PERFORMANCE ANALYSIS FOR FACIAL EXPRESSION RECOGNITION UNDER SALT AND PEPPER NOISE WITH MEDIAN FILTER APPROACH

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ABSTRACT

Facial expression provides an important behavioural measure for studies of emotion, cognitive processes, and social interaction. Facial expression recognition has recently become a promising research area. In face recognition, the simple process of face recognition system should go through image data retrieval, face detection, facial feature extraction and face recognition. However, some researches focus on the part of face recognition system, such as face detection, face recognition, or algorithms dealing with certain drawbacks issues such as illumination, occlusion, noise, and angle. Thus, in this research we have considered the facial changes as represented by face emotions from JAFFE Database results for different noise levels. The proposed system consists of three modules. The first module read the images face of three different emotions such as happy, fear and surprise. Those images are flawed with different level of salt and pepper noise. Then filter is applied on the corrupted images with average and median filter. The second module constructs PCA that are responsible for feature extraction, while the third module extracts the features by processing the image and measuring dimensions of PCA using k-NN and NN. Using the proposed classifiers, some experimental results have been obtained. It is found that the highest percentage of accuracy is 71.43 % and 83.96 % for K-NN and NN classifier respectively.

ABSTRAK

Eksperisi mimik muka amat penting dalam kajian emosi, proses kognitif dan interaksi sosial. Eksperisi pengenalan muka menjadi topik kajian yang amat penting. Dalam system pengenalan muka proses pengenalan muka yang mudah, perlu melalui data ambilan, kenalan muka, ciri penekstrakan, dan pengenalan muka. Walaubagaimanapun pengkaji pengenalan muka, pengesan muka, terpaksa menghadapi masalah, pencahayaan, sudut, putaran dan gangguan. Maka kajian kami mengkaji emosi muka menggunakan JAFFE data berserta beberapa peringkat gangguan. Sistem yang dirancang terdiri dari tiga peringkat. Peringkat pertama membaca imej muka yang terdiri daripada tiga emosi seperti gembira, takut dan terkejut. Imej tersebut dietakkan dengan garam dan lada gangguan. Kami membuang gannguan tersebut dengan menggunakan penapis jenis purata dan nombor tengah. Kaedah kedua menggunakan prinsip komponen analisis (PCA) sebagai pengekstrak ciri. Peringkat ketiga menggunakan Jiran Terdekat K (k-NN) dan dan Rangkaian Neural (NN). Ketepatan yang paling tinggi ialah 71.43 % dan 83.96 % untuk K-NN and NN pengelasan

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LIST OF ABBREVIATIONS

EROS	Emotion Recognition System
FFNN	Feed Forward Neural Network
F-KNN	Fuzzy k-NN
HCI	Human Computer Interface
HSV	Hue, saturation, value
JAFFE	Japanese Female Facial Expression Database
k-NN	k- Nearest Neighbor
LDA	Linear Discriminate Analysis
MIC	Morphological Image Cleaning
NN	Neural Network
ORL	Olivetti Research Lab
PCA	Principal Component Analysis
PSNR	Peak signal-to-noise ratio

LIST OF SYMBOLS

M	Eigen-faces
Γ	images
φ	Average
Φ_i	Vector
C	co- variance
f	acquired image
u	orthonormal vectors
Ω	weight vector
M	Total number of pixels
N	Noise
N	Number of features
N	Number of Neighboorhood
x	Coordinate of x value
y	Coordinate of $y$value
v_{ij}	Weight between input and hidden layer
w_{jk}	Weight between hidden layer and output
x	Input data
$f(x)$	Activation function
Z_j	Hidden layer neuron
Y_K	Output layer neuron
δ_k	Error for each output neuron
δ_j	Error for each hidden neuron
i	Row Pixel
j	Column Pixel
s	Second
s	Signal
Σ	Covariance
%	Percentage

CHAPTER 1

INTRODUCTION

1.1 Project Background

Facial expression provides an important behavioural measure for studies of emotion, cognitive processes, and social interaction. Facial expression recognition has recently become a promising research area (Leonardo et al., 2001; Ira Cohen et al., 2003; W. A. Felenz et al., 1999; Alaa Eleyan & Hasan Demirel (2007); Jasmina Novakovica et al., 2011; P.Latha et al., 2013). Its applications include human-computer interfaces, human emotion analysis, and medical care and cure, thus many well-known algorithms are created in the recent years Andrea (F. Abate et al., 2007).

In face recognition, the simple process of face recognition system should go through image data retrieval, face detection, facial feature extraction and face recognition. However, some researches focus on a part of face recognition system, such as face detection, face recognition, or algorithms dealing with certain drawbacks issues such as illumination, occlusion, noise, and angle (Leonardo et al., 2001; Ira Cohen et al., 2003; W. A. Felenz et al., 1999; Alaa Eleyan et al., 2007; Jasmina Novakovica et al.,2011;). Even do some robust algorithm may overcome the limitation as discussed, another constraint was rise. Matthew N. Dailey and Garrison W. Cottrell thought that “Surprise” expressions are between “Happiness” and “Fear” expressions, due to their perceived similarity. They agreed that these circumstances make it uneasy to discriminate (Dailey, M.N. et al., 2002).

Some of the hybrid matching method, both holistic and local features are used to overcome this matter. A feature combination scheme for face recognition by fusion of global and local features was presented in (Y. Fang at al., 2002). A fully automatic system for face recognition in databases with only a small number of samples was presented by (Yan et al., 2004). Global and local texture features were extracted and used in the recognition with different database such as the Japanese Female Facial Expression (JAFFE) database, Olivetti Research Lab (ORL) and YALE database (Jasmina Novakovica et al., 2011; P.Latha et al., 2013; W. Zhao et al., 2003; Erik Hjelmas (2001)).

