Journal of Information Systems Engineering and Management
2025, 10(42s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Facial Recognition Using Hog Algorithm and Svm Classifier

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ARTICLE INFO

Received: 18 Dec 2024

Revised: 10 Feb 2025

Accepted: 28 Feb 2025

ABSTRACT

Facial recognition systems play a critical role in various security applications, including video surveillance, biometric authentication, and thermal imaging in public environments. This study presents the design and implementation of a facial recognition system utilizing machine learning techniques. The Histogram of Oriented Gradients (HOG) algorithm is employed to extract feature-rich representations by converting images into gradient distributions. To address facial alignment issues relative to the camera, Regression Trees are utilized for precise face alignment. Additionally, a Support Vector Machine (SVM) classifier is implemented to differentiate between stored identities in the database. The integration of HOG for feature extraction and SVM for classification enhances recognition accuracy, ensuring reliable facial identification.

Keywords: Facial recognition, Histogram of Oriented Gradients (HOG), Support Vector Machine (SVM), image gradients, machine learning.

1. INTRODUCTION:-

Machine learning is a area derived from artificial intelligence(AI).With a rapid growth of AI (Artificial Intelligence) in past few year, face recognition (FR)is gaining more attention compared to the traditional finger print recognition, iris recognition and card recognition.FR is a hot topic now a days because it has relatively more advantages than any other recognition programs currently being used. Face recognition have a wide range of applications like video surveillance, face detection, security systems, home automation and many more. Face recognition comes under the field of computer vision ,we can also call it as a main function of computer vision. But as we all know the then Face recognition programs works on algorithm designed by humans which only checks the parameters given to it and sometimes with a very low accuracy and thus sometimes people don't believe in such systems.

In recent years, a lot of progress has been made in the field of machine learning an AI, thus result in changing the perspective of humans towards programmed machines. This progress was only made possible due to research and development in the field of computer science, resulting in efficient and accurate outputs. The rest of that research gave birth to a algorithm called HOG (Histogram Oriented Gradient) algorithm and SVM (support vector machine) classifier.

The HOG algorithm was made in 2005 proposed by (Dalal, Navneet, Triggs, et al. 2005) and achieved a good detection rate, keeping the results in mind we have selected the HOG algorithm for the best results .For classification of images we are going to use SVM classifiers for simplicity and faster results(Saranya R Benedict, 2016., Salah Nasr et al 2009, Pradipta K. Banerjee et.al, 2009).The recognition of face has many advantages. It is contact less, it can be accessed and monitor remotely without personal interaction. Mainly no user can perfectly imitate person as a unique face recognition algorithm. It can be used in schools for attendance purpose and student monitoring system. Face recognition technique are emerging day by day into security systems.

When we talk about face recognition we should make sure that the user faces no difficulties in scanning their faces through, camera, therefore we have used face alignment with an ensemble of regression trees (Vahid Kazemi and Josephine Sullivan,2008).We know that the face angle is a key part in face recognition input, by using this technique we can capture the face at any angle and then correct it through our algorithm. The technology is gaining

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more and more demand per day there for we can't afford to have a drawback. This technique (Vahid Kazemi and Josephine Sullivan,2008).helps the user to scan their faces accurately and easily.

The SVM classifier plays a main role in our project as this algorithm helps us to find needle in a hay stack. Since a long time, the SVM are used for pattern classification (Salah Nasr et al 2009).SVM can classify different classes by not only making hyper-planes ,but also separation by region between classes. In the purposed method bag of features methods is used for feature extraction and multi class SVM is used to test query image, this can be used for real time offline face recognition(Salah Nasr et al 2009).

Face recognition systems has great potential for use in government agencies, public institutions, security, e-commerce, retail, education and many other fields(Dalal, Navneet, Triggs, et al.2005).The crime rates have been increasing since a long time ,people want to be more safe in their houses and protect their assets. The demand of an affordable security system has been increasing day by day. Traditional techniques like fingerprint scanners and iris scanners comes at a very expensive rate. This project is going to solve the problem of affordability of a security system at a very cost effective rate and with a very high accuracy rate. This project has additional features like chat bot and voice assistant so that you can always be connected to your home or office from any where in the world.

The remaining paper is planned as follows, in the next 3 sections we are going to know about the overview of the project, methodology and block diagrams.

