

# Moment Invariant based on Master Eye Block for Face Identification

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**Abstract**— Face identification is one of current biometrics techniques research that receive a great deal of concentration over last period because this application is needed in many vital applications like in security and surveillance field, in identity authentication and image database investigations, also in other domains. In this paper, a new face identification system is presented to identify face image in front view, left and right orientations, more than one expression. The framework of proposed system passes through two phases: the training phase and identification phase. The two phases sharing the same stages of the system (face detection, eye detection, edge detection and feature extraction). In this work features vector that represent the face attributes consists of seven moment invariant values obtained by applying moment invariant on master eye block. Probabilistic neural networks (PNN) have been used to make a decision in matching stage; the system was tested over a dataset collected from 30 volunteers, where 10 images for each person were collected in different poses, expressions and orientations. The achieved training rate was 100%, while the achieved recognition rate was 100% in case of front view, 68% in case of right rotate, 69% in case of left rotate and 79% is average rate.

**Index Terms**— Face Identification, Moment Invariant, Probabilistic Neural Network.

## 1 INTRODUCTION

From the 1989, the research in this subject has increased. This kind of biometric has several advantages over other biometric applications, such as, most of these applications need certain action by person; to place his/her hand or finger on specific device, or to stand in a fixed place front of a camera without any movement for iris or retina recognition. In face identification the process can be done without any specific action. Also, the image can be acquired from a distance by a camera there is no participation part of the person. This is beneficial for security and surveillance field. One problem of data acquisition in biometrics applications depend on hands or fingers can be useless if there is any damaged like bruised or cracked, also using the same device to capture biological characteristics potentially expose the person to transmission of germs from other persons. In case of Iris and retina recognition the acquisition device is expensive and is too much sensitive to any body motion. The background noises in public places very effecting in voice recognition. Biometric depend on signatures, the signature may be modified. For facial images can be obtained without difficulty and with inexpensive fixed cameras [1].

According to these facts the face recognition has become an attractive and challenging task for researchers. Also, there are some difficulties in implementing this system; these difficulties belong to the following sources [2]:

1. Variations in Face Poses: the face can take many poses, these poses may be the face in front view, look upside, look down, profile, rotate to left from 1 to 45 degree, rotate to right from 1 to 45 de-

gree. In this kind of Variations, the facial features for example an eye or the nose may become partially or completely occluded.

2. Variations in Background: face border or shape is important feature, and it is different from person to person and effect by the distance of the face from the camera. Thus this boundary is not expected, for this reason the background is ignored.
3. Variation in Shape: this kind of variation meaning different facial expression like the face smile, sad, surprise, the mouth or eyes are open or closed, glasses or without glasses, if there is beards or no.
4. Occlusion: some objects or faces may be occlude partially or completely other faces.
5. Light: all the previous variations have resulted from the location or orientation of the face, the changes in lighting source can make fundamental change in face appearance.
6. Image Conditions: many factors of camera characteristic such as (sensor response, lenses) affect the appearance of a face.

## 2 BIOMETRICS AND BIOMETRIC SYSTEM

The fundamental introduction of "biometric" is recognition or authentication the persons based on their body part attribute. These attributes may be physiology or behavior of that person. The origin of this phrase is come from "bio" which is Greek name and "metric" which is also Greek name and refers to measure.

The work flow of any one of biometric technology is approximately to pattern recognition system, which depends on person physiology or behavior attributes to localize and extract pattern that used in recognition process [3]. The biometric techniques can be classified into two types as indicated by the attributes that are used:

1. Biometric Techniques Based on Physiological Characteristics They include all biometrics methods which are based on straightforward computation on a specific part of person body, iris, face, fingerprint, hand and DNA are the mostly known and popular kinds. These kinds are reliable more than kinds depend on behavior [4].
2. Biometric Techniques Based on Behavioral Characteristics Depending on the behavior or action of person, this type of methods extracts attributes; the most prominent and successful kinds are voice, keystroke and signature, in this type of biometric; the time is used as measure to determine person attribute [4].

### 3 BIOMETRIC SYSTEM PROCESSING FLOW

All biometric techniques are passing through two fundamental processes: enrollment phase and verification or identification phase [5].

#### 3.1 Enrollment Phase

The task of enrollment phase is to create a record about the person in the database. In case the methods based on physiology, the person presents his/her face, iris or hand to specific device. Many samples for each person are using in this phase to obtain distinctive features, these feature should be extracted and stored as template for using in matching process. Figure (1) illustrates a standard biometric enrollment process for face identification system [6].

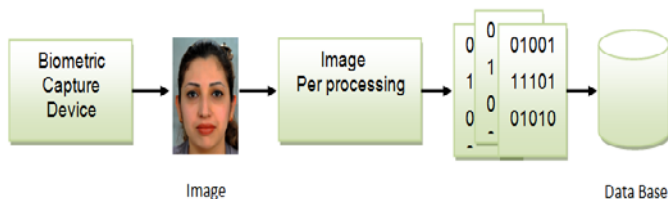


Fig.1 Enrollment process for face identification system [6]

#### 3.2 Verification and Identification Phase

Verification (authentication): which means one-to-one matching, the input biometric (a probe face image) is matched against a single biometric record. In other words; confirm that I am person X [6]. Identification (Recognition): which means one-to-many matching, means the determination of the corresponding person from a database containing many people, or decision that the person is not enrolled in the database, answer the question who am I [6], as shown in Figure (2).