This work introduced a different approach for face recognition. Images were corrupted with salt and pepper noise. The performance is then compared with the original JAFFE face database. This new trial task will generalize the result of feature selection in test phase with median filter and linear filter. For further demonstration, the obtained results from the trial, will be compare with the simple PCA k- Nearest Neighbor (k-NN) and PCA Neural Network (PCA-NN) that are used as feature extraction and classification respectively.

1.2 Problem Statement

In real environment, images are from nature scenes instead of from pre-collected images, which there are many variant factors, such as complex background noise, lightening condition, poses variation, and other factors (W. Zhao et al., 2003), under the nature scenes; and most of the researches only deal with certain issues. Furthermore, most experiments are by software simulation on a computer. However, for image sequences, the image processing tasks are computational expensive (Erik Hjelmas 2001), which the implementation cannot be put into a real environment to test. As a result, in this study salt and pepper noise is added in the image. Furthermore, a simple PCA feature extraction, feed forward neural network and k-nearest neighbor are employed in order to obtain the comparison performance between those two experiments.

1.3 Objective

The objective of this research is as follows.

1) To study the performance of median filter, linear filter with salt and pepper noise.
2) To extract Principal Component Analysis (PCA) features from the Japanese Female Facial Expression (JAFFE) database.
3) To classify surprise, happy and fear emotion with feed forward neural network and k-nearest neighbour.

1.4 Scope

There is a lack of commercial technologies under the generic topic of monitoring emotion facial expression. This answers too many of the misjudged problems. In this research, one approach to Human Computer Interface (HCI) for detecting emotion is presented. In this dissertation, the design and development of intelligent monitoring system for facial expression analysis of JAFFE database is proudly presented. The database contains 213 images of 7 facial expressions (6 basic facial expressions + 1 neutral) posed by 10 Japanese female models. Each image has been rated on 6 emotion adjectives by 60 Japanese subjects. This research, study is only limited to JAFFE database. In addition, a study is also made on varied noise levels on the JAFFE database. The proposed monitoring scheme is to be robust within selected levels of noise on the face database.

1.5 Expected Output

This research focused on feature representation and expression classification schemes to recognize three different expressions, such as suppprise, happy and fear in the Japanese Female Facial Expression (JAFFE) database. This study consists of three main stage. The first stage implements several preprocessing algorithm such as grayscale image, adding noise and filtering. Secondly, feature extraction such as Principal Component Analysis (PCA) was adopted. The third module extracts the PCA feature of faces with feed forward neural network and k-nearest neighbor. The comparison performance between those two classifiers were studied.

1.6 Dissertation Outline

The chapter of this dissertation largely follows the order in which the work was done, the scope and objective of the work is presented in this chapter. The second chapter is the literature review encompassing most of the history of image processing techniques. This chapter also describes some existing applications that have been developed using some of the most common techniques and a critical analysis has been made on them. In addition, some new performance evaluation methods are introduced to clarify how these methods are quantified amongst the different approaches using the most commonly used benchmarks. Third chapter presents the experimental setup of design, development and testing of the proposed system for the (HCI). In Chapter four the software design and development of the system, are briefly discussed. The fifth chapter encompasses the outcome of experimental analysis and in the final chapter, a conclusion on performing experiments and acquiring the results are derived. Conclusions are made in terms of advantages, disadvantages, limitations, dependencies and affecting factors. This chapter also recommends future suggestion for advancements of this work.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The processing of face images receives more and more interest in the field of image analysis. The task of facial image analysis includes the face localization, the recognition of human faces and the analysis of mimics or facial expressions. Face localization is needed as a pre-processing step for many applications such as object-orientated image coding, security control, expression recognition and intelligent man-machine interaction. Various methods for face detection have been documented in the past by Kirby & Sirovich (1990); Turk & Pentland (1991). The methods can roughly be divided into four classes, according to Yang et al. (2002).

a) Knowledge-Based Methods are rule-based approaches which try to model intuitive knowledge of facial features. In general, these facial features have to be extracted first by a pre-processing step.

b) Feature Invariant Methods utilize invariant (scale, orientation, and lighting) features for face detection. One of the most frequently used features for this purpose is skin colour.

c) Template Matching Methods use manually defined patterns of the whole face or the facial features which are matched against the input image.

d) Appearance Based Methods try to find the relevant characteristics of face images by machine learning from a training set. Often, face tracking systems exploit a single localization technique to locate and track the users' face. While a modality is able to track a user face under optimal conditions, it may suffer from typical failures in unconstrained conditions.

To arrive at more robust face detection under a number of constraints such as out of plane rotation, presence or absence of structural components, facial expressions, occlusion and illumination level, indicate a difficult research effort. Many researchers have documented their outcome in terms of certain constraints applied in face detection methods. However, no one has considered the above constraints all at a time, in face detection.

Many research demonstration and commercial applications have been developed from these efforts. The first step of any face processing system is that of detecting the locations in images where faces are present. After location of the face had been determined, the features of face such as eye, mouth, chin, nose, skin and ear are separated based on requirements. In particular, such techniques can be used to develop objective emotion detection. The performance parameters under study are different noise and filters. The design parameters such as accuracy and detection rate using different classifiers are discussed in Chapter 5.

2.2 Types of Face Detection

Among the most successful applications of image analysis and understanding, face detection has recently received significant attention, especially during the past decade. Applications of face detection technology (FDT) range from static, controlled-format photographs to uncontrolled video images, posing a wide range of technical challenges requiring an equally wide range of techniques from image processing, analysis, understanding and pattern recognition.

