Analysis of Face Recognition Under Varying Facial Expression: A Survey

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Abstract: *Automatic Face Recognition is one of the most emphasizing dilemmas in diverse of potential relevance like in different surveillance systems, security systems, authentication or verification of individual like criminals etc. Adjoining of dynamic expression in face causes a broad range of discrepancies in recognition systems. Facial Expression not only exposes the sensation or passion of any person but can also be used to judge his/her mental views and psychosomatic aspects. This paper is based on a complete survey of face recognition conducted under varying facial expressions. In order to analyze different techniques, motion-based, model-based and muscles-based approaches have been used in order to handle the facial expression and recognition catastrophe. The analysis has been completed by evaluating various existing algorithms while comparing their results in general. It also expands the scope for other researchers for answering the question of effectively dealing with such problems.*

Keywords: *Facial expression, holistic, local, model, optical flow, muscles based and coding system.*

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1. Introduction

Face Recognition has the most relevance in real life issues of security, criminal investigation, and verification intention. Thus it has a broad range of applications. Three issues in the field of face recognition are: illumination variation [62], pose variation and more importantly expression variation which is the main focus of this paper [78]

Facial expression is a way of non verbal communication. A person depicts his/her sentiment by using facial expression but these expressions create vagueness for recognition system. There is not been much research on this issue; and most of the researchers have investigated various algorithms to handle expression variation [32].

Generally, face is an amalgamation of bones, facial muscles and skin tissues [10]. When these muscles contract, deformed facial features are produced [23]. According to Seongah and Kyoung in [10] and Ekman in [20] facial expression acts as a rapid signal that varies with contraction of facial features like eye brows, lips, eyes, cheeks etc, thereby affecting the recognition accuracy. On the other hand, static (skin color, gender, age etc) and slow signals (wrinkles, bulges) do not portray the type of emotion but do affect rapid signal.

The work of facial expression basically started in nineteenth century. In 1872 Darwin [16] introduced an idea that there are definite inherent emotions that are derived from allied habits and are referred to as basic emotions. His idea was based on the assumption that the physiognomies are universal across ethnicities and customs which engross basic emotions like happiness, sadness, fear, disgust, surprise and anger. Primarily facial expressions are examined and analyzed by psychologists [23], but in 1978, Suwa *et al*. were the first to attempt automatic face recognition using image sequence [66]. Later the research on facial expression matured in 1990s (nineties) by the efforts of Mase and Pentland [48]. By the time, it had gained more attention due to its extensive applications in pertinent areas. Majority of the researchers focused on understanding image based techniques (video based), some focused on model based approaches, and some worked on motion based approaches, while some took advantages of facial expression recognition by proposing different algorithms that were incredibly practical in the field of medicine [18]. Generally, the attention on facial expression was focused to many social psychologists, clinical and medical practitioners, actors and artists etc [4]. Later in the twentieth century facial expression became an active topic that was rigorously researched under the development of robotics, computer graphics, computer visions and animators etc [4].

The brief survey conducted by Fasel and Pantic *et al.* [23, 59] highlights different contributions to the research in this field from 1990 to 2001.

The general frame work for automatic facial expression is shown in Figure 1. Primarily the face images are acquired and normalized in order to eliminate the complications like pose and illumination factor during face analysis. It is an axiom that feature extraction is a great milestone which uses various techniques to characterize facial features like motion, model, and muscles-based approaches. Finally these features are classified and trained in different subspaces and then used for recognition.

This paper is also a survey-based timeline view that performs an analysis on different techniques to handle facial expressions in order to recognize faces. Finally the evaluation has been done by comparing the recognition results against different algorithms.

