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A Literature Survey of Fuzzy Based Facial Expression Classification

Sudharson D[1], K Mageswari[2], S Mohana Gowri [2], P Divya [3]

Assistant Professor, Dept. of IT, SKCET, Coimbatore, Tamil Nadu, India[1]

Assistant Professor, Dept. of CSE, SKCET, Coimbatore, Tamil Nadu, India [2]

Assistant Professor, Dept. of IT, VSB Engineering College, Karur, Tamil Nadu, India [3]

ABSTRACT: This survey work is much essential since facial expression has much importance in the field of machine simulation in artificial intelligence. Several techniques were proposed in the industry for this analysis in which they make use of several action units(Eyes, Lips) via Fuzzy C Means *(FCM) Clustering Algorithm and are being interlinked with one another and manipulated together for expressions classification such as anger, happy, sadness etc but also the system concentrates on the analysis of individual units referred as patterns which are observed by using Adaptively Weighted Sub Pattern Principal Component Analysis(AW-SPPCA) with Support Vector Machines (SVM) which are used along Hidden Markov Model(HMM) for pattern tracking and expression classification.

KEYWORDS: Support Vector Machines, Hidden Markov Model, Adaptively Weighted Sub Pattern Principal Component Analysis, Action Units, Fuzzy C Means Clustering.

I. INTRODUCTION

Facial expression classification is one of the most crucial field which is involves classifying the face expressions such as anger, Happy, Sadness,Surprise etc which is extensively used in machine simulation. This survey work helps in understanding the performance, drawbacks and their techniques which has been done in this field. It considers the problem of extracting emotional state (facial expression) from facial images. Focusing faces in form of interlinked action units and patterns are the common ways that has been used so far. Hence the following section includes categorization of projects with respect to their dimensionality, Patterns and Models. Then next following section includes the section of pattern extraction and tabulation of these with respect to their performance, drawback and eventually followed by the future work and conclusion.

II. TECHNIQUES AND ALGORITHMS

The techniques and methods are classified with respect to the factors of dimensionality as two dimensional and three dimensional. The Action units are classified with respect to the Facial Feature Points and Patterns. Then eventually the model based methods are termed with respect to shape as ASM (Active Shape Model), Appearance as AAM (Active Appearance Model) and in terms of DAM (Direct Appearance Model).

A) Dimensionality Based Methods

There are several algorithms which are used for the face recognition and are classified with respect to dimensionality and linearity. In certain cases where three dimensional images are involved then it uses BU-3DFE algorithm by IordanisMpiperis, Sotiris Malassiotis[17] which uses an prominent 3-D face analysis system. This scheme is capable of analyzing both factors of including the human faces across all the expression exhibited and facial expressions with their respective intensity. Parameters including the unique identity, sex and common property identified among is relaxed.

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B)Action Unit Based Method

While the other schemes which are used in facial expression recognition involved with facial action units (FACS) which is associated with SVMs, the radial basis function (RBF) kernel in the scheme proposed by ZichengLiu,Mingli Song [4] uses a predefined threshold value for the expression to be classified and is given in terms of facial action points (FAP). Particle filtering has been used by Michel F. Valstar, and MajaPantic [3] proven to be effective where the temporal models are replaced by temporal segments.

Though according to the proposal made by Yongqiang Li, Shangfei Wang [1] using the Dynamic Bayesian Network and Principal Component Analysis considering a unified probabilistic framework based on parallel and intelligibly represent the facial evolvement in various ranges, their inter communication and their observations. Then the system has been brought up with the introduction of Hidden Markov Models (HMM) by M. Pantic and I. Patras [22] which is considered to be the most optimal solution to the inference probabilistic problems.

C)Model Based Methods

Model based methods are much effective in cases where the images are known to be predetermined and their dimensional properties such as size, format and other factors could be known well. The table below gives a typical view of the models and their usage which categorized with respect to their importance

Table 1. Models with their importance

Model	**Technique**	**Importance**
ASM[26]	PCA[18]	Focus on explicitly modeling the statistical model-based approach to representdeformable objects
AM[24]	PCA	Texture variation
DAM[25]	AdaBoostclassifiers,Sparse Representation (SR) classifiers [16],[17].	Classification of expression in cases where the conflict occurs among surprise and happiness.

From the previous existing schemes and present market tools it is found that almost all the tools which are making use of several facial action units from 64 in case of surprise Petar S. Aleksic,Aggelos K. Katsaggelos [23]uses a interrelated analysis model.Updated scheme makes use of the patterns which are isolated using Principal Component Analysis(PCA) while the associated hyperplanes are analyzed using Support Vector Machine by Yongqiang Li, Shangfei Wang, Yongping Zhao, and QiangJi[1].

