Journal of Current Research in Engineering and Science
Bi-Annual Online Journal (ISSN : 2581 - 611X)
Volume 6 –Issue 2,August 2023
Paper:64

Face Identification and Recognition using Deep Learning

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***Abstract*— Face is a major trait to identify a human being. Even twins, everyone has their own unique face. Therefore, a methodology is required to identify and distinguish between different faces. Face recognition model can be considered as a system to identify the required face among many available. Now a days, face recognition has become a major requirement in day-to-day life in processes like face unlocking, attendance marking, authentication, etc. Based on security, it is considered as safest, as it doesn't require any identity card or anything except a human face for verification. Face recognition models mainly go through 2 processes i.e., face detection and then identifying it. This proposed paper illustrates the idea on how to plan and build a face recognition classification with the concept of deep learning with the use of OpenCV of python programming language. Deep learning is a methodology to execute face recognition and appears to be a suitable method to perform face recognition because of its superior accuracy.**

Keywords—Face recognition, deep learning, OpenCV, Methodology

I. INTRODUCTION

An essential field of study in computer vision is facial identification in photographs. Face identification and recognition in photographs is a straightforward process for humans, but not for machines. For detecting and recognising faces, a variety of machine learning algorithms are available. Since the human face is made up of multidimensional components, sophisticated computer methods are needed for recognition. We must take into account a number of factors in order to recognise faces in an image, including patterns like height, facial colour, and the dimensions of other objects like the nose, eyes, and lips. There are unmistakably an pattern; unique faces has unique shapes and proportions, and related faces has the same characteristics. I have to change a specific face into a number. for the reason that machine learning algorithms only take numbers. The HOG and Haar Cascade base face detection were compared by I Muhiqqin, R Asmara, H Darmono, Dharma I, D R H Putra, and C Rahmad [1] who concluded that HOG basis face detection was more accurate. Ever since the first algorithm was created, enhancing face recognition performance has been a challenge. In 1991, Principal Component Analysis was used by Alex Pentland and Matthew Turk [2]. (PCA) which is referred to as the eigen faces technique which is a strategy for all the face recognition procedures developing at the moment. The PCA techniques used by N Dalal et al. [3] were modified by substituting HOG features for Eigen faces. HOG features offer benefits of scale gradient, binning of orientation, somewhat coarse spatial binning, and normalization of good quality local contrast, which is why Dadi HS and Pillutla GM [4] in 2016 showed 8.75% improvement in HOG over PCA. However, it still requires a stronger preprocessing phase and contrast amplification for improved face recognition results. The solution to this issue is what we provide in this paper. For the preprocessing steps of noise removal, contrast enhancement, and illumination equalization, we use CLAHE. The SVM classifier is then used to categorise the HOG features that were extracted from the input picture. Despite the fact that the input dimension for maximum classifiers is fixed, different numbers of significant points are extracted from different photos. As a result, the input dimension is different. By recognising all salient characteristics in the picture, SVM results are obtained. In line with the analysis of the SVM result, the computer will identify the individual.

II. RELATED WORKS

Almost 5% greater accuracy was discovered in Hog than in the Haar cascade technique by I Muhiqqin, R Asmara, Darmono H, Dharma I, D R Putra, and C Rahmad [1]. The rate of false-positive identification in images using the Haar cascade is also higher.

The majority of face recognition methods work with images that have huge dimensions. This makes recognition extremely challenging. It was decided to introduce dimension reduction to solve this issue. The most popular procedure for both dimension decrease, and subspace prediction is PCA. PCA is a technique for unsupervised machine learning that uses the entire dataset of d-dimensional models while disregarding all class tags. The covariance matrix, scatter matrix, eigenvectors, and related eigenvalues are all computed.

In contrast to more comprehensive approaches like PCA [2] or LDA, Pillutla GM and Dadi HS [4] and Monzo D, Albiol A, Martin A, Albiol and Sastre J[6] discovered that face recognition based on HOG features was more accurate.

A preprocessing technique that combines several preprocessing algorithms, such as histogram equalisation and gabber filter, was suggested by Anila S. and Devarajan N. [7].

