

# Facial Expression Detection using Hidden Markov model

Dr.Poonam Tanwar  
Associate Professor  
Computer Science Department  
Lingaya's University, Faridabad  
poonam.tanwar@rediff.com

Divya Arora  
Student  
Computer Science Department  
Lingaya's University, Faridabad  
divya.arora.lu@gmail.com

Dhruv Anand  
Student  
Computer Science Department  
Lingaya's University, Faridabad  
dhruv11anand@gmail.com

## ABSTRACT

Face recognition has them ostrelevance in real life issues of security, criminal investigation, and verification intention. Thus it has broad range of applications. Three issues in the field of face recognition are: illumination variation, pose variation and more importantly expression variation which is the main focus of this paper. Human-Computer Interaction is an emerging field of Computer Science where, Computer Vision, especially facial expression recognition occupies an essential role. There are so many approaches to resolve this problem; among them HMM is a considerable one. In this paper, we study Hidden Markov Mode l(HMM) and KNearest Neighbor (KNN) classifiers ,and put forward a combined approach for facial expression recognition. The reared eight different facial expression classified here: angry, annoyed, disgusted, grumpy, happy, natural, sad and surprise. The basic idea of this approach is to employ the KNN and HMM classifiers in as sequential way. Experiment on faced at a bases how that the proposed method has encouraging recognition performance.

## Keywords

Hidden Markov model; KNN; Active Appearance model.

## 1. INTRODUCTION

In today's world computers have become indispensable and ubiquitous part of our lives. For this same reason Human Computer Interaction is an emerging area of research and it is prior necessity for imparting intelligence to computers to understand the situation and act sensibly according to situation like human beings do. Interpersonal communication is broadly classified as nonverbal communication and verbal communication. Nonverbal communication accounts for the pitch, intensity and tone of voice merged with gestures and facial expressions whereas Verbal communication consists of only raw voice data input. The vocal part of the message contributes only 38% of the message as a whole, and the verbal part is 7%, while facial expression contributes rest of the message, that is 55% of the effect of the Person's message

The real-time and automated facial expression recognition would be useful in many applications, e.g., customer satisfaction studies, virtual reality, videoconferencing, human computer interfaces, etc. is done to get the suitable output. Although humans detect and interpret faces and facial expressions in a scene with little or no effort, accurate and efficient facial expression recognition by machine is still a challenge that we face. Several research have been made on facial expression recognition. Generally,

expressions that are made by human faces are divided into six basic categories by psychologists that are anger, disgust, fear, happiness, sadness, and surprise. Face recognition systems architecture **mainly contains of the three following tasks:**

- **Acquisition (Detection, Tracking of face like images)**
- Feature extraction (Segmentation, Alignment of the face image)
- Recognition

**One of the major problems in trying to recognize emotions is the fact that there is no uniform agreement about the definition of emotions.**

Generally, it is agreed that emotions are short term way of expressing inner feelings, whereas temperaments or personalities and moods are categorized in long term way of expressions. Emotions can be expressed in various different ways, through facial expressions, voice, tone and other physiological means .Although there are arguments on how to interpret these physiological measurements, it is clear that there's a strong correlation between measurable physiological signals and emotions of a human being. In the past years there has been research on recognizing emotion through facial expressions. A part of the research was pioneered by Ekman and Friesen who started their work from the psychology perspective. In the late 20<sup>th</sup> century, the engineering community started to use these results to construct automatic methods of recognizing emotions from facial expressions in images or video

## 2. REALTED WORK

Although many studies on facial expression and emotions have been carried out for a long time, Paul Ekman and his colleagues did significant work about the facial expression in the 1970s, became the foundation of the existing automatic facial expression recognition system moreover Ekman and Friesen postulated six basic emotions (anger, disgust, fear, happiness, sadness, and surprise) and produced Facial Action Coding System (FACS) to categorize facial expressions by describing changes in the facial muscles. For the classification of facial expressions, approaches have been classified into two groups: Spatial and Spatio-temporal approaches. Spatial **methods utilize a still image or only a single frame in video sequences without temporal**

**information.** Bayesian Network (BN), Neural Network (NN), **rule-based classifiers, Support Vector Machine (SVM) led to a good success for facial expression** recognition. On the contrary, spatio-temporal approaches are not simple, but make better performances **in video sequences than spatial approaches without temporal information.** **Hidden Markov Models (HMM)** has also been applied to facial expression recognition as one of the most popular classifiers **among spatio-temporal methods.**

**In 2011 Xufen Jiang made research in HMM based facial expression recognition,** in which he proposed a new method for facial recognition. Lu Tai, Pu Xiaorong, Tan Heng and Zhou Zhihu, published a paper in that they proposed an HMM for partially hidden face recognition. Another notable contribution is the work of Lahbiri, M. ;Fnaiech, A. ; Bouchouicha, M. ; Sayadi, M. ; Gorce, P. **in 2013 which navigates a novel HMM for facial expression recognition** .In this paper, we make a pre-classification with KNN, select the classes with high matching ratio as the basic classes of reclassification of HMM, which will reduce the workload of recognition calculation of Human faces.