2. FLOW DIAGRAM:-

This section give an overview of project chain which is present in fig1.The method is based on evaluating well-normalized local histogram of image gradient orientation in a dense grid(Dalal, Navneet, Triggs, et al.,2005).The basic idea is that local object appearance and shapes can be characterized using edge detection. The basic flow of project includes four major steps as shown in fig1.First steps includes detection or locating the face and encoding the picture using HOG algorithm. Description of HOG algorithm is continued in methodology section. Second step involves finding the pose of the face and wrapping the image using feature points. Third step involves passing the image through a neural network that knows how to measure the features of the face. Fourth step involves in classifying the image using SVM classifier.

After classifying the image the result is displayed in respective console. The voice reply feature is also added in this project using Espeak module.

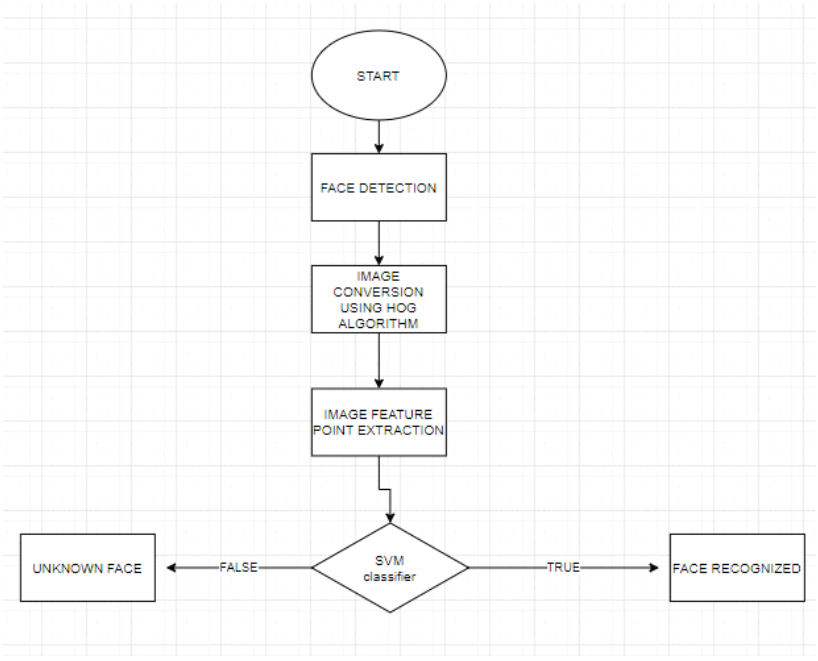

fig1:-Block Diagram of facial recognition system using HOG

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3. METHODOLOGY

This section gives us the overview of how our feature extraction process works. The method is based on HOG algorithm for evaluating the well normalized local histogram of the image gradient orientation in a dense grid. The idea is local object detection can be characterized rather well by the distribution of intensity gradient or edge detection. In practice this is done by dividing the image window into small spatial regions such that the placement of the pixel is in a direction relative to its gradient in a one-d plane. We will consider the normalized descriptors as HOG descriptors. Comparing the image with detection window using a dense grid of HOG descriptor and SVM gives us a required output. This is the block diagram described in fig2.

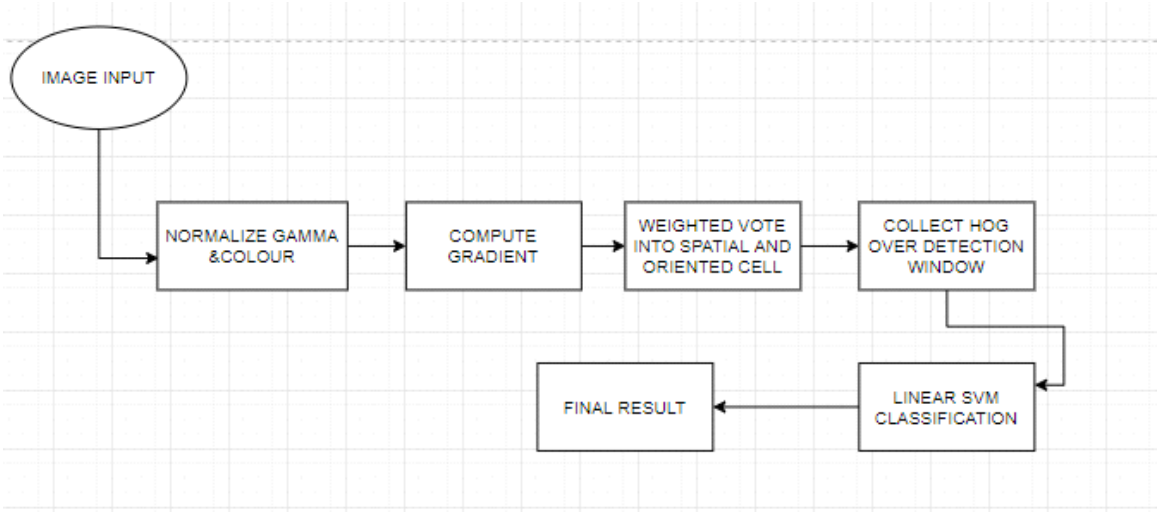

fig2:-flow of image conversion from JPG to black and white, gradient distribution pattern and feature point extraction.

