Automatic Attendance System Using Deep Learning

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ABSTRACT

In this paper, novel automatic attendance system is proposed by using machine learning and deep learning algorithms. Real-time face recognition algorithms are used and integrated with existing University management system which detects and recognize faces of students in real time while attending lectures. This new proposed system for automatic attendance system aims to be less time consuming in comparison to the existing system of marking the attendance. The designed system does not interrupt class in any manner. Therefore, it saves potential time of students as well as of teachers. From the experiment analysis it is found that the accuracy of proposed system is 97%. Hence proposed system doesn't require any rectification and verification from teachers.

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1. Introduction

In this era of technology, privacy has always been a hot topic of discussion. With the growth of technology, various social media and other platform came into action. The benchmark of security always used to be pin and password. Pin and password are a very popular medium for verification of identity [Bae, Mi-Young, and Dae-Jea Cho,2015]. After few years of evolution biometric verification are being used. One of the most popular biometric verification is facial verification. It is widely used in public place surveillance system, for security purpose. One of the benchmarks set by Sydney Airport to use facial recognition instead of a passport for verification purpose. Accuracy, Anti-spoofing capability, Acceptability, and cost-effectiveness are factors to be considered before the development of a biometric system. To be identified by biometric factors that affect are universality, uniqueness, permanence, measurability, and performance [Jogiji, Aditya, and P. Ghate,2017]. Today facial recognition is widely used in phones, laptops and other devices for identification purpose. Almost every smartphone in today's time come with facial recognition.

According to Oxford dictionary attendance is "The action or state of going regularly to or being present at a place or event.". Various research carried out has shown that there is a noteworthy relationship between the attendance and a student's performance whatever it may be professional life or educational life. It has been proved that student with poor attendance tends to perform poorly in their schooling [Ahmedi, Aziza, and Suvarna Nandyal,2015].

Marking attendance manually has always been hectic work and extra time-consuming. A proper record is to be maintained by teacher or faculty day to day only for attendance which consumes a lot of time and maintaining record may be hectic [Krishnan, R. Ramya, R. Renuka, C. Swetha, and R. Ramakrishnan,2016]. There is a high chance of error during maintaining a paper record and it requires a lot of time a1And calculation of average attendance and various criteria to be fulfilled. Hence there is a requirement of a system which takes attendance automatically and maintains a proper record. Hence the purposed system should take attendance automatically and maintain a record of average attendance, students present and absent in a class.

The conventional system of marking attendance is being used in many universities throughout the world, which contains many issues such as the false sign, name missing out is sheet and submitting sheets manually to the computer [Shengli, K., Jun, Z., Guang, S., Chunhong, W., Wenpei, Z. and Tao,2015]. All this process consumes a significant amount of time and is very tedious to maintain. So purposed system would be automatically marking attendance of student and keeping record itself, which is easily accessible by the teacher and easy to analyze and maintain a record in no time.

2.Related Work:

Most of the modern learning systems use some type of attendance management systems. Moodle [Konatham, S., Chalasani, B. S., Kulkarni, N., & El Taeib, T.,2016] automates the process using external RFID [Shengli, K., Jun, Z., Guang, S., Chunhong, W., Wenpei, Z. and Tao2015] or barcode scanners. Other LMS systems like the one by Angel accept students to mark their attendance using a onetime key in an online portal [Kar, N., Debbarma, M.K., Saha, A. and Pal, D.R,2012]. The use of such kind of system hinders the regular teaching and learning process in the class. Using face recognition in time attendance management systems is not new. There are few commercial solutions available to companies, that implement face recognition in work environments. Kawaguchi [Balcoh, Naveed Khan, M. Haroon Yousaf, Waqar Ahmad, and M. Iram Baig,2012] proposes face recognition in attendance management systems. This system aims to detect the position of each student and capture an image for that student, which is later identified. The systems that use biometrics such as iris recognition, fingerprint recognition, etc. to identify users are being used in many institutions [Saraswat, Chitresh, and Amit Kumar,2010]. However, these require a lot of financial input. It would also require from the university to record biometric information from all students, which would introduce further privacy concerns. These systems are also subject to physical damage from their users. Therefore, they need additional maintenance costs [Patel, Unnati A., and S. Priya,2014]. The idea proposed by us, removes physical access from anyone to the system.

