IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 8, June 2022
Impact Factor: 6.252

SMART FACIAL ATTENDANCE SYSTEM

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Abstract: *Managing the attendance in school has proven to be a great burden to teachers and pupils. As of late, automatic attendance systems have been introduced to help solve these issues by creating a more interactive and computerized environment in order to allow teachers to better track the performance of their students. The Open-Source Technology Center (OTC) program is an application that was created using the Qt framework. This program runs on Linux and utilizes the OpenCV library in order to read the faces of students when they enter the classroom and mark their presence on a control panel interface, which is then also streamed through a local server through UDP protocol. The system uses MVC architecture, allowing for easy separation between data, models and controllers. The model consisting of face detection is developed using dlib libraries which allows for more advanced modeling.*

Keywords: Attendance System, Automated Attendance, Image Processing, Face Detection, Feature Matching, Face Recognition, etc.

I. INTRODUCTION

Face recognition technology is based on the extraction of facial features such as eyes, nose, ears, etc., and then storing them in an encrypted format. Face recognition works better than other biometric system like finger print, palm-print and iris because of its non-contact process. Facial features are more stable than finger-print or palm-print and provide more uniqueness than iris. Almost all the major companies like Google, Facebook are now implementing face recognition for security purpose. A face recognition methodology is described in this paper that works with real surveillance video captured under uncontrolled light conditions and various face poses. The proposed methodology is an incremental learning framework, wherein a system incrementally learns to predict face depictions from a small set of latent variables. The system utilizes limited number of local image patches around multiple faces within the video frame to predict the garnered representation of each face. The result shows that the proposed approach outperforms state-of-the-art face recognition systems by a decent margin.

II. RELATED WORK

Face recognition has become an important issue in security areas. It has been used to identify individuals in airports, stadiums and other public areas. Face recognition system under controlled conditions is the type of technique which performs accurate face recognition under controlled environment conditions. When compared with these systems, this paper proposes a method of performing face recognition under uncontrolled conditions. This method uses existing face recognition techniques but still it is unable to maintain operational condition. So, this paper focuses on modularization of a real time system that can be used even in unstable situations like different
illumination, pose, expression and distance etc., where the desired operation condition cannot be maintained.
Facial recognition based on stereo vision can be used as anti-cheating system. The proposed system will predict the cheating of a facial recognition-based system using a biometric authentication system in particular face recognition. The features used are the right eye, left eye and ears of a person that can be obtained using the optical flow that is produced by applying stereo vision.
Attendance for all level of schools can be a nightmare especially for management. It is estimated that each year there are thousands of dollars and time consumed by the visit of all levels of management, to the school to check whether learning institutions currently by students. This paper will cover the different kinds of attendance

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management system, a new concept called mobile presence, NFC based on the face authority and then, after taking care issue learning institutions in areas or groups may be copied from the server or from implementation application can run on an existing network infrastructure (cloud base) as a program interface (API) available.

There are a number of systems for attendance purpose, like traditional methods of data, have drawbacks and hard to use that list, a biometric presence. There is a lack of human error in the system like fingerprint scan is not accepted because of wet conditions Fingers, dirty, very dry or peeled fingers. So, the author proposes Authority to add mobile presence system and face with NFC Safety facility and possibility to store using Raspberry Pi data in the cloud. The paper reviews relatable works. Attendance management system, NFC, face authority area, Microcomputers and Cloud area. Then, it provides new Method and design system and planning. Outcome of this is a system which reduces the usage of paper, ending time and energy wasted by attendance Mobile Based Attendance System.[4]

Computers are intelligent to communicate with humans in various perspectives. It will be participation If it is based then it is more acceptable for both humans and computers. On the validation process. The author is concerned Integrating and developing a student recognition using"survival- Ing" algorithm. Then embedding is used in classification of a person's face the system offers a variety of applications such as attendance - Systems, security etc. After making a system, aresulting display, is shown in the paper. [5]

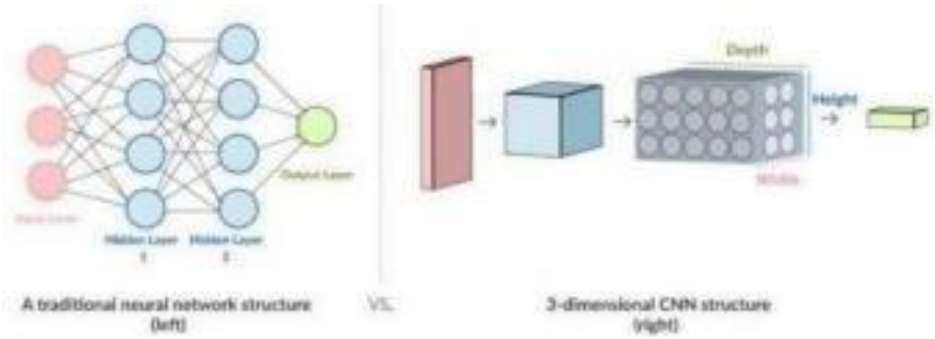

Figure 1: Traditional neural network versus CNN.

