International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-4, November 2019

A Gist Warning of Sighting in Face Classification and Recognition

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Abstract: ***Face classification and recognition is the fastest growing, challenging area in real time applications. A large number of algorithms are there in the network to recognize the face. It is the important part of the biometric traits and it not only contributes to the theoretical insights but also to practical insights of many algorithms. Conversely, the first face recognition in the main reckons on a priori in a row of hurdle folks and might not free itself from human intervention. Until the looks of high-speed, better-quality computers, the face recognition methodology makes a big disintegrate through. Face recognition has been a quick growing, difficult and mesmerizing space in real time applications. Facial classifications and recognition becomes an interesting research topic. A large range of face classification and recognition algorithms are developed in last decades. In this paper a attempt is created to review a good vary of strategies used for face recognition expansively. This paper contributes a huge survey of varied face detection and feature extraction techniques. At the moment, there are loads of face classification and recognition techniques and algorithms found and developed round the world.***

Keywords: face classification, face recognition, Classifier, Neural Networks

I. INTRODUCTION

An image is a visual perception of 2 D picture which is actually a similar appearance of a physical object or person. It is a screen display and it is captured by any optical device like camera, microscope, telescope, lens etc. There are three types of image: Volatile Image which exists for a short period of time. This may be the reflection of a mirror. A fixed image is a hard copy of an image which has been recorded on a material or the object. A mental image is in the individual's mind for something to remember. A still image is a static image used for photography, visual media. Before moving ahead with the face recognition the one should know about the face detection, feature extraction and then face classification and at last got the face recognition [1].

II. FACE CLASSIFICATION

To classify the image after the feature extraction and feature selection process. There is a wide variety of classification methods and they also may used with the combination of two or more classifiers for improving the algorithm of learning method [2] [3].

Manuscript published on November 30, 2019.
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Classification is used in many areas so it is having a wide variety of examples to explore it. The classification method is involved in all types of learning methods i.e., unsupervised, semi-supervised and unsupervised learning. The concept of classification is broadly divided into 3 types of classifiers i.e., similarity classifiers, probability classifiers and decision boundary classifiers are shown in Fig 1.1.

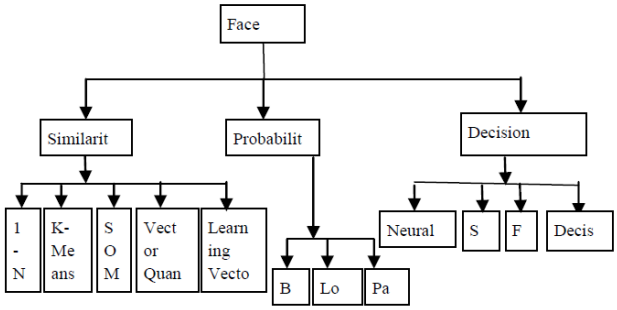

Fig 1.1: Methods of Face Classification

2.1.1 Similarity Classifier: It is a simple and intuitive approach. In this patterns are similar and they will belong to same class to establish the metrics which defines the similarity and the representation of the class and patterns of that class [4]. There are number of classifiers based on similarity classifiers explained in are-

2.1.1.1 NN Classifier

Nearest neighborhood is the simplest method for matching the feature vectors. It calculates the distance
between probe image and the gallery image. If the distance is zero then the image is matched, and both the images are exactly same. There are multiple methods and they are used according to the need of the task.

2.1.1.2. Manhattan Distance (L1 metrics): It computes the distance from one data point to another, if a grid like path is followed [5]. The distance between a point $x=(x_1, x_2,\ldots,x_n)$ and $y=(y_1,y_2,\ldots,y_n)$ is

$$MD(x,y) = \sum_{i=1}^{n}(x_i - y_i) \quad (1)$$

Where n is number of variables, x_i and y_i are the values of i^{th} variable of x and y respectively.