One can broadly classify FDT schemes into two groups depending on whether they make use of static images or video. A general problem statement of machine recognition of faces can be formulated as follows: Given still or video images of a scene, identify or verify one or more persons in the scene using a stored database of faces. Available collateral information such as race, age, gender, facial expression or speech may be used in narrowing the search (enhancing recognition) according to Zhou et al. (2003). The solution to the problem involves segmentation of faces (face detection) from cluttered scenes, feature extraction from the face regions, recognition, or verification.

In identification problems, the input to the system is an unknown face, and the system reports back the determined identity from a database of known individuals; whereas in verification problems, the system needs to confirm or reject the claimed identity of the input face.

2.2.1 Knowledge Based Methods

It is easy to come up with simple rules to describe the features of a face and their relationships. For example, a face often appears in an image with two eyes that are symmetric, a nose, and a mouth (Yang & Huang 1994) as shown in Figure 2.1. The relationships between features can be represented by their relative distances and positions in the face image. Facial features in an input image are extracted first and face candidates are identified based on the coded rules. A verification process is usually applied to reduce false detections.

Yang & Huang (1994) introduced a knowledge based method for detecting faces in three stages or levels. At the first stage, high level rules are applied. In the second stage, the histogram and equalization methods are used for edge detection and finally in the third stage eyes and the mouth features are derived.

Theoretically, it seems simple to develop rule based face detection but in practice these methods are not very useful. If one tries to define detailed rules for a face, there may be a number of faces satisfying the rules. Unfortunatley, there are few rules which are unable to describe the face exactly. Generalisation of these methods to moving face images and faces with varied poses also decrease the accuracy and performance of the face detection methods Kotropoulos & Pitas (1997).

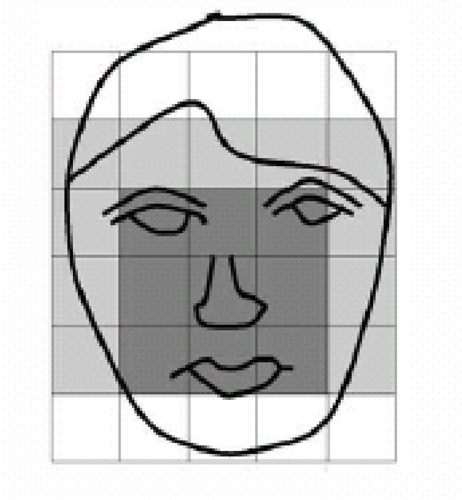

Figure 2.1: A typical face used in knowledge-based top-down methods: Rules are coded based on human knowledge about the characteristics (e.g., intensity distribution and difference) of the facial regions (Yang & Huang 1994).

2.2.2 Feature Invariant Approaches

It is also known as bottom up approach by Yow & Cipolla (1997). The main focus is to find the invariant features of the face in the first step. The results are collected by integrating them. A number of methods have been proposed by a number of researchers based on facial feature, texture, skin colour and their combinations. Edge detection, segmentation and histogram are commonly used for extracting facial features, textures, skin colour and others from the images.

Leung et al. (1995) have proposed face detection by matching labelled graph. Gaussian filters and distribution distance are used. The initial step is to localise the facial feature locations. Five facial features like two eyes, two nostrils and nose are considered. Mouth junctions are considered as necessary to form a face. Feature based methods are not successful when faces have different poses with varied illuminations and occlusion with other objects. Figure 2.2 illustrates a face model by Yow & Cipolla (1997) as shown below.

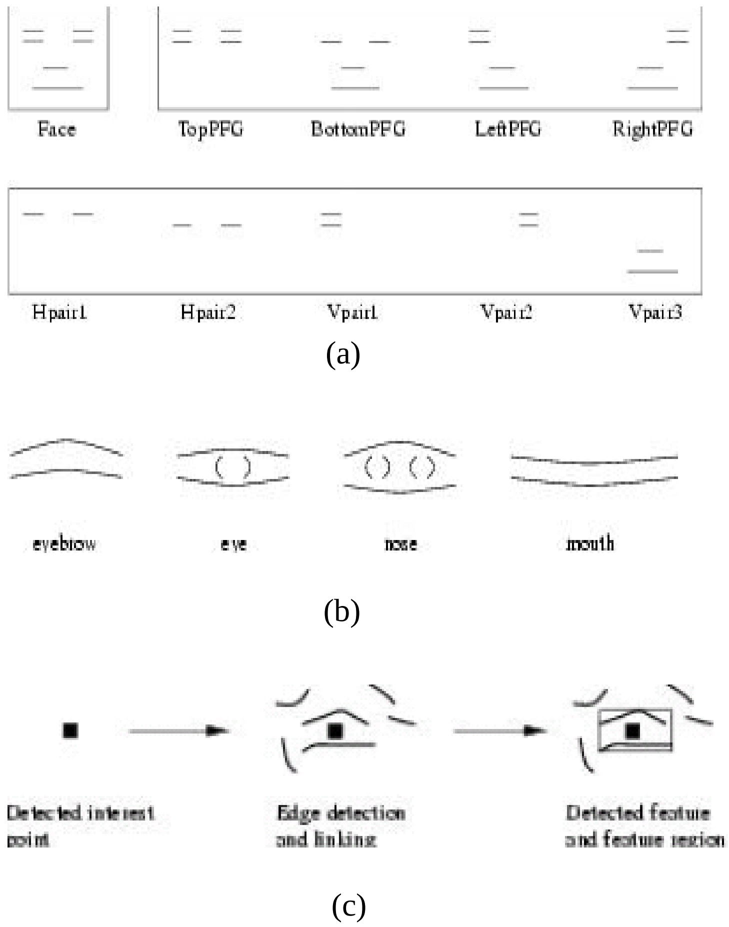

Figure 2.2: (a) Yow and Cipolla model a face as a plane with six oriented facial features (eyebrows, eyes, nose, and mouth) [179]. (b) Each facial feature is modeled as pairs of oriented edges. (c) The feature selection process starts with interest points, followed by edge detection and linking, and tested by a statistical model (Yow & Cipolla 1997).