In this paper "Face Recognition based Attendance System using Machine Learning Algorithms"by Radhika C. Damale, the author says identification of a person by facial features Known as facial recognition. A face feature can be used for various computer-based vision algorithms such as face recognition, emotion detection and multiple camera surveillance applications. Face recognitionsystem is attracting scholars towards it. In this, different methods such as SVM, MLP and CNN are discussed. DNN is used to "face detection". For SVM and MLP approaches, the features like PCA and LDA extracted using extraction algorithms. In CNN approach, images fed directly to CNN Module as a feature. The approach shows Good detection accuracy percentage for CNN based approaches. SVM, MLP and CNN achieve test accuracy of 87%, 86.5% and 98% on self- generateddatabases respectively. [6]

In the paper" Class Attendance framework the on- Face Recognition" composed by Priyanka Wagh. To distinguish the understudies sitting on the last columns conveniently, the histogram leveling of picture should be finished. The picture will be passed for individual's face discovery. The productivity of Ada Boost calculation is best of all these. In this way, this will paper utilizes this calculation for identifying countenances of understudies by utilizing the haar highlight classifiers and course ideas of Ada-Boost calculation .Every understudy's face is trimmed and the different highlights are removed from them like separation between eyes, nose, blueprint of face, and so forthutilizing these countenances as Eigen includes, the understudy is perceived and by contrasting themand the face database and their participation are stamped. A database of faces should be made withthe end goal of examination. [7]

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III. METHODOLOGY

In order to mark attendance, we follow a series of steps which includes enrolment, face detection, face recognition, and then marking the attendance in a database. Unlike Eigenfaces and Fisherfaces, where in most modern face verification systems, training and enrolment are two different steps. Training is performed on millions of images. On the other hand, enrolment is performed using a small set of images. In case of Dlib, enrolling a person is simply passing a fewimages of the person through the network to obtain 128- dimensional feature descriptors corresponding to each image. In other words, we convert each image to a feature in a high-dimensional space. In this high dimensional space, features belonging to the same person will be close to each other and far away for different persons.

A. Traditional Image Classification

Pipeline Versus Dlib's Face Recognition Model in a traditional image classification pipeline, we convert the image into a feature vector (or equivalently a point) in higher dimensional space. Thiswas done by calculating the feature descriptor (e.g., HOG) for an image patch. Once the image is represented as a point in higher dimensional space, we then use a learning algorithm like SVM to partition the space using hyperplanes that separated points representing different classes.

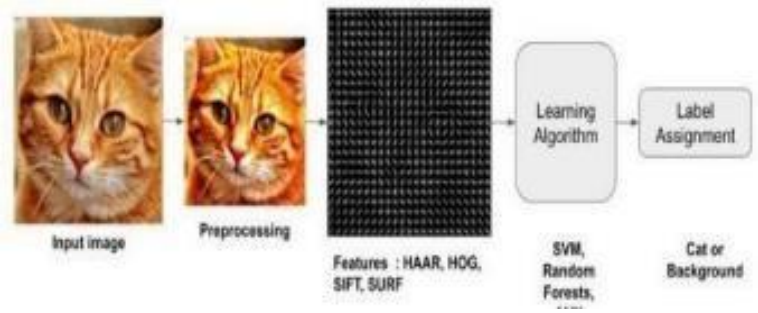

Figure 2: Traditional image classification pipeline.

Even though on the surface Deep Learning looks very different from the above model, there are conceptual similarities.