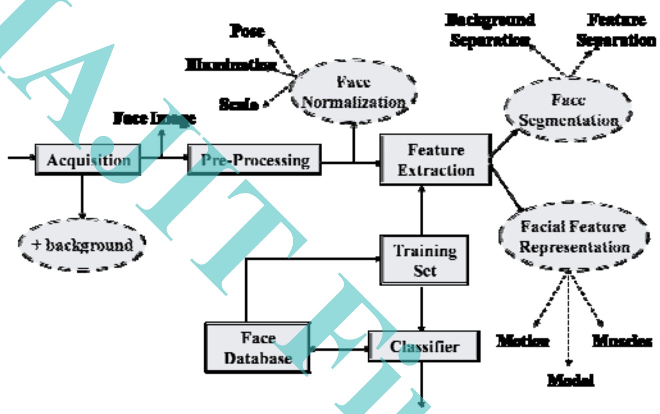

Figure 1. General frame work for automatic facial expressions.

2. Pre-Processing Steps

Ideally, faces are acquired by locating them from chaotic backgrounds. Actually pre-processing are applied to normalize images so that it can easily processed in a format in which it can simply process in given condition or scenario [68]. For pre-processing images different researchers used different algorithms either used their proposed steps for processing or used already pre-processed images to test the proposed algorithm. Pre-processing is not the necessary steps. Image acquisition is also a part of pre-processing. Ideally, faces are acquired by locating faces from the chaotic backgrounds. Accurately measuring the position of faces plays a vital role in order to extract facial features [60, 61]. Active Shape Model (ASM) is a feature orientation method that is used to extort transient and intransient facial features [30, 43] and it was first applied by Hong *et al*. Steffens [64] however preferred the Person Spotter system for features extraction. In 1982 Essa and Pentland used view-based and modular Eigen space methods to locate the faces [22, 56]. Automatic facial expression is a complex task because the outer appearance of a person may vary by the changed mood of a person and thus subsequently affect the facial expression. These expressions may vary with age, ethnicity, gender and occluding objects like facial hair, cosmetic products, glasses and hair etc. Additionally, pose, lighting conditions, and expression variations also affects face recognition rate. Although, face normalization is not mandatory [23] but used to overcome the harmful effects of illumination and pose variations because facial expression recognition depends on the angle, distance and illumination invariant conditions against each face [78].

3. Feature Extraction

Physically face is classified as many local and global features which may change with the change of facial muscles and skin tissues. This alteration causes a serious dilemma in automatic face recognition that downgrades the performance of recognition rate. Before going in to the deep particulars, let's first take a brief view of the classification of faces.

1. Intransient facial features permanently lie on the face, however may be deformed with the change of facial expressions [5].
2. Transient facial features are like creases i.e. wrinkles bulges etc that affect on skin texture but do not notify the type of emotion [27, 50]. Nevertheless, facial expression provides a way of transferring messages so it is mostly video-based. The quality of video frames depends on the environment from which it is taken and that affected by the lighting and pose conditions [78] for e.g. Ira *et al.* used tree augmented-naïve Bayes (TAN) [13] while Philipp *et al.* in 2003 [49] used SVM classifier to track facial features. In 2008 Vito *et al.* introduced the concept of calculating symmetry from set of sub-images [25]. Finally, Huafeng *et al.* in [74] provides an up-to-date survey of image based approaches till 2009.

Transient and Intransient facial features can be categorically divided as to whether they rely on certain actions of muscles or warping of faces and facial features respectively as shown in Figure 2.

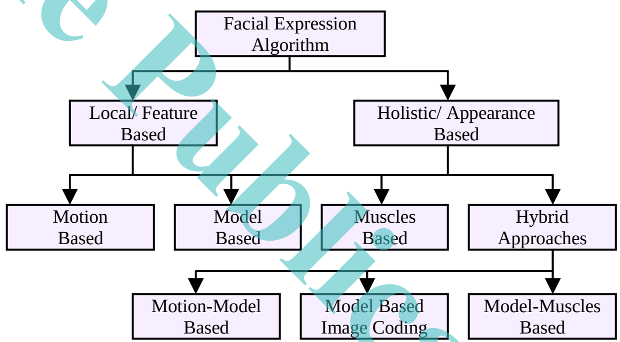

Figure 2. Distinction of Feature Extraction and Representation.