All the major steps occurred here are described in fig2.The HOG algorithm has several advantages .It capture edge or gradient structure that is very characteristic of local shape, and it does so in local representation with an easily controllable degree of in variance to local geometric and photometric transformation(Vaishnavi Chawda et.al., 2020, Dalal, Navneet, Triggs, et al.2005) .For human detection, rather coarse spatial sampling, fine orientation sampling and strong local photometric normalization turns out to be the best strategy(Ngo-Doanh Nguyen, Duy-Hieu Bui, Xuan-Tu Tran,2019).

Here we use 7 images as a sample test image as a positive training example and 14 negative training examples for verifying the accuracy of the program. Actually we planned to design a training set of more than 1000 image but we restricted the data because the algorithm as already trained and we are using it. We have few different types of HOG algorithms like R-HOG,C-HOG, etc.

There are many feature extraction algorithm, some of the few implementation like "Normalize the color space", "Image graying", "Gamma correction" ," Gradient Calculation", "calculate the histogram of gradient direction","classifier",etc.

3.1. Normalize the color space :-

Due to factor such as image enhancing environment, collecting units, a given face image samples may be mistakenly identified or leaked, so it needs to have a preprocessing of collected images. This is done using two steps.

3.1.1. Image graying:-

Color image gets converted to grayscale image. The RGB components are transformed into grayscale images. Using the formula:

Gray=0.3*R+0.59*G+0.11*B

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3.1.2. Gamma correction

The overall brightness of the image is adjusted using this formula.(r=0.5) $y(x,y)=I(x,y)^r$

the purpose of this step is to adjust the image contras.

3.1.3. Gradient Calculation

The gradient operator is:

horizontal direction H1: [-1 0 1]; vertical direction H2:$[-1\ 0\ 1]^T$

H1 and H2 were used to convolve the original image respectively and two intermediate images were obtained the gradient of pixel g(x, y)

$Gx(x, y)=I(x+I, y)-I(x-I, y)$

$Gy(x,y)=I(x, y+I)-I(x, y-I)$

These represent the horizontal and vertical direction gradient of the pixel points in the input image and the pixel values at the point.

$G(x,y)=(Gx(x,y)^2+Gy(x,y)^2)^{1/2}$

$theta(x,y)=\arctan(Gy(x,y)/Gx(x,y))$

The purpose of this step is to obtain the information and texture of all objects in the image.

3.1.4. Calculate the histogram of gradient direction:-

Divide the image into cells, such as a cell containing 8*8=64 pixels. Adjust he cells such that they do not overlap, and the histogram of gradient direction within each cell is counted for example, if the gradient direction of a pixel is (20-40) or (200-400) degree, the count in the second bin of the histogram is needed to add one. Every some cells forms a block is obtained by concatenating the gradient histogram of all cells in a block. All the gradient direction is divided into 9 dimensional feature vector, each feature vector as the horizontal axis of the gradient histogram, the scope of angle corresponding o the accumulated value of the gradient value as a histogram of the vertical axis. (Ngo-Doanh Nguyen, Duy-Hieu Bui, Xuan-Tu Tran,2019, Vaishnavi Chawda et.al., 2020, Dalal, Navneet, Triggs, et al.,2005, Pradipta K. Banerjee et.al, 2009) .