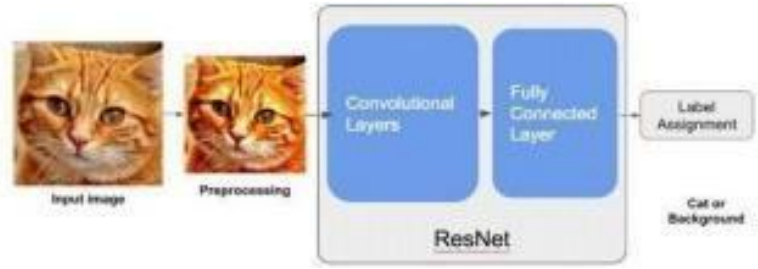

Figure 3: Dlib's Face Recognition module

Figure 3 reveals the Dlib's Face Recognition module is based on an CNN architecture called ResNet. ResNet contains a bank of Convolutional Layers followed by one Fully Connected Layer. As most CNN architectures, ResNet contains a bank of Convolutional (Conv) Layers followed by aFully Connected (FC) Layer. The bank of convolutional layers produces a feature vector in higher dimensional space just like the HOG descriptor.

The most important differences between bank of convolutional layer and HOG descriptor are: 1.HOG is a fixed descriptor. There is an exact recipe for calculating the descriptor. On the other hand, a bank of conv layers contains many convolution filters. These filters are learned from thedata. So unlike HOG, they adapt based on the problem at hand.

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The FC layer does the same job as the SVM classifier in traditional approaches. It classifiesthe feature vector. In fact, sometimes the final FC layer is replaced by an SVM. Usually, when we want to use the word "distance" between two points we are talking about the Euclidean distance between them.

For example, the distance between 3D points (1, 0, 1) and (1, 3, 5) is Eq (1.1) In general, if we have an n dimensional vectors x and y the L2 distance (also called the Euclidean distance) is given by Eq(1.2) However, in mathematics a distance (also known as a metric) has a much broader definition.For example, a different kind of distance is called the L1 distance. It is the sum of absolute values of elements of the two vectors. The following rules define when a function involving two vectors can be called a metric. A mapping d(x,y) is called a metric if The distance between any two points is greater than or equal to zero d(x,y)
≥0 2. A point has zero distance from itself i.e., d(x,x)=0

3. The distance from x to y i.e., the same as the distance from y to x i.e., d(x,y)=d(y,x) 4.Triangle inequality: For any three points x, y and z the following inequality holds true.
i.e., d(x,y) +d(y,z)≥d(z,x)

1. Deep Metric Learning

Any image can be vectorized by simply storing all the pixel values in a tall vector. This vector represents a point in higher dimensional space. However, this space is not very good for measuring distances. In a face recognition application, the points representing two different imagesof the same person may be very far away and the points representing images of two different peoplemay be close by.

Deep Metric Learning is a class of techniques that uses Deep Learning to learn a lower dimensional effective metric space where images are represented by points such that images of the same class are clustered together, and images of different class are far apart. Instead of directly reducing the dimension of the pixel space, the convolution layers first calculate the meaningful features which are then implicitly used to create the metric space. Turns out we can use the same CNN architecture we use for image classification for deep metric learning.

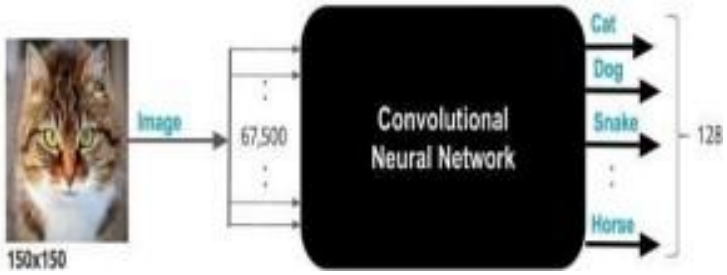

Figure 4: CNN for clarification task

In Figure 4 see a CNN that is trained to take as input a 150x150 colour image (which is the same asa vector of size 150x150x3 = 67,500) and output the probability that it belongs to one of the
128 different animal classes. In Deep Metric Learning, the architecture remains the same, but the loss function is changed.

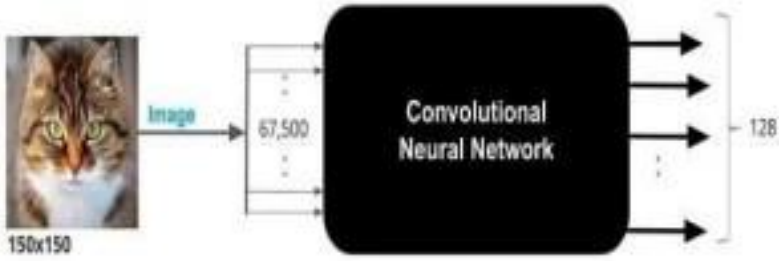

Figure 5: CNN for metric learning

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Figure 5 reveals in Deep Metric Learning, the architecture remains the same as for CNNclassification task, but the loss function is changed.
In other words, you input an image and the output is a point in 128-dimensional space. If you want to find how closely related two images are, you can simply find the pass both images through the CNN and obtain the two points in this 128-dimensional space. You can compare the two points using simple L2 (Euclidean) distance between them.