Fig.2 Face Identification process [6]

### 4 FACE IDENTIFICATION SYSTEM

The face is the primary focus of attention in the society, playing a major role in conveying identity. Face identification has become an important issue in many applications such as security systems, credit card verification, and criminal identification. In the following sections the stages for desing and implementation of the proposed face identification system and as shown in Figure (3) and Figure (5):

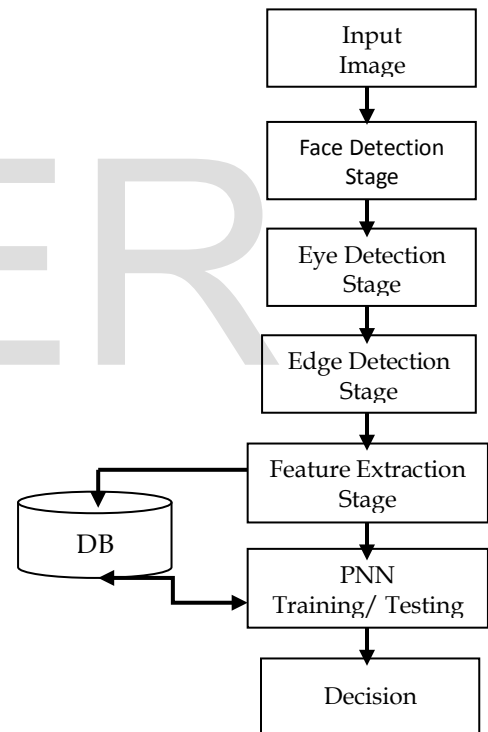


Fig.3 layout Structure of Proposed System

#### 4.1 Face Detection stage

After reading the color face image as bmp file format, the first stage is detect and extract face clip from face image [7, 8] which consists of following sub stages:

##### 4.1.1 Skin Color Modeling

This sub stage consists of two steps; the aim of these steps is to determine skin area in face image. These steps are:

1. Convert to HSV color space: convert image from RGB to HSV color space as shown in Figure (3) [9].

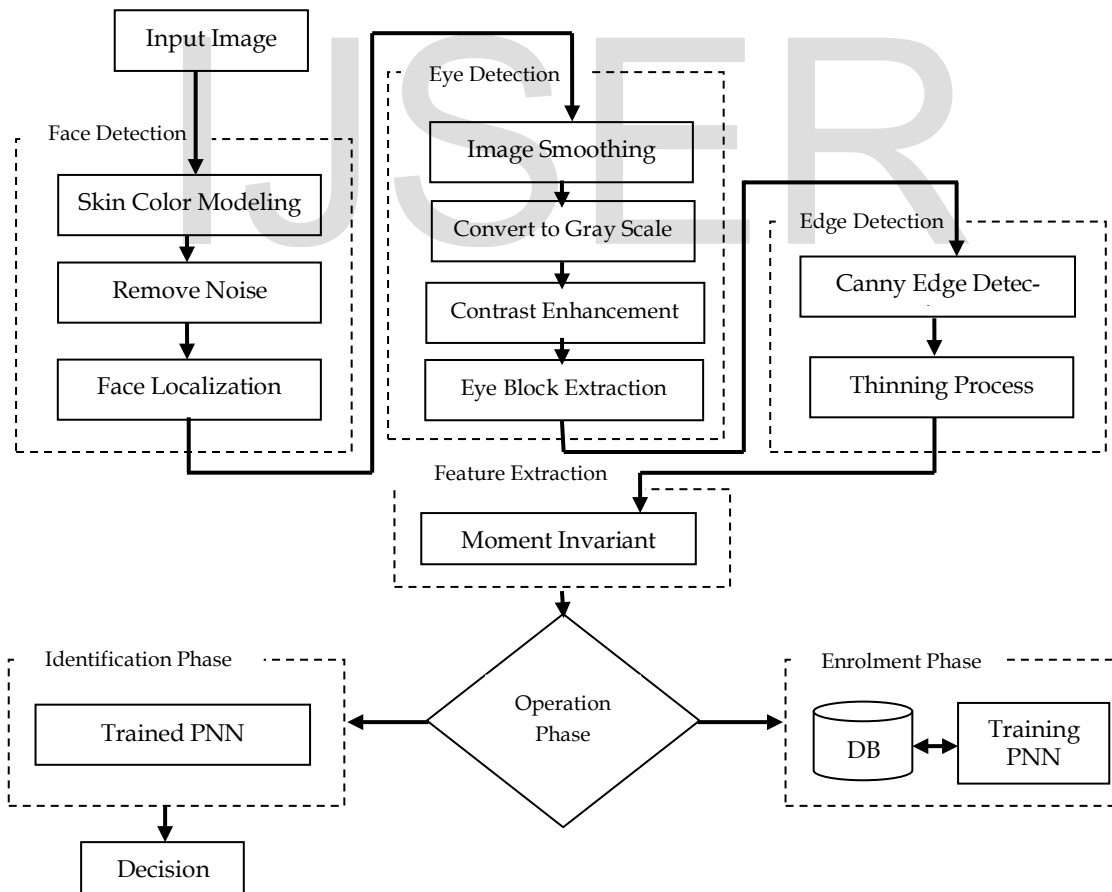


**Fig. 4 Convert color Image to HSV Color Space:**  
 (a) face image in RGB color space  
 (b) After converting face image to HVS color space

