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FACIAL RECOGNITION USING NEURAL NETWORKS

A Term paper report submitted in partial fulfillment of the requirement for the Award of degree

BACHELOR OF TECHNOLOGY
IN
COMPUTER SCIENCE AND ENGINEERING

Submitted
By

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(An Autonomous institute, affiliated to J.N.T.University kakinada)
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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CERTIFICATE

This is to certify that term paper report titled **"Facial Recognition Using Neural Networks"** *submitted by* **Upparapalli Ramesh** *bearing* **Reg. No:19341A05H5** *has been carried out in partial fulfillment for the award of* **B.Tech** *degree in the discipline of* ***Computer Science & Engineering*** *to* **JNTUK** *is a record of bona fide work carried out under our guidance and supervision.*

The report embodied in this paper has not submitted to any other university or institution for the award of any degree or diploma.

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Upparapalli Ramesh

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ABSTRACT

The biometric system in our daily life plays a key role that use physiological features (fingerprint, iris, palm print, face, etc.) as well as systems that use behavioral characteristics (signature, walking, speech patterns, facial dynamics, etc.). Facial biometrics has been one of the most preferred biometric data since it generally does not require the cooperation of the user and can be obtained without violating the personal private space. The recognition is done by capturing the image of a person and remove the background of the captured image and comparing the characteristics of the new face to that of known images in the database . It has Face localization part, where mouth end point and eyeballs will be obtained. In feature Extraction, Distance between eyeballs and mouth end point will be calculated. The main face recognition methods are Geometric Feature Method and subspace analysis method and Neural Network method and Support Vector Machine (SVM) method. Facial recognition is low cost and easy to use and install while providing basic protection from unauthorized access. It is can successfully work in automatic mode, however, for higher certainty in safety.

Keywords: Face recognition, Video processing, Neural networks, Facial dynamics, Video-based face recognition

INTRODUCTION

Neural networks are played a crucial for providing security and solve many complex real-world problems. Neural networks, also known as artificial neural networks (ANNs) or simulated neural networks (SNNs), are a subset of machine learning and are at the heart of deep learning algorithms. Their name and structure are inspired by the human brain, mimicking the way that biological neurons signal to one another. The applications of neural network is speech recognition, character recognition, signature verification, fingerprint verification, image recognition and human face recognition. In particular the study is focused on human face recognition. Face has been one of the main biometric traits, which has many application areas including security and law enforcement, health, education, marketing, finance, entertainment, and human computer interaction. the facial recognition is very helpful in real-world by providing security to electronic devices and vehicles. the problem of face recognition in unconstrained environments is a challenging problem due to head pose, illumination, age, and facial expression related variations. There may also be changes in appearance due to make-up, facial hair or accessories (e.g., glasses, scarves). Another difficulty in face recognition is the similarity among individuals (e.g., relatives, twins).by using neural network this type of problems are solved. Neural networks are also ideally suited to help people solve complex problems in real-life situations. They can learn and model the relationships between inputs and outputs that are nonlinear and complex; make generalizations and inferences; reveal hidden relationships, patterns and predictions; and model highly volatile data (such as financial time series data) and variances needed to predict rare events (such as fraud detection).

Types of Neural Networks

There are different kinds of deep neural networks – and each has advantages and disadvantages, depending upon the use. Examples include:

- Convolutional neural networks (CNNs) contain five types of layers: input, convolution, pooling, fully connected and output. Each layer has a specific purpose, like summarizing, connecting or activating. Convolutional neural networks have popularized image classification and object detection. However, CNNs have also been applied to other areas, such as natural language processing and forecasting.
- Recurrent neural networks (RNNs) use sequential information such as time-stamped data from a sensor device or a spoken sentence, composed of a sequence of terms. Unlike traditional neural networks, all inputs to a recurrent neural network are not independent of each other, and the output

for each element depends on the computations of its preceding elements. RNNs are used in forecasting and time series applications, sentiment analysis and other text applications.

- Feedforward neural networks, in which each perceptron in one layer is connected to every perceptron from the next layer. Information is fed forward from one layer to the next in the forward direction only. There are no feedback loops.