3. Purposed Technique:

In this system, we have integrated facial recognition algorithm with machine learning algorithm into the process of automatic attendance system. This system is implemented in basic and fundamental principle on the presence of a digital camera in the classroom. The digital camera would capture 2 images in the time interval of 25 minutes in a lecture of 50 minutes. Now image would be provided to system and system would extract all the faces from the image. Now face would be compared with the existing trained model of faces and checks if face exists or not. If face exists on current database [Patil, Ajinkya, and Mrudang Shukla,2014] then the system would save unique ID of a student in attendance database or discards in case student doesn't exist in classroom database. In this paper, we have addressed various problems such as real-time face detection, multiple face detection and integration with the machine learning algorithm.

During the implementation of an idea, the real problem was the extraction of a face from the image in real time. So, to address this issue we used Tensorflow estimator API to classify different faces using Deep Neural Network (DNN) [Tian, Y.L. and Bolle, R.M,2005] which again gets trained from the images extracted in real time. However, detecting face like patterns constitutes just a part of the problem. One must implement a face recognition algorithm which is used to positively identify a student from a database of students. To address this issue, we have used facenet [Tian, Ying-Li, and Rudolf M. Bolle,2005] developed by Google which is a pre-trained model in 150000 images inspired by google pixel.

3.1 System Architecture:

This system can be classified into 3 different steps in broad. It involves:

- Image Capture
- Face Detection
- Face Recognition

The complete process is described in the pseudocode shown in Fig 1:

```
scan room with digital camera
for each detected object
transfer the object in server
next object
for each face in server
if face in student's database
record student as enrolled
save face in students database
else
mark face as unrecognized
next face
```

Fig 1: System architecture pseudocode

The required infrastructure is a classroom with 3 rotating cameras positioned in two corner and in center in-front of classroom. (Fig 2)

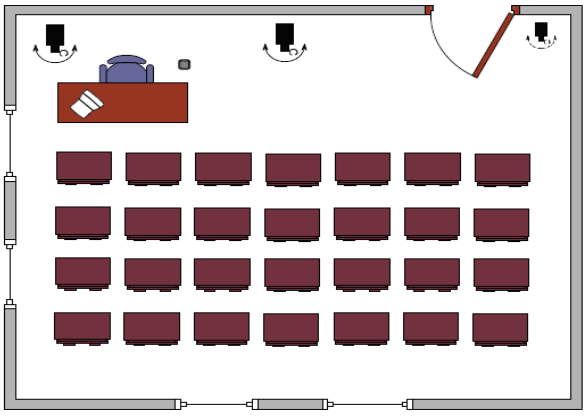

Fig 2. Classroom setup

Using three rotating camera we would have 180-degree view of entire classroom. The view would look something like shown in figure 3.

Fig 3. A classroom with students

A different approach for such a system would be placing the camera in front of entering a door. This would be less work to be done for detection of face for the system but there would be very less time for a system to capture, store, detect and recognize the face. So, placing the camera in front of the class would be helpful for the errorless attendance system [Kar, Nirmalya, Mrinal Kanti Debbarma, Ashim Saha, and Dwijen Rudra Pal,2012].

For fulfilling system requirement, a classroom must have a system(computer) which relates to 3 cameras of classroom and active internet [Wagh, P., Thakare, R., Chaudhari, J., & Patil, S,2015]. Now each system of the classroom would be connected to a master server responsible for the attendance of an entire university.

Figure 4 shows how system looks like.

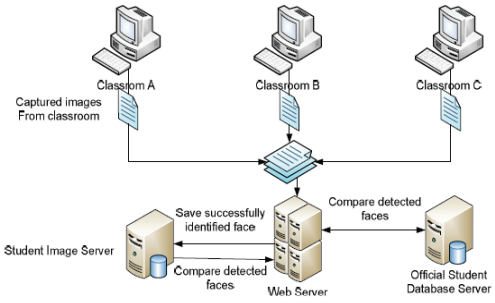

Figure 4. Physical system architecture

4. Detail Working:

4.1 Image Capturing:

To capture image regular camera application (desktop based) was developed using python. As we have 3 different camera presents in the classroom so, we would extract the face from each image. If there is a presence of 2 faces of the same person one would get discarded. The image was captured using traditional CV2(Computer Vision) package in python [Turk, Matthew, and Alex Pentland,1991].

Images are captured in an interval of 25 minutes until all faces get extracted or else until it is triggered to stop. Example, when a face doesn't get identified properly camera, keeps taking the picture until the face is identified.