2.2.3 Template Matching

In template matching, a standard face pattern (usually frontal) is manually predefined or parameterized by a function (Craw et al., 1992). Given an input image, the correlation values with the standard patterns are computed for the face contour, eyes, nose, and mouth independently. The existence of a face is determined based on the correlation values. This approach has the advantage of being simple to implement. However, it has proven to be inadequate for face detection since it cannot effectively deal with variation in scale, pose, and shape. Multiresolution, multiscale, sub templates, and deformable templates have subsequently been proposed to achieve scale and shape invariance by Yuille et al. (1992).

A number of methods have been proposed to overcome the variations in poses and illumination. Sinha (1994) has used a set of image invariants to describe the face pattern. The brightness of different parts of the face such as eyes and nose, changes while illumination conditions. This method calculates the pair wise ratios of brightness and projected directions Yang et al. (2002). A face is localised by satisfying all conditions for dark and bright regions. Figure 2.3 illustrates 23 defined relations for a face template as shown below.

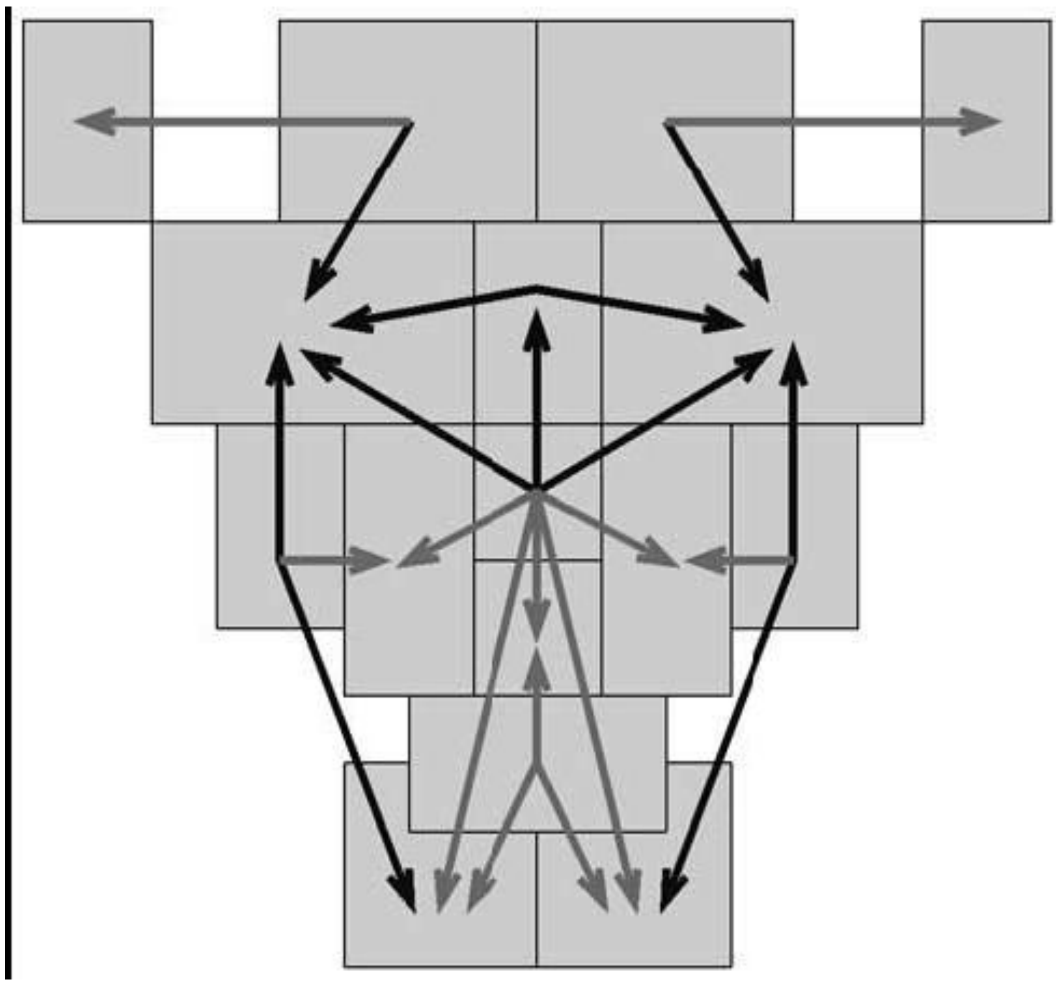

Figure 2.3: Face template for face localization (Sinha, 1994).

However it is hard to define all templates for the faces. Therefore, these methods are not successful in varied poses and illumination levels.

2.2.4 Appearance Based Method

The appearance based methods have gained a considerable attention during the last few years due to their accuracy and efficiency. However the template based methods require templates as learnt by the computer system. Machine learning techniques though complex are widely used for learning face and non-face classes. All appearance based methods have common properties like classification of face and non-face classes, pre-processing, learning and post processing of the images by Yang et al. (2002).