In 2016, a new method called AERSCIEA aimed at satellite color pictures was suggested by Bora DJ and Gupta AK.

which produced much better results than CLAHE and is built on binary search.
CLAHE was applied to PCA-based facial recognition by Olivares-Mercado J, Benitez G G, Aguilar-Torres G, Perez M H and Sanchez-Perez G [10].
With the aid of binary tree classification approach and linear support vector machines, Li SZ and Guo G, Chan K [11]. represented the face recognition method. The experimental findings demonstrate that SVMs are a superior learning algorithm for facial recognition when compared to the nearest centre method.

III. Face Detection

The first stage in facial recognition and verification is face detection. It also encompasses a wide range of additional uses, including as face monitoring for surveillance [17], facial expression recognition, digital classification over social networking sites, and customer claims for alphanumeric expertise, such automatic focusing over mobile cameras. The methods of face detection as they relay to facial recognition and verification will be examined in this survey.
In the past, the biggest challenge for face identification algorithms was achieving elevated precision in unrestrained environments. Accordingly, their pertinency in realistic-world settings was constrained. Nonetheless, face detection in realistic world frameworks has became very frequent with the invention of the face detection algorithm based on Viola Jones boosting [18].
Since then, sophisticated feature extraction approaches have been created, including Histograms of Oriented Gradients (HoGs) [20], Scale Invariant Feature Transform (SIFT) [19], and techniques like Integral Channel Features (ICF) [22] and Local Binary Patterns (LBPs) [21]. Bibliophiles are directed to [23] for a existing and thorough calculation of these conventional face identification algorithms. As an alternative, this examination will concentrate on additional newly developed deep learning methods, which existed created in response to Haar and HoG wavelet characterictics' limitations in taking salient facial info under unrestricted circumstances, such as those involving wide dissimilarities in tenacity, radiance, pose, appearance, and colour. In essence, classifiers haven't been able to perform to their full potential up until now because of the restrictions of these feature representations [24]. Additionally, as shown by [25], [26], and [27], DCNNs often perform better in object and face identification tasks because to the huge rise in the availability of big datasets.

A. Face Recognition

Computer vision (CV) includes face recognition. Biometric technologies employ the technology of face recognition [4] to recognise individuals from a picture of their face. A person can be identified by their biotic characteristics. Social eyes can swiftly identify people by simply glancing at them, but their range of focus is constrained. Consequently, a computerised method of doing facial recognition is created.
Face recognition includes the procedures for automatically recognising, then verifying, a person from an image or a video. [5].
Although though facial recognition has been the subject of substantial study [6–10], there are still obstacles to be solved, including the following:

- Expression Variation
- Misalignment
- Illumination Variation
- Pose Variation

To increase the precision and accuracy of face recognition, many strategies must be evaluated.

B. Deep Learning

Artificial neural network development gave rise to deep learning [11].
Training MLPs (Multi-layers Perceptrons) first involves adding a rectilinear layer from input of the grid construction to the output [12].
A innovative concept known as deep learning was subsequently proposed by G. Thomson [13], and it is a new prototypical training as depicted in Figure 1.

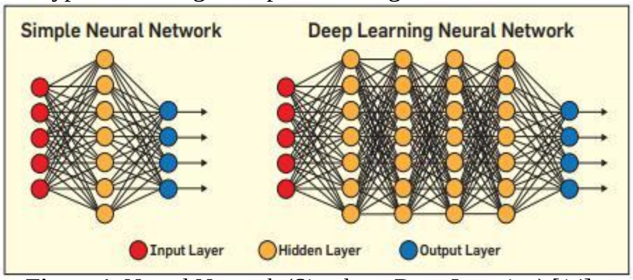

Figure 1. Neural Network (Simple vs Deep Learning) [14].

Deep learning may achieve amazing results for face recognition since the inclusion of hidden layers enables it to generate a good approximation of a complicated function. Machine language offers the capacity to instruct computers to perform tasks similarly to how people would naturally perform them. Deep learning is the strategy used in this study as a result.

C. Interface

Matlab and OpenCV were compared in terms of speed by S. Matuska et al. [15].
As shown in Figure 2, the fundamental image processing algorithm is described, with the time ingesting in Matlab and OpenCV serving as the primary focus.
According to tests, OpenCV outperforms Matlab by up to 30x and by up to 100x for the Erosion method.