3.1. Feature vs. Appearance Based Approaches

Basically, face recognition under varying facial expression algorithms is categorized as local or feature based approaches [26] and holistic or appearance based approaches [9] that process the whole face for extracting facial features and hence give the detailed information. But sometimes, all the information becomes irrelevant because all facial features are not changed by the appearance of single emotion as, for example, the degree of smile doesn't affect all features but influences only the appearance of cheeks and lips etc [9] [44]. So, in contrast to holistic based approaches local based approaches provide a way to process only the affected facial features [26]. Kakumanu used local graph in order to track facial features while global graph to store the information of face texture [37]. Kyong initiated the idea of toning the overlapping area around the nose [8]. Similarly, Satyanadh in [29] selected the local facial features via modular kernel Eigen-spaces for multi dimensional spaces.

Feature and appearance based approaches are further categorized as motion, model, muscles-based and hybrid approaches which provide further distinctions of motion-model based, motion based image coding and model-muscles based approaches.

3.1.1. Motion-Based Approaches

Intensity measurement is a key factor that depicts the amount of pixel variation. Abundant of algorithms are used to calculate the intensities deviation like face plane algorithm with displacement vector [70], geometric deformation of facial features etc which may be affected due to transient facial features like wrinkles and bulges.

The involvement of different researchers in motion based approaches is mentioned as below:

Y. Dai *et al.* in [15] recognize the expressions of patients without speaking ability. The direction of facial features is identified from corresponding contiguous sequence of frames throughout the computation of optical flow histogram which actually compose the associative memory model against each facial expression.

Table 1. Assessment of motion based facial expressions.

Motion Based Approaches						
References	**Approach**	**Feature Extraction**	**Classifier**	**Data base**	**Performance**	**Important Points**
Y. Dai *et al* .2000 [15]	Appearance based	Calculate difference image from YIQ image	Optical flow projection histogram for each expression is used to classify features	--	Performance is calculated on the basis of classification of facial features	1. Compute optical flow histogram from adjacent frames. 2. Difference of image from YIQ image
Yongbin *et al.* 2001 [77]	Appearance based	Using AAMs	--	--	Performance is calculated on the basis of classification of facial features	1. Used subspace method 2. Not successfully recognized identity of a person
Sungsoo *et al* .2008 [55]	Appearance based	Using AAMs	Support vector machines	POSTECH SFED07 DB	Maximum overall performance for medium attains 88.125%	1. Facial expression magnification increase recognition performance

According to Yongbin and Aleix in [77], performance of recognition of facial features depends on the trained subspace methods. Sungsoo and Daijin in [55] recommend an impulsive classification of facial expression techniques via facial motion magnification through Active Appearance Model (AAM) and calculating motion vectors respectively.

3.1.2. Model-Based Approaches

In facial expression recognition shaping of facial feature are the most imperative phenomena because problem arises in facial expression recognition when facial motions are put in static facial features. Image modeling uses candied models as a reference image [58]. In fact facial features are disturbed with tightening of facial muscles which is more composite to approximate facial expression [67]. Contributions of researchers under model based approaches are as under:

Salih Burak *et al.* in [28] twist the facial expression recognition into a new direction that are independent to the view and pose variation. Instead, pose and geometry of the face in contiguous frames are positioned using 3D model based tracker.

Bourel *et al.* [7] provide a robust recognition under spatially-localized model to handle partial occlusion and noisy data produced during feature tracking.

Mahesh *et al.* [58] use CANDIDE model or triangular mesh that portrays the generic model of the human face. Once the mesh like model is assembled, Active Appearance Model (AAM) is used to automatically register the model to the face. Yun and Nanning merge all the limitation of face recognition techniques i.e. pose, aging, expressions and illumination variation in one class called merging face (M-face) [24].

Like other researchers Alexander *et al.* in [6] represent the human expressions by incorporating the geometric isometric model into some low dimensional linear space. The low dimension dissimilarity of faces and is incorporating in to R3.

The goal of Maringanti *et al.* [5] was to classify the nature of the emotions using a model based approach with the potential to flexibly reinforce the number of emotions. Finally Gabor Wavelet transform is used for removal of noise.

