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Facial Expression Recognition using Active Shape Models and Support Vector Machines

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***Abstract*— Facial Expression Recognition is the subsequent step after Face Detection and Real time recognition of facial expressions is a challenging task. Various technologies of Facial Expression Recognition has been experimented by researchers over the past few years. In this paper, it has been observed the accuracy and effectiveness of employing Active Shape Models and Support Vector Machines to achieve higher recognition rates. Active Shape Model is used to locate the facial feature deformations of a face detected by using Haar classifiers. These facial coordinates are fed into a Support Vector Machine and the trained system classifies the expressions into seven categories, namely happy, sad, anger, disgust, fear, surprise and neutral. The system was tested on JAFFE Database and Cross Validation had been used as a mechanism for analysing the results of the experiment.**

***Keywords*— Feature Extraction, Machine Learning, Active Shape Models, Support Vector Machines**

I. Introduction

Facial expressions convey non-verbal cues, which play an important role in interpersonal relations. Facial Expression Recognition is a challenging task since it involves face detection, facial landmark points detection and also performing machine learning to identify variations in facial expressions. According to [2], although humans recognize facial expressions virtually without effort or delay, reliable expression recognition by machine is still a challenge.

Facial expressions play a vital role in human communication. Thus identifying facial expressions has an utmost importance. Referring [7], Mehrabian has reported that facial expressions have a considerable effort on a listening interlocutor; the facial expression of a speaker account for about 55% of the effect, 38% of the latter is conveyed by voice intonation and 7% by the spoken words." This implies that the facial expressions form the major modality in human communication.

Face Detection is the preliminary step in expression recognition. According to [12], face detection has being classified into 3 groups, namely

- Knowledge Based Methods
- Feature Invariant Approaches
- Template Matching Methods

However, [10] discusses three initial mechanisms used in face detection

- Novel image representation named Integral image [8]
- Creating a classifier by selecting a small number of important features using AdaBoost [3]
- Combining more complex classifiers in a cascade structure by focusing attention on promising regions of the image [1]

for the development of a real time face detection classifier. It could be seen this is a more efficient method for face detection since it was implemented adopting three renowned contributions in Computer Vision. Furthermore the statement in [9], "Of all the face detectors currently in use, the one introduced by Viola and Jones is probably the best known and most widely used" further confirms this opinion.

Hence, it was decided to employ Viola Jones face detection Haar classifier for face detection.

Active Shape Models enable users to mark landmark points thus a model of the image could be created. Active Shape Models manipulate a shape model to describe the location of the structures in a target image.

Support Vector Machines (SVMs) are based on the results of statistical learning theory carried out by Vapnik. SVM maps feature vectors into a higher dimensional space and classify data using linear algebra by employing a kernel function. Then an optimal hyper plane that fits into the training data is created. In a linear classification the margin between the separating hyper plane and the nearest feature vectors from both classes is maximal. The feature vectors closest to the hyper plane are called "support vectors".

SVM has evolved from sound theory to implementation and experiments while Neural Networks has followed a more heuristic path, from application and extensive experimentation to theory [11]. Moreover it states that SVM has achieved practical learning benchmarks in digit recognition, computer vision and text categorization.

Furthermore SVM has been adopted as the classification technique by many researchers in computer vision. None withstanding this, research conducted in [5] also has adopted SVM for classifying facial expressions in real time. They have used the coordinates of feature points as the input to a multi class SVM as discussed in the feature extraction section. Assuming the training data is $(g_1,l_1),\ldots,(g_N, l_N)$ where $g_j \in \Re^F$ $j = 1,\ldots,N$ the deformation feature vectors and $l_j \in \{1,\ldots,6\}$ $j = 1,\ldots,N$ are the facial expression labels of the feature vector. It constructs 6 (six facial expressions) two-class rules where the k-th function, $w_k^T \emptyset(g_i) + b_k$ separates training vectors of the class k from the rest of the vectors. Hence, there are 6 decision functions, all obtained by solving one SVM problem. 93.7% accuracy rate has been achieved with the Cohn-Kanade database. Moreover it indicates that the given accuracy is the highest reported in literature for Cohn-Kanade database up to 2005 according to their knowledge. Thus it proves that using SVM for classification was a driving factor for achieving a high accuracy rate as given.

Similarly reason in [6] is that SVM's ability to outperform ANN in a variety of applications was a factor considered in selecting SVM for their Real Time Facial Expression Recognition system. They have achieved an 86% accuracy rate for still images and 71.8% for person independent classification.

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