2. Skin color range rule: determine the skin area by applying certain rules as shown in Figure (6), these rules determined after trying many samples and examination of the skin color subspace, a set of range rules are got from the HSV color space. The range rules are derived for intensity values between (0 and 255) for each of H, S and V bands, make scan for all image pixels As follow:

```

{ For all X, Y Do {where 0 to Wid-1, 0 to Hgt-1}
    If (ImagePixels(H, X,Y).HSV > 0) And (ImagePixels(H, X,Y).HSV < 40) And (ImagePixels(S, X,Y).HSV > 30) And (ImagePixels(S, X,Y).HSV < 160) And (ImagePixels(V, X,Y).HSV > 150) And (ImagePixels(V, X,Y).HSV < 255) Then
        ImagePixels(Skin, X,Y).SkinHSV ← 255
    Else
        ImagePixels(Skin, X,Y).SkinHSV ← 0
    End If }
    
```



**Fig.5 layout of two of Proposed System**

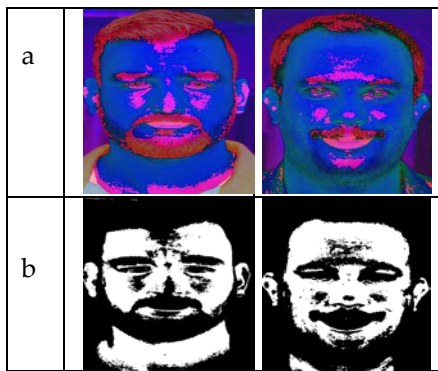
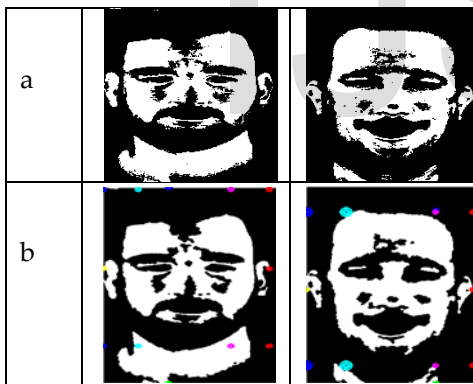


Fig.6

Face  
**Skin Area Segmentation:**  
 (a) face image in HVS color space  
 (b) After face skin area detection

#### 4.1.2 Remove Noise

Noise can be reduced by using preprocessing methods such as the use of spatial filtering. Spatial filtering is typically done for noise removal; among the most commonly used filters is median filter. This type of filter is non linear, characterizing by reduce the noise with saving sharp and precise details exist in image. It is applied 3 times with kernel size 3x3 as shown in Figure (7)[10].



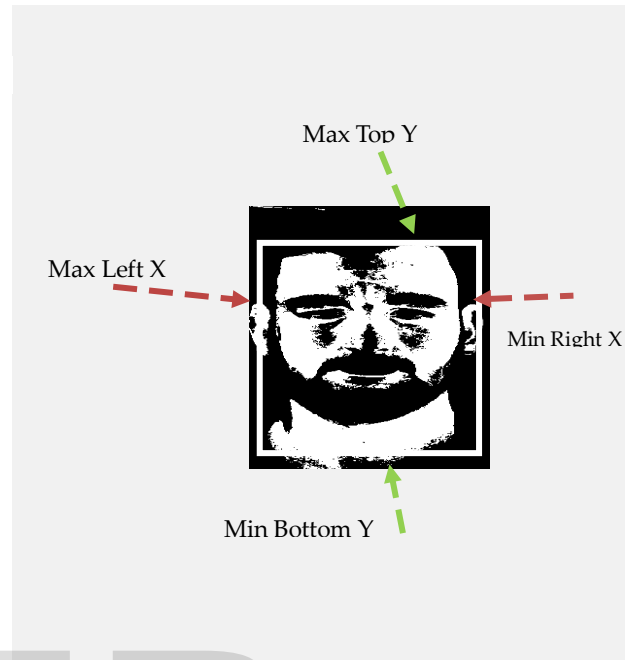
**Fig. 7 Remove Noise:**  
 (a)The noisy images after skin detection  
 (b) The images after Remove Noise

#### 4.1.3 Face Localization

The aim of this step is determining and extracting the position of face clip in the image. This is done by:

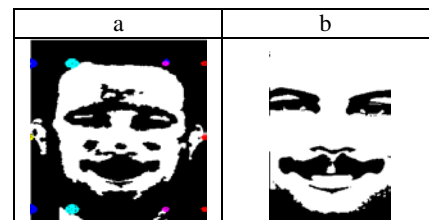
1. Points Localization: the position of skin area is determined in order to localize interesting clip in testing face image, which is based on checking the coordinates of skin area in order to find the minimum and maximum points. In this scanning, the minimum and maximum values of x and y-coordinates (the margins of the skin area) register, the minimum and maximum x values which represent the

left and right margins, while minimum and maximum y values represent the top and bottom margins, respectively, Figure (8) presents a sample explain the localization of face skin area.