Christian, Uwe and Horst-Michael [46] focuses on real time settings by applying model based AAM on edge images and provides accurate classification of emotions. After constructing the AAM model images are warped in order to apply appearance model that transform high dimensional input image to linear sub-space Eigen faces. Later images are converted into edges using an edge vector which makes it insensitive to illumination factor.

Model based methods are very useful for morphological operations. It is because the automatic face recognition is done to remove noisy data [1]. N. Vretos, N. Nikolaidis and I.Pitas [73] also exploit the Candide model grid and locate two Eigenvectors of the model vertices using PCA. Most researchers' focus on the model based approaches because it gives the concise information of facial features geometry [41]. Yi Sun in [65] attempts to improve the prior work and highlights the limitations across the control point's vertex in the model based approaches. The author's tries to make the vertices superior by means of tracking model and catch the spatial and temporal information, spatiotemporal hidden Markov model (ST-HMM) is used by coupling S-HMM and T-HMM. The overall snapshot of model based facial expression recognition is shown in Table 2.

Table 2. Assessment of model based facial expression.

Model Based Approaches						
References	**Approach**	**Feature Extraction**	**Classifier**	**Data base**	**Performance**	**Important Points**
Salih *et al*.2002 [28]	Appearance based	Stereo tracking algorithm	Support vector machines (SVM) provides a robust classification	--	Recognition rates up to 91% by classifying into 5 distinct facial motion and 98% for 3 distinct facial motion	1. Independent to view and posed variation
Bourel *et al*. 2002 [7]	Appearance based	State based feature extractor	Rank-weighted *k*-nearest neighbour classifier	Cohn-Kanade facial expression database	Recognition rate = 99%	1. Handle occlusion and noisy data 2. State based feature modeling
Mahesh *et al*. 2005 [58]	Appearance based	Control Points of the Candide model actually determines the transient features	Implement PCA + LDA classifier	Use FERET Database for neutral & smiling face	The expression with expression normalized achieves 73.8% results	1. Model based Approach 2. Provides synthetic image using affine warping of the texture
Yun Fu *et al* .2006 [24]	Appearance based	--	--	MPI Caucasian Face Database and AI&R Asian Face Database	See result from reference # [23]	1. Efficient for realistic face model. 2. Reduced computations via M-Face
Alexander *et al*. 2007 [6]	Feature based	--	--	Expression data base	Minimum error = 7.09%	1. Embedding of geometric model with low dimension space leads to less metric distortions. 2. Representation of expression rather than generating expressions
Maringanti *et al*. 2007 [5]	Appearance based	1. Discrete Hopfield Networks for feature extraction 2. Hough transform and 3. Histogram approach	Reduced the size using PCA based classifier.	Cohn-Kanade Action Unit Coded Facial Expression Database.	Recognition accuracy of 85.7%	1. Model flexibly generates the number of emotions. 2. Cognitive emotions are sensed 3. Emotions are characterized with positive & negative reinforces.
Christian *et al*. 2008 [46]	Appearance based	Using AAM based model	AAM classifier set instead of MLP and SVM based classifier.	FEEDTUM mimic database	Anger emotion with average accuracy of 94.9% but other emotions are low between 10 to 30%.	1. Real time facial expression recognition. 2. AAM based model 3. Robust to lighting condition 4. False positive rate high for emotions except anger.
Brian *et al*. 2008 [1]	Appearance based	--	--	GavabDB database and the UND database	99.7% for GavabDB with improved speed	1. Handle noise 2. Recognition rate high
Vretos *et al*. 2009 [73]	Appearance based	Model vertices are determined using PCA	SVM based classifier	Cohn-Kanade facial expressions database	Classification accuracy achieved up to 90%	1. Good framework towards model based approach 2. Robust against 3D transformation operation on the face 3. Not sensitive to SVM configuration.
Yi Sun *et al* .May 2010 [65]	Appearance based	1. Locate ROI (region of interest) 2. Apply PCA to ROI to locate nose tip.	PCA and LDA classifiers	4D face data base called BU-4DFE	Expression dependent achieves up to 97.4% result.	1. Highlights the lack of control points 2. Focus on 4D data 3. Time consuming 4. Forehead area not specified

3.1.3. Muscles-Based Approaches

Facial expressions engendered with the contraction of subcutaneous muscles that control and alter facial features like eye brows, nose, lips, eye lids and skin texture etc. The muscles actions are distinguished in two facial parameters as.