D)COMPARATIVE ANALYSIS

The following analysis has been made with respect to the mandatory sub process those are associated with the expression classification process. The following routines are essential for detecting a human face from an image where the patterns or essential facial points can be recognized easily. Tracking of above action units or patterns are much essential as they could help in predicting the expression in an exact manner.

a.Face Detection

For face detection, Adaboost Learning Algorithm which is used by Seyed Mehdi Lajevardi and Hong Ren Wu[8]making use of RGB color in perceptual color space. Adaboost supports high robustness while making use of Haar-like features provides normalized intensity but is of low sensitive to horizontal and vertical lines that are caused by low light factors.This has resolved the conflicts such as found intensive lighting and albedo variations in the scheme of Facial Action Parameters which is given byMingli Song, DachengTaozichengand Mengchu Zhou[12].The geometric deformations has been resolved by bilinear models given by IordanisMpiperis, Sotiris Malassiotis, and Michael G. Strintzis [17].

b.FacialFeature and Pattern Recognition

This process can be useful in tracking a particular portion or a point. Thus the feature tracking could be done by the ways of recognizing in forms of points else in forms of patterns. The proposal given by Mingli Song, DachengTaozichengand MengchuZhou[12] uses a graphics-processing unit (GPU)-based active shape model (ASM) which is much effective in edge detection though it suffers from issues of noise thus particle filtering with factorized

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likelihoods (PFFL) has been put forward by Michel F. Valstar, and MajaPantic[3] which uses the facial fiducial points detection along with the Gabor-feature-based boosted classifiers. Apart from the above logic patterns were analyzed by EsubalewBekele, ZhiZheng, Amy Swanson and Julie Crittendon[2] used Gaussian mixture clustering (GMM) which tries to relate the fiducial points in reference with patterns. A fuzzy based logic which is given by description of the FCM clustering algorithm can be found in books on fuzzy pattern recognition by ArunaChakraborty, AmitKonar and Uday Kumar Chakraborty[14] given a perception that human teeth could be used in tracking the essential regions of mouth as it could be identified with easier white color. The lip region (V_L)and non lip region (V_{NL})

$$V_L = \sum_{K=1}^{n^2} [L(J_K)]^m J_K / \sum_{K=1}^{n^2} [L(J_K)]^m \quad (1)$$

$$V_{NL} = \sum_{K=1}^{n^2} [NL(J_K)]^m J_K / \sum_{K=1}^{n^2} [NL(J_K)]^m \quad (2)$$

Where the sizes of the images were considered to be of size n*n and J_k being the data value to be evaluated while parameter m (>1) is any real number that affects the membership grade then we assume that k begins from 1 to n^2.

Tobii software development kit (SDK) [2] has been used in eye detection could be related with scheme of Adaptively Weighted Sub Pattern Principal Component Algorithm works in a way such that each image is partitioned into equally sized sub images which depends on the user options. The patterns are named as N_1, N_2, N_3,…$N_n$which could be collectively represented by N. Thus when there are NW1*W2 images belonging to K persons which are given in the training data set each with their respective weights given by W. At first each image needs to be segmented into L equally sized images which belongs to K persons. Thus collection of these vectors at same position of all face images forms a specific pattern that could be determined.

Thus the j^{th}SubPattern for any I^{th} person is computed as follows

$$I_{ij\_median} = \text{Median}\ (I_{ij1}, I_{ij2}\ldots,, I_{ijKi}) \quad (3)$$

Thus the sub pattern mean of a face for any image P is found by

$$I_{ij\_mean} = (1/K_i) \sum_{P=1}^{K} I_{ijP} \quad (4)$$

c. Action Unit Tracking

Hidden Markov Models (HMM) has been extensively used in the tracking which can of two cases of either being the Single Stream HMM else Multi Stream HMM.As a result of the MS-HMM training process, a set of ‘n’ state-synchronous MS-HMMs corresponding to the respective basic facial expressions of ‘n’ types as per Petar S. Aleksic and Aggelos K. Katsaggelos [23].In case of AAM coefficients, a radial basis frequency kernel is used, and for the LGBP features, a histogram intersection kernel is used. The SVM output is temporally filtered by taking for every frame the average over a short time windowMichel F. Valstar, Marc Mehu, Bihan Jiang, MajaPantic[4].Bayesian network to simultaneously and coherently represent the facial evolvement in different levels, their interactions and their observations based on 3 level facial activites by Yongqiang Li, Shangfei Wang, Yongping Zhao, and QiangJi[1] using AdaBoost classifier alone and using the proposed model respectively.

