponding query sequence with each atlas sequence.

3.1Atlas Construction by Sparse GroupWise Registration

In input image sequence three phases are there. The phase starts with neutral expression followed by offset and ends with apex. Atlases are constructed for each emotion by using sparse registration method. Image registration means to transfer the set of images to the common i.e. called template space. Input for this stage is video or set of images. From that video it takes some image sequence and divide time interval between that set. We formulate the following equation no. 1 to construct atlases by using sparse group-wise registration:

$$M_t,\emptyset^i = \arg\min \sum_{t\in T}\sum_{I=1}^{C}\{ (d(\widetilde{M}_t,\widetilde{\emptyset}^i_{(t_0^i\to t)}(I_{t_0^i}))^2 + \gamma_{\emptyset^i} R(\widetilde{\emptyset}^i)\}$$

Eq no. (1)

3.2 Recognition of Query Sequence

For recognition of facial expression atlas sequence is used. In this stage, a query image sequence is used as input for evaluation of emotion. Image appearance information, evaluation information and temporal information are used to perform recognition. Recognition process is described by the following eq no. 2:

$$L_{opt} = \arg\min_{L} \left\{ \frac{\sum_{i=0}^{e-b} d\left(M^L_{t1+i}, \emptyset^{new}_{(t_b\to t_{b+i})}(I_b^{new})\right)^2}{(e-b+1)} + \beta \cdot \sum_{j=b}^{e-1} \left\| \vec{F}^{new}_{t_j\to t_{j+1}} - D^L_{t_j\to t_{j+1}} \cdot \vec{a}^{opt}_{t_j,L} \right\|_2^2 \right\}$$

Eq no. (2)

3.3 Diffeomorphic Image Registrations

Basically, Image registration means to take set of images that are captured at any place, any time and transfer them to common space. Optimizer is used to minimize similarity measures and transfer moving image to fixed image. The properties of diffeomorphic image registration give better evaluation of expression. The topology presentation property helps to capture facial movements and suppress the errors which are occurred at registration. This eq3 summarizes the pair wise registration problem.

$$T_{opt} = \arg\min_{T\in\emptyset} E(I_{fix}, T(I_{mov})) \text{Eq no. (3)}$$

3.4. Spatio-Temporal Features

Spatio-temporal relation carries important information that helps in recognition process [9]. Spatio-temporal feature

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proposed for encoding the motion information of facial component .Features are exploit to enhance the expression recognition performance. There are many features: Scalar projection, rot feature, divergence of the flow field and local spin. 1) Scalar projection captures the amount of expansion of each point with respect to the nose point. 2) Rot feature The Rot feature measures the amount of rotation with respect to position vector. 3) Divergence of the flow measures the amount of local contraction of the facial muscles. 4) Local spin captures the dynamics of the local circular motion of the facial components

IV. CONCLUSION

We outline the matter of facial expression technique. Here we have compared many existing system and methods to get ride over which is more efficient technique. The survey exhibits higher recognition rate gives higher performance. This technique gives high quality performance than other compared method.

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