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FACE RECOGNITION WITH NOVEL SELF ORGANIZING MAP USING NEURAL NETWORK

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ABSTRACT

Faces represent complex, multidimensional, meaningful visual stimuli and developing a computational model for face recognition is difficult. In recent years, face recognition has received attention from both research communities and the market. A lot of face recognition algorithms, along with their medications, have been developed during the past decades. A number of typical algorithms are presented. In this paper, we propose to label a Self-Organizing Map to measure image similarity. To manage this goal, we feed facial images associated to regions of interest into the neural network. At the end of learning step, each neural unit is tuned to a particular facial image prototype. The Self-Organizing Map provides a quantization of the image samples into a topological space where inputs that are nearby in the original space are also nearby in the output space, thereby providing dimensionality reduction and in variance to minor changes in the image sample. This paper presents a novel Self-Organizing Map for face recognition. The SOM method is trained on images from one database. A face Recognition system is a computer application for automatically identifying or verifying a person from a digital image or a video frame from a video source. One of the way is to do this is by comparing selected facial features from the image and a facial database. It is typically used in security systems and also compared to other biometrics like fingerprint or eye iris recognition systems.

KEYWORDS:-Face recognition, Self-Organizing Map (SOM), neural network, artificial intelligence, scope, etc.

INTRODUCTION

Facial expression is one of the most natural and direct means for humans to communicate their emotions. Facial expression recognition means finding the expressions of an image and recognizes which expression it is such as happy, sad, angry and neutral. Some application area related to face and its expression includes personal identification, access control, video calling and teleconferencing and human computer interaction. Automatic facial expression recognition has been used in various real life applications such as security systems, interactive computer simulations and computer vision. Face detection and face localization is the primary problem in the automatic identification system of facial expression, including the face into simple background and complex background. In 1971, Ekman and Frisen discovered six different facial expressions that are universally accepted as basic emotion include happiness, sadness, fear, disgust, surprise and anger along with neutral face. Facial expression recognition system solves the problem of face detection and feature extraction. Commonly three main steps are followed for expression recognition. First, detection of face boundary, second feature extraction and the last is facial recognition. Feature extraction referred to facial expression information. It is often useful to have a machine perform pattern recognition. In particular, machines which can read face images are very cost effective. A machine that reads passenger passports can process many more passports than a human being in the same time. This kind of application saves time and money, and eliminates the requirement that a human perform such a repetitive task. This document demonstrates how face recognition can be done with a back propagation artificial neural network.

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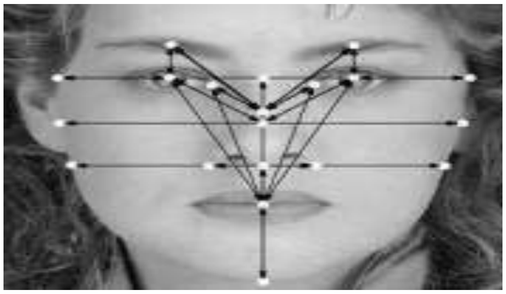

Figure 1: Some facial points and distances between them are used in face recognition.

Pattern recognition is a modern day machine intelligence problem with numerous applications in a wide field, including Face recognition, Character recognition, Speech recognition as well as other types of object recognition. The field of pattern recognition is still very much in it is infancy, although in recent years some of the barriers that hampered such automated pattern recognition systems have been lifted due to advances in computer hardware providing machines capable of faster and more complex computation. Face recognition, although a trivial task for the human brain has proved to be extremely difficult to imitate artificially. It is commonly used in applications such as human-machine interfaces and automatic access control systems. Face recognition involves comparing an image with a database of stored faces in order to identify the individual in that input image. The related task of face detection has direct relevance to face recognition because images must be analyzed and faces identified, before they can be recognized. Detecting faces in an image can also help to focus the computational resources of the face recognition system, optimizing the systems speed and performance.