Journal of Current Research in Engineering and Science
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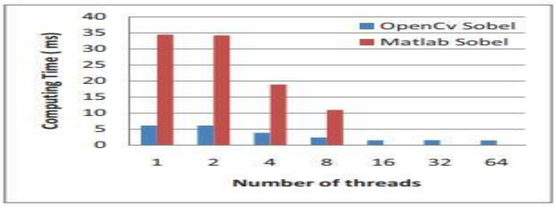

Figure 2. Time feeding among Matlab & OpenCV [16].

Yet, because it offers a variety of algorithms and functions, the Matlab system environment is more straightforward and user-friendly. While not problems in Matlab, memory allocation and memory leaks are a major task for OpenCV.

Like Java is constructed with the help of C programming language while Matlab is built with the use of Java and is created in a high level language. As a result, when a Matlab programme run, the computer must spend time decoding the program. After that, it converts them into the Java code before finally running the code. On the other hand, OpenCV is often a C language library. Major processing operations are performed, but not interpreting. As a result, OpenCV programmes execute faster than Matlab programmes.

Moreover, OpenCV is thought to be more effective than Matlab. Matlab wastes system resources by using them excessively to prevent problems with memory allocation and memory leaks. Yet, the Memory component in current computers is not a cause for concern. As a result, OpenCV is the utmost wide-ranging open-source library for the purpose of computer vision and generally runs faster than Matlab. Additionally, it has a sizable user base, meaning that additional guidance can be collected from a variety of inputs. Matlab, alternatively, is not open source and honestly posh to purchase. OpenCV is selected to be used in this paper as a result.

IV. Methodology For Face Recognition

The succeeding picture represents the stages elaborated in the projected method in a categorization method:

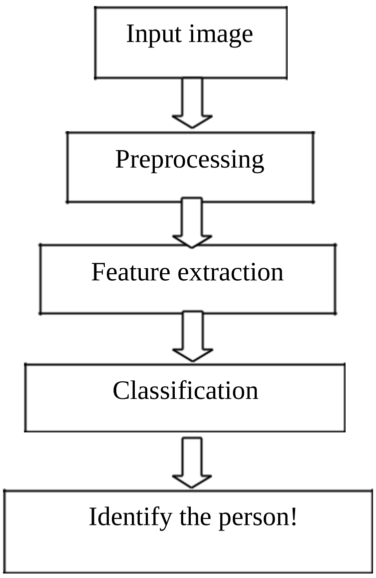

Fig.3. Block diagram for the proposed method.

A. Preprocessing

In the discipline of image processing, preprocessing is crucial. The intensity of the image can be changed using the image processing technique known as histogram equalisation. This improves an image's contrast. A histogram could be used to explain it. When all of the grey levels in the image are used equally, the histogram is said to be equalised. As a result, the histogram's intensities are evenly distributed. AHE has evolved into CLAHE. The CLAHE algorithm, developed by Pisano et al. [4] in 1998, is used to find hypotheses in dense mammograms. AHE had the flaw of excessively amplifying noise. The histogram is clipped by CLAHE at a predetermined value to reduce the amplification. Noise is enhanced in almost constant locations using adaptive histogram equalisation. To lessen amplified noise, CLAHE restricts contrast amplification. It accomplishes this by dividing evenly over all histograms the portion of the histogram that surpasses the clip boundary. The goal of CLAHE, an AHE version, is to minimise the noise ratio by lowering disparity in unvarying portions of the picture to prevent over-development. This technique divides the image into contextual regions—non-overlapping areas that don't overlap. The supreme height of each appropriate region's histogram is obtained, and a histogram is computed for each region. The clip limit to improve contrast is determined by height. The threshold value is the clip limit, and the histograms are reorganized inside the limit. This process heightens the divergence yet intensifies homogeneity.

where Imin is the lowest brightness and Imax is the brightest. The term "luminance" refers to a value in a digital image that ranges from black (0) to a extreme value dependent on colour complexity. As there are 255 possible options with 8-bit arrangements, presumptuous 0–1 values for separately, the value for conventional 8-bit images, or grayscale, is 28 – 1.

The input data picture I, the quantity of containers n, the smallest strength min, the extreme strength max, the window sizes ht w, wd w, and the clip edge clip are required to perform CLAHE. The output image after CLAHE will have new intensities. The input and output strengths of our input pictures are displayed in the following graphic.