**Fig. 8 Determining the four points position of skin area**The white represents the skin area and the black represents the non skin area in the face image

2. Face clipping: the aim of this step is to extract face clip, without unnecessary parts like right ear, left ear, neck and Palate as in Figure (9) below. The process of removing all unnecessary parts from the face depends on computing the percentage of white to black, the minimum ratio of white value to the black value for all pixels in the area. The minimum ratio is from left to remove left ear and from right to remove right ear, also from bottom to remove neck and palate.



**Fig.9 Face Clip after removing unnecessary parts**  
 (a) face image before clipping (b) face clip after clipping

#### 4.2 Eye Detection Stage

The stage of extracting face clip from image is followed by another stage which is eye detection, the aim of this stage is to detect and extract eye block, by doing the following:

#### 4.2.1 Image Smoothing Based on Gaussian Filter

This type of filter is used for two objectives, first noise reducing and second for blurring. Blurring is used for remove small details from an image prior to object extraction, also, for bridging of small gaps in lines or curves. Gaussian filter as expressed in equation (1) is used in this work with kernel size (3x3) and sigma values (0.8) as shown in Figure (10). The smoothing step is processed to achieve better edge extraction results [11].

$$f(x, y) = \frac{1}{2\pi\sigma^2} \exp\left(-\frac{x^2 + y^2}{2\sigma^2}\right) \quad \dots (1)$$

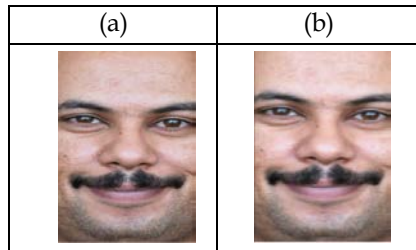


Fig. 10 Explain the effect of applying Gaussian filter

#### 4.2.2 Convert to Gray-scale Sub Stage

The gray image can be used to describe the spatial distribution of light intensity (or brightness) [12], each pixel value represent by 8 bits from 0 to 255. The equation (2) has been applied in this work; the proper threshold value is assessed after applying different threshold values to image that resulted from smoothing step. The test results indicated that the best value for the threshold is 140 as shown in Figure (11).

$$F(x,y) = \text{Thresholds} \left( \frac{R}{255} + \frac{G}{255} + \frac{B}{255} \right) \quad \dots (2)$$

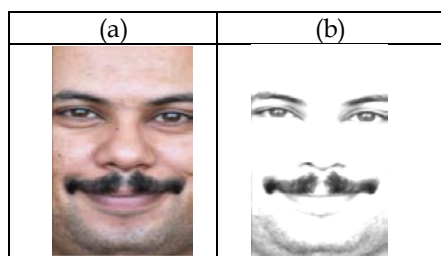


Fig. 11 An example of convert to gray with threshold (140)  
 (a) face clip after Gaussian filter  
 (b) face clip after convert to Gray-Scale

#### 4.2.3 Contrast Enhancement Sub Stage

It is an important sub stage in this stage, which makes the face details more suitable for the next step of work [12]. Contrast stretching has been applied to face image after converted to gray scale. Contrast stretching comprises two steps; the first is determining the minimum and maximum threshold values. After that, linear stretching is applied; it moves the low intensity values that are less than the determined (min value) toward 0, and the high level values high-

er than (max value) are moved toward 255. All values which lie between min and max values are linearly mapped (using equation 3). As a result, the range of intensity levels is stretched to the full range (0-255), A look table is established for speeding up the mapping process; this table is utilized to straightforwardly change each pixel value to its corresponding new value. Once, this look table is established, each pixel is mapped into its corresponding new value directly without the need to recalculate the same equation. Figure (12) shows the effect of contrast enhancement for  $\delta$  values (9).

$$\text{Img}(x, y) = \text{round}\left(\frac{(\text{img}(x, y) - \text{Min})^{\alpha + 255}}{(\text{Max} - \text{Min})}\right) \quad \dots (3)$$

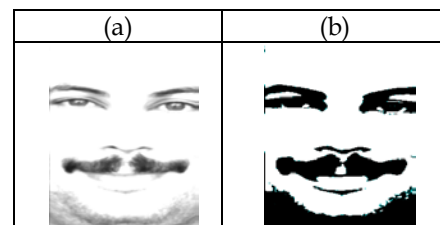


Fig. 12 An example of contrast enhancement  
 (a) Image in grayscale  
 (b) Image after contracts Enhancement

#### 4.2.4 Extract Master Eye Block Sub Stage

The objective of this work is to identify face image in different cases (front view, left and right orientations, more than one expression), as shown in Figure (13). The major issue characterizing this work is avoiding the effect of partial loss of eye in the cases when the face is rotate to left and right orientation.