E.Classification of Expressions

Emotions can be classified with respect to the models used and with respect to the features used.on considering the appearance-based techniques, the theory of nonnegative matrix factorization (NMF) has recently led to a number of promising works. A technique called graph-preserving sparse NMF (GSNMF) by Michel F. Valstar, Marc Mehu, Bihan Jiang, MajaPantic[4]. For emotion detection of an image, then to find the Bezier curve of the lip, left eye and right eye according to the computation of ArunaChakraborty, AmitKonar and Uday Kumar Chakraborty[14].The selected features using the aforementioned Mutual Information Quotient (MIQ) technique are classified by a multiclass Linear Discriminant Analysis (LDA) classifier as per Seyed Mehdi Lajevardi and Hong RenWu[8].According to

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Michel F. Valstar, and MajaPantic [3] the problem of dynamic multiclass event detection problemin case of video, indeed to determine which class it belongs. To do so, shouldtrain an multi-class GentleBoost Support Vector Machines and Hidden Markov Models (MC-GentleSVMs) are employed.Then to classify an expression X the image is partitioned in to Q sub patterns of as in previous case of training images. Thus by calculation of distance matrix which is given by

$$D(Z)=(d_{ij})_{K*I} \quad (5)$$

Which holds the size of K*L where the distance between the corresponding J^{th}sub Pattern of Z and I th person and d_{ij} is the set to $W_j$if the computed identity.

The following table provides an overview of papers that has been classified with respect to the techniques that are adopted in them in their respective database which gives a clear information about their drawbacks and their further enhancement which is observed from their result.

Table 2.illustrating projects with their result

Technique	**Data Base**	**Drawbacks**	**Result**
Eigen Faces+AAM + LDA+PCA [11]	NVIE Database	Facial temperature of subjects are conflicted since requires moderate room temperature	Artificial expressions are usually exaggerated which helps in expression classification.
K-means clustering and Gaussian mixture clustering (GMM)[2]	Clinical Research Database	Novel Data undergoes some loss of accuracy.	They reduce the dimensionality of the problem
Intensity Cloning +Derivative Motion Trajectory [13]	3D Database	Asymmetricity area is not covered by feature points hence cannot be handled	Surprise 83% and happiness receives 80% while the conflict among them is reduced and 89% to be of sadness.
Pca + svd [17]	BU-3DFE face database	Cloud of facial points leads to a smoother forcefield	an overall 90.5% facial expression recognition rate
MPEG-4 facial animation parameters (FAPS)+Bayesian Networks)[19]	Cohn-Kanade Database	quantitative performance Evaluation reconstructed Faps and their temporal development	coupled Bayesian network to unify the facial expression analysis and synthesis into one coherent structure to synthesize dynamic facial expressions
Local Gabor binary patterns (LGBPs)+Local Phase Quantization (LPQ) [4]	M3 database	actors were present in both training and test sets, but actual portrayals made were different in both sets	reporting a 93% classification accuracy
Dynamic Bayesian Network + principal Component Algorithm [1]	Cohn-KanadeCK +database and M&M Initiative (MMI) facial expression database	not uses any measurement specifically for expression and the global expression is directly inferred from AU	average recognition rate of 87.43% for action units.
Fuzzy C Means clustering [14]Algorithm	MS SQL Server Database	limited number of expression as the adaptive weight seems to be much similar.	High Classification Accuracy of 90%.

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III. CONCLUSION AND FUTURE WORK

This survey paper concentrateson the previous work done on facial expression classification and it relates how the techniques have been used in extracting a human face from an image. The survey has been done with respect to divisions of their dimensionality such as two or three dimensional, Models that they make use of such as AAM,DAM,ASM and the usage of Bayesian Networks and Hidden Markov Models. The action unit tracking has been categorized with respect to facial action points and Patterns with reference to Fuzzy Logic. By above furnished information it could be suggested that usage of Adaptively Weighted Sub Pattern PCA along with Fuzzy C Means Clustering Algorithm could be an option for uncategorized patterns. Though this combination could be implemented with limitations in terms of fiducial action point tracking.

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BIOGRAPHY

Mr Sudharsonis working as an Assistant Professor in the department of Information Technology at Sri Krishna College of Engineering and Technology, Coimbatore.His areas of interest include Software Engineering and Image Processing.