Table 3. Assessment of muscles based facial expressions.

Muscles Based Approaches						
References	**Approach**	**Feature Extraction**	**Classifier**	**Data base**	**Performance**	**Important Points**
Byoungwon *et al* 2001 [11]	Feature based	Tracking of muscles contraction via optical capture system	--	Algorithm is implemented on PC platform	Artist-in-the-loop method provide superior results	1. Analyze muscles actuation 2. Easy to control facial expressions 3. Provide synthetic images
Benedict *et al* 2004 [2]	Feature based	Features extract using EMG electrodes	Minimum distance classifier	--	Achieves 85 to 94.44% accuracy	1. Emotion analysis on male and female 2. Use EMG signals to create feature templates
Ibrahim *et al* 2006 [34]	Feature based	Use sEMG instead of EMG signal	--	--	Spectral density range is between 19 to 45 Hz	1. Utilize surface EMG 2. Applied on different age categories
Takami *et al* 2008 [67]	Feature based	Displacement of controlled feature points	--	--	Quasi-muscles is helpful for tracking FPs	1. Easy to estimate FPs using quasi-muscles
Dushyantha *et al* 2008 [35]	Feature based	Features extract using EMG	--	--	Greater displacement at grid points 2 and 6 [35]	Artificial smile recovery method via robots 2. EMG based facial expression analysis

Facial Action Coding System: FACS: Facial Action coding system (FACS) illustrates another way to measure the facial expression by examining the upper and lower FACS [54]. FACS is a standard that offers uniform functionality as optic flow. FACS was initiated by Ekman and Friesen in 1978 [21] that defined 46 AUs in which 12 for upper face and 18 for lower face. The remaining are the grouping of different AUs constitute of additive AUs [71]. Although there is a bit difference between FACS and facial muscles but it expresses the muscles contraction [17].

Ying-li *et al.* in 2001 presented an automatic face analysis method [71] by tracking the transient and in-transient facial features and classified it as upper and lower AUs. Ashish Kapoor proposed a new idea of analyzing automatic AUs by tracking the pupil in the eye [39]. Similarly Pantic and Leon recognize facial gestures in static and posed faces [3, 54]. On the other hand in 2005 Yongmian and Qiang mingled dynamic Bayesian network (DBNs) with FACs [53, 75].

Facial Animation Parameters FAPs: It is the standard of SNHC, ISO/IEC developed by MPEG-4 coding system [4, 63] emphasized on synthetic and animation that are allied with AUs. MPEG- standard used the static image with their associated 84 feature points FPs [4].

Facial expressions on face illustrate visual impact on others which are usually controlled by contraction of muscles, through subcutaneous muscles just under the skin. Entirely, human face restrains 43 muscles, also called mimetic muscles. One of the six basic facial signals like anger, disgust, sadness, fear, surprise, happiness is an outcome of change of these muscles.

In 2001 Byoungwon and Hyeong-Seok in [11] introduced the concept of analyzing the muscles actuation in order to synthesize expressions.

The field of muscles-based emotion recognition expanded further in 2004 when Benedict *et al.* [2] examined the facial muscles activities for computers to automatically recognize facial emotions. Primarily the emotions of male and female are captured from facial muscles through electromyogram Sensors (EMG) signals and were used to create feature templates. Ibrahim *et al.* expanded the work of Benedict *et al.* in 2006 [34] and used surface electromyography (sEMG) to acquire facial muscles actions in different age categories with mean age of 47.5 and 23 years old females. Similarly in 2008 a research was conducted by Takami, Kyoko and Shogo against quasi-muscles to quantify facial expressions by estimating FPs [67].

