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Omnipresent Surveillance for Efficient Face Detection and Recognition Techniques Using Probabilistic Neural Networks

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ABSTRACT

There has been a tremendous amount of study in the field of biometrics and face recognition being one of it has numerous applications in various areas. Being one of the most important part under computer vision, face detection and recognition also has numerous challenges. Face detection is the process of finding out if there is any face in the image and locating it. Face recognition is identifying the person in the image. This recognition is done by the person's facial characteristics. This paper creates a probabilistic neural networks which is trained on sets of faces and non faces. The Voila Jones algorithm is used to detect faces and Local Binary Pattern is used for feature extraction.

Keywords:- Biometrics, Face detection, Face recognition, Probabilistic Neural Network, Local Binary Pattern

I. INTRODUCTION

With people being more aware on security, the use of video surveillance in on the move. Extraction of useful information from the entire video sequence has always been a matter of concern. Also it is cumbersome for an individual to check all the data by himself. On the other hand detecting a face is an easy task for a human but for a machine, it needs to be trained such that when it is put against a live dataset it should be able to detect the face and recognize the person as well. The traditional method of password and identification cards in computerized access control although being popular can easily be bypassed if the card is stolen or if the password is divulged. Another approach to it is, identifying an individual using biometrics. Biometrics can be face, fingerprint, iris, etc. Fingerprint cannot be detected with wet or greasy or sweaty fingers. Also problems arise in the fingerprint recognition if henna is applied. The iris recognition system has problems like the person has to be close and the infrared light may affect the eye. One of the biggest advantage the face detection system has over the rest is that it is a passive system that seldom requires physical without bothering the person much. In our proposed system, a video sequence is recorded and converted to frames. The most expressive frame is selected for further processing. Voila Jones algorithm is used to detect face. Local Binary Pattern is used for feature extraction purpose. A Probabilistic Neural Network is created for training purposes. The face area is first divided into small regions from which PNN, histograms are extracted and concatenated into a single feature vector.

II. EXISTING WORKS

There are many video surveillance system have already been developed in recent years, but the real time surveillance has been a challenge till date. The Viola–Jones object detection framework [1] is the first object detection framework to provide competitive object detection rates in real-time proposed in 2001 by Paul Viola and Michael Jones. The main advantage of this approach is uncompetitive detection speed while relatively high detection accuracy, comparable to much slower algorithms. Also cascading the classifiers reduces the computation time and improves the detection accuracy.

The existing system makes use of neural networks for the detection and recognition purposes. It consists of face detection and face recognition. In the verification stage, a known face to the system is identified. The system if does not recognize the individual, marks the person as an imposter. It suggests that having a machine platform recognition is useful. Different neural networks types are explained for this purpose thus making use of the ANN[2].

III. PROPOSED SYSTEM

The face recognition part starts with the detection/identification of the face from the frames of the video captured.

3.1 THE VOILA JONES ALGORITHM

We will be using Voila Jones algorithm to detect human faces efficiently. In 2001, Paul Voila and Michael Jones came up with an effective algorithm to detect human faces and its parts. It provides with a framework which is thought as to be the initial and most effective face detection algorithms[3].

Even with advancements in technology, this algorithm still remains the best one to detect faces. The Voila Jones algorithm consists of three main parts:

3.1.1 Integral Image:

The feature computation is done using An integral image is used for feature computation. It is an intermediate representation of an image which computes the rectangle feature rapidly by doing the summation of the pixels of an image at the very beginning to reduce the computational time. The features help in encoding the domain knowledge and above all feature operating systems work faster than the pixels[4]. We apply the extended Haar-like features to construct the space of the weak classifiers and choose modest AdaBoost algorithm to train the strong classifiers which form the cascaded multi-layer ear detector. There are many reasons for using features rather than the pixels directly, for example, the feature based method system operates much faster than a pixel based method. The simple features used in this paper for face detection are reminiscent of Haar basis functions[5].

Fig 3.1: Haar -Like features

The integral image at a location (p,q) can be calculated as:

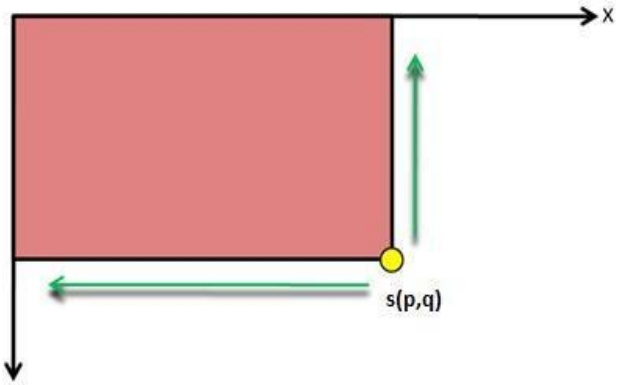
$$ii(p,q) = \sum_{p \le p', q \le q'} i(p'q')$$

where $i(p,q)$ is original image.

The integral image can be computed in one pass over the original image by using the pair of recurrences shown below.

