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 lightning 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 better 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, YCBBR, 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).
- **Defuzzification**: 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

HMM. Figure (5) shows an example of face detection result using HMM method.

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

- **A**: State transition probability matrix
- **B**: Observation symbol probability matrix
- **\( \mu \)**: 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

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

Figure 4: One –dimensional HMM

Figure 5: Recognition result using HMM

Figure 6: A single neuron example neural network
Problems that are further compound can be recognized by counting more neurons, forming multiple layers of a number of neurons, interconnected 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).

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

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

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

<table>
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<th>output</th>
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<th>test</th>
<th>Accuracy of recognition</th>
</tr>
</thead>
<tbody>
<tr>
<td>[18] artificial neural networks</td>
<td>face regions</td>
<td>Classify regions of faces as a face or non-face.</td>
<td>Allowing the detection of upright, tilted, and non-frontal faces in cluttered images.</td>
<td>faces with different kind of noise</td>
<td>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</td>
<td>96.81%</td>
</tr>
<tr>
<td>[7] artificial neural network</td>
<td>noisy images (CMU faces, MIT faces &amp; Web faces )</td>
<td>the face which the network picked (correctly)</td>
<td>it saves time and money, and eliminates the requirement that a human perform.</td>
<td>faces with different kind of noise</td>
<td>96.66% recognition rateusing BPN</td>
<td>98.88% using BPN+RBF</td>
</tr>
<tr>
<td>[19] Back propagation Neural network (BPN)&amp;Radial Basis function network(RBF) implemented in MATLAB</td>
<td>Unknown faces</td>
<td>Human faces Recognition</td>
<td>These combination methods give very high recognition accuracy.</td>
<td>Database contains 90 images, sixty four for training and the remaining for testing</td>
<td>98.88% using BPN+RBF</td>
<td></td>
</tr>
<tr>
<td>[20] Back propagation Neural Network</td>
<td>Information from lowest 4 sub bands from five training images</td>
<td>finding faces in images</td>
<td>The operation on multiple scale will be fine</td>
<td>Images not in the training</td>
<td>98.88% using BPN+RBF</td>
<td></td>
</tr>
<tr>
<td>[17] Hidden Markov Based classifier</td>
<td>Sample image (training data)</td>
<td>Classified faces</td>
<td>If HMM gets robust features it will carry good results as well HMM gives a good exchange between simplicity and quality</td>
<td>XM2VTS database</td>
<td>HMM confirms its worth on images that contain a quite number of variations, above 90 %classification</td>
<td></td>
</tr>
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</table>

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

<table>
<thead>
<tr>
<th>Techniques</th>
<th>advantage</th>
<th>disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuzzy Logic</td>
<td>It can deal with compound problems. Abstractly simple to understand.</td>
<td>Depends on previous knowledge for decision limits</td>
</tr>
<tr>
<td></td>
<td>It provides a base for the development of new tools for dealing with natural languages and knowledge representation.</td>
<td></td>
</tr>
<tr>
<td>Neural Network</td>
<td>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.</td>
<td>the network architecture has to be broadly adjusted (figure of layers, figure of nodes, learning rates, etc)</td>
</tr>
<tr>
<td>Hidden Markov</td>
<td>It is a promising method that works well for images with variations in lighting, facial expression</td>
<td>Computationally very complex when data two dimensional</td>
</tr>
</tbody>
</table>

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

References