On the other hand Dushyantha *et al.* in [35] made an effort to restore facial expressions (smile recovery) by exploiting robot mask for paralyze patients.

On the whole appraisal against muscles based approaches are depicted in Table 3.

3.1.4. Hybrid Approaches

Motion-Model Based Techniques: Chao, Shang and Yung in [31, 32] proposed a relative algorithm of Optical Flow (OF) that provides the noticeable motion of objects, surfaces or edges in a visual scene. The main goal of this paper is to adjoin the intra-person optical flow with neutral images to synthesized faces. Finally the images are synthesized.

Model Based Image Coding Techniques: During video transmission most of the information is attached with the first frame and is based on model as well as prior information of code from first frame that’s why it is so called “Model based Image coding”, “Knowledge based image coding” or “semantic image coding” [12] etc which controls the knowledge of Facial Expression Parameters (FEP).

In contrast to conventional coding systems Chang, Kiyoharu, Hiroshi, and Tsuyoshi in [12] improves the image quality and bit rate by transmitting the corresponding parameters instead of image itself.

Peter Eisert and Bernd Girod in [19] also present an analysis of 3D motion by indicating geometry, texture, facial motions and facial expressions through model based coding systems. The exterior of the person are controlled with triangular B-splines model while Facial Animation Parameter (FAP) depicts facial expression. On the other hand Hiroshi Kobayashi, Fumio Hara in [40] offers human machine interaction between 3D face robots with human beings. In order to examine the facial motion in the human face, 46 Aus are inspected with face robots.

Irfan. Essa and Alex in [22] basically present an analysis of basic coding action units that are useful to guess facial motions. The facial motions are estimated by measuring optical flow. Finally construct the physics-based model by adding anatomical based muscles in Platt and Badler's model [57]. Similarly, Zhang *et al*. in [76] show his effort in real time environment to produce synthetic image. FACs is incorporated with deformed physical based spring model to approximate animated facial muscles using lagrangian dynamics.

According to Hans, Marco and Marten in [14, 42], automatic facial expression recognition is not an effortless chore since pose, illumination and expression variation is the grand dilemma in the pertinent field.
Model-Muscles Based Techniques Hiroshi, Hitoshi and Hiromasa in [51] used exhaustive anatomical knowledge by exploiting muscle based feature models to track facial features such as eye brows, eyes and mouth. On the whole, the main emphasis to this approach is to provide the deformable models. Tang *et al*. in 2003 attempts to create a control B-splines curves (NURBS) by generating a motion vector in order to control facial expressions [69]. The general description of hybrid based approaches is shown in Table 4.

4. Classification

The final phase of automatic facial expression recognition classifies the transient and in-transient facial features in accordance with the desired result. Selecting a low dimensional feature subspace from thousands of features is a key phenomenon for optimal classification. The main ambition to use subspace classifiers is to convert high dimensional input data into low dimensional feature subspace. Subspace classifiers selectively represent the features that minimize the processing area. Feature extraction plays a vital role to reduce the computational cost and progress the classification results because selecting a low dimensional feature subspace from bundle of features is very crucial for optimal classification. Wrong features selection degrades the performance of face recognition; even though superlative classifier may be used. There are bunch of linear and non-linear classifier's that offers categorization between correlated and uncorrelated variables. The two basic linear classification techniques are principal component analysis PCA [10, 16, 31, 32, 42, 59], and Linear discriminant analysis LDA [10, 31, 32, 59], Others classifiers are Independent Component analysis ICA, Support vector machine SVM [10, 18, 78], Singular Value decomposition SVD and kernel versions classifiers like KPCA, KLDA, Rank weighted k-nearest neighbors k-NN [32], elastic bunch graph algorithm, AAM [66], Active Shape model ASM, Minimum distance classifier [2], Back propagation neural network [36, 40, 45] and 3D morph able model based approaches are commonly used.

For supplementary aspect Tsai and Jan analyze different subspace model in [72].