$s(p, q) = s(p, q-1) + i(p, q)$

$ii(p, q) = ii(p-1, q) + s(p, q)$



3.1.2 Adaboost Algorithm

Considering a window of 24x24 size which contains around 160,000 features. All these features if computed, are very expensive and not practically easy. Some of these features are not relevant and may not help in distinguishing a face from a non-face. Although, if combined can give out a relevant result[4]. Adaboost is a technique in which weak classifiers are combined together to form a strong classifier. Every iteration forms a linear combination of the weak classifiers $h_t(x)$. The $h_t(x)$can be thought of as one feature.

i. Consider some images$(x_1, y_1), \ldots, (x_L, y_L)$,where $y\_1 \in \{1,0\}$ indicates positive or negative examples; $g_j\ (x_i)$ is the j^{th} Haar-Like feature of i^{th} example x_i.

ii. Initialize the weights.

$$w_{L,i} = \begin{cases} 0.5/m, & i \le m \\ 0.5/n, & otherwise \end{cases}$$

Here m and n number of positive and the negative numbers respectively.

And L the summation of these m and n.

iii. For $t = 1 \ldots T$

a) Normalize the weights $w_{t,i} = w_{t,i} / \sum_{j=1}^{l} w_{t,j}$

b) For every feature j, a weak classifier h_j is trained and its error ε_j is evaluated with respect to w_t

$$\varepsilon_j = \sum_{i=l}^{L} w_{t,i} |h_j(x_i - y_i)|$$

$$h_j(x) = \begin{cases} 1, & p_j g_j(x) < p_j \theta_j \\ 0, & otherwise \end{cases}$$

Where $p_j \in \{1, -1\}$ is a parity bit and θ_j is the threshold value.

c) A classifier h_t with the lowest error ε_t is chosen.

d) The weight $w_{t+1,i} = w_{t,i} \beta_t^{1-e_i}$ is updated $e_i = 0$ if the example x_i is classified correctly else $e_i = 1$ otherwise,

And $\beta_t = \varepsilon_t / (1 - \varepsilon_t)$

iv. And the final classifier :

$$H(x) = \begin{cases} 1, \ \sum_{t=1}^{T} \alpha_t h_t(x) \ge 0.5 \sum_{t=1}^{T} \alpha_t \\ 0, \ otherwise \end{cases}$$

where $\alpha_t = \log(1/\beta_t$

3.1.3 Cascade Architecture :

Adaboost algorithm displays greedy character and hence it can able to large sets of weak classifiers.[6] Hence in order to reduce the computational time and

increased detection performance, a cascade classifier is to be used[4]. It also reduced the false positive rate.

If more complex classifiers are cascaded, it leads to better detection. The cascade classifier is used to achieve real timeliness by reducing the sub-windows that further need processing with a small number of operations [4].

1. Evaluate rectangle features.
2. Work out the weak classifier for each feature.
3. Combine the weak classifiers.

3.2 Feature Extraction

The LBP operator came into existence for texture descriptor. a label is assigned for every pixel by the operator. It considers binary number as a result set. Steps for implementing this algorithm is as follows:

Step 1: labelling of the pixels of an image is used by LBP operator for defining the threshold value in 3x3-neighbourhood of each pixel with the consideration of each pixel in the result set which looks like binary number.

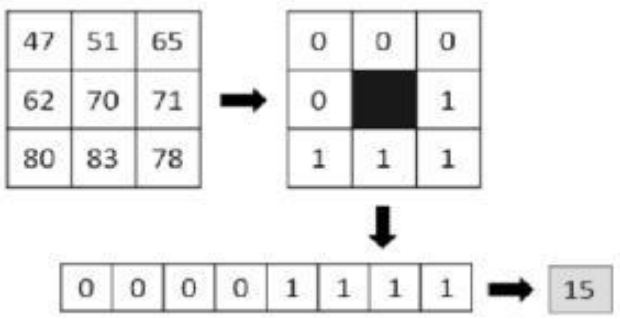


fig 3:the basic LBP operator [7]

Step2: A Local Binary Pattern is then said to be uniform if it contains upto two bitwise transitions from 0 to 1 or 1 to 0 when the binary string is considered circular. For example, 00000000, 10000011, and 00011110 are uniform patterns.

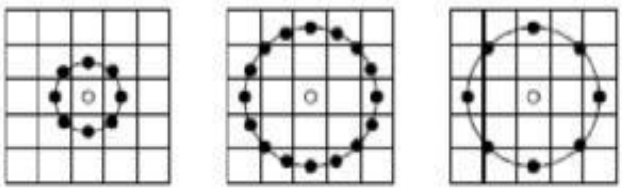


fig 4:the circular mapping of faces[8]

Step 3:The labelled image $f_l(x, y)$ is then converted into histogram which can be defined

$$H_i = \sum_{x,y} I\{f_1(x,y) = i\}\, i = 0, 1, \ldots\ldots, n-1$$

where n is the number of various label produced by the LBP operator.