One approach in appearance-based methods is to find a discriminate function (i.e., decision surface, separating hyper plane, threshold function) between face and non-face classes. Conventionally, image patterns are projected to a lower dimensional space and then a discriminate function is formed (usually based on distance metrics) for classification by Turk & Pentland (1991) or a nonlinear decision surface can be formed using multilayer neural networks by Rowley et al. (1998). Recently, support vector machines and other kernel methods have been proposed. These methods implicitly project patterns to a higher dimensional space and then form a decision surface between the projected face and non-face patterns by Osuna et al. (1997) and Park et al. (2006).

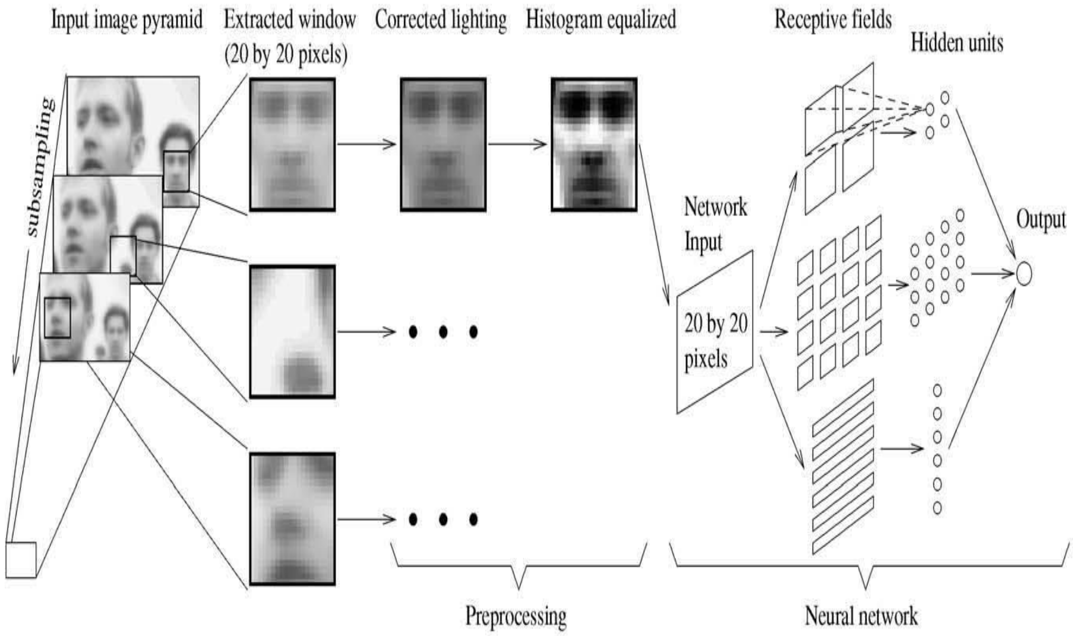

Figure 2.4: System diagram of Rowley's method. Each face is preprocessed before feeding it to an ensemble of neural networks. Several arbitration methods are used to determine whether a face exists based on the output of these networks (Rowley et al. 1998)

2.3 Recent Works

Ko et al. (1999) uses complete graph matching from threshold images. That is, after labelling the binaries image that is separated by a proper threshold value, the algorithm computes the similarity between all pairs of objects. After that, the two objects that have the greatest similarity are selected as eyes.

A framework for automatic initialization using colour predicates and connected component algorithms was described by Smith et al. (2000). It relies on optical flow and colour predicates to robustly track a person's head and facial features. The system classifies rotation in all viewing directions, detects eye/mouth occlusion, detects eye blinking and recovers the 3D gaze of the eyes.

Zhang & Lenders (2000) approach an effective and fast localization of the face and eye regions. There are two stages; the first stage locates the eye region roughly. In the second stage, eye edge contour searching directed by knowledge is introduced in detail. Regional image processing techniques are also described in the second stage. The algorithm employed in the second stage is restricted to application just in this region. This approach reduces the complexity of features localization in the first stage and improves the reliability in the second stage.

Sirohey & Rosenfeld (2001) employs Gabor wavelets to detect the edges of the eye away from the corners of the eye. At an appropriate scale and orientation, filtering with a single Gabor wavelet gives a prominent response to the corresponding pattern of intensity variations in the image.

Lin & Ming (2001) develops a real time system for eye detection and tracking in video sequences. The HSI colour model is used to extract skin-colour pixels. The same types of pixels are gathered by a region-growing algorithm and the maximum area of this region is selected as the face candidate. Furthermore, a Face-Circle Fitting (FCF) method is proposed to confirm the extracted face region. Once the face is detected, a Dark-Pixel Filter (DPF) is used to perform the eye detection and tracking. The proposed system has been implemented on personal computer with a PC-camera and can perform eye detection and tracking in real-time. The correct eye identification rate is high during the actual operation.

Perez (2001) proposes a non-invasive interface for eye tracking, built into four stages. These include: coarse and fine face detection, finding the eye region of maximum probability, mapping of the pupil/iris location and pupil/iris detection. Using frontal face images obtained from a database, the probability maps for the eye region are built.

Lin & Sengupta (2001) presents a colour and gradient maps of the face. These maps are used in combination with other image processing techniques to detect the eyes, nose tip and mouth of the user. Using novel methods of eye and mouth region tracking, the eye corners and mouth centroid points can be continuously tracked in real time. The coordinates of these points serve as inputs for computing the 3D posture of the face.

Tan et al. (2002) presents a method for estimating eye gaze direction, which represents a departure from conventional eye gaze estimation methods, the majority of which are based on tracking specific optical phenomena like corneal reflection and the Purkinje images Sibert et al., (2001). By employing an appearance manifold model, instead of using a densely sampled spline to perform the nearest manifold point query, the original set of sparse appearance samples had been retained and linear interpolation among a small subset of samples had been used to approximate the nearest manifold point. The advantage of this approach is that, only storing a sparse set of samples can be a high dimensional vector that retains more representational accuracy than short vectors produced with dimensionality reduction methods.