2. Metric Loss

Millions of images are typically used to train a production ready CNN. Obviously, these millionsof images cannot be simultaneously used to update the knobs of the CNN. Training is done iteratively using one small batch of images at a time. This small batch is called a mini batch. As mentioned in the previous section, we need to define a new loss function so that the CNN output is a point in this 128-dimensional space. The loss function is defined over all pairs of images in a minibatch.

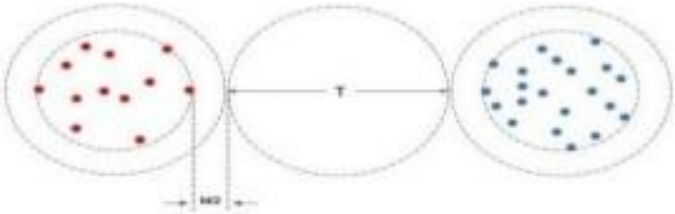

Figure 6: Metric loss defined by Dlib's Face Recogniser

For simplicity, the concept is shown in 2D. The loss is defined in terms of two parameters:
1) Threshold (T) and
2) Margin. The blue and the red dots present images of two different classes. Forthe metric loss to be 0, the maximum distance between any two points of the same class should be (T - M) and the minimum distance between any two points of different classes should be (T + M)

Let p1 and p2 represent the points corresponding to images l1 and l2 in the 128- dimensionalspace. If the images belong to the same class, the loss is given by max (0, ||p1-p2||-T+M)
On the other hand, if l1 and l2 have two different class labels then their contribution to theloss function is: max (0, T- ||p1-p2||+M
Figure 6 shows how this loss function prefers embedding where images of the same class areclustered together, and images of different classes are separated by a large margin.

3. Hard Negative Mining

In a mini batch, there are many non-matching pairs (images from different classes) than matching pairs (images from the same class). It is important to take this imbalance into account while calculating the metric loss function. If there are N matching pairs that share the same class in a mini batch, then the algorithm includes ONLY the N worst non-matching pairs in the loss computation. In other words, performs hard negative mining on the mini batch by picks the worst non-matching pairs.

B. Enrolment

For enrolment we define smaller ResNet neural network. Training was also done using this network.A Persons' images we are going to enrol are structured in following way: We will be having subfolders, each subfolder has images of one person. We will store this mapping of images and theircorresponding labels to use it later in testing. Then we process enrolment images one by one, converteach image from BGR to RGB format, because Dlib uses RGB as default format. Then convertOpenCV BGR image to Dlib's cv_image and then

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Dlib's cv_image to Dlib's matrix format since Dlib's cv_image format is not recognized by neural network module. Detect faces in the image. For each face we detect facial landmarks and get a normalized and warped patch of detected face. Compute face descriptor using facial landmarks. This is a 128- dimensional vector which represents a face. Then save labels and names to disk and face descriptors and corresponding labels to disk.

C. Face Detection And Recognition

Given a new image of a person, we can verify if it is the same person by checking the distance between the enrolled faces and the new face in the 128-dimensional space. Read name- labels mapping and descriptors from disk. Then read the query image that is an image of classroom with multiple students and convert it from BGR to RGB format. Because Dlib uses RGB as default format. Then convert OpenCV RGB image to Dlib's cv_image, and then Dlib's cv_image to Dlib'smatrix format. Dlib's cv_image format is not recognized by neural network module. Detect faces in query image. For each face detect facial landmarks. Get a warped and patch of 150x150 for each face. Now compute face descriptor for each face.

Now we calculate Euclidean distance between facedescriptors in query images versus face descriptors of enrolled images. Find the enrolled face for which distance is minimum. Dlib specifies that in general, if two face descriptor vectors have a Euclidean distance between them less than 0.6 then they are from the same person, otherwise they are from different people. This threshold will vary depending upon number of images enrolled and various variations (illumination, camera quality) between enrolled images and query image. We areusing a threshold of 0.5. If minimum distance is less than threshold, find the name of person from index, else the person in query image is unknown.

D. Attendance Marking

For each face detected and matched with enrolled face, the attendance is marked for the corresponding USN in the database. The name of student along with day and time of attendance is also be stored in the database.

IV. CONCLUSION

The above method provides the best outcome will be achieved. This is achieved using OpenCV for frame extraction and dlib for face recognition. This method will have higher accuracy in recognition of multiple faces from a single frame with lower response time.

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