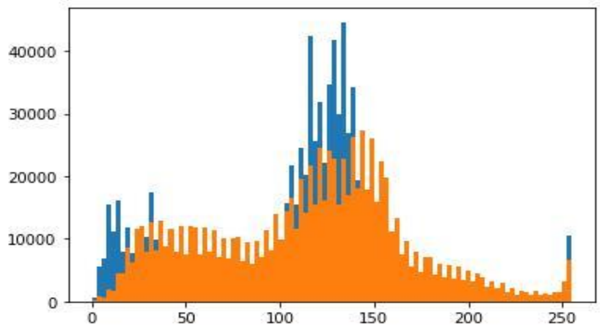

Fig.4.Blue extraction plot demonstrating input image strengths and Orange is representing CLAHE intensities.

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B. Features

Feature-based semantics called the HOGs is applied to images. It is typically applied to computer vision in order to detect things.

Calculating the gradient standards is the initial stage in every calculation. Applying 1-dimensional derived the first method uses masks in both the vertical and horizontal dimensions.

Binding by orientation is the second stage in the process of getting HOG characteristics. Depending on the amount of data used in the gradient computation, each pixel within the cell casts a weighted vote for a histogram channel that is based on the orientation.

Depending on whether the gradient is defined or not, the compartments can either be outstretched or quadrilateral in form, and the networks can range from 0 to 3600 or 0 to 1800.

Block descriptors: To take local changes in contrast and illumination into account, the gradient's power must be normalised. Cells must be grouped together into bigger, geographically connected blocks to do this. The mechanisms of the compartment histograms that are normalised from every of the wedge sections are ordered to provide the Histogram of (OG) Oriented Gradients descriptor. The fact that these wedges frequently intersection means that each cell donates to the final description at least twice.

Block normalisation: Four distinct approaches to block normalisation were investigated by Dalal and Triggs [3]. Assume that "v" is the unnormalized vector.

C. Classification

An algorithm for supervised learning is the support vector machine. It is a multiclass classifier that has been extended from its original two-class structure. Regression uses it as well.

Support vectors: The position and direction of the hyperplane are determined by the closest data points, or support vectors. The margin of the classifier may be increased by employing these support vectors, and the position of the hyperplane can be changed by eliminating them. These are the elements that really support the development of the SVM. The Support Vectors' distances from the Hyperplane are equal. Because the Hyperplane shifts if their position does, they are referred to as sustenance vectors. This indicates that the Hyperplane is independent of all observations and is supported only on the support vectors.

Hyperplane: The lines that divide the data points into two categories are known as hyperplanes. The Hyperplane's dimensions depend on how many features there are; for example, if there are two features, the Hyperplane is an mark. Similar to this, a two-dimensional level will be the Hyperplane if there are 3 input structures. If there are more than three features, it gets impossible to visualize.

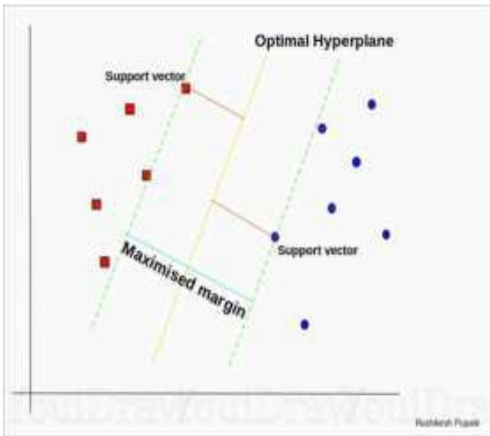

Fig.4. SVM diagram

Among different classification algorithms, Svm is among the most reliable, fast and accurate Machine learning techniques. The Hyperplane and svm are not significantly impacted by a modest adjustment to the data. The svm prototypical is therefore stable.

V. Experimental Result

With various photos, the suggested process is tested. Below are some of the results:

We can see from the above image that it has identified 22 people, with one incorrect-positive result being displayed. Three people were not detectable. because only a portion of their faces are visible in the picture. Hence, it is clear that this algorithm has a significantly greater accuracy level.

VI. Conclusion

This study introduces a face recognition algorithm based on the CLAHE, HOG, and SVM classifiers. The HOG features and SVM classifier-based face identification algorithms are contrasted with the suggested algorithm. Findings indicate that the proposed algorithm performs better at face recognition. Although it takes a lot of time, this method is more accurate and productive than other machine learning algorithms.

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