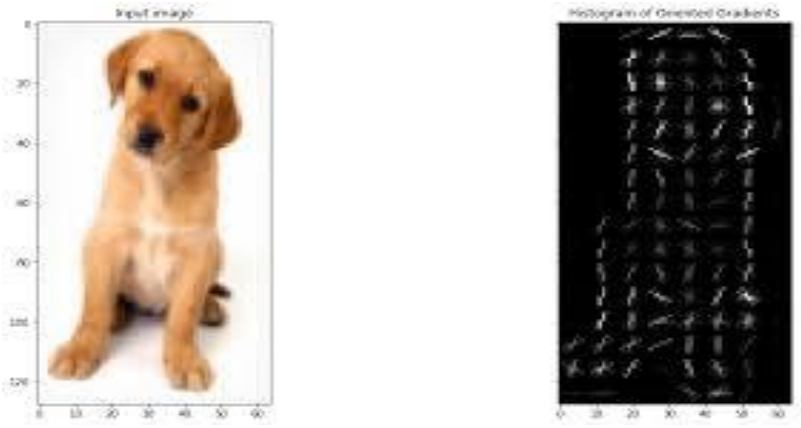

Fig 3: HOG for images

3.1.5. The measure of HOG eigen dimension

Suppose a 64*64dimension image, and the cell size is defined as 8*8 pixels Every 2*2 cell from a block. According to the above analysis, a cell has 9 features, so each block has 4*9 features. Her are a total of 2*7*36 =1765 feature dimensions.

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3.2. Feature points:-

This paper describes about the algorithm that estimates the feature points of a face input and compute it efficiently. Our preposed method use cascade regression (Vahid Kazemi and Josephine Sullivan,2008).

3.2.1. Cascade Regression:-

The main aim of the step is to take the critical points of the cascade regressor (rt) and make its prediction based on the features, such as pixel intensity value, computed from I and indexed relativity to the current shape estimate S^(t).

$S^{(t+1)} = S^{(t)} + rt(I, S^{(t)})$

3.2.2. Learning each regressor in cascade:-

This step majorly consists of learning each cascaded data from the previous step to provide and chech the algorithm .It also gives a sufficient level of accuracy (Saranya R Benedict, 2016).

$\pi i \in \{1, \ldots, n\}$ (2)

$Si^{(0)} \in \{S1, \ldots, Sn\} \backslash S\pi i$

$\Delta Si(0) = S\pi i - S^{(0)}$

to provide data for next regressor ri is cascaded.

$Si^{(t+1)} = Si^{(t)} + rt(I\pi i, Si^{(t)})$

$\Delta Si^{(t+1)} = S\pi i - Si^{(t+1)}$

3.2.3. Tree based regressor:-

We now review the implementation details for training each regression tree. We do this in three steps.

a.)Shape invariant split test

At each split node in the regression tree we make a decision based on thresholding the difference between the intensity of two pixels.

b.)Choosing the node splits

For each regression we approximate the function (Vahid Kazemi and Josephine Sullivan,2008., Rooban, S et al 2019, Rooban, S., Chowdary, B.N., Vinay, B., Sai Sandeep, M.V.S.,2019., Gattim, N. K et al ., 2019., Mannepalli, K., Sastry, P.N., Suman, M ., 2017., Mannepalli, K., Sastry, P. N., & Rajesh, V. .,2015) with a piecewise constant function where a constant vector is fit to each leaf node.

c.)Feature selection

This step is performed to change or adjust the global lighting of the image. The points being used for the classification are select using the Exponential prior[Vahid Kazemi and Josephine Sullivan,2008][13][14][15][16][17].

3.2.4. Handeling missing labels

This step is used when some land marks are not labeled in some of the training image.

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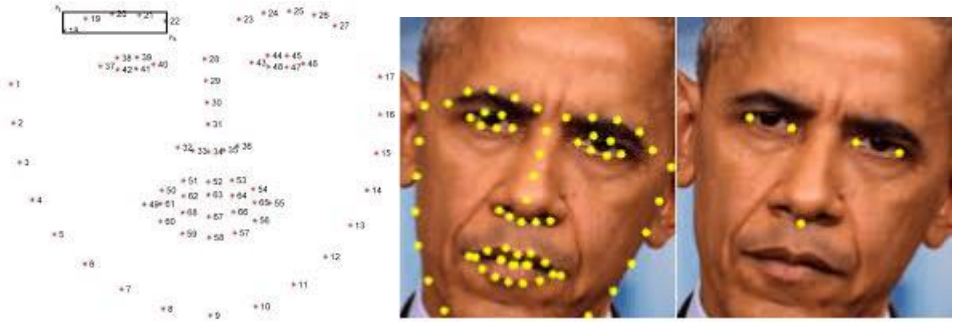

Fig 4: Features of input image.

3.3. SVM classifier:-

Our data base consists of more than two face images, instead of using a binary classifier our proposed method uses multi-class support vector machine classify the face image. The multi class SVM is trained using the error correction output code framework, multi-class SVM uses bag of feature to encode images from the training set into histogram of visual word (Salah Nasr et al 2009).SVM is a popular classifier that has vas application in image classification and data mining. we use a probabilistic approach for the hyper plane

$wx+b=0$

The length of histogram is dependent on the number of visual word and a feature vector is created from the histogram.