4.2Face Detection:

4.2.1 Multi-task Cascaded Convolutional Networks:

Face detection and alignment in the unconstrained environment are challenging due to various poses, illuminations, and occlusions. Recent studies have proven that today's deep learning approaches are able to cater can with these problems. In this paper, we propose a deep cascaded multi-task framework which exploits the inherent correlation between detection and alignment to boost up their performance. Our framework leverages a cascaded architecture with three stages of carefully designed deep convolutional networks to predict face and landmark location in a coarse-to-fine manner. In addition, we propose a new online hard sample mining strategy that further improves the performance in practice. Our method achieves superior accuracy over the state-of-the-art techniques on the challenging FDDB and WIDER FACE [Tian, Ying-Li, and Rudolf M. Bolle,2005] benchmarks face detection, and AFLW [Surekha, Borra, Kanchan Jayant Nazare, S. Viswanadha Raju, and Nilanjan Dey,2017] benchmark for face alignment, while keeps real-time performance.

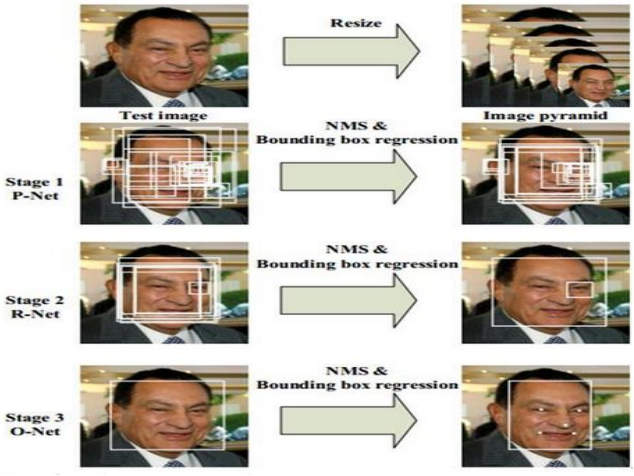

Fig 5: Face Detection using MTCCN

4.2.2MobileNet:

MobileNets are tiny, low-power models specially configured to meet the requirements of a variety of use cases. They can be built for embeddings, segmentation classification and detection like any other large-scale models, such as Inception. MobileNets [Joseph, Jomon, and K. P. Zacharia,2013] can be used effectively using TensorFlow Mobile.

MobileNets are capable of competing with popular models in measure of performances.

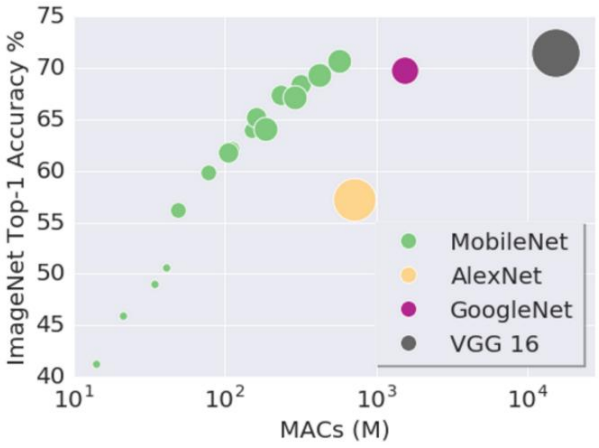

Fig 6: MobileNets trade off

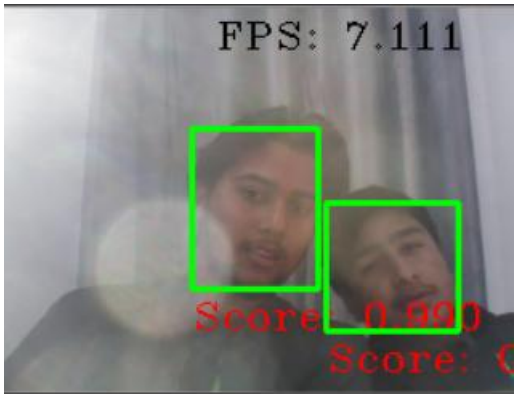

Fig 7: Multiple Faces being Detected

Face detection can obtain region of interest (ROI) using CNN architecture which further can be pre-processed a face to feed into recognition phase. Transfer learning is used to reduce the computational aspect.

4.3 Face Recognition

4.3.1 Eigen Face

Because of intensive processing, this tool is server based. Detecting a face is an object detection task, where the object of interest, in this case, is the face. However, many factors can influence the face detection algorithms, such as scaling, position, rotation, lighting, etc. The same problems arise when one wants to identify a face, with an addition to some other obstacles which is discussed shortly. There are plenty of face detection algorithms which can effectively detect a face (or any other specific object) in a picture. In the system presented here, most students face the camera frontally, so we chose to use the HAAR classifier [Krishnan, R. Ramya, R. Renuka, C. Swetha, and R. Ramakrishnan,2016] for face detection. This classifier is implemented on Intel's Open CV library.