Fig.13 An example of Dataset showing all views of face

The aim of this stage is detect and extracting one cutout block of eye (master eye). Many holes in image were filled in. Flood filling algorithm based on 4-connectives used for filling these holes [13]. After applying filling algorithm, one eye remains none filled in. This eye is called master eye (eye that has complete shape). The width and height of the eye cutout block may not be equal, so the block dimensions may not be equal. Figure (14) explains the detection of master eye for three main view cases, this block of master eye

will be used in feature extraction step to extract its attributes.

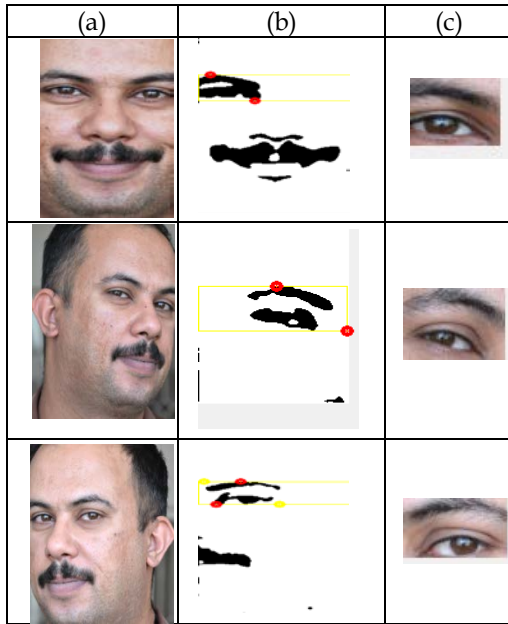


Fig. 14 Explain the extraction of master eye: (a) face clip (b) after contrast enhancement and flood fill (c) master eye block

**4.3 Edge Detection Stage**

Detect the main edge in eye block is the main aim of this stage, which includes two steps, applying canny edge detection and thinning process.

**4.3.1 Canny Edge Detection Sub Stage**

The main objective of applying edge detection filter is decreasing object's amount of data in an image, with preserves fundamental structural of that object to be used for further image analysis. Canny edge detection has become one of the standard edge detection methods, its algorithm runs in 4 separate steps [14]:

**First step:** smoothing the image (Gaussian filter is used for this purpose).

**Second step:** compute intensity gradient of the image (applying two convolution masks X, Y directions and find the gradient).

$$G_x = \begin{bmatrix} -1 & 0 & +1 \\ -2 & 0 & +2 \\ -1 & 0 & +1 \end{bmatrix} \dots (4)$$

$$G_y = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ +1 & +2 & +1 \end{bmatrix}$$

$$G = \sqrt{G_x^2 + G_y^2} \dots (5)$$

**Third step:** Non-maximum suppression which means labels only the pixels that are considered to be part an edge.

**Fourth step:** Hysteresis which means choose minimum and maximum thresholds, accepted the pixel gradient that is between these two thresholds.

In Figure (15) there is an explanation of applying canny filter, on the eye cutout block resulted from contrast enhancement,

the sigma values  $\delta = 9$

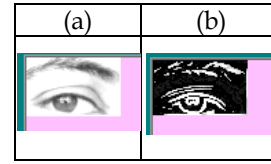


Fig.15 Explaining the edge detection: (a) after enhancement (b) after canny edge detection

**4.3.2 Thinning Based on Zhang-Suen Sub Stage**

It is fast algorithm, used mask 3x3 size which moved towards down and calculation are execute to each image pixel. Check all pixels that have value (1), and determine if it can stay in image or no. Usually, this algorithm consists of two fundamental successive passes (sub-iteration), the algorithm operates on all white pixels P1, the neighbours are in order, arranged as shown in Figure (16).

The main objective of applying thinning algorithm is to reduce objects edge to lines that approximate the center skeletons of that object, which can utilized to infer the shape of any object in image [15].

P9(x-1,y-1)	P2(x-1,y)	P3(x-1,y+1)
P8(x,y-1)	P1(x,y)	P4(x,y+1)
P7(x+1,y-1)	P6(x+1,y)	P5(x+1,y+1)

Fig. 16 Neighborhoods arrangement

The following two definitions are necessary to clarify the conditions of the two sub iterations:

1. A(P1) define the number of transitions from black to white, (0 to1) behave following sequence P2,P3,P4,P5,P6,P7,P8,P9,P2.
2. B(P1) define the number of white pixel neighbours of P1. (sum(P2 - P9) )

**First sub-iteration**

Any picture element is satisfying all the below conditions is marked in this iteration.

1. The pixel is white and has eight neighbors
2.  $2 \leq B(P1) \leq 6$
3.  $A(P1) = 1$
4. At least one of P2 and P4 and P6 is black
5. P8 is black

At the end of scanning the image and determining all pixels satisfying all first sub iteration conditions, all these pixels satisfying previous condition are set to black.