Kapoor & Picard (2002) tracked using the red eye effect by an infrared sensitive camera equipped with infrared LEDs. Templates are used to parameterize the facial features. For each new frame, the pupil coordinates are used to extract cropped images of eyes and eyebrows. The template parameters are recovered by PCA analysis on these extracted images using a PCA basis, which was constructed during the training phase with some example images.

Hua et al. (2003) use both colour information (skin colour and hair colour), and edge information (edge strength and edge orientation) and detects the minimum region (hereafter exact face region) that contains all facial organs by applying the integral projection method. Finally, the facial feature points are extracted from each facial organ by using the Susan corner detector (Canny, 1986).

Jurgen & Peter (2003) have developed an automatic method for face feature detection using synthetic deformable templates. The algorithm does not require a training procedure or parameter set. It can be applied to images with different sizes of the face area. Iris-pupil centers, mouth corners and mouth inner mouth line are robustly found with high accuracy from one still image. This automatic process allows to setting up an advanced video conference system that uses 3D head models of the participants to synthesize new views.

Fathi & Manzuri (2004) finds the face region using the features of skin color; and then the location of eye is determined by applying three cues on the detected face region. The first cue is the eye intensity and color, due to the fact that the intensity of each eye region is relatively low and its color differs from the color of surrounding skin. The second cue is based on the position and size of eyes. The third cue is based on the convolution of the proposed eye-variance-filter with the eye-window candidates. After finding the precise location of the eye, it is tracked in a finite search window.

Zheng et al. (2004) detected the pupil centre in H channel of HSV colour space; the pupil radius is estimated and refined. Secondly, eye corners are localized using eye-corner filter based on Gabor feature space. Finally, eyelid curves are fitted by spline function. The new algorithm has been tested on Shanghai Jiao Tong University Library (SJTU) database and on some other pictures taken from the web. The experimental results show that the algorithm has high accuracy and is robust under different conditions.

Ji & Lan (2004) has proposed a method that uses active IR illumination to brighten subject's faces to produce the bright pupil effect. Each pupil is surrounded by the eye region, has a unique intensity distribution and appears different from other parts of the face. The appearance of an eye can therefore be utilized to separate it from non eyes. Finally support vector machine (SVM) classifier analyzed the locations of the remaining binary blobs to the dark pupil images.

Peng & Chen (2005) presents a robust eye detection algorithm for gray intensity images. The idea of their method is to combine the respective advantages of two existing techniques, the feature based method and the template based method, and to overcome their shortcomings. Results of experiments to the faces without spectacles show that the proposed approach is not only robust but also quite efficient.

Wang (2005) proposes probabilistic classifier to separate regions of eyes and non-eyes. A powerful discriminate feature instead of rectangular Haar features is employed to improve eye detection accuracy. The results for automated detection manually compared to marked points between Principal Component Analysis (PCA) and Linear Discriminate Analysis (LDA) recognition and manually marked points.

Kuo et al. (2005) proposes improved feature extraction algorithms for mouth, eyes and eyebrows using a combination of methods including balloon colour snakes, adaptive colour threshold, deformable templates, light balancing, shadow removal and k-means clustering.

Wang & Yin (2005) presents a novel approach for eye detection without finding the face region using topographic features. A terrain map, which denotes the terrain type of each pixel, is derived from the original image by applying topographic classification approach. From the terrain map, eyes usually locate in the region around the pit-labelled pixels because of their intrinsic reflectance characteristic. The distribution of pit-labelled candidates were been described by the Gaussian Mixture

Model based probabilistic model. The eye pair detection problem is transformed to maximizing the probability that the selected candidate pair belongs to the eye space.

Park et al. (2006) proposes a simple illumination compensation algorithm and a novel way of measuring of eyelid movements. In order to estimate the performance of the proposed methods, eye region (obtained by the eye corner filter) is classified into eye groups and non-eye groups by hand for the configuration of cascaded SVM respectively for open eyes and for closed eyes classifiers.

Su (2006) proposes a hybrid method for eye detection. In this method, three different projections are computed first and then eye region is located by checking whether the weighted sum of these three projections is above a specified threshold. Finally, the p-tile algorithm transforms the eye block into a binary image such that the pupils can be retained and other regions are discarded as most as possible. The value of the p-parameter was experimentally found .Then the FCM (Fuzzy C-Means) algorithm with p-parameter is used to locate the pupils. Each cluster center corresponds to the location of a pupil.

Xingming (2006) presents an integrated eye detection algorithm to overcome some limitations. First, an effective illumination normalization method is designed to overcome variable lighting condition, and then a pose independent Adaboost method to detect faces is employed for any detected face image. A feature point extraction method is used to extract face feature candidates. In the end, a heuristic rule is used to filter non-eye pair candidates, and the Support Vector Machine, (SVM) is employed to verify eye-pair. Experiment results indicate that this approach has an excellent performance under variable illumination and various face pose conditions.

Jung & Yoo (2006) applies SQI (self quotient image) to the face images to reduce illumination effect. Then, by using the gradient descent, which is a simple and fast computing method, the eyes were extracted. Finally, the classifier which has been trained by using AdaBoost algorithm selects the eyes from all of the eye candidates.