$|b|/||w||$ represent the perpendicular of the hyperplane to the origin.$||w||$ is the mean of the Euclidean.

linear separable planes:-

$wxi+b \geq +1, yi = +1$

$wxi+b \leq -1, yi = -1$

gives us

$yi(wxi+b)-1 \geq 0$

for solving the multi class problems ,this framework is widely used in computer vision systems for face recognition.

4. RESULTS:-

Facial Detection

In this model, HOG Algorithm is used for executing face detection operation. Cascade files are created using this algorithm. Human face detection is executed using face recognition module. Detection of the object using the Haar feature based cascade classifiers is an excellent approach. The algorithm requires positive and negative images to train the classifier. Subsequently, features are extracted from it.

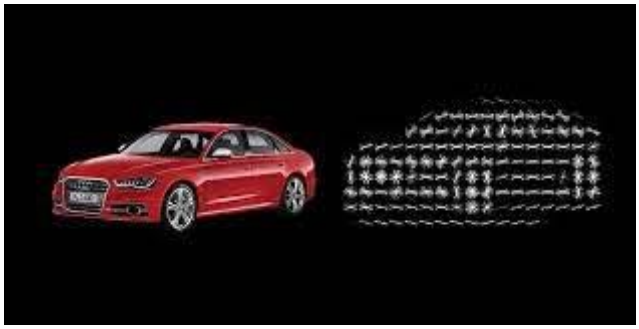

Figure 3: Feature Extraction in HOG Algorithm

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The sum of the pixels in light rectangular boxes is subtracted from sum of the pixels in dark rectangular boxes representing a single value for each feature. Features are computed quickly using integral imaging since only four pixels are used at once to define the image. The learning algorithm used is Adaboost. This algorithm has the capability of precisely choosing facial features from a large set. So, the efficiency of the classifier is eminent. The classifier discards the background region and hence helps in identifying regions with a better probability of finding the desired target. Face recognition is a non-contact process so, it is advantageous over fingerprint or iris based methods the system capturing images does not intervene the activities of the person and clicks pictures maintaining some distance.

Also, the identification process is independent and does not interrupt the person. In addition, crime rates can be lessened using face recognition technology as the face images captured can be stored in a database and retrieved to identify threats

Real-time face recognition is done of the detected faces. The system identifies the person from a video frame. To recognize the face in a frame, first a face has to be detected in the frame. If it is present, a region of interest (ROI) is marked. The ROI is processed for facial recognition.

The resolution of camera is 720 by 1080 pixels, encapsulated in a blue rectangular box. The size, colorobot is tested for face detection in two conditions. One detection step gives a successful result. Also, in bright light condition, face detection gives a positive result when nearly half face is visible to the camera.

Upon detection of a human face, the face recognition algorithm is triggered between a known person and an intruder by comparing the feature of face captured. upon discerning whether the human is a there or not. However, in the case of unknown face.

The resolution of camera is 720 by 1080 pixels. Upon detection often capsulated in a blue rectangular box, the size, color and shape of the rectangular box are coded in python language. Robot is tested for face detection in two conditions. One is in bright light and another in dim light. In detection step gives a successful result. Also, in bright light condition, face detection gives a positive result up on detection of a human face; the face recognition algorithm is triggered. According to between a known person and an intruder by comparing the feature of face captured. illustrates the messages received upon discerning whether the human is a threat or not. In case of a known person .

Table 1: Records vs Response Time

Activity	Minimum(sec)	Maximum(sec)	Average(sec)
Clicking Picture	3.5	5.7	4.65
Face Detection	1	1.8	1.45
Face Recognition	1.3	2.5	1.9

5. CONCLUSION

HOG Algorithm along with SVM classifier is used for the facial detection. The clip of a person or a photograph of a face, From the video clipping, we select the best possible frame and apply the traditional method of facial recognition. In the traditional method, HOG algorithm to detect and recognize the face. We need to find the landmarks on the face where SVM classifier is used. So with the help of both these algorithm we determine the gradients and find the spots with highest gradient changes and use them as landmarks. These landmarks mainly become eyes, nose, lips, and so on. These landmarks are compared with the images present in the data; the image with the nearest possible values will become the possible output. After training the algorithm with more training data, the result becomes more accurate. The output will be the name of the person or the person in a photograph. The result will be announced using a speaker as a voice output. If there is no matching image in the data, Output

will be unknown person. Hence, this method can be used as a security algorithm. It can alert us if anyone tries to trespass and can also act as a virtual assistant with features like time, date, weather, and so on.

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