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Review on Face Recognition Using Fuzzy Logic Hidden Markov and Neural Network Techniques

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Abstract: ***In the modern years face recognition has grown up to be one of the mainly successful machine learning applications . Face detection is a serious problem as an outcome of the wide difference of face appearance. It is required for business and law rescue consequently many researchers are interested in this searching area. Moreover, many different face detection models have developed and many different methods have applied as well various image features were selected. However, in this paper we outline the strategy and the description as well the performance of three remarkable classification techniques specifically fuzzy logic, Hidden Markov and Neural network that have been implemented in face recognition task. The result showed that Neural network is a competitive technique based on the study of its performance as well the advantages and disadvantages of considered face detection methods.***

Keywords: Face Recognition, Fuzzy logic, Hidden Markov, Neural network

1. Introduction

Face detection has become an attractiveness research of machine vision in recent years. The reason for popularity of face recognition is that it can be applied in a wide range of fields, such as identity validation, access control and so on [1]. However, different algorithms with different feature have been projected for face detection. Although a large amount challenges require to be line out variety in lighting of the scene, changes in pose, orientation and appearance are examples of some issues to be taken carefully[2]. It noticeable that the most important concern in face recognition system is to have high accuracy that's why the face recognition has taken the attention of researchers.[3]presented a suggestion of up to date of face recognition tools. They introduced the difficulty and the feature challenge in face detection as well some mechanisms system to handle the addressed problem. They state that current face recognition systems have reached a certain degree of maturity when operating under constrained conditions; however, they are far from achieving the ideal of being able to perform adequately in all the various situations problem.[4] survey study of how face recognition system has done using ANN, CBIR, LDA and PCA techniques. They suggest that two methods can be merging to get the batter results in revere to accuracy & broader classes.[5]explain the essential elements of the neural and fuzzy logic and how they have been used in face detection problem . The researcher come up with that neural network approach BPN and fuzzy approaches such as linguistic variables and if than rules will give high recognition precision.[6]introduced a novel fuzzy facial expression recognition system. Facial features are mathematical characteristics of 5 basic regions which were produced using 10 lines on the image of neutral face. The system uses triangular membership functions for both input and output. On the other hand, Neural networks have been applied productively in numerous pattern recognition problems, such as visual character recognition, entity recognition, and autonomous robot driving.[7]Shows how the artificial neural network can be applied for face recognition system. the network was trained a number of times on different input and noisy images that content faces. Moreover, training a Neural network on diverse sets of noisy images learn the Neural network how to deal with noise. However, the dependability of the neural network pattern recognition system is considered by testing the network with hundreds of input images with changeable capacities of noise[7]. [8] presents Fuzzy membership function for detecting human faces in a complex background. The model is performed by using color images The system is based on the visual information of the face and is commenced with the detection of face regions by connected component analysis of the skin color segmentation of images in HSV,YCBCR,YIQ color model and the Fuzzy membership function. In the other hand, [9] provides a model based on HMM to reduce the computational difficulty of preceding HMM based face detection method. They resulted that using HMM for modeling human face could be an encouraging process for face recognition in a broader range of image orientation and facial expressions. In this paper we review study of three different tools used for face recognition task furthermore, the characters and performance of these techniques involved in this article.

2. Material and Methods

There have been various approaches used for handling the face detection problem, on the other hand, we introduce the most remarkable approaches namely fuzzy logic, Hidden Markov and Neural network. Accordingly this section will involve the description and the strategies of these approaches as well some of its models of face recognition.