2.1.1.3. Euclidean distance (L2 metrics): Euclidean Distance is commonly used distance measure. It is also called L2 distance metric. (x, y) represents the Eigen vectors with length n as explained in [Wu and Wang].The vectors in a two dimensional hyper plane are, $U=(x_1,x_2,\ldots.x_n)$ and $v=(y_1,y_2,\ldots.y_n)$ and the Euclidean Distance for these vectors are-

$$ED(x,y) = \sqrt{\sum_{i=1}^{n}(x_i - y_i)^2} \quad (2)$$

2.1.1.4. K-means classifier [7]: The earliest concept in pattern classification is the distance function. In the k-means classifier, the distance of similarity between the features of test sample and training sample is computed. In the unknown pattern of a class serves as a measure of its classification. It is a non-parametric classifier, where the posteriori probability is estimated from the frequency of nearest neighbor of the unknown pattern. Let x is the incoming pattern, m number of classes for c_i, i=1…m and N sample patterns y_i, i=1…N whose classification is priori known. The x is classified by the nearest neighbor classification approach with the set y_i,i=1,…N i.e.,

$$If \|x - y_j\|^2 = min\|x - y_i\|^2, 1 \le i \le N, then x \in c_j \quad (3)$$

2.1.1.4. Vector Quantization: It is a classical quantization technique and it allows a modeling of probability density function. It divides a large set of vectors into a number of groups having same number of vectors closest to them and each group is represented by its centroid. It is useful for high dimensional data and lossy data compression also. It is also discussed in used in deep learning because it is based on competitive learning approach which is closely related to Self Organizing Maps and sparse coding which are the major parts of deep learning.

2.1.1.5. Learning Vector Quantization: LVQ is a supervised method of vector quantization and it is used with the labeled data. It will improve the quality of the classifier decision regions. It is a 2 stage process i.e., a SOM followed by LVQ shown in Fig 1.2 given below-

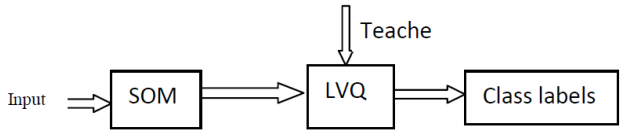

Fig 1.2: Learning Vector Quantization

It is useful for pattern classification problems. Feature selection process is performed with unsupervised identification for a small set of features in which information of input is concentrated. After this classification is performed where feature domains are assigned to individual classes.

2.1.2 Probability Classifier: These types of classifiers were built on probabilistic approach. These classifiers compute the distances between the test pattern and the samples of the training data set. The basic idea of this is to pre process the images offline, so that the algorithm is much faster when performs the face recognition. But the drawback is to perform the large number of computations and for avoiding these computations vector quantization and the branch and bound method are the better approaches from this. The various types of probability classifiers i.e., bayes classifier, parzen classifier and logistic classifier.

2.1.2.1. Bayes Classifier: According to it is a probabilistic approach of face recognition because in pattern recognition the pattern classes are generated randomly. It yields with the lowest probability of committing classification errors. If a pattern x may belong to N classes, the average loss incurred in assigning x to a class [8]. The probability that a particular pattern x belongs to class c_i is denoted by p (c_i/x). If the pattern classifier decides that x is in cj when it actually belongs to c_i , it incurs a loss, L_{ij}. As pattern x may belong to any one of N classes under consideration, the average loss incurred in assigning x to class c_j is

$$r_j(x) = \frac{1}{p(x)} \sum_{k=1}^{N} L_{kjp}\left(x/c_k\right) P(c_k) \quad (4)$$

Here p (x/c_k)-Probability Density Function of the patterns from class c_k

P (c_k) is the probability of occurrence of class c_k.

The expression for the average loss then reduces to

$$r_j(x) \cong \sum_{k=1}^{N} L_{kjp}\left(x/c_k\right) P(c_k) \quad (5)$$

If it computes r1(x), r2(x),….,rm(x) for each pattern x and assigns it to the class with the smallest loss, so the total average loss with minimum. The classifier that minimizes the total average loss is called the Bayes classifier.