- Autoencoder neural networks are used to create abstractions called encoders, created from a given set of inputs. Although similar to more traditional neural networks, autoencoders seek to model the inputs themselves, and therefore the method is considered unsupervised. The premise of autoencoders is to desensitize the irrelevant and sensitize the relevant. As layers are added, further abstractions are formulated at higher layers (layers closest to the point at which a decoder layer is introduced). These abstractions can then be used by linear or nonlinear classifiers.

- A neural network has at least two physical components, namely, the processing elements and the connections between them. The processing elements are called neurons, and the connections between the neurons are known as links. Every link has a weight parameter associated with it.

- A neural network has at least two physical components, namely**,** the processing elements and the connections between them. The processing elements are called neurons, and the connections between the neurons are known as links. Every link has a weight parameter associated with it.

- Neural networks can be applied to a broad range of problems and can assess many different types of input, including images, videos, files, databases, and more. They also do not require explicit programming to interpret the content of those inputs.

- . Some common applications of neural networks today, include image/pattern recognition, self-driving vehicle trajectory prediction, facial recognition, data mining, email spam filtering, medical diagnosis, and cancer research.

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LITERATURE SURVEY

[1] H. Yang and X. Han, "Face Recognition Attendance System Based on Real-Time Video Processing," in IEEE Access, vol. 8, pp. 159143-159150, 2020

This paper is about human face recognition attendance system by using neural networks. The general enterprises need to take the attendance of the employees. This human face recognition attendance system is used to record the attendance of the employees, which is a basic requirement of the company. The algorithms used in this paper is geometric feature method, subspace analysis method, neural network method, support vector machine method. The main face recognition methods are Geometric Feature Method and subspace analysis method and Neural Network method and Support Vector Machine (SVM) method. face recognition attendance system based on real-time video processing is carried out. Experimental data shows that the accuracy rate of the video face recognition system is up to 82%. Compared with the traditional check-in method, the face recognition attendance system can be reduced by about 60%.

[2] Costa, Valter Sousa, Armando Reis, Ana. (2018). Image-Based Object Spoofing Detection: 19th International Workshop, IWCIA 2018, Porto, Portugal, November 22–24, 2018, Proceedings.

This paper is about anti-spoofing method based on two different color space transforms and histograms calculation using a single image for a wine anticounterfeiting system. This method is used to find the authentication system using fake models possessing identical visual properties of the genuine one or not. The results on the private database show that the anti-spoofing approach is able to distinguish with high accuracy a real photo from an attack. Finally, the results confirm the hypothesis raised in this work: the combination of YCrCb and CIE L*u*v* color histograms provide enough discrimination for image spoofing detection applications.

[3] S. Chakraborty, S. K. Singh, and P. Chakraborty, ‘‘Local gradient hexa-pattern: A descriptor for face recognition and retrieval,’’ IEEE Trans. Circuits Syst. Video Technol., vol. 28, no. 1, pp. 171–180, Jan. 2018

In this paper a local descriptor has been proposed for face recognition and facial image retrieval. In this paper a local gradient hexa-pattern(LGHP) is proposed that identifies the relationship amongst the reference pixel and its neighboring pixels at different distances across different derivative directions recognition and retrieval performance of the proposed descriptor has been compared with state-of-the-art descriptors namely LDP, LTrP , MLBP and LVP over the most challenging and benchmark facial image databases, i.e. Cropped Extended Yale-B, CMU-PIE, colour-FERET,LFW, and Gallagher database.

[4] Masi, Iacopo & Wu, Yue & Hassner, Tal & Natarajan, Prem. (2018). Deep Face Recognition.

This paper about deep face recognition. The paper provides a clear, structured presentation of the principal, state-of-the-art (SOTA) face recognition techniques appearing within the past five years in top computer vision venues. Deep learning is a collection of statistical techniques of machine learning for learning feature hierarchies that are actually based on artificial neural networks. The paper is broken down into multiple parts that follow a standard face recognition pipeline: (a) how SOTA systems are trained and which public data sets have they used; (b) face preprocessing part (detection, alignment, etc.); (c) architecture and loss functions used for transfer learning (d) face recognition for verification and identification. Finally it concludes with an overview of the SOTA results at a glance along with some open issues currently overlooked by the community.

