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Face Recognition & Detection Using Image Processing

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Abstract: **Face Recognition appears to be an integral part in human-computer interfaces and eservices. To carry out security and fault tolerance various Image Processing techniques have been incorporated using 'Curse of Dimensionality' that refers to Classifying a pattern with high dimensions that requires a large number of training data. A face recognition & Detection system is a computer-driven application for automatically identifying or verifying a person from still or video image. It does that by comparing selected facial features in the live image and a facial database where the system returns a possible list of faces corresponding to training samples from the database. The nodal points are measured creating a numerical code, called a faceprint, representing the face in the database. Relatively many techniques are used. Image processing technique has been implemented using Feature extraction by Gabor Filters and database training data using Neural Networks. Multiscale resolution and matrix sampling is efficiently performed using this technique.**

Keywords: **Image Processing techniques, Curse of Dimensionality, Faceprint, Feature extraction, Gabor Filters, Neural Networks.**

I. INTRODUCTION

Automated face detection & recognition is an interesting computer vision problem with many commercial and law enforcement applications.Mugshot matching, user verification and user access control, crowd surveillance, enhanced human computer interaction all become possible if an effective face recognition system can be implemented.

While research into this area dates back to the 1960's, it is only very recently that acceptable results have been obtained. However, face recognition is still an area of active research since a completely successful approach or model has not been proposed to solve the face recognition problem.

The face is an important part of who you are and how people identify you. Except in the case of identical twins, the face is arguably a person's most unique physical characteristics. While humans have the innate ability to recognize and distinguish different faces for millions of years, computers are just now catching up.

For face recognition there are two types of comparisons .the first is verification. This is where the system compares the given individual with who that individual says they are and gives a yes or no decision. The second is identification. This is where the system compares the given individual to all the other individuals in the database and gives a ranked list of matches. All identification or authentication technologies operate using the following four stages:

a. Enrollment and also in identification or verification process

b. Extraction: unique data is extracted from the sample and a template is created.

c. Comparison: the template is then compared with a new sample.

d. Match/non match: the system decides if the features extracted from the new Samples are a match or a non match Face recognition technology analyze the unique shape, pattern and positioning of the facial features. Face recognition is very complex technology and is largely software based.

The inadequacy of automated face recognition systems is especially apparent when compared to our own innate face recognition ability. We perform face recognition, an extremely complex visual task, almost instantaneously and our own recognition ability is far more robust than any computer's can hope to be. We can recognize a familiar individual under very adverse lighting conditions, from varying angles or view points. Scaling differences (a face being near or far away), different backgrounds do not affect our ability to recognize faces and we can even recognize individuals with just a fraction of their face visible or even after several years have passed. Furthermore, we are able to recognize the faces of several thousand individuals whom we have met during our lifetime. Over the last few decades many techniques have been proposed for face recognition. Many of the techniques proposed during the early stages of computer vision cannot be considered successful, but almost all of the recent approaches to the face recognition problem have been creditable. According to the research by Brunelli and Poggio (1993) all approaches to human face recognition can be divided into two strategies: (1) Template matching. (2) Geometrical features.

II. LITERATURE REVIEW

Researchers have established that there is difficulty of computer vision, unfortunately it is not possible now, nor will it be possible in the foreseeable future to make a computing machine that actually 'understands' what is sees. The level of vision and understanding which is instinctive to us (humans) is still far out of the reach of our silicon creations.

But technically, why are computer vision problems so hard to solve? After all, while laudable results have been obtained in other artificial intelligence areas such as natural language processing, game theory, forecasting, control and even speech processing. The main difficulty in vision problems is that almost all of them are ill-defined. Another factor is that even well defined computer vision problems may be ill-posed. Hadamard (1923) defined a problem as well posed if: a solution exists, the solution is unique, and the solution depends continuously on the initial data (stability property).

Many computer vision problems are ill-posed because information is lost in the transformation from the 3D world to a 2D image. Therefore, we cannot uniquely reconstruct the 3D representation from the 2D image and multiple solutions are often 'correct'. The complexity of computer vision problems is exacerbated by the fact that we are dealing with huge chunks of data. A typical gray-scale image has 640x480 pixels, each with 8-bit (256) intensity values (gray-levels). Therefore, the size of the whole image is 640x480x8 bits = 2,457,600 bits. Any algorithm with high complexity would be extremely slow in computer vision and we must therefore make an effort to solve these problems using very simple processing techniques. However, even with all these constraints it is possible to get useful results in computer vision by reducing a problem's generality. The computer vision application's problem domain can be restricted to a well-defined structured environment and assumptions could be made about lighting, types of object, etc. Therefore, instead of trying to create a system that is suitable for all vision problems the computer vision and artificial intelligence communities have concentrated on obtaining useful results to real-world, limited applications in vision.