2.1 Fuzzy logic

Fuzzy logic is more common than binary logical methods. Though is required to deal with compound problems in searching area. it provides a base for the development of new tools for dealing with natural languages and knowledge representation. Fuzzy logic is abstractly simple to understand. Furthermore, fuzzy logic has been applied to

many fields from control theory to intelligence it also has been employed to handle the concept of partial truth, where the truth value may range between completely true and completely false in term of human reasoning. Fuzzy logic uses the complete period between 0 (false) and 1(true). Fuzzy logic got great acceptance of the various fields so, it is desired in face recognition task. Fuzzy logic affords an easy way to arrive at a definite confusing, inaccurate, noisy, or omitted input information The fuzzy logic system consists of:

- Fuzzification: Using a set of input membership function for the extracted features to values from 0 to 1.In figure (1) different shapes of frequently used function.
- Fuzzy Inference System: Using fuzzy set theory to map features to classes as in figure (2).
- Deffuzzification: Using to convert inputs of the fuzzy system after treatment with the inference rules

One example of a fuzzy rule:
Rule: IF x1 is true AND x2 is false AND ... AND xn is false THEN y is false

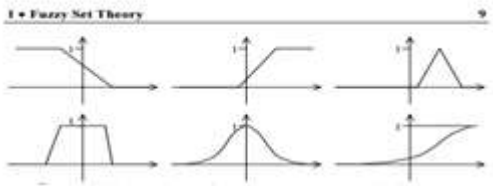

Figure 1: Various shapes of commonly used member function

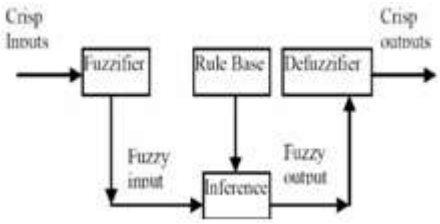

Figure 2: Fuzzy inference system

2.2 Hidden Markov Model (HMM)

HMM is a set of fixed states with related probability distributions. Furthermore , is a capable technique that works well for images with different in illumination. It stands for a supplementary fixed size method for face detection**.** Basically the result is visible to the external user not the states and therefore the name Hidden Markov Model. The HMM consists of two organized processes: First, underlying, unobservable Markov chain with a finite number of states and initial state probability distribution. Second, a set probability density function related with each state.HMM is defined as the triplets , $\pi = (A, B, \mu)$ Where
B: Observation symbol probability matrix
A: State transition probability matrix
μ : Initial state distribution

HMM during one dimensional is characterized by an embedded one dimensional HMM[10] as in figure (3 and 4).However the structure is not completely related in two dimensions, therefore it is only pseudo two-dimensional HMM. Figure (5) shows an example of face detection result using HMM method.

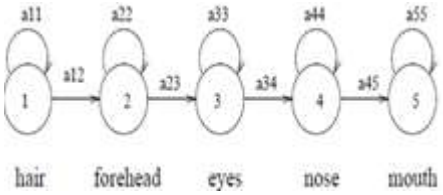

Figure 3: left to right one-dimensional HMM for face recognition

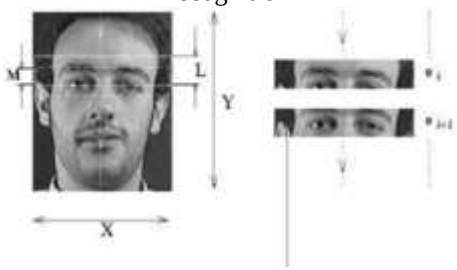

Figure 4: One –dimensional HMM

Figure 5: Recognition result using HMM

2.3 Neural Network

Artificial Neural Networks have been effectively engaged in various areas of artificial intelligence. Such as instance, NLP, image processing, pattern recognition and classification tasks. Neural networks have become an important tool for classification. The feasibility of training a system to capture the complex class density of face patterns that led to use neural networks for face detection. Neural network is a very powerful and robust classification technique which can be used for predicting known and un unknown data. Neural Networks contain a parallel interconnections of simple neural processors. Figure (6) illustrates an instance of a single neural processor, or neuron. Neurons have numerous weighted inputs, which each input (p1, p2, p3… pm) has a correlated weighting (w1, w2, w3… wm) according to its importance