Thus the Bayes classifier assigns an unknown classifier pattern x to class ci if ri(x) <rj (x) for j = 1, 2, m, j≠ i. i.e., x is assigned to class c_i if

$$\sum_{k=1}^{N} L_{kjp}\left(x/c_k\right) P(c_k) < \sum_{q=1}^{N} L_{qjp}\left(x/c_q\right) P(c_q) \quad (6)$$

2.1.2.2. Parzen Probabilistic Classifier: This classifier having the wide utility in pattern recognition, image registration, tacking, classification, segmentation and restoration of image. It is a density estimation function used for data interpolation. Suppose, we want to estimate the value of probability density function (PDF), P(x), at the random sample x [9]. Then place a parzen window function at x and find how many observations x_i will fall within the window and what is the contribution of each observation x_i to this window. Now, sum of the total of contribution from the observations to this window is P(x).It is represented as-

$$P(x) = \frac{1}{n} \sum_{i=1}^{n} \frac{1}{h_n^d} k \frac{(x - x_i)}{h_n} \quad (7)$$

Here k(x) is the window function

The Gaussian PDF is a popular kernel for Parzen-window density estimation. So the parzen window estimate the Gaussian kernel, then it is-

$$P(x) = \frac{1}{n} \sum_{i=1}^{n} \frac{1}{(\sqrt[h]{2\pi})^d} e^{\left(-\frac{1}{2}\left(\frac{x - x_i}{n}\right)^2\right)} \quad (8)$$

2.1.3 Decision Boundary Classifier: The main approach behind this classifier is to choose a metric which will minimize the error between the live template and stored template. It is trained by an iterative selection of individual features that are most salient at each node of the tree [10]. There are various decision boundary based methods some are mentioned here-

2.1.3.1. Fisher Linear Discriminant: The solution provided by the fisher for classification is beyond second order statistics. So, it is not expected by this method for accurate indication of features which should be extracted for classification. In FLD there are 2 Matrix which are to be formed. First is within class scatter Matrix and another is between class scatter Matrix. Now, within class scatter Matrix is computed as a weighted sum of class conditional sample covariance matrix is used. It is defined as-

$$S^I = \frac{1}{k} \sum_{k=1}^{k} \Sigma_k \quad (9)$$

Here Σ_k is the class-conditional covariance matrix, estimated from the sample set.

The between class-scatter matrix is defined as,

$$S^E = \frac{1}{K} \sum_{k=1}^{k} (\mu_k - \mu_0).(\mu_k - \mu_0)^T \quad (10)$$

Here, μk is the class-conditional sample mean
μ0 is the unconditional (global) sample mean.

2.1.3.2. Decision Trees: It is a method in which a pattern is classified through a sequence of question in which the next question will depends on the answer of current question. All the questions can be asked in 'yes/no' or 'true/false' or 'value (property) ϵ set of values' pattern which does not require any notation of metric [11]. Such a sequence of question is displayed in a simply tree , where first node or root node is at the top and connected to other successive directed links or branches to other nodes and reach at terminal or leaf nodes, which have no further links.

III. FACE RECOGNITION

Face recognition is a computer application which is capable of identifies the person from an image or video frame or video sequence. Face recognition involves a comparison from one to many of live template and the stored template which is shown in Fig 1.3. Face recognition also called as face identification.

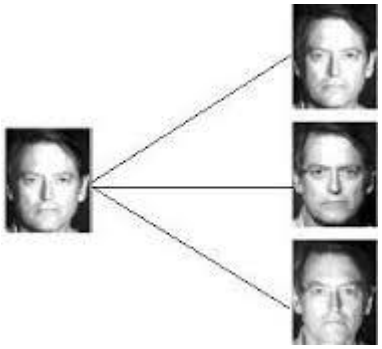

Fig 1.3: Face Recognition

Consider a set of images and a probe p which is to be identified having m training images

$T = \{t1, \dots \dots . tm\}$ (11)

We take p and score it with every image in the set t_i

$\delta = \sum_{i=1}^{m} \alpha_i \, y_i k(s_i, t_i - p) + b$ (12)

The image with the lowest score but below a threshold is recognized [12]. The various methods for face recognition are shown in Fig 1.4