III. METHODOLOGY

Face detection & recognition is a multi-class problem, therefore, in order to using Gabor Filter for classification, Based on a large database of images, Gabor Filter selects a small set of available Gabor features from the extremely large set. The final strong classifier, which combines a few hundreds of weak classifiers (Gabor features), can evaluate the similarity of two face images. The flowchart of recognition process in our system is as following:

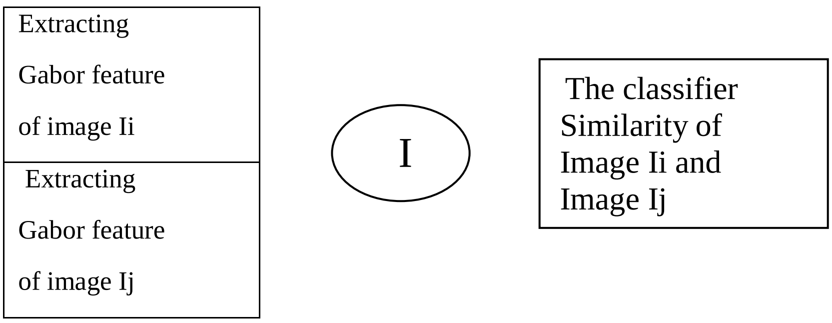

Fig1. The flowchart of the proposed face recognition Method

IV. GABOR FILTER

Features based on Gabor filters have been used in image processing due to their powerful properties. The main characteristics of wavelet are the possibility to provide a multiresolution analysis of the image in the form of coefficient matrices. These are used to extract facial appearance changes as a set of multiscale and multi orientation coefficients. Gabor filter is shown to be robust against noise and changes in illumination. Gabor kernels are characterized as localized, orientation selective, and frequency selective. A family of Gabor kernel is the product of a Gaussian envelope and a plane wave. A 2D Gabor filter is expressed as a Gaussian modulated sinusoid in the spatial domain and as shifted Gaussian in the frequency domain.

The Gabor wavelet representation of images allows description of spatial frequency structure in the image while preserving information about spatial relations with equation defined as,

$P_K(\bar{x}) = k^2/\sigma^2 \exp(-k^2/2\sigma^2 (\bar{x})^2)\,(\exp(i\,k\,\bar{x}) - \exp(-\sigma^2/2))$……………………………..(1)

Where (x, y) is the variable in spatial domain and k is the frequency vector which determines the scale and direction of Gabor functions. k (kx, ky)=(kvcosθw, kvsinθw) and kv=(0, 1, 2, 3, 4) is the discrete set of different frequencies and w=(0, 1, 2...7) is the orientation.

V. NEURAL NETWORKS

Neural Nets are essentially networks of simple neural processors, arranged and interconnected in parallel. Neural Networks are based on our current level of knowledge of the human brain, and attract interest from both engineers, who can use Neural Nets to solve a wide range of problems, and scientists who can use them to help further our understanding of the human brain. Since the early stages of development in the 1970's, interest in neural networks has spread through many fields, due to the speed of processing and ability to solve complex problems. As with all techniques though, there are limitations. They can be slow for complex problems, are often susceptible to noise, and can be too dependent on the training set used, but these effects can be minimized through careful design for which Neural Nets are building up.

Neural Nets can be used to construct systems that are able to classify data into a given set or class, in the case of face detection, a set of images containing one or more face, and a set of images that contains no faces. Neural Networks consist of parallel interconnections of simple neural processors. Figure 2 shows an example of a single neural processor, or neuron. Neurons have many weighted inputs, that is to say each input (p1, p2, p3… pm) has a related weighting (w1, w2, w3… wm) according to its importance. Each of these inputs is a scalar, representing the data. In the case of face detection, the shade of GRAY of each pixel could be presented to the neuron in parallel (thus for a 10x10 pixel image, there would be 100 input lines p1 to p100, with respective weightings w1 to w100, corresponding to the 100 pixels in the input image). Problems that are more complex can be realized by adding more neurons, forming multiple layers of several neurons, interconnected via a weighted matrix (as shown in figure 2). Additional layers of neurons not connected directly to the inputs or the outputs are called hidden layers (layers 1 and 2 in figure 2).