The need of histogram is to obtain information about all the patterns which are local that exist as distributed like spots, edges and flat areas, over the whole image. For efficient face representation, one should retain also spatial information. For this purpose, the image is divided into regions R0,R1, . . . Rm−1 and the spatially histogram is defined as

$$H_{i,j} = \sum_{x,y} I\{f_1(x,y) = i\} I\{f_1(x,y) \in R_j\}, i = 0, 1, \ldots\ldots, n-1, j = 0, 1, \ldots\ldots, m-1$$

3.3 Probabilistic Neural Network

The probabilistic neural network (PNN) was developed by Donald Specht (Specht, 1990). PNN can be considered as 'probability density estimation' network formulation. This model of neural networks is competitive learning based. Multivariate probability provides to be the core concept of it. The PNN uses Bayesian Classifiers which provides a general solution to pattern classification problems [12].

Face recognition process is a pattern classification problem as mentioned in [13, 14]. The problem distinguishes faces from non-face patterns which are further classified into true or false classes respectively. Any image that does not contain a face falls into the non-face category patterns or the false class. It is utmost important that the ideal images with faces are classified properly as they'll be further required for training purpose. The system is proposed using probabilistic neural network (PNN) as given in Face recognition process is a pattern classification problem as mentioned in [13, 14]. The problem distinguishes faces from non-face patterns which are further classified into true or false classes respectively. Any image that does not contain a face falls into the non-face category patterns or the false class. It is utmost important that the ideal images with faces are classified properly as they'll be further required for training purpose. The system is proposed using probabilistic neural network (PNN) as given in [15].

The system uses a combination of feed-forward neural networks and statistical pattern recognition. The Probabilistic Neural Network generally has three layers viz. an input layer, the radial basis layer and the competitive layer. The classification is made on the basis of the radial basis unit with the largest output and all this is done by the competitive layer. The radial basis function or the kernel function (like Gaussian) is calculated by the first layer which calculates the distance each of kernel vectors and the input vectors. It is called as the radial basis function because the radial distance is the

argument to the function. The weight is considered as a function of its radial distance. i.e., far to the point, less is the influence it shows on a particular point. The largest sum is found by the second layer which calculates K sums of the radial basis kernel outputs. The class which has the largest sum has the maximum probability of being correct and thus it is considered as the output of the network. Proper training and determining the threshold values with proper distinguishing power are necessary. Usually the feature points are not uniformly distributed into true and false classes. Hence, the neural network models are aimed separately for each reference image [16]. Each PNN model accepts or rejects the claim based on different, but precise threshold values.

IV. MATHEMATICAL MODULE

Let S be the Entire system in which:
S= {IP, Pro, OP}.
Where,

A. IP is the input to the system.
B. Pro is the procedure applied on the system to process the input

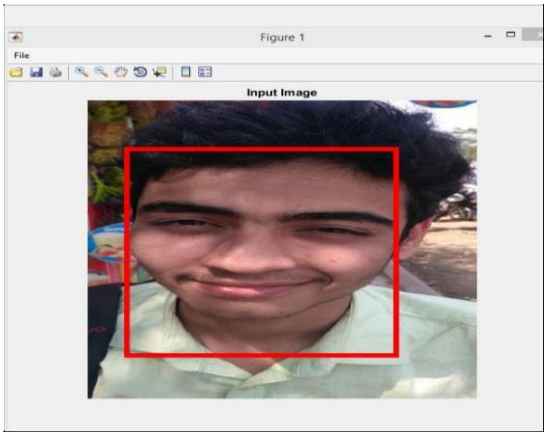
IP = {I}.
Where,
I is set of images, given as an input.

Step 1: Web camera video captures the user face.
Step 2: Corroborate the information into database
Step 3: Use Voila Jones algorithm to detect faces.
Step 4: Proposed work deals with automated face detection and recognition system to detect person and classify the Faces using LBP and PNN algorithm.
Step 5: The most useful and unique features of the face image are extracted in the feature extraction phase.
Step 6: The captured image of the face is compared with the images from the database.
Step 7: The features are compared and unauthorized person is detected if no face matches.
Step8: Show results according to the face recognition.

C. Output : Identified and unidentified face named and result is displayed.

V. EXPERIMENTAL RESULTS

In this experiment, the images are simply stored for detection and recognition. Here image dataset consists of around 450 images which will be used to compare and recognize. Viola Jones has been used to detect faces. Here experiment includes video to frame conversion of surveillance video in order to get all face images for recognition. Again Viola Jones will be used for face detection.



Above image shows the input image from pre-defined dataset of face images which will be get compared with surveillance video's face images. Here it shows that Viola Jones has detected face. Once all face images detected from image dataset of video, it will be compared with face image dataset.

Above image shows GUI's where options like record video, output checking are available. Where surveillance video will be recorded and output of recognition would be displayed. GUI also includes pop-up window of result which shows name of recognized person.

VI. CONCLUSION

The main aim of this paper is to automate the process of identification. It uses neural networks and from the results, it is evident that face detection and recognition works well with neural network. The hidden layer processing assists in detecting face even if it is not really proper. The time for training too is reduced with the use of Probabilistic Neural Networks.

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