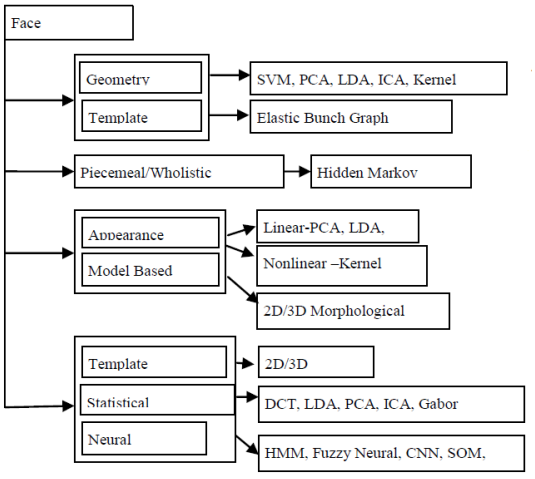

Fig 1.4: Methods for Face Recognition

3.1.1. Independent Component Analysis: ICA is a computational and statistical technique for disclose the hidden factors which are the set of signals, measurements and random variables. ICA reduces the second order and higher order dependencies of the input data. The performance of ICA depends upon the algorithm and function which is used to approximate the ICA. It also retains the number of subspace dimensions.ICA algorithm is applied on face recognition in two different ways first is it process images as random variables and pixels as observations and the another is process pixels as random variables and images.

3.1.2 Kernel Methods and Kernel PCA: It is described that a kernel is a most important component of anything [13]. If kernel is applied to particular method then it means that it will change its performance and the kernel plays an important role on particular function. The KPCA solves the Eigen value problem-

$\lambda\alpha = K\alpha subjectto \|\alpha\|_2 = \frac{1}{\lambda}$ (13)

Classic Kernels are the polynomial Kernels, q ϵ $\mathbb{R}^+$ and P ϵ$\mathbb{N}^+$

$K(x,y) = (\langle x,y\rangle_R + q)^P$ (14)

Gaussian Kernels, σ ϵ$\mathbb{R}^+$

$K(x,y) = exp\left(-\frac{\|x-y\|^2}{2\sigma^2}\right)$ (15)

At last feature space of N-by-N Kernel

$K = k(x,y) = \big(\varphi(x), \varphi(y)\big) = \varphi(x)^T \varphi(y)$ (16)

3.1.3 Elastic Bunch Graph Matching: As defined the major thought over the Elastic Bunch graph matching in accordance with the algorithm is to perform comparative analysis between the images and also find the quantitative analysis between them. The facial image between each bounding box is assumed to be a threshold value of skin segmentation. The basic object representation in EGBM is a graph, and because it is for the face so it is known as facial graph. The nodes of the graph are the wavelet responses of local jet and the edges are defined by the length. These corresponding jets are selected by the Gabor wavelet transform. A Gabor Kernels are generated for dilations and a set of degree of rotations. These Kernels will extract the 'jets' from the image-

$J_j(\vec{x}) = \int I(\vec{x}) \Psi_j(\vec{x} - \vec{x'}) d^2\vec{x'}$ (17)

The similarity between the image graph and the elastic bunch graph is shown by the equation- $S_B(G^I, B) = \frac{1}{N}\sum_\eta max_m \left(S_\varphi\left(J_n^I, J_n^{Bm}\right)\right) - \frac{\lambda}{E}\sum_e \frac{(\Delta\vec{x_e^I} - \Delta\vec{x_e^B})}{(\Delta\vec{x_e^B})^2}$ (18)

3.1.4 2D/3D Models: 2D models and approaches are the early trends and it is very sensitive to illumination changes, pose variations. For solving this problem elastic bunch graph matching is used. This problem is removed in 3D models and these models have the ability to make 3D patterns; but the major problem with this is to scan the data in a 3D controlled environment and then after used for recognition therefore in the surveillance applications this 3D kind of data is not available

3.1.5 Fuzzy Neural Network: The fuzzy neural is also known as neuro fuzzy .Its parameters are fuzzy sets and fuzzy rules. It works as a learning machine and from neural networks it exploits the approximation techniques.