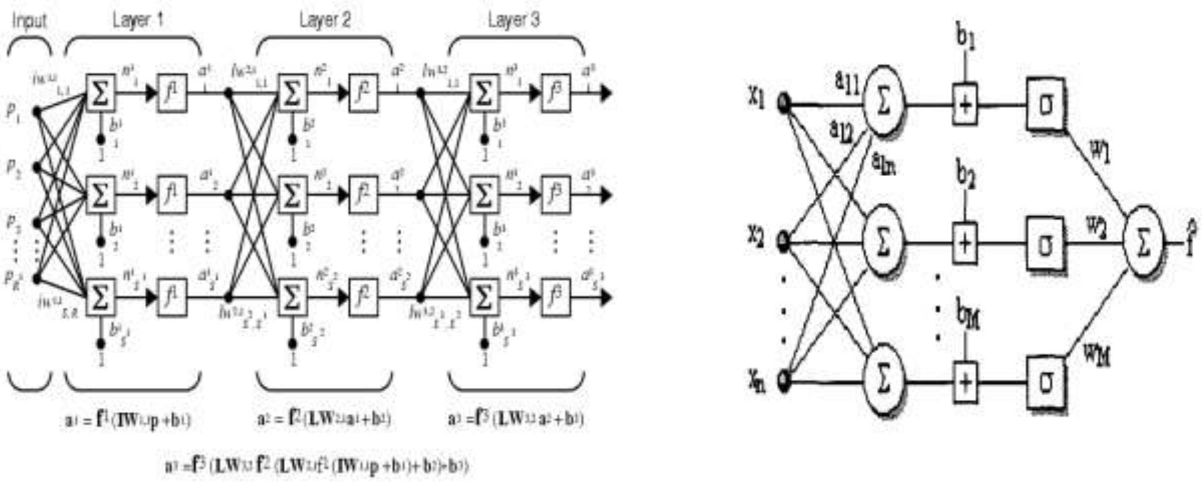

Fig2. Description of Neural Net.