Face detection involves separating image windows into two classes; one containing faces (targets), and one containing the background (clutter). It is difficult because although commonalities exist between faces, they can vary considerably in terms of age, skin color and facial expression. The problem is further complicated by differing lighting conditions, image qualities and geometries, as well as the possibility of partial occlusion and disguise. An ideal face detector would therefore be able to detect the presence of any face under any set of lighting conditions, upon any background. For basic pattern recognition systems, someof these effects can be avoided by assuming and ensuring a uniform background and fixed uniform lighting conditions. This assumption is acceptable for some applications such as the automated separation of nuts from screws on a production line, where lighting conditions can be controlled, and the image background will be uniform. For many applications however, this is unsuitable, and systems must be designed to accurately classify images subject to a variety unpredictable conditions.

A variety of different face detection techniques exist, but all can be represented by the same basic model, depicted in figure 2.

Figure 2: A generic representation of a face detection system.

Each technique takes a slightly different approach to the face detection problem, and although most produce encouraging results, they are not without their limitations.

LITERATURE SURVEY

The Literature survey describes some of the different approaches to face detection, and should give the reader an insight into some of the techniques being applied in the field. Feature-based and image-based approaches are discussed and both have a great deal to offer the face detection problem. Feature-based systems are better suited to real-time application where the limitations of the Image-Based detectors restrict their use. Image-based systems have been shown to be more robust and more powerful, and have many uses. Despite reports of immense computational expense, recent attempts to optimize algorithms, coupled with advances in computer hardware, have reduced processing time dramatically.

Face detection is still most commonly applied as a pre-processing stage in face recognition systems. It has many potential applications in a wide range of fields, some of which are here. Accompanied by voice data and fingerprints, face recognition is often an integral part of Biometric Identification systems, with model based, template-based and Eigen face methods all in development. Popularity with video conferencing, a technology used extensively for worldwide corporate communication, has driven research for improvements in the area. The integration of face detection, allows a single camera to track a speaker, or a multiple camera set-up, to choose which camera to use based upon the

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orientation of the speaker's face, improving the experience for those participating. The increasing popularity of digital cameras and internet improvements, have spurred a growth in the amount and accessibility of digital information. Efforts have been made to catalogue this digital content for search and retrieval purposes, including 'Name-It' and the 'Informedia project', both of which utilize the face detection systems of Rowley et al, as does Web seer, as part of an image based search engine.

The survey details many different approaches, although, a comparative analysis of the technique is not possible, due to the absence of a standard test procedure. The reported results in each case are from tests carried out on different test sets under different conditions, making performance comparison an impossible task.

NEURAL NETWORK

The network will receive the 960 real values as a 960-pixel input image (Image size ~ 32 x 30). It will then be required to identify the face by responding with a 94-element output vector. The 94 elements of the output vector each represent a face. To operate correctly the network should respond with a 1 in the position of the face being presented to the network all other values in the output vector should be 0. In addition, the network should be able to handle noise. In practice the network will not receive a perfect image of face which represented by vector as input. Specifically, the network should make as few mistakes as possible when classifying images with noise of mean 0 and standard deviation of 0.2 or less.

To model our way of recognizing faces is imitated somewhat by employing neural network. This is accomplished with the aim of developing detection systems that incorporates artificial intelligence for the sake of coming up with a system that is intelligent. We can see the suggestion of a semi-supervised learning method that uses support vector machines for face recognition. There have been many efforts in which in addition to the common techniques neural networks were implemented. For example in a system was proposed that uses a combination of Eigen faces and neural network. Firstly the dimensionality of face image is reduced by the Principal component analysis (PCA) and later the recognition is done by the Back propagation Neural Network (BPNN).

A. NEURAL NETWORKS FOR ACCESS CONTROL:

Face Recognition is a widespread technology used for Access Control. The task is stated as follows. There is a group of authorized people, which a recognition system must accept. All the other people are unauthorized or "aliens" and should be rejected. We can train a system to recognize the small group of people that is why application of a Multilayer Perceptron (MLP) Neural Network (NN) was studied for this task. Configuration of our MLP was chosen by experiments. It contains three layers. Input for NN is a gray scale image. Number of input units is equal to the number of pixels in the image. Number of hidden units was 30. Number of output units is equal to the number of persons to be recognized. Every output unit is associated with one person. NN is trained to respond "+1" on output unit, corresponding to recognized person and "-1" on other outputs. We called this perfect output. After training highest output of NN indicates recognized person for test image. Most of these experiments were passed on ORL face database. Any input image was previously normalized by angle, size, position and lighting conditions. We also studied other image representations: a set of discrete cosine transform coefficients and a gradient map. Using DCT first coefficients we reduce the sample size and significantly speedup the training process. DCT representations allow us to process JPEG and MPEG compressed images almost without decompression. A gradient map allows to achieve partial invariance to lightning conditions. In our experiments with NNs we studied several subjects. We explored thresholding rules allowing us to accept or reject decisions of NN. We introduced a thresholding rule, which allow improving recognition performance by considering all outputs of NN. We called this "sqr" rule. It calculates the Euclidean distance between perfect and real output for recognized person. When this distance is greater than the threshold we reject this person. The best threshold we reject this person. Otherwise we accept this person. The best threshold is chosen experimentally.