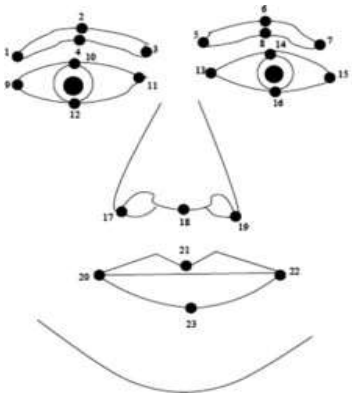
[5] Y. Duan, J. Lu, J. Feng, and J. Zhou, ‘‘Context-aware local binary feature learning for face recognition,’’ IEEE Trans. Pattern Anal. Mach. Intell., vol. 40, no. 5, pp. 1139–1153, May 2018.

This paper is about for context aware local binary feature for face recognition. In this paper, two methods are applied to heterogeneous by coupled learning methods C-CA-LBFL and C-CA-LBMFL. This methods achieve better or very competitive recognition performance on four widely used benchmark face databases compared with the state of-the-art face descriptors. This methods are general feature learning methods, it is reasonable and interesting to apply them to other computer vision applications such as object recognition and visual tracking in the future.

METHODOLOGY

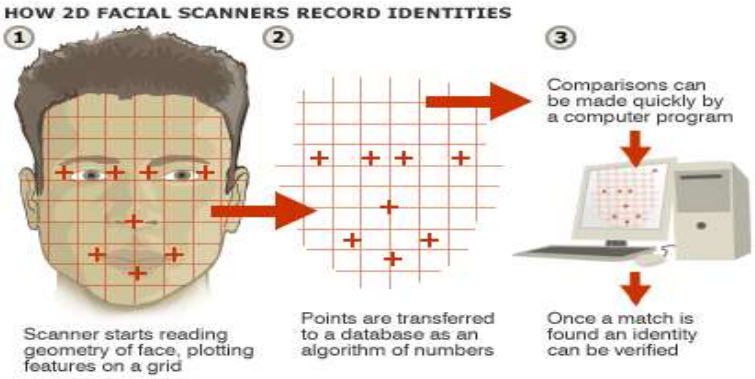
Geometric Feature Method:

- Geometric feature learning methods extract distinctive geometric features from images. Geometric features are features of objects constructed by a set of geometric elements like points, lines, curves or surfaces. These features can be corner features, edge features and so on, which can be detected by feature detection methods.
- The facial features such as eyes, nose, ears, mouth, etc. are different in structure, different human faces are represented according to different characteristics of the characteristic shapes of these organs. Geometric features were first used in the description and recognition of the side profile of a human face. It determines a number of feature points based on the profile line of the person's side, and then derives a set of feature quantities for recognition such as angle and distance based on these feature points.
- Geometric features used in this study consist of outer lip width (w_{outer}), outer lip height (h_{outer}), inner lip width (w_{inner}), inner lip height (h_{inner}), outer lip area (a_{outer}), inner lip area (a_{inner}), and teeth area (t). These are extracted from the tracked lip
- In 2D face recognition, images are often represented either by their geometric structure, or by encoding their intensity values. A geometric representation is obtained by transforming the image into geometric primitives such as points and curves.
- The geometric-based features extraction operation is used for extracting the local characteristics (landmarks) of a set of emotion expressions (anger, happiness, sadness, surprise) for images
- Most ways to deal with facial expression examination endeavor to understand a little arrangement of prototypic passionate facial expressions, i.e., dread, misery, repugnance, outrage, shock, and satisfaction