Qayyum & Javed (2006) deals with fusion of motion and colour cues to classify skin colour. The classified skin colour is passed to morphological operations (recurring erosion and dilation) to remove the noise and holes from the classified skin regions. The contiguous regions are extracted using union-structure component labelling algorithm and scale normalization is applied by nearest neighbour interpolation method. Using the aspect ratio of width and height size, Region of Interest (ROI) is obtained and then passed to face/non-face classifier. Notch (Gaussian) based templates are used to find circular darker regions in ROI keeping the fact in view that face texture is coarser in nature due to eyes, mouth and nostril darker portions. Various sizes of notch based templates are matched with ROI using Normalized Cross Correlation (NCC), to get matching score (for the classification of input region as face/non-face). The visual guidance reduces the search space and helps to detect and track skin region whereas each region is categorized as face/non-face using a face/non-face classifier. The classified face region is handed over to facial feature localization phase, which uses YCbCr eyes and mouth mask for face feature localization.

Nasiri et al. (2007) used colour characteristics way to detect eyes. Special colour space, YCbCr components give worthwhile information about eyes. Two maps according to its components were been merged together to obtain a final map. Candidates are generated on this final map and extra phase to determine suitable eye pair. The extra phase consists of flexible thresholding and geometrical tests. Flexible thresholding makes generating candidates more carefully and geometrical tests allow proper candidates to be selected as eyes.

Akashi et al. (2007) used template matching with genetic algorithm, in order to overcome these problems. A high speed and accuracy tracking scheme using Evolutionary Video Processing for eye detection and tracking is proposed. The generality of this proposed method is provided by the artificial iris template used.

Hansen & Hammoud (2007) proposed a log likelihood-ratio function of foreground and background models in a particle filter based eye tracking framework. It fuses key information from even, odd infrared fields (dark and bright pupil) and their corresponding subtractive image into one single observation model. An eye detector relies on physiological infrared eye responses and a modified version of a cascaded classifier.

Oravec et al. (2008) exploits colour properties of human skin to localize image regions face candidates. The facial features extraction is performed only on reselected face-candidate regions. Likewise, for eyes and mouth localization colour information and local contrast around eyes are used. The face boundary is determined using gradient image and Hough transform.

Kim et al. (2008) proposed an eye detection method exploiting Zernike moments with SVM. The method utilizes the magnitude of Zernike moments to represent eye/non-eye patterns by employing the SVM as a classifier. Due to the rotation-invariant characteristics of the magnitude of Zernike moments, the proposed method can detect eyes well even if a face has been rotated.

Zhang (2008) proposed and developed a real-time eye detection method using support vector machine (SVM) with Hu invariant moment. In this method, the binarization and the heuristic rules to screen the contour are first used to find the region of interest (ROI) of the eye. Then the Hu invariant moments of the ROI are calculated and further used in developing the SVM model.

Mamun (2009) approached a novel method for eye detection which exploits the flexibility of deformable template and uses genetic algorithm to match the template for eye detection. Implementation of genetic algorithm reduces the time required for template matching than conventional template matching algorithm. Moreover the method does not require any prior knowledge about eye geometry or potential eye location tags on facial image. The proposed scheme can easily be implemented in real-time as it can detect eye in few genetic epochs.

Rajpathak (2009) proposed a novel technique for eye detection using color and morphological image processing. It is observed that eye regions in an image are characterized by low illumination, high density edges and high contrast as compared to other parts of the face. The method proposed is based on assumption that a frontal face image (full frontal) is available. Firstly, the skin region is detected using a color based training algorithm and six-sigma technique operated on RGB, HSV and NTSC scales. Further analysis involves morphological processing using boundary region detection and detection of light source reflection by an eye, commonly known as an eye dot. This gives a finite number of eye candidates from which noise is subsequently removed. This technique is found to be highly efficient and accurate for detecting eyes in frontal face images.

Richard Alan Peters (1995) introduced a new morphological image cleaning algorithm (MIC) that preserves thin features while removing noise. MIC is useful for grayscale images corrupted by dense, low-amplitude, random or patterned noise. Such noise is typical of scanned or still-video images. MIC differs from previous morphological noise filters in that it manipulates residual images – the differences between the original image and morphologically smoothed versions. It calculates residuals on a number of different scales via a morphological size distribution. It discards regions in the various residuals that it judges to contain noise. MIC creates a cleaned image by recombining the processed residual images with a smoothed version.

Meanwhile, J.J. Francis & G. de Jager (2008) provide a natural modification of the bilateral filter. The proposed filter is seen to provide a good compromise between detail preservation and removing image structures at the specified scale. Not surprisingly, the proposed filter performs better for “Salt and Pepper” noise as compared to additive Gaussian noise. The performance of the proposed and original filters is seen to be similar for Gaussian noise. It is clear that alternative kernels can provide a compromise between speed and performance for both the traditional and proposed the bilateral filters with PSNR. Influence from that, (D.Maheswari & V.Radha (2010); Mohamed Ghouse & M. Siddappa (2011) respectively, proposes median filtering technique and adaptive nonlinear filter for removing salt & pepper noise from various types of images. Both of them also employed PSNR to evaluate the performance of their proposed method.

On the other hand, Prachi C. Khanzode & S. A. Ladhake (2011) developed two-stage noise removal algorithm to deal with impulse noise. In the first stage, a two level noise removal procedure with Neural Network-based noise detection was applied to remove the noise cleanly and keep the uncorrupted information as well as possible. In the second stage, a fuzzy decision rule inspired by the HVS was proposed to classify pixels of the image into human perception sensitive and non sensitive classes. An NN is proposed to enhance the sensitive regions to perform better visual quality.