### 3. K-NEAREST NEIGHBOR (KNN)

In pattern recognition, the k-Nearest Neighbors algorithm (or k-NN) is a non-parametric method which is used for classification and regression. The input consists of the k closest training examples in the feature space. The output depends on whether k-NN is used for regression or classification .In k-NN classification, the output is a class member. An object is classified by a majority vote of its neighbors, **with the object being assigned to the class most common among its k nearest neighbors (k is a positive integer, k<1).** If k = 1, then the object is simply assigned to the class of that single nearest neighbor.

In K-NN regression, the output is the property value for the object. This value is the average of the values of its k nearest neighbors. K-NN comes under instance-based **learning, or lazy learning, where the function is only approximated locally and all evaluation** is deferred until classification. The KNN algorithm is among the simplest of all machine learning algorithms in the terms of classification and regression, it can be useful to weight the contributions of the neighbors, so that the nearer neighbors contribute more to the average than the more distant ones. For example, a common weighing scheme consists in giving each neighbor a weight of 1/d, where d is the distance to the neighbor. The neighbors are taken from a set of objects for which the object property value (for K-NN regression) and class (for K-NN classification) is known. This can be thought of as the training set for the algorithm, though no explicit training step is required

### 4. HIDDEN MARKOV MODEL

HMM, as a dynamic time series statistical model of signals, has precise data structure and reliable capability of calculating. As well as, it can extract reliable models through less samples, find out the model which is the most similar with test samples according to the theory of model matching.

Therefore, HMM has become the main technology in speech recognition, expression recognition and biologic series contrast, it is because real condition is much more complex than what Markov can describe. HMM is developed **on the base of Markov chain, now it becomes a major statistical model in speech recognition.** HMM is a double random process. What HMM observes is not corresponding one to one, but percepts the existence and character of state. Because the state cannot be seen directly, it is called Hidden Markov Model which can implement statistical learning and probability reasoning. One is **Markov chain and the other is explaining the statistical corresponding relation between every observation value and state.** By the reason, HMM describes the observation value series **in statistical model, it has exact and clear mathematic result and more integrally reflects the performance** trait of whole observation value series.

HMM can be marked by  $\lambda=[M, \pi, N, A, B]$  , ‘M’ is the number of **possible corresponding observation value of every state, ‘ $\pi$ ’ original possibility distribution** vector, ‘N’ is the number of states in Markov chain, ‘A’ possibility matrix of state transfer, ‘B’ **possibility matrix of observation value, for continuous HMM, ‘B’ is a group of existability**function of observed value.

There are three algorithms in HMM. The first one is Baum-Welch algorithm (**adjust the model parameters to increase the probability of the observation sequence** given the model  $\lambda$ ). The second is forward-backward algorithm (given the model  $\lambda$ , compute the probability of the observation sequence O). The third is Viterbi algorithm (given the model  $\lambda$  and the observation sequence O, choose an optimal state sequence)

### 5. PROPOSED METHOD

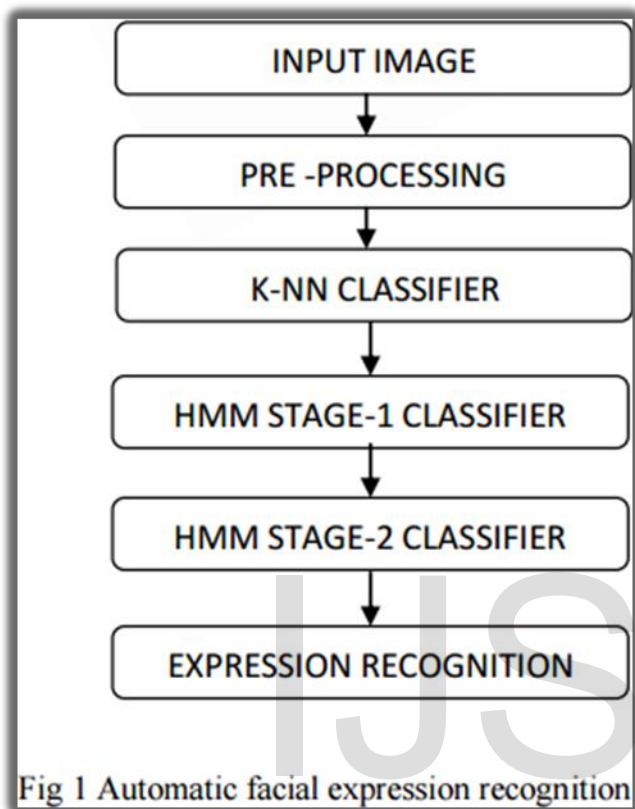
The block diagram of the automatic facial expression recognition system is shown in Figure 1. HMMs, commonly used tool for automatic speech recognition, are utilized in this work as a classification **approach. The methods we propose automatically recognize the various facial expressions,** using a multi-level HMM structure.