B. ARCHITECTURE OF NEURAL NETWORK:

The neural network needs 960 inputs and 94 neurons in output layer to identify the faces. The network is a two-layer log-sigmoid/log-sigmoid network. The log-sigmoid transfer function was picked because its output range (0 to 1) is perfect for learning to output Boolean values (see figure3).

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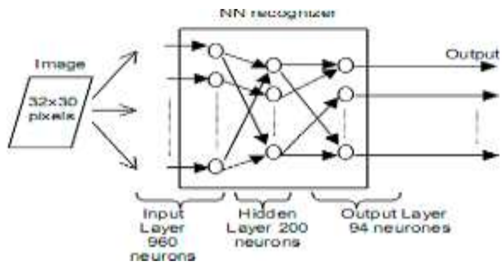

Figure 3: Architecture of neural network.

The hidden layer has 200 neurons. This number was picked by guesswork and experience. If the network has trouble learning, then neurons can be added to this layer. The network is trained to output a 1 in the correct position of the output vector and to fill the rest of the output vector with 0's. However, noisy input images may result in the network not creating perfect 1's and 0's. After the network has been trained the output will be passed through the competitive transfer function. This function makes sure that the output corresponding to the face most like the noisy input image takes on a value of 1 and all others have a value of 0. The result of this post processing is the output that is actually used.

THE SELF ORGANIZING MAP

Maps are an important part of both natural and artificial neural information processing systems. Examples of maps in the nervous system are retinotopic maps in the visual cortex, tonopic maps from the skin onto the somatosensoric cortex. The self-organizing map, or SOM, introduced by Teuvo Kohonen is an supervised learning process which learns the distribution of a set of patterns without any class information. A pattern is projected from an input space to a position in the map – information is coded as the location of an activated node. The SOM is unlike most classification or clustering techniques in that it provides a topological ordering of the classes. Similarity in input patterns is preserved in the output of the process. The topological preservation of the SOM process makes it especially useful in the classification of data which includes a large number of classes. In the local image sample classification, for example, there may be a very large number of classes in which the transition from one class to the next is practically continuous (making it difficult to define hard class boundaries).

A. ALGORITHM:

We give a brief description of the SOM algorithm. The SOM defines a mapping from an input space R^n onto a topologically ordered set of of nodes, usually in a lower dimensional space. An example of a two-dimensional SOM is shown in figure 4. A reference vector in the input space,

m_i= $[\mu_{i1,}\mu_{i2}, \ldots\ldots \mu_{in}]$* $[\mu_{i1,}\mu_{i2}, \ldots\ldots \mu_{in}]$ ε R^n,

is assigned to each node in the SOM. During training, each input vector, x, is compared to all of the m_i, obtaining the location of the closest match m_c. The input point is mapped to this location in the SOM. Nodes in the SOM are updated according to:

$$m_i(t+1) = m_i(t) + h_{ci}(t)[x(t) - m_i(t)]$$

Where t is the time during learning and $h_{ci}(t)$ is the neighborhood function, a smoothing kernel which is maximum at m_c. $h_{ci}(t)$ =h ($|r_c - r_i|$, t), where r_c , r_i represent the location of the nodes in the SOM output space. A widely applied neighbourhood function is:

$$h_{ci} = \alpha(t) \exp\left(-\frac{|\mathbf{r}_c - \mathbf{r}_i|^2}{2\sigma^2(t)}\right)$$

where ά(t) is a valued learning rate and σ(t) defines the width of the kernel. They are generally both monotonically decreasing with time. The use of the neighborhood function means that nodes which are topographically close in the SOM structure are moved towards the input pattern along with the winning node. This creates a smoothing effect which leads to a global ordering of the map. Note that σ(t) should not be reduced too far as the map will lose its topographical order if neighboring nodes are not updated along with the closest node. The SOM can be considered a non-linear projection of the probability density p(x).