PCA is a powerful method and was employed as feature extraction in (Leonardo & Alessandro Treves (2001); W. A. Felenz et al.,1999; Alaa Eleyan & Hasan Demirel (2007); P.Latha et al., 2013). The results of the entire papers are quiet promising. Four facial expressions such as neural face, happy, sad and surprised from Yale Database were extracted with Principles component analysis (PCA) and tested with neuron network in Leonardo & Alessandro Treves (2001). However, Carnegie Mellon University database adopted other four facial expressions such as happy, angry, sad, and neutral with PCA and tested with Multi-layer perception was employed (W. A. Felenz et al., 1999). The PCA representation showed excellent classification and reconstruction performance on the training-set but does not allow generalizing to novel faces (W. A. Felenz et al., 1999).

Following study in Alaa Eleyan & Hasan Demirel (2007), Olivetti Research Labs (ORL) database with two features such as Principles Component Analysis (PCA) and Linear Discriminate Analysis (LDA) were employed. Then, two classifiers such as Euclidean Distance and Fast Forward Neuron Network (FFNN) are used. The result recognition performance of LDA-NN is higher than the PCA-NN among the proposed systems Alaa Eleyan & Hasan Demirel (2007). In (Jasmina Novakovica et al.,2011) , Japanese Female Facial Expression (JAFFE) database with seven facial expressions such as happiness, sadness, fear, surprise, anger, disgust and neutral were run with Neural Network and Karhunen-Loeve transform. Neural networks with PCA are effective in emotion recognition using facial expressions (Jasmina Novakovica et al.,2011) .

Various intelligent techniques were employed from (Alaa Eleyan & Hasan Demirel (2007); Jasmina Novakovica et al.,2011; Muhammad Naufal Mansor et al.,2011; Muhammad Naufal Mansor et al., 2012; Ahmad Kadri Junoh et al., 2012), and most of them prefer a simple, yet a prompt classifier such as k-nn (Muhammad Naufal Mansor et al., 2012; Ahmad Kadri Junoh et al., 2012). However some other put their trust in (Alaa Eleyan & Hasan Demirel (2007); Jasmina Novakovica et al.,2011) because of the high accuracy detection even do the processing time are crucial.

Thus, in this research, expression classification schemes to recognize three different facial expressions, such as surprise, happy and fear from the Japanese Female Facial Expression (JAFFE) databases are investigated suggest by (Dailey et al., 2002). This study consists of two experiments. Verily, to make the trial more difficult and to gain the robustness of the system, one of the experiments was corrupted with salt and pepper noise. Feature extraction such as Principal component analysis (PCA) was employed for both experiments suggest by M. Kirby & L.Sirovich . (1990). Finally the performance of the system was compare with feed forward neural network and k-nearest neighbor classifier (k-nn). Table 1 presents a summary of all the previous work discussed earlier.

Table 1: Summary of the Research Results

Author	Year	Method	Results	Advantages	Disadvantages
Ko et al.	1999	Complete graph matching + threshold images.	The computing time is within 0.2 (sec)	A satisfactory performance in both speed and accuracy.	Not both robust and fast
Paul Smith et al.	2000	Global Motion + color statistics	recognize all gaze directions >50%	It was tested under varying daylight conditions with good success	The system is not perfect and one problem that was noticed is that when the eyes close
Zhang & Lenders	2000	Regional image processing techniques	Effective and fast localization of the face and eye regions accuracy>80%	Reduces the complexity of features	Only tested for Yale Face Database
Sirohey & Rosenfeld	2001	Nonlinear filters + the edges	90% detection rate with	High accuracy	the detection rate was

			nonlinear filter + the edges		(80% on one dataset, 95% on another), without linear filter+ the edges
Lin & Ming	2001	HIS colour model+ Face-Circle Fitting (FCF) method+ Dark-Pixel Filter (DPF)	The correct eye identification rate is high during the actual operation. accuracy>80%	tracking in real-time	Control room
Perez	2001	coarse + maximum probability, mapping of the pupil/iris	tracking in real-time and high accuracy >80%	a non-invasive interface for eye tracking	Using only frontal face images obtained from a database
Lin & Sengupta	2001	Colour + gradient maps	tracking in real-time and high accuracy>80%	novel methods of eye and mouth region	Control room
Tan et al.	2002	appearance manifold+ linear interpolation	tracking in real-	more	Control room

			time and high accuracy>80%	representational accuracy	
Kapoor & Picard	2002	LEDs+ Templates+PCA	tracking in real-time and high accuracy>80%	more representational accuracy	Lack of images
Hua et al.	2003	Color information + edge + Susan corner detector	Effective and fast localization of the face and eye regions>80%	Reduces the complexity of features	Lack of images
Jurgen & Peter	2003	Synthetic deformable templates.	High accuracy >80%from one still image.	The algorithm does not require a training procedure or parameter set	Not a real time approach
Fathi & Manzuri	2004	features of skin color; + eye intensity + size of eyes+ eye-variance-filter	High accuracy>80% from one still image.	The algorithm does not require a training procedure or parameter set	Not a real time approach
Zheng et al.	2004	HSV colour +Gabor feature space.	High accuracy>80% and	Novel algorithm	Not a real time approach

			is robust under different conditions.		
Ji & Lan	2004	IR illumination +SVM	High accuracy>80% and is robust under different conditions.	Novel algorithm	Not a real time approach
Peng & Chen	2005	feature based method + the template based method	High accuracy from one still image.	robust but also quite efficient	Only good at faces without spectacles
Wang	2005	PCA+LDA	High accuracy>80%	Improve eye detection accuracy	manually marked points
Kuo et al.	2005	Balloon colour snakes+ adaptive colour threshold+ deformable templates +light balancing+shadow removal + k-means clustering.	High accuracy>80%	improved feature extraction	High time process
Wang & Yin	2005	Topographic features+ Gaussian Mixture Model +based probabilistic model.	High accuracy>80%	novel approach for eye detection	Not a real time approach

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