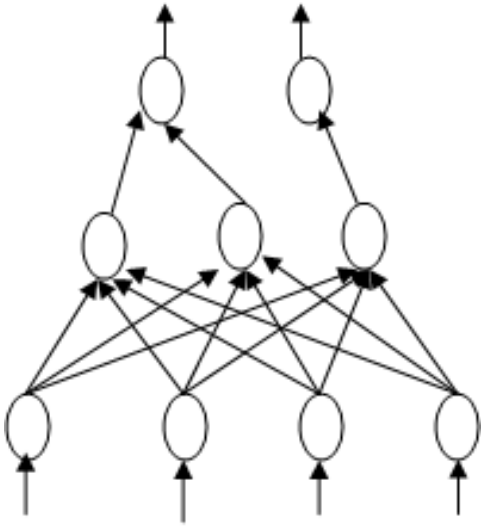

Fig 1.5: Fuzzy Neural Network

It is represented as a three layer feed forward neural network; the first layer is input layer corresponds to the input variables, second layer is for the fuzzy rules, third layer produces output variables and fuzzy sets are converted as a fuzzy connection weights shown in fig 1.5 given above.

3.1.6 Convolutional Neural Network: The Convolutional Neural Network are similar to neural networks but the thing where it is different from the neural network is that it holds the images as a input and it allows to encode the various properties into the architecture[14]. This will help to make the forward function more effective to implement and also reduce the amount of parameters in the network. In the fig 2.14 the left side of the figure consists of 3-layer neural network and the right side of the figure consists of a Convolutional neural network. It will arrange its neurons in 3D that is height, width and depth which are the layers of network. In this fig 1.6 the depth shows the image and the height and width are the dimensions of the image.

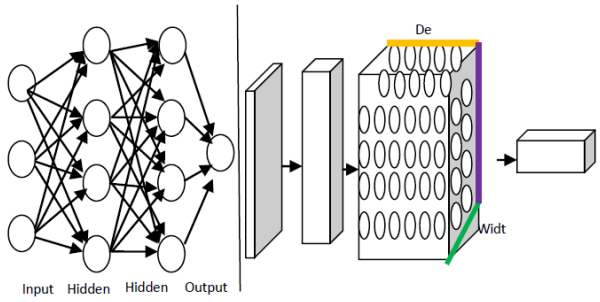

Fig 1.6: Convolutional Neural Network

3.1.7 Feed Forward Neural Networks: The network having no loops is known as feed forward network. In this neurons are organized in different layers or single layers. But all these layers have the unidirectional connections with each and every neuron of the network [15]. So, these are networks are static in their behavior and the output of these networks is totally depends upon the present input pattern. The architecture of multi layer network comprises with an input layer, output layer and the intermediate layer or also known as hidden layer.

x_i: Input Neurons y_m: Hidden Neurons z_n: Output Neurons w_{ij}: Input hidden layer weights w_{jk}: Output hidden layer weights

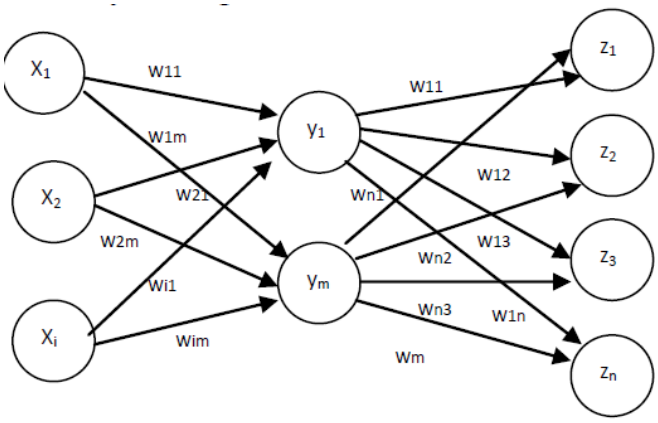

Fig 1.7 Feed Forward Neural Networks

The units of the hidden layer are known as hidden neurons. Its aim is to perform the intermediate computations of input layer and the output layer. The input layer neurons are linked with the hidden layer then these neurons are known as input hidden layer weights and those hidden layer neurons which are linked with the output layer are known as hidden output layer neurons. It is shown in fig 1.7 shown above.