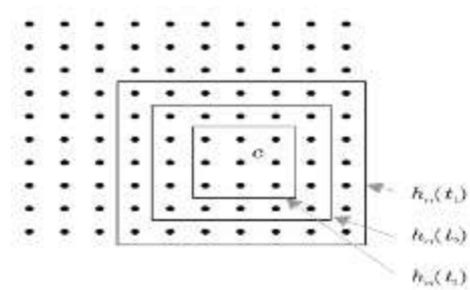

Figure 4: A two-dimensional SOM showing a square neighborhood function which starts as $h_{ci}(t1)$and reduces in size to $h_{ci}(t3)$ over time.

B. IMPROVING THE BASIC SOM:

The original self-organising map is computationally expensive due to:

1. In the early stages of learning, many nodes are adjusted in a correlated manner. Luttrel proposed a method, which is used here, that starts by learning in a small network, and doubles the size of the network periodically during training. When doubling, new nodes are inserted between the current nodes. The

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weights of the new nodes are set equal to the average of the weights of the immediately neighboring nodes.
2. Each learning pass requires computation of the distance of the current sample to all nodes in the network, which is O(N). However, this may be reduced to O(log N) using a hierarchy of networks which is created from the above node doubling strategy.

NEURAL NETWORK

To create a neural network that can handle noisy input images it is best to train the network on both ideal and noisy images. To do this the network will first be trained on ideal images until it has a low sum-squared error. Then the network will be trained on 10 sets of ideal and noisy images. The network is trained on two copies of the noise-free database at the same time as it is trained on noisy images. The two copies of the noise free database are used to maintain the network's ability to classify ideal input images. Unfortunately, after the training described above the network may have learned to classify some difficult noisy images at the expense of properly classifying a noise free image. Therefore, the network will again be trained on just ideal images. This ensures that the network will respond perfectly when presented with an ideal face. All training is done using back propagation with both adaptive learning rate and momentum.

A. TRAINING WITHOUT NOISE:

The network is initially trained without noise for a maximum of 10 000 epochs or until the network sum-squared error falls below 0.1 (see this figure).

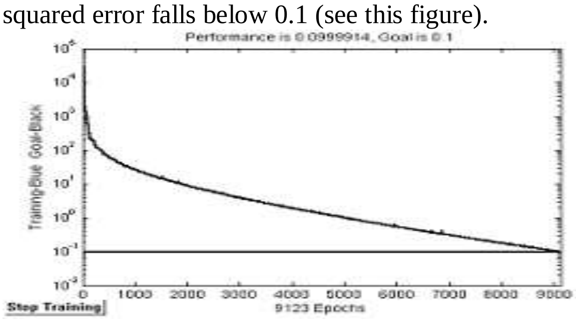

Figure 5: Training without Noise.

B. TRAINING WITH NOISE:

To obtain a network not sensitive to noise, we trained with two ideal copies and two noisy copies of the images in database. The noisy images have noise of mean 0.1 ("salt & pepper" noise) and 0.2 ("Poisson" noise) added to them. This forces the neurons of network to learn how to properly identify noisy faces, while requiring that it can still respond well to ideal images. To train with noise the maximum number of epochs is reduced to300 and the error goal is increased to 0.6, reflecting that higher error is expected due to more images, including some with noise, are being presented.

SYSTEM PERFORMANCE

The reliability of the neural network pattern recognition system is measured by testing the network with hundreds of input images with varying quantities of noise. We test the network at various noise levels and then graph the percentage of network errors versus noise. Noise with mean of 0 and standard deviation from 0 to 0.5 are added to input images. At each noise level 100 presentations of different noisy versions of each face are made and the network's output is calculated. The output is then passed through the competitive transfer function so that only one of the 94 outputs, representing the faces of the database, has a value of 1. The number of erroreous classification is then added and percentages are obtained (see figure):

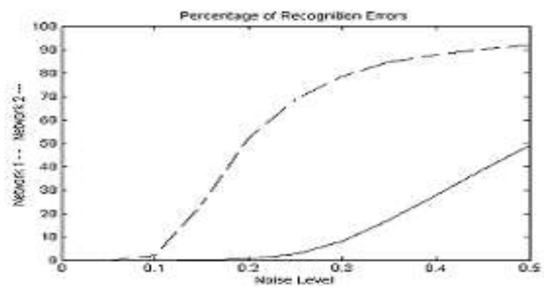

Figure 6: Number of Percentage of Recognition Errors.