#### 5.1 Reprocessing

##### (1) Feature Extraction:

Feature extraction is a process that possess **simplifying the amount of resources required to describe a large** set of data accurately and efficiently. Performing analysis of complex data is one of the major problems stems from the number of variables involved in the process. Analysis with a large numbers and variables generally requires a large amount of memory and a classification algorithm **which over fits the training sample and generalizes poorly to new samples.** Feature extraction is a general term for methods of constructing combinations of variables to get around **these problems while still explaining the data with sufficient accuracy.** **Facial Feature Extraction (FFE) method is proposed to solve number of**

**things: AAM is used to detect some feature points of the face automatically, then the center of eyes, mouth are calculated, lastly the local texture information, global information and shape information are integrated together to form the feature vector**



**(2) Dimension Reduction:**

Dimension reduction is a process of reducing the number of **variables under observation. Principal Component Analysis (PCA) is guaranteed to find the dimensionality of the manifold and produces a compact representation.** By moving the points we can adjust the Model on the face image. That is, by adjusting the size, length and width of AAM model points we can fix points on image. There are 68 AAM points, which are considered and place on image. After marking these points, it is like a mesh network. These points are set by using steepest descent method.

**5.2 KNN Classification**

We propose to use k-NN algorithm because it is simple to use and can conveniently output a very limited set of discrete values for each sequence of units. These outputs form the observed sequences which are used in input **to the paired HMM in the second stage. The first stage utilizes N k-NN classifiers differing in their k value.** This allows the

system to take into considering different degrees of variability in features between levels of an affective dimension.

**5.3 HMM Stage1 Classification**

Each classifier of the first stage is paired with an HMM in second stage. For each HMM, the observed sequence is based on the decision values output by its paired first stage classifier. HMM classification is processed. After that its result is stored in workspace. It will be used in next stage classification.

**5.4 HMM Stage 2 Classification**

In this decision fusion stage, the Markov chain property of temporal relationships in the sequences is further taken into account through the use of another HMM, that fuses the outputs from the preceding stage. In the final stage of HMM classification, desired result are obtained. For result data are collected from first stage and Second stage classification.

**6. Results**

We have tested our result with the facial expression database. This database contains 240 images of eight facial expressions (angry, annoyed, disgusted, grumpy, happy, natural, sad and surprise). From the database we have tested 15 images for expression angry, annoyed, happy, natural and sad and surprise and 7 images from disgusted and grumpy expression.

**7. Conclusion**

In this paper, we have presented an automatic facial expression recognition system utilizing Matlab 2016, which adopts the AAM technique to extract facial feature also KNN+HMM classify the facial expression emotion. A three stage classification approach is used. The output of a first-stage classification is used as observation sequences for a second stage **classification, modeled as a HMM based framework. The k-NN will be utilized for the first stage classification.** A third classification stage, a decision fusion tool is then used to boost overall performance.

**8. References**

- 1.P. Ekman and W.V. Friesen, Facial Action Coding System:Investigator’s Guide, Palo Alto, CA: Consulting PsychologistPress, 1978.
- 2.K. Mase, “Recognition of facial expression from opticalflow,” IEICE Transactions, vol. E74, pp. 3474-3483, October 1991.
- 3.T. Otsuka and J. Ohya, “Recognizing multiple persons faciaexpressions using HMM based on automatic extraction ofsignificant frames from image sequences,” in Proc. Int. Conf. on Image Processing (ICIP-97), (Santa Barbara, CA, USA), pp. 546-549, Oct. 26-29, 1997.

4. Y. Yacoob and L. Davis, "Recognizing human facial expressions from long image sequences using optical flow,"
- 5.M. Rosenblum, Y. Yacoob, and L. Davis, "Human expression recognition from motion using a radial basis function network architecture," IEEE Transactions on Neural Network, vol.7, pp.1121-1138, September 1996.
- 6.L.S. Chen, "Joint processing of audio-visual information for the recognition of emotional expressions in human-computer interaction," PhD dissertation, University of Illinois at Urbana-Champaign, Dept. of Electrical Engineering, 2000.
- 7.Mehrabian, A." Communication without words", Psychology Today vol.2,no.4, pp.53-56,1968. P. Ekman. Strong evidence for universals in facial expressions: a reply to Russell's mistaken critique. Psychology Bulletin, 115(2):268-287, 1994.
- 8.B. Fasel and J. Luetttin. Automatic facial expression analysis: a survey. Pattern Recognition, 36(1):259 - 275, 2003. J. J.-J. Lien, T. Kanade, J. F. Cohn, and C.-C. Li. Detection, tracking, and classification of action units in facial expression. Robotics and Autonomous Systems, 31(3):131-146, 2000.
- 9.Xuefeng Jiang "A facial expression recognition model based on HMM" IEEE 2011
- 10.Pu Xiaorong ; Zhou Zhihu ; Tan Heng ; Lu Tai Partially occluded face recognition using subface hidden Markov models IEEE 2012.
- 11.Lahbiri, M. ; Fnaiech, A. ; Bouchouicha, M. ; Sayadi, M. ; Gorce, P. "Facial emotion recognition with the hidden Markov model" IEEE 2014.

IJSER