VI. RESULTS

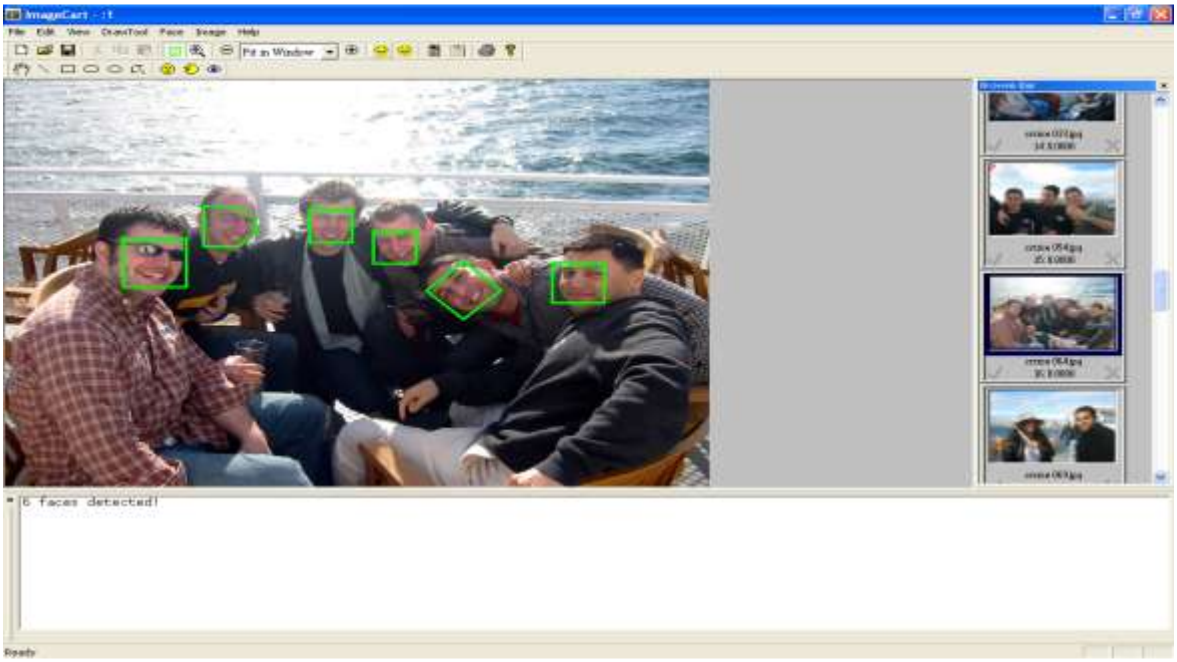

Fig3. Window Highlighted after MATLAB program

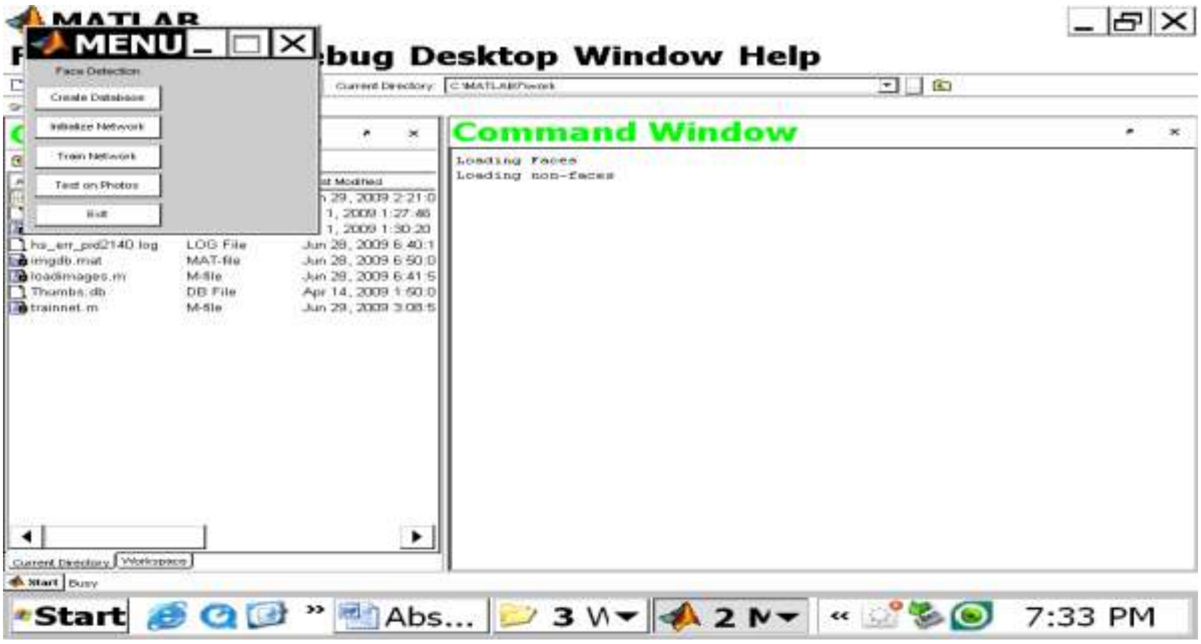

Fig4. Simulation in Command Window after MATLAB program

VII. FUTURE WORK

The world continues to search for ‘who the terrorists are’, resulting in a database of photographs called a ‘Watch list’. However, how can we detect a terrorist threat before they strike when all we have to work from is a photograph? Most agree that facial recognition has a major role to play in providing security at our airports. The ability to recognize an individual before they gain access to a door or board a plane is paramount to effective security. Likewise, the ability to recognize a face at every transit point, such as airport passport control, train stations and metros, is key to our protection. However, the sensitivity of existing 2D facial recognition systems to subject pose and lighting causes the technology to be questionable for both access control and Watch list surveillance applications.

The limitations of 2D facial recognition have been known for some time and were confirmed in the recent Face Recognition Vendor Tests performed in the US under the auspices of the US government. The results are really not too surprising, given the fact that existing algorithms are trying to identify a 3-dimensional object – the face. One conclusion of the study was that while facial recognition is improving, it is still not robust enough to stand on its own. In fact, NIST recommends a combination of facial recognition and fingerprints as the best biometric performance available today, 'true 3D' facial recognition is definitely somewhere in the future – that is, using 3D enrollment cameras, 3D surveillance cameras and 3D facial recognition algorithms – Genex believes that much can be done to improve the performance of existing 2D facial recognition well before true 3D arrives. Rather than force the infrastructure to change by purchasing all-new surveillance cameras and software, the goal is to improve 2D facial recognition sufficiently so that its performance can be significantly enhanced using existing 2D infrastructure.

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