**Second sub-iteration**

Any picture element is satisfying all the below conditions is marked in this iteration.

1. The pixel is white and has eight neighbours
2.  $2 \leq B(P1) \leq 6$
3.  $A(P1) = 1$
4. At least one of P2 and P4 and P8 is black
5. P6 is black

At the end of scanning the image and determining all pixels satisfying all second sub iteration conditions, all these pixels satisfying previous condition are again set to black.

The figure below clarifies edges detection through applying the previous algorithm with thinning process.

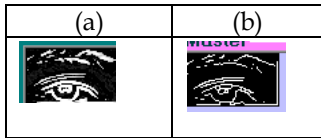


Fig.17 Explaining the effect of thinning:  
 (a) After canny filter (b) After thinning

**4.4 Feature Extraction Stage**

In order to give accurate recognition of individuals, the most discriminating information present in a pattern must be extracted and encoded so that comparisons between templates can be made. The common image features extraction technique extract properties of the shape of object is Moment Invariant [2, 16].

**5 Moment Invariant**

Moment invariants have been widely applied to image pattern recognition in a variety of applications due to its invariant features on image translation, scaling and rotation [16, 17]. The two dimensional geometric moment of order (p + q) of a function f(x, y) defined in equation (6).

$$m_{pq} = \sum_{x=0}^{N-1} \sum_{y=0}^{M-1} x^p y^q f(x, y) \tag{6}$$

Where

p, q = 0,1,2, ..., ∞

N: is the number of columns, M: is the number of rows.

The moments that have the property of translation invariance are called central moments and are denoted by μ<sub>pq</sub>, it is defined as in equation (7):

$$\mu_{pq} = \sum_{x=0}^{N-1} \sum_{y=0}^{M-1} (x - \bar{x})^p \cdot (y - \bar{y})^q f(x, y) \tag{7}$$

Where  $\bar{x}$  and  $\bar{y}$  are the coordinates of the centered and they are calculated using (8) and (9).

$$\bar{x} = \frac{m_{10}}{m_{00}} \tag{8}$$

$$\bar{y} = \frac{m_{01}}{m_{00}} \tag{9}$$

It can be easily verified that the central moments up to the order p + q ≤ 3 may be computed by the following formulas, equations (10) - (19):

It can be easily verified that the central moments up to the order p + q ≤ 3 may be computed by the following formulas, equations (10) - (19):

$$\mu_{00} = m_{00} \tag{10}$$

$$\mu_{10} = 0$$

$$\mu_{01} = 0$$

$$\mu_{20} = m_{20} - \bar{x} m_{10}$$

$$\mu_{02} = m_{02} - \bar{y} m_{01}$$

$$\mu_{11} = m_{11} - \bar{y} m_{10}$$

$$\mu_{30} = m_{30} - 3 \bar{x} m_{20} + 2 \bar{x}^2 m_{10}$$

$$\begin{aligned} \mu_{12} &= m_{12} - 2 \bar{y} m_{11} - \bar{x} m_{02} + 2 \bar{y}^2 m_{10} \\ \mu_{21} &= m_{21} - 2 \bar{x} m_{11} - \bar{y} m_{20} + 2 \bar{y}^2 m_{01} \\ \mu_{03} &= m_{03} - 3 \bar{y} m_{02} + 2 \bar{y}^2 m_{01} \end{aligned} \tag{19}$$

Scale invariance can be obtained by using normalized central moments η<sub>pq</sub>, as equations (20) and (21).

$$\eta_{pq} = \frac{\mu_{pq}}{\mu_{00}^\gamma} \tag{20}$$

Where

$$\gamma = \left[ \frac{(p+q)}{2} \right] + 1 \tag{21}$$

A seven non-linear absolute moment invariants are given as equations (22) to (28):

$$\phi_1 = \eta_{20} + \eta_{02} \tag{22}$$

$$\phi_2 = (\eta_{20} - \eta_{02})^2 + 4\eta_{11}^2$$

$$\phi_3 = (\eta_{30} - 3\eta_{12})^2 + (3\eta_{21} - \eta_{03})^2$$

$$\phi_4 = (\eta_{30} + \eta_{12})^2 + (\eta_{21} + \eta_{03})^2$$

$$\phi_5 = (\eta_{30} - 3\eta_{12})(\eta_{30} + \eta_{12})$$

$$+ [(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2]$$

$$+ (3\eta_{21} - \eta_{03})(\eta_{21} + \eta_{03})$$

$$[3(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2]$$

$$\phi_6 = (\eta_{20} - \eta_{02}) [(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2]$$

$$+ 4\eta_{11}(\eta_{30} + \eta_{12})(\eta_{21} + \eta_{03})$$

$$\phi_7 = (3\eta_{21} - \eta_{03})(\eta_{30} + \eta_{12})$$

$$+ [(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2]$$

$$+ (3\eta_{12} - \eta_{30})(\eta_{21} + \eta_{03})$$

$$[3(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2] \tag{28}$$

**6 PROBABILISTIC NEURAL NETWORK**

The (PNN) is multilayered feed forward network consists of four layers: an input layer, a pattern layer, a summation layer, and an output layer as shown in Figure (18). It is utilize a supervised learning training algorithm [18, 19].