4.1. Proposed Methodology And Flow Diagram: The architectural view of proposed methodology is divided into 3 parts i.e. matriculation development or it is also known as enrollment phase, next is sign in phase and the last phase is performance calculation phase. It is shown in fig given below initially the encapsulation step is performed where you can capture the image then face detection is performed and after this feature extraction is performed and feature template is created and all these features are stored in template database which are used for the comparison at the time of sign in process. Coming up to the another phase that is sign in process again the image is captured from the video and then feature extraction is performed and the feature template is compared with the template database and if there is a match then the sign in process is successful otherwise failure. The comparison is performed with the proposed methodology i.e., a fusion of RBF, Hopfield and AlexNet. [16]

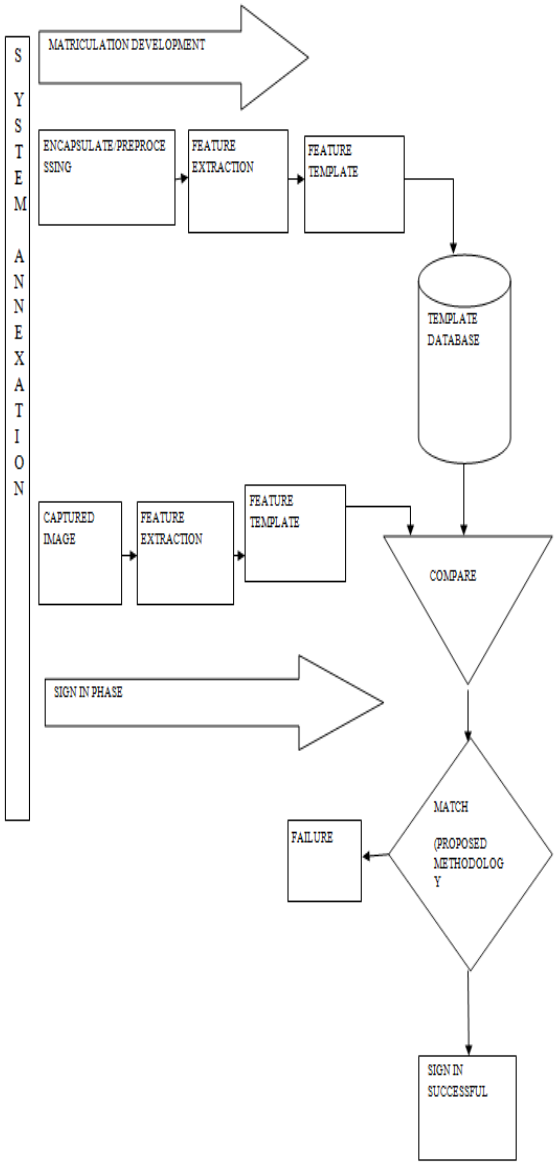

Fig 1.8 Architectural view of Proposed Method

4.1.3. Result Analysis: To perform any of the evaluation the primary need of any project is its dataset. The testing and training dataset is shown in table 4.1 given below which shows the testing classes, training classes, total no of images on which we have to perform the evaluation and also the total no of classes which are supposed to be divide.

Table 4.1: Dataset of Images

Major Class	Training Images	Testing Images	Total No.Of Images
Class 1	321	20	341
Class 2	351	11	362
Class 3	212	12	224
Class 4	100	15	115
Class 5	97	13	110

The Google Collaboratory tool and phython is used to evaluate the performance of the proposed model for the given dataset. The ReLU activation function is used for the same. Total no of epochs are 50 and the validation steps are 100.The accuracy for the proposed model after the completion of the validation steps is approx. 99.7%.

IV. CONCLUSION

The face recognition is a subject of machine learning and pattern recognition. Among face recognition methods the most popular method is neural networks but we also can say this it will depend on the type of application. This paper will also mention the state of art face recognition image database and face technology benefits in various applications. In this paper the author proposed a high performance, agile and low cost face recognition system. The advantage of this system is that the author has created his own database so that this research is good for real time conditions and also this research is compared to the other research papers and it is observed that this research is comparatively good in compare to the similar research areas.

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