The solid line on the graph shows the reliability for the network trained with and without noise. The reliability of the same network when it had only been trained without noise is shown with a dashed line. Thus, training the network on noisy input images of face greatly reduced its errors when it had to classify or to recognize noisy images. The network did not make any errors for faces with noise of mean 0.00 or 0.05. When noise of mean 0.10 was added to the images both networks began to make errors. If a higher accuracy is needed the network could be trained for a longer time or retrained with more neurons in its hidden layer. Also, the resolution of the input images of face could be increased to say, a 640 by 480 matrix. Finally, the network could be trained on input images with greater amounts of noise if greater reliability were needed for higher levels of noise.

SCOPE IN INDIA

1) In order to prevent the frauds of ATM in India, it is recommended to prepare the database of all ATM

customers with the banks in India & deployment of high resolution camera and face recognition software at all ATMs So, whenever user will enter in ATM his photograph will be taken to permit the access after it is being matched with stored photo from the database.

2) Duplicate voters are being reported in India. To prevent this, a database of all voters, of course, of all constituencies, is recommended to be prepared. Then at the time of voting the resolution camera and face recognition equipped of voting site will accept a subject face 100% and generates the recognition for voting if match is found.

3) Passport and vise verification can also be done using face recognition technology as explained above.

4) Driving license verification can also be exercised face recognition technology as mentioned earlier.

5) To identify and verify terrorists at airports, railway stations and malls the face recognition technology will be the best choice in India as compared with other biometric technologies since other technologies cannot be helpful in crowdie places.

6) In defense ministry and all other important places the face technology can be deployed for better security.

7) This technology can also be used effectively in various important examinations such as SSC, HSC, Medical, Engineering, MCA, MBA, B-Pharmacy, Nursing courses etc. The examinee can be identified and verified using Face Recognition Technique.

8) In all government and private offices this system can be deployed for identification, verification and attendance.

9) It can also be deployed in police station to identify and verify the criminals.

10) It can also be deployed vaults and lockers in banks for access control verification and identification of authentic users.

11) Present bar code system could be completely replaced with the face recognition technology as it is a better choice for access & security since the barcode could be stolen by anybody else.

CONCLUSION AND FUTURE WORK

Face recognition is a both challenging and important recognition technique. Among all the biometric techniques, face recognition approach possesses one great advantage, which is its user-friendliness. In this paper, we have given an introductory survey for the face recognition technology. We have covered issues such as the generic framework for face recognition; factors that may affect the performance of the recognizer, and several state-of-the art face recognition algorithms. We hope this paper can provide the readers a better understanding about face recognition, and we encourage the readers who are interested in this topic to go to the references for more detailed study.

Face recognition technologies have been associated generally with very costly top secure applications. Today the core technologies have evolved and the cost of equipments is going down dramatically due to the integration and the increasing processing power. Certain applications of face recognition technology are now cost effective, reliable and highly accurate. As a result there are no technological or financial barriers for stepping from the pilot project to widespread deployment. Though there are some weaknesses of facial recognition system, there is a tremendous scope in India. This system can be effectively used in ATM's, identifying duplicate voters, passport and visa verification, driving license verification, in defense, competitive and other exams, in governments and private sectors. Government and NGOs should concentrate and promote applications of facial recognition system in India in various fields by giving economical support and appreciation. There are a number of directions for future work. The main limitation of the current system is that it only detects upright faces looking at the camera. Separate versions of the system could be trained for each head orientation, and the results could be combined using arbitration methods similar to those presented here. Preliminary work in this area indicates that detecting pro files views of faces is more difficult than detecting frontal views, because they have fewer stable features and because the input window will contain more background pixels.

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