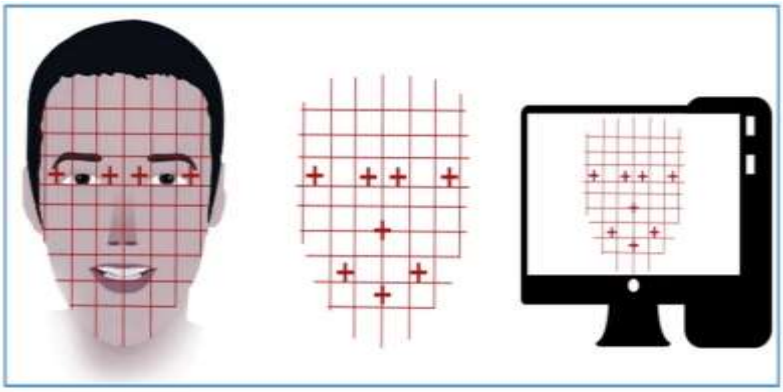


Geometric features	Number of features	Description
Eyebrow	4x2	Two extreme corners, upper and lower mid points
Eyes	4x2	Two extreme corners, upper and lower mid points
Nose	3	Two nostrils and nose tip
Lip	4	Two extreme corners, upper and lower mid points

Fig(1).Geometric features



Fig(2).Facial scanner for recording identities



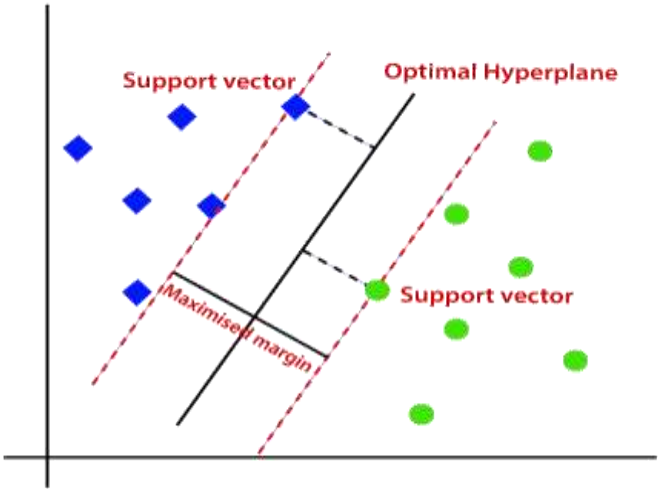
Fig(3).Facial scanner for checking features

Support Vector Machine:

- Support Vector Machine or SVM is one of the most popular Supervised Learning algorithms, which is used for Classification as well as Regression problems. However, primarily, it is used for Classification problems in Machine Learning.
- The goal of the SVM algorithm is to create the best line or decision boundary that can segregate n-dimensional space into classes so that we can easily put the new data point in the correct category in the future. This best decision boundary is called a hyperplane.
- SVM chooses the extreme points/vectors that help in creating the hyperplane. These extreme cases are called as support vectors, and hence algorithm is termed as Support Vector Machine.there are two different categories that are classified using a decision boundary or hyperplane
- The basic principle of the algorithm is to use samples to form a lattice in the high-level feature space, select sample points as the support vector near the boundary between the two types of sample points, and use the support vector to make the decision. And finally achieve the purpose of classification and identification

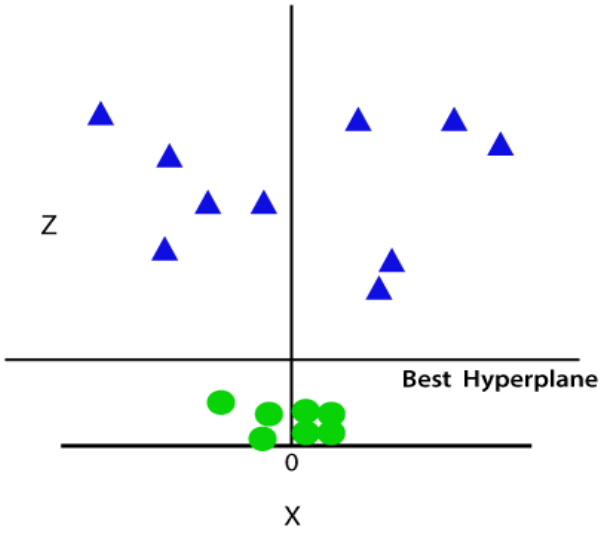
SVM can be of two types:

- **Linear SVM:** Linear SVM is used for linearly separable data, which means if a dataset can be classified into two classes by using a single straight line, then such data is termed as linearly separable data, and classifier is used called as Linear SVM classifier.
- **Non-linear SVM:** Non-Linear SVM is used for non-linearly separated data, which means if a dataset cannot be classified by using a straight line, then such data is termed as non-linear data and classifier used is called as Non-linear SVM classifier.
- For 2-D the hyper plane should be line equation i.e., y=mx + c.
- For 3-D the hyper plane should be any 2-D plane.
- For linear data, we have used two dimensions x and y, so for non-linear data, we will add a third-dimension z and it is calculated as z=x^2+y^2
- SVM algorithm is not suitable for large data sets. SVM does not perform very well when the data set has more noise



(a). Linear svm

- For linear svm we can use a segregate the data points by using a single straight line or any line equation. In the fig(a) the points are segregated by using a straight line

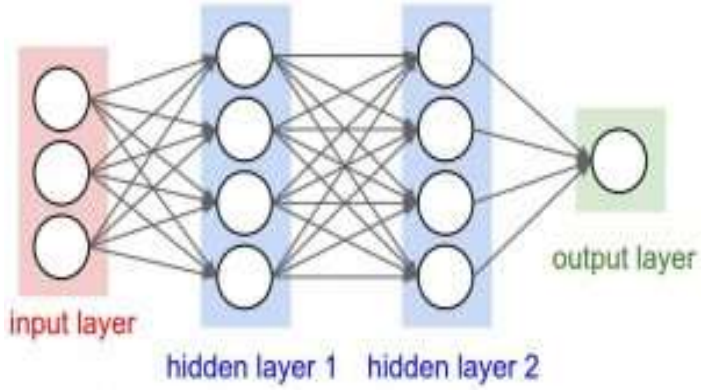


(b). Non-Linear svm

- For a non-linear svm the data points are segregated by using a 2-d plane and we can add another dimension to the graph. In the fig(b) the points are not segregated by using a line equation. the locus transformation formula i.e. $z=x^2+y^2$ is used .then the points which lies bottom then the points are moved top then we segregate by using a line equation.

Neural Networks

- A neural network is a computational learning system that uses a network of functions to understand and translate a data input of one form into a desired output, usually in another form. The concept of +function together to understand input from human senses
- Neural networks are being applied to many real-life problems today, including speech and image recognition, spam email filtering, finance, and medical diagnosis, face recognition.
- Neural Networks are a set of algorithms that tries to recognize the patterns, relationships, and information from the data through the process which is inspired by and works like the human brain/biology.
- Artificial neural networks (ANNs) are comprised of a node layers, containing an input layer, one or more hidden layers, and an output layer. Each node, or artificial neuron, connects to another and has an associated weight and threshold. If the output of any individual node is above the specified threshold value, that node is activated, sending data to the next layer of the network. Otherwise, no data is passed along to the next layer of the network.
- Its principle is to use a large number of simple calculation units to form a certain hierarchical structure
- Although neural networks have some advantages in face recognition, they also have considerable defects. The structure of neural networks is huge and complex, and their training requires a huge sample library. The training time often takes days or even months. The speed is not fast enough. Therefore, neural networks are not commonly used in the actual application of face recognition.
- Artificial Neural Networks are used in various classification tasks like image, audio, words. Different types of Neural Networks are used for different purposes, for example for predicting the sequence of words we use Recurrent Neural Networks more precisely an LSTM, similarly for image classification we use Convolution Neural networks. In this blog, we are going to build a basic building block for CNN.



Fig(a). Layered diagram of the Convolution Neural Network

- **Input Layers:** It's the layer in which we give input to our model. The number of neurons in this layer is equal to the total number of features in our data (number of pixels in the case of an image).
- **Hidden Layer:** The input from the Input layer is then feed into the hidden layer. There can be many hidden layers depending upon our model and data size. Each hidden layer can have different numbers of neurons which are generally greater than the number of features. The output from each layer is computed by matrix multiplication of output of the previous layer with learnable weights of that layer and then by the addition of learnable biases followed by activation function which makes the network nonlinear.
- **Output Layer:** The output from the hidden layer is then fed into a logistic function like sigmoid or SoftMax which converts the output of each class into the probability score of each class.
- The data is then fed into the model and output from each layer is obtained this step is called feedforward, we then calculate the error using an error function, some common error functions are cross-entropy, square loss error, etc. After that, we backpropagate into the model by calculating the derivatives. This step is called Backpropagation which basically is used to minimize the loss.