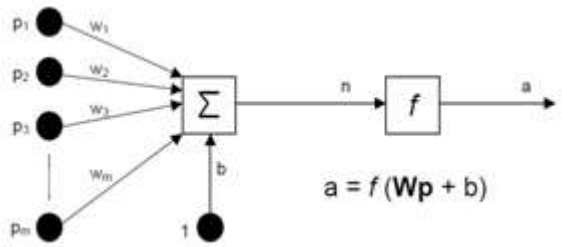

Figure 6: A single neuron example neural network

Problems that are further compound can be recognized by count more neurons, form in multiple layers of a number of neurons, inter connected using a weighted matrix. bonus layers of neurons not related straight to the inputs or the outputs are called hidden layers (layers 1 and 2 in figure 7).

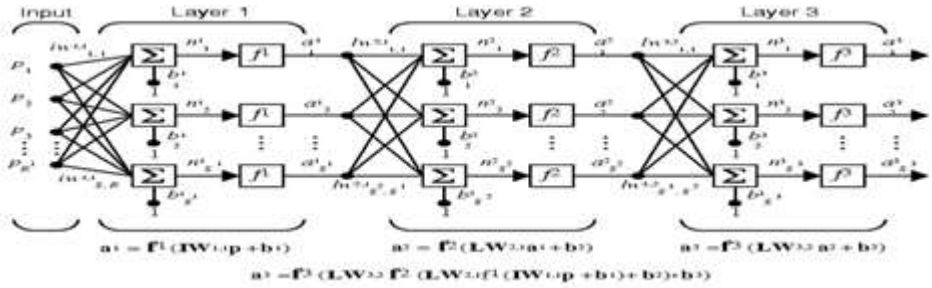

Figure 7: An example of a three layer network with multiple neurons per layer taken from Matlab documentation

Three procedures to process the neural network for face detection:

1) Design and construction of a neural network
2) Selection of training data, factors, and training
3) Examining images to find faces

3. Result and Dissection

In the presented paper we have offered the most common and successful classifier techniques that implemented in face recognition task. The best model is one with not many constraints as likely that can hold the behavior of the training data set[11]. However, the experimental result presented in the next tables to investigate and summarize the performance of some different face detection models of each classifier technique. In addition we will provide a table that contains the most common advantage and disadvantage of each method. It seem that each method has its particular process that can be deal with face detection problem in different aspect. The study undertakings of Fuzzy logic in recent years have confirmed that its strength to handle the difference in feature and can be deal with ambiguity information as well its performance is reasonable and satisfy. As shown in table(1) Fuzzy logic is confirmed to be robust technique.

Table 1: Examples of face recognition systems using Fuzzy logic

The aurther	Process tool	input	output	advantage	test	Accuracy of recognition
[6]	Fuzzy if then rule	Staticimage	Expression of face	a good mathematical framework to deal with uncertainty of information.	JAFFE Data base	92.3%
[12]	MATLAB7.6	Digital image	Edge of an image	Less time elapsed 23.0313	GTVA Data base	Better than existing fuzzy method
[13]	Matlab2010.	Real image	locate all regions of the face	it provides robustness to the variation in the feature which makes the proposed method is robust.	ORL database	94.74%
[8]	The Fuzzy Membership function	color images	face regions in an image	it can deal with illumination changes and moderate rotations	simple and complex backgrounds for different types of face and non-face	above 96%

In addition, based on the reconsider study in current research the HMM has proved its capability to handle differences in balance which is challenging issue projected for each face detection models. As confirmed in table(2) if HMM given a strong features it will carry good results. As exposed also that HMM is a promising and efficient technique based on its performance in face image detection. As well it gives a good exchange among simplicity and quality as stated in table(2).