5. Database

The good choice of database under uncontrollable condition like occlusion and pose, illumination, expression variation is a very challenging task that deals with testing the novel approaches. Databases are used to test the proposed system on different images under varying condition like pose, illumination, occlusion, expression etc. Some databases are publically available for researchers. In some cases various databases stores the preprocessed data of images for learners. One subject or individual has number of samples in different varying conditions. Number of databases includes FERET, CMU-PIE, Extended YaleB, Cohn Kanade, AR, ORL, Japanese Female Facial Expression JAFEE, Indian Face database etc. In all, FERET face database and CMU (PIE) pose, illumination and expression face database is the one which are de-facto standard and are very courageous to handle different problem domain. In contrast to FERET database there are some common expression databases which is openly available that are Cohn-Kanade database sometimes stated as CMU-Pittsburg AU coded database which has posed expressions [38] and is not fit for spontaneous expressions. Similar posed expression database are AR face database [47], Japnese Female Facial Expression Database (JAFFE) [33] etc.

6. Discussion and Comparasion

The goal of each technique mentioned above is to recognize faces under varying facial expressions. Even though some approaches provide desired results but do not offer more accurate domino effect. In order to evaluate the vulnerability of such approaches, the comparison chart has been drawn as in Table 1 (Motion-based), Table 2 (Model-based), Table 3 (Muscles-based) and Table 4 (Hybrid Approaches).

Motion based approaches are extensively used to estimate the degree of face deformation and intensity variation [77], that endow comprehensive information about local and global features but it takes much time to estimate pixel by pixel motion vectors [55]. These motion vectors are provided by the detailed information [22].

Table 4. Judgment of hybrid approaches.

Motion-Model Based Approaches						
References	**Approach**	**Feature Extraction**	**Classifier**	**Data base**	**Performance**	**Important Points**
Chao-Kuei *et al* June 2009 [31] & Jan 2010 [32]	Feature Based	Calculate intra-person OF from inter-person + overall OF	PCA + LDA based classifier	Binghamton University 3D Face Expression (BU-3DFE) database	Average recognition rate of 94.44%	1.Time taken by OF-Syn and OF is 2.01 and 1.43s respectively 2. Costly
Model Based Image Coding						
Chang *et al* June 1994 [12]	Appearance based	Encoding & Decoding with muscle based Aus of de-facto standards	Deforming rules for 34 AU for both upper & lower faces	--	Texture update: Method I: 1.Less bit rate 2. Low quality image Method II: 1. Improves quality image 2.Large memory space No texture update: Estimated bit rate 1.4, 3.5 & 10.5 Kbits/s	1. Facial Expression video transmission 2. Image synthesize (decoding) 3. Texture update improves the quality of image 4. Handle head motion
Peter *et al* September 1997 [19]	Feature based	Encoding and Decoding with FAPs of ISO/IEC standard developed by MPEG.	FAPs of ISO/IEC standard developed by MPEG.	--	Estimated bit rate of less than 1kbit/s with error rate of 0.06% in each frame for both synthetic & video sequence	1.Estimate 3D motion with facial expression 2. B-splines are suitable for modeling facial skins
Hiroshi *et al* 1997 [40]	Feature based	Data acquired using CCD camera	Back propagation Neural Network ensemble classifier	--	Achieve recognition rate of 85%	1. Human machine interaction between robots & human beings
Irfan *et al* July 1997 [22]	Feature based	Optical flow based approach	FAC+ instead of FAC	Database of 52 sequence	Recognition accuracy 98%	1. Efficient in terms of time & space
Zhang *et al* 2001 [76]	Appearance based	FACs	FACs based anatomical spring model	Facial Modeling using Open GL/C++	--	1. Based on physical anatomical information 2. Real-time based synthetic image 3. Analyze relationship btw deformed facial skin and inside state
Hans *et al* July 2005 [42]	Appearance based	Delauny triangulation	1. PCA based classifier that converts the shape into low dimensional space. 2. FACs	--	Emotional Expression classifier accuracy up to 89% while Aus detect with average accuracy of 86%.	1. Use holistic based approach 2. Back propagation trained neural network. 3. Use trained classification network.
Model-Muscles Based Approaches						
Hiroshi *et al* 2000 [51]	Feature based	Muscle based control points	--	--	Facial parameters like eyebrows, mouth corners and upper lip shows effective results.	1. Muscle based feature modeling 2. Provide deformable models
Tang *et al* 2003 [69]	Appearance based	Reference and current NURBS control points	--	VC++/Open GL	The more the NURBS flexible the more it gave the desired results	1. Control facial expressions via NURBS 2. FACS based implementation
Seongah *et al* 2009 [10]	Appearance based	Rubber band method	--	Not based on 3D data base	Surprise achieve 8.3, fear = 5.5, disgust = 7.2, anger = 8.7, happiness = 8.0 and sadness = 8.9	1. Transform facial expression in a target face 2. 3D face model