EXPERIMENTAL STUDY

This section consists of steps we processed to achieve the accurate result using CNN algorithms.

Steps in handwritten digit recognition:

A. Input Face
B. Localization Feature
C. Extraction
D. Neural Network Recognizer

A.Input face:

Input image is acquired by taking photographs using the digital camera. These images are taken in color mode and saved in JPG format and remove the background data However, the proposed method is suitable for working with any file format.

B. Localization Feature:

Face localization aims to determine the image position of a single face. This is a simplified detection problem with the assumption than an input image consists only one face. Various pre-processing activities are done in this phase to make the raw data into usable format. The procedure below explains the proposed face localization technique.

1)Image Conversion: The input image is first converted into the gray-scale image. The grayscale image is then converted into its binary form.

2) Dilation: The dilation process removes the noise encountered in the binary image. Hence, the dilation operation is performed on the binary image obtained. The gray-scale image is then converted into its binary form. Then, the dilated image is mapped on to the gray scale image using intensity calculation formula below. Let Im denotes the intensity of mapped image Id denotes the intensity of the dilated image and Ig denotes the intensity of the gray scale image.

3) Image Cropping: The mapped image is converted into binary image and the required face region is cropped from the binary image

C. Feature Extraction:

The feature extraction is done by using the features such as eyes, mouth, nose, ears etc. Generally, there are two methods of representation about facial features: One is the local facial features such as eyes, nose and mouth are located; the other is about the whole facial features as expressing with a rectangle area containing eyes, nose and mouth. In this paper, the two features, eyes and mouth are taken into consideration. The proposed feature extraction algorithm is explained below.

1. Divide the localized face column wise into two equal parts.

2. For each row 'r' do steps 3 and 4.

3. The first black pixels encountered on either side are taken as (x1, y1) and (x2, y2) respectively.

4. Calculate the distance between those points using the formula: Distance = Sqrt ((x2 – x1) 2)+ ((y2 – y1) 2)

5. From step 4, two sets of non-zero distance vales corresponding to eyes and mouth are obtained.

6. Find the maximum of the distances for each non-zero set. They represent the distance between the eyeballs and the distance between the mouth end points

7. Using the pixels corresponding to that maximum distance, calculate the following:

   i. Distance from the left eyeball to the right eyeball.

   ii. Distance from the left mouth end point to the right mouth end point.

   iii. Distance from the left eyeball to the left mouth end point.

   iv. Distance from the right eyeball to the right mouth end point

   v. Distance from the left eyeball to the right mouth end point.

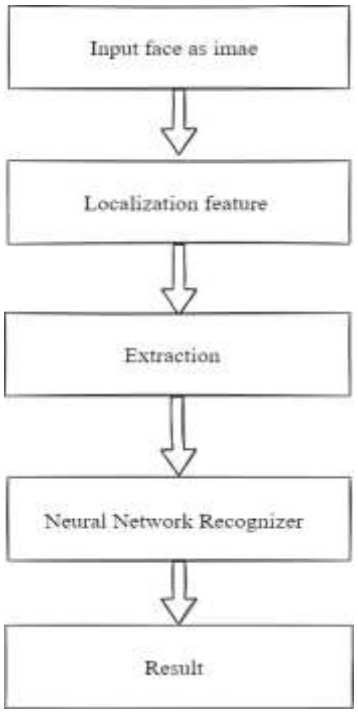
   vi. Distance from the right eyeball to the left mouth end point. 8. The six values calculated above are given as the inputs to the neural network recognizer.