Table 2: Examples of face recognition systems using hidden markov method

The author	Process Tool	Input	output	Advantage	Test	Accuracy Of recognition
[9]	One diminution HMM	Gray scale face images	Face image	Reduces the computational complexity of HMM face recognition system	Olivetti Research Ltd (400images)	Recognition rate 84%
[15]	Pseudo two-dimension HMMs	Image for face	Photo of face	process images using HMM, the temporal or space sequences are to be considered	ORL Data base	99.8 %
[16]	Markov modeling of the face images	Set of Face images	Human face	Its ability to handle variations in scale which is challenging problem for any face detection system	MIT database	The correct detection rate 90%

[17]	Hidden Markov Based classifier	Sample image (training data)	Classified faces	If HMM gets robust features it will carry good results as well HMM gives a good exchange between simplicity and quality	ORL dataset	Achieved remarkable results. 99% classification rates
					XM2VTS database	HMM confirms its worth on images that contain a quite number of variations. above 90 %classification

Moreover, the recent wide study activities in neural classification have recognized that neural networks are talented option to a variety of straight classification methods. The performance of neural network as can be seen in table (3) can reach to a complete recognition accuracy. To sum up neural network is a challenge classifier based on its capability to handle unseen data and its efficiency for detecting images accurately

Table 3: Examples of face recognition models using

The author	Process tool	input	output	advantage	test	Accuracy of recognition
[18]	artificial neural networks	face regions	Classify regions of faces as a face or non-face.	Allowing the detection of upright, tilted, and non-frontal faces in cluttered images.	set of images called the FERET.	between 81.9% and 90.1% of 130 test images 79.6% over several large test sets,
						the non-frontal detector finds 56.2% of 96 faces
[7]	artificial neural network	noisy images (CMU faces, MIT faces & Web faces)	the face which the network picked (correctly(	it saves time and money, and eliminates the requirement that a human perform.	faces with different kind of noise	96.81%
[19]	Back propagation Neural network (BPN)&Radial Basis function network(RBF) implemented I in MATLAB	Unknown faces	Human faces Recognition	These combination methods give very high recognition accuracy	Database contains 90 images,64 for training and the remaining for testing	96.66% recognition rateusing BPN
						98.88% using BPN+RBF
[20]	Back propagation Neural Network	Information from lowest 4 sub bands from five training images	finding faces in images	The operation on multiple scale will be fine	Images not in the training	Misclassification rate 24%

Based on the study of the three mentioned classifiers in this paper for solving face recognition task, table (4) covers the most common advantage and disadvantage of each approach. We projected that each method can be appropriate in a particular side of the presented mater as stated in table (4). For example neural network can be used for predicting not the known data but also the unknown data while HHM appropriate for images with differences in lighting. Likewise Fuzzy logic suitable for dealing with natural languages and knowledge representation. on the other hand, there are some drawback for each methods wanted to be improved.

Table 4: Advantage and disadvantage of Fuzzy logic, Neural Network and Hidden Markov methods

Techniques	advantage	disadvantage
Fuzzy Logic	It can deal with compound problems. Abstractly simple to understand. provides a base for the development of new tools for dealing with natural languages and knowledge representation.	Depends on previous knowledge for decision limits
Neural Network	It successes in many area of artificial intelligence. Feasibility of training a system to capture the complex class conditional density of face patterns. Robust classification technique used for predicting not only for the known data, furthermore for the unknown data.	the network architecture has to be broadly adjusted (figure of layers, figure of nodes, learning rates, etc
Hidden Markov	It is a promising method that works well for images with variations in lighting, facial expression	Computationally very complex when data two dimensional

4. Conclusions

The report provides a concise investigation of some broadly used classification approaches to handle face image detection problem. Face recognition has gained attention of the researchers due to its applications in different domains. Although face detection is not an easy task consequently there are a lot of works that require to be completed in this area. Conversely, the present study demonstrated that each method has its individual advantage that can be deal with face detection problem in different aspect. In another side there are some drawbacks for each method that wanted to work on.However, neural network has proved its ability to

be a competitive method. Our future work could be directed toward study other different techniques.

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