On the other hand in model based advancements CANDIDE model is used as a reference image that improves the accuracy of such systems [58, 73]. This reference image is helpful for recognizing facial expressions [1, 6] and can be used to produce animation [46, 49, 76] and synthetic images [46, 58] but the main constraint across this approach is the boosted complexity [1] while estimation of mesh for constructing model is not an easy task [22]. Model based techniques are also reliable for real time system because of corresponding triangle to triangle mapping rather than pixel by pixel transformation [46, 76].

Though it present more detailed information across edges but not trustworthy for texture transformation due to lower anatomical information [42, 55] so, much of the researchers overcome this issue using muscles based algorithms. Similarly, muscles based approaches are powerful that are provided by detailed anatomical information [52] while facial features are tracked by only locating the varied features and the direction of muscles shifting [51] but it also increased the complexity [11]. Facial muscles anatomical aspect are also supportive to judge the patients muscles activities which are unable to produce expressions on faces [35] but various diseases and facial warping become powerless to extract facial features [67].

Facial muscles can be monitored through coding system which is an image based technique [17]. In order to diminishes the complexity of muscles based approaches coding systems like FACs, FAPs, Emotional Facial Action Coding System (EMFACs), Facial Action Scoring Technique (FAST), Maximally Discriminative Facial Movement Coding System (MAX), Facial Electromyography (EMG) etc are the reliable measure that increase the accuracy rate while speed up the system [17]. Here is an interesting thing that more classification are provided by the facial actions the more it provides the detailed information [17] but less classification causes lack of temporal and spatial knowledge [75]. Exactness of the images increased across the assigned code area but is not good for texture transformation because Action units are basically local spatial [17, 75]. Another constraint of this system is that it becomes more complex for automatic machine facial expression recognition [17].
In combination to such approaches like motion-model based technique that estimate the intensity variation for feature extraction and use CANDIDE model for face recognition [31]. Likewise model based image coding is a technique, preferable for texture transformation and for corresponding edge matching for face recognition [12, 40]. Since, model muscles based techniques takes the advantage of couple of model and muscles based technique respectively for face recognition under varying facial expressions. Though missing facts (texture) are provided by anatomical muscles based algorithms whereas complexities are reduced using CANDIDE model as a reference image [51, 69].

7. Conclusions

Facial expression are fabricated during communication transmission so images may be acquired in uncontrollable condition like occlusion (glasses, scarf, facial hair, cosmetics and it also effects recognition rate), pose, illumination and expression variation etc. Facial Expression not only exposes the sensation or passion of any person but also used to judge his/her mental views and psychosomatic aspects. Classification of different facial expression recognition algorithms provides a way to analyze the emotions produced by human faces. It helps to answer the question of which techniques are practicable in which type of environments. Various researchers have taken advantage by utilizing the rapid assigned code from the dictionary of diverse of coding system techniques i.e., FACs, FAPs etc during face recognition process. Similarly, model is used to speed up the recognition method. This paper provides a snapshot of different algorithms which are very helpful for other researchers to enhance the existing techniques in order to get better and accurate results.

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