D. Neural Network Recognizer:

After extracting the features from the given face image, a recognizer is needed to recognize the face image from the stored database. This paper proposes a recognition method, which uses two networks: Back Propagation Network (BPN) and Radial Basis Function Network (RBF). The input layer consists of six neurons the inputs to this network are feature vectors derived from the feature extraction method. During feed forward, each input neuron (p1) receives an input value and broadcasts it to each hidden neuron, which in turn computes the activation and passes it on to each output unit, which again computes the activation to obtain the net output. During training, the net output is compared with the target value and the appropriate error is calculated. From this, the error factor is obtained which is used to distribute the error back to the hidden layer. The weights are updated accordingly. In a similar manner, the error factor is calculated for units. After the error factors are obtained, the weights are updated simultaneously. The output layer contains one neuron. The result obtained from the output layer is given as the input to the RBF.

DESIGN

The working of facial recognition contains 4 phases. The below flow chart contains and describes about the 4 phases. The phases are Input, Localization feature, Extraction, Neural Network recognizer. The phases are already explained above in the experimental study section

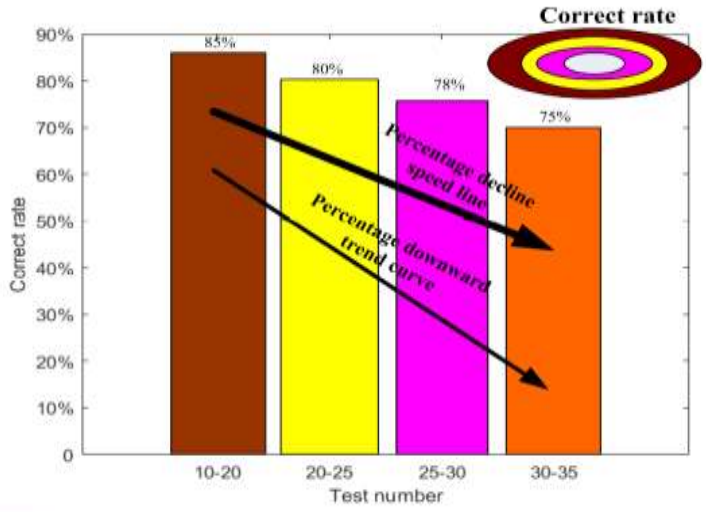


Fig(a): flow chart for the facial Recognition

RESULTS

- This paper mainly sets four directions to consider the problems: the accuracy rate of the face recognition system in the actual check-in, the stability of the face recognition system with real-time video processing, and the truancy rate of the face recognition system with real-time video processing
- The test results of the system under different test sample numbers are as follows: when the input is 10 ~ 20, the recognition and sign-in correct rate is 85%; when the input is 20 ~ 50, the correct rate is 80%.
- There is an error rate of about 20% in the test results. Most face information errors that will change, such as changes in facial features, accessories, cosmetics and lighting caused by medical plastics, making it impossible to extract the correct logo from the picture.
- Another main reason is the accuracy of identification code comparison. conditions, make sure to adapt to various situations

Test number	Correct rate
10~20	85%
20~25	80%
25~30	78%
30~35	75%



GURE 6. Test number and accuracy rate chart.

CONCLUSION AND FUTURE SCOPE

In this paper, a new face localization technique is proposed and a new feature extraction algorithm is developed for human face recognition. The neural network model is used for recognizing the frontal or nearly frontal faces and the results are tabulated. The network is trained and tested. From these results, it can be concluded that, recognition accuracy achieved by this method is very high. This method can be suitably extended for moving images and the images with varying background. The system has made tremendous innovations, greatly improving the security rate and Face Recognition System Based on Real-Time Video Processing reliability of face recognition technology. It is worthy of further exploration and realization by our scientists**.**

This paper, which we developed is about facial recognition The automobile industry is another that is investing in facial recognition technology. Car owners can also set up permissions or restrictions for other people such as family members hey could set up certain restrictions on their children learning to drive such as a time or speed limit or deny access without an adult present. If an unauthorized person enters the car, the system can notify the owner or block the car from starting. This helps prevent theft and gives owners better control of their cars. Facial recognition is here to stay and rather than seeing facial recognition as a threat to our personal privacy, we should instead be embracing the many benefits that facial recognition provides.

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