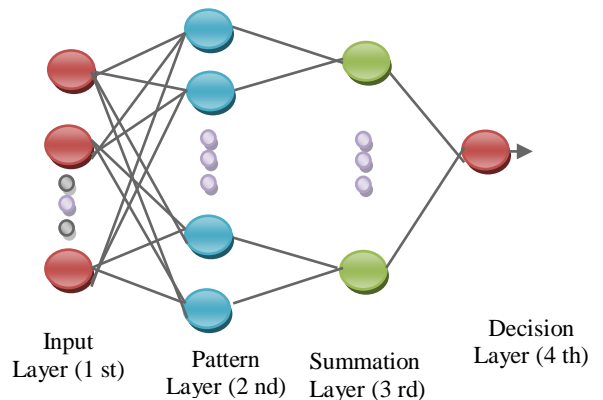


Fig. 18 PNN Structure

The input layer is completely connected to the pattern layer, the features vector (x) are distributes to all nodes in pattern layer. Each node in the pattern layer computes Gaussian function (radial transfer function) to calculate the distances between the input features vector and the training samples

as follows:

$$G(x) = \exp\left(-\frac{D}{2\sigma^2}\right) \tag{29}$$

Where

G: represent the output of a neuron pattern node.  
 X: is the input features vector to be assigned into class Ci  
 D: is the distance between the input features vector and the pattern vector that belongs to specific class, (Euclidean distance has been used in this thesis).  
 σ :is smoothing factor

The pattern layer neurons which belong to the same class are connected to the same summation neuron node. In the summation layer, there is one node for each class, sums the outputs of pattern layer for each class and produces the probabilities of that class, as equation (30).

$$G(x) = \exp\left(-\frac{D}{2\sigma^2}\right) \tag{30}$$

Where

O(x): the output of summation node i for class Ci  
 nj: the number of samples in pattern layer of class Ci  
 G(x): represent the output of pattern node i

Finally, the decision layer picks the maximum of these probabilities, and provides the target class for the input features vector [21], as equation (31).

$$\text{Targetclass}(x) = \text{maximum}\left(\frac{1}{n_j} \sum_{i=1}^{n_j} G(x)\right) \tag{31}$$

The only decision remains; of which standard deviation σ value to assign to the Gaussians. The value of σ affects the recognition results of PNN classifies, In this work the interval of σ are determined by compute the Min and Max standard deviation value of each class.

In this work the input Layer consists of (7) input nodes, represent the length of features vector. Pattern Layer consists of (240) neuron pattern nodes. There is one pattern node for each training sample. For each class (8) training pattern, these patterns are the features vectors sequentially extracted from eight eye block (eye block in front view, eye block rotate to right, eye block rotate to left). Summation Layer consists of (30) neuron nodes (number of classes). Output Layer consists of one largest node. As shown in Figure (19).

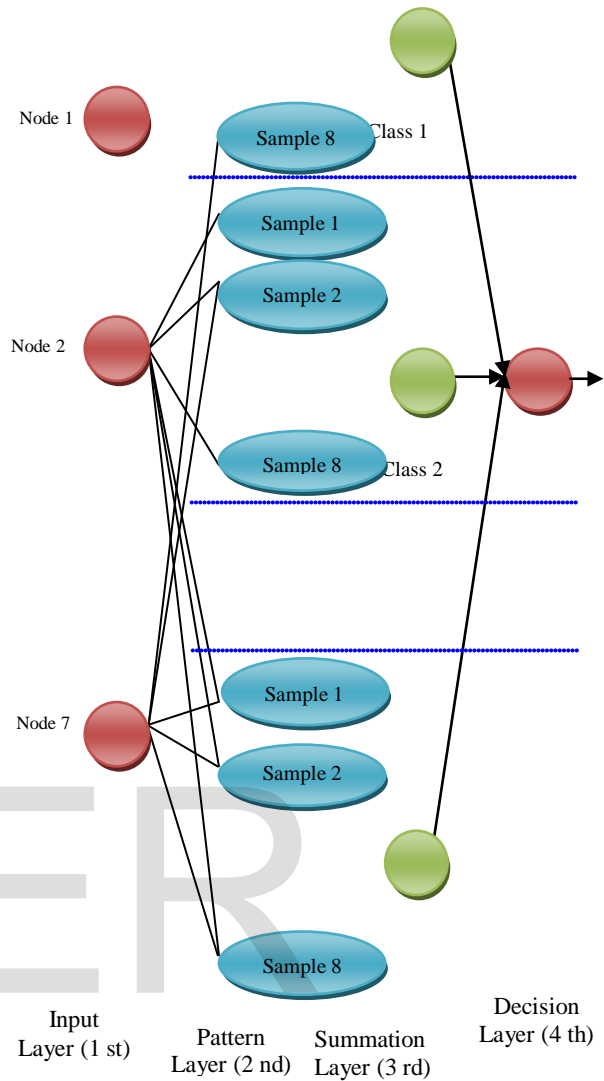
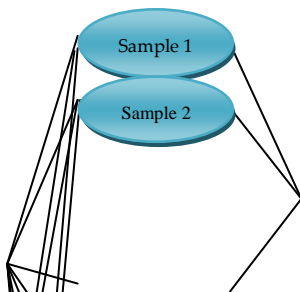


Fig. 19 The Design of PNN of this work

**Algorithm of Probabilistic Neural Network**

**Input:** vector (x) // features vector.

σ // smoothing parameter value

**Output:** Class number.

**Step1:** Read features vector (x) // read vector (x) and feed it to each Gaussian function in each pattern neuron node in pattern layer.

**Step2:** Each neuron node in pattern layer computes Gaussian functional values.

For all k do { where 1 to Cn } // all classes

For all i do { where 1 to Pn } // all patterns

For all j do { where 1 to Fn } // all features values

Set  $D(x, y) \leftarrow \sqrt{\sum(x - y)^2}$  // x is the input vector, y is the vector belong to class k

End for

Set  $G(x) \leftarrow \exp\left(-\frac{D(x,y)}{2\sigma^2}\right)$

End for

End for

**Step 3:** feed all outputs nodes in pattern layer (Gaussian functional values) of each class to its single node in summation layer.



```

Set Sum ← 0
For all k do { where 1 to Cn } // all classes
    For all I do { where 1 to Pn } // all patterns
        Set Sum ← Sum + Gj(x)
    End for
Set O(x) ←  $\frac{1}{Pn}$  Sum
End for
Step 4: comparing all the output values of neurons in summation layer to find the maximum one and assigned it to its class number.
Target class(x) = maximum (O(X))
End.
    
```

### 7 EVALUATION CRITERIA

Two measures; False Alarm Rate (FAR) and Recognition Rate (RR) are used to evaluate the performance of the face identification system. The formulas of these measures are:

$$FRR = \frac{\text{Number of false recognition attempts}}{\text{Total number of attempts}} \times 100 \quad (32)$$

$$RR = \frac{\text{Number of correct attempts}}{\text{Total number of attempts}} \times 100 \quad (33)$$

all features vectors of images in dataset are determined through the enrollment phase and saved in access file In the training phase, more than one value within the determined range of smoothing parameter [0.1\_ 0.9] are applying continuously until determining the suitable value that reaching least rate errors in recognition process as explain in below table.

### 8 CONCLUSIONS

Some important conclusions can be drawn from this work: For face detection stage based on color features it is indicated that the use of HSV color space for skin color modeling leads to higher detection results. The proposed algorithms for localizing and extracting face clip shows the best result is; even though there are the invariant of pose, orientation and expression. The illumination should be controlled, because if there will be some shadow on the face this makes face detection process difficult. The proposed algorithms for detect and extract master and second eye cutouts block from the face clip show the best results; even though there are the invariant of poses, orientations, and expressions. The results of the conducted tests on data set samples indicate that the best achieved recognition rate occurs when using; the values of control parameters are: kernel size of

**TABLE 1**  
RECOGNITION RATES FOR SMOOTHING PARAMETER VALUES FOR TRAINING PHASE

Recognition Rate ( RR)				
System Phase	Control parameter			
	Smoothing parameter	Total Cases	FAR	RR
Training	0.4	90	8	91.1%
	0.5	90	0	100%
	0.7	90	15	83.3%

**TABLE 2**  
FINAL RECOGNITION RATE FOR ALL CONTROL PARAMETER

Recognition Rate							
System Phase	Control Parameter						RR
	σ	Kernel size	Thre-shold	Sigma	Canny Edge Thresholds		
					Min	Max	
Training	0.8	3×3	140	9	40	200	100%
Testing	0.8	3×3	140	9	40	200	79%

**TABLE 3**  
THE RECOGNITION RATES FOR EACH CASE OF VIEW

Recognition Rate				
System Phase	View	RR		
		Total Cases	False Attempts	RR
Testing	Front view	90	0	100%
	Rotate to Left	60	19	69%
	Rotate to Right	60	18	68%
	All cases	210	44	79%

Gaussian filter equal to (3x3) and its sigma equal to (0.8), threshold of gray scale equal to (140), sigma value for contrast enhancement equal to (9), and finally the values of maximum and minimum thresholds of canny filter are equal to (40) and (200). The results of the conducted tests on data set samples indicate that the best achieved recognition rate occurs in case of front view which reach to 100%, and for all cases (front view, rotate to left, rotate to right) reach to 79%. This work has demonstrated that the effect of control parameters is indeed a practical solution to generate proper feature vectors from fea-

ture extraction stage.

This work can be extended in different directions. In below are some suggested ideas:

- Partitioning the master eye cutout block as matrix 3x3 and compute the moment invariant for each cell in the matrix and make feature analysis to obtain the best features which lead to best recognition rate.
- Trying to detect and extract mouth and nose cutouts blocks plus eye block and apply the same features extraction techniques to obtain three feature vectors, make feature analysis to obtain (features have better discrimination power) that are fed to the PNN with same structure to improve the recognition rate.

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