In Open CV [Kar, Nirmalya, Mrinal Kanti Debbarma, Ashim Saha, and Dwijen Rudra Pal,2012] library, higher cascade and eigenface algorithm are used. Eigenface is most commonly and widely used PCA (Principle of Component Analysis) [Patil, Ajinkya, and Mrudang Shukla,2014] approach facial recognition system. In this approach the face into essential small set characteristics: eigenface which is also the main component of learning or training data set. Finally, recognition of the face is done by the projection of the image in eigenface vector subspace and the person's face is classified based on the

position of an individual to eigenface. The advantages of eigenface over other algorithm or techniques is its unsophistication, speed and insensitive to little changes in the face.

Figure 8 shows how Eigen Face [Patil, Ajinkya, and Mrudang Shukla,2014] works:

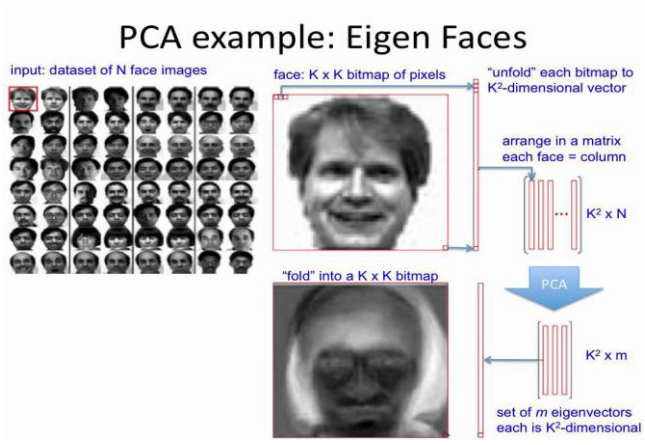

Fig 8: Eigen Face

Recognizing a face means to identify that face from a list of faces on a database. Our university, upon enrolment takes pictures and now images are stored in database which are later trained for model.

4.3.2 Deep Metric Learning:

The detected face is further processed to convert into 128 embeddings which are pre-trained by Davis King [Schroff, Florian, Dmitry Kalenichenko, and James Philbin,2015] on dataset of 3 million images in the wild LFW data set. Instead of outputting labels it output 128 encoded embeddings which are optimized based upon triplet loss [Schroff, Florian, Dmitry Kalenichenko, and James Philbin,2015].

Suppose we have three images A, B, C. For each image, we have a feature vector, a=f(A) etc. The formula for the triplet loss is then:

$$loss(a,p,n)=max(\|a-p\|_2-\|a-n\|_2+\alpha,0)$$

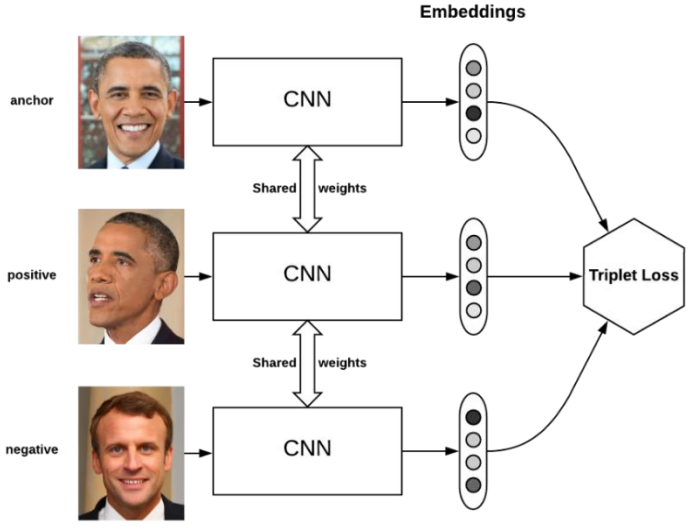

Fig:9 Triplet Loss

5. Result and FINDINGS:

With this approach, optimized marking of entities can be automated. This process will take minimum amount of time and will not be affected due to external factors like shadow, dust, etc. With implementation of supervised deep learning and transfer learning approach, our model can predict with ease in parameter tuning and less computation for training. The bias and variance trade off will decrease periodically with increased number of samples or input. After training face images, we will train the image to classify whether it's a live object or some 2D photograph.

As compared to traditional computer vision algorithm like CNN (Conv Net) this model will use SSD (Single Shot Multi-Box Detect) with ease in architecture(resent). The total training time decreases by using 1*1 convolution window.

After detection of face using our system, face would have unique ID in database with would get compared with each face. If face match with existing database's face a query will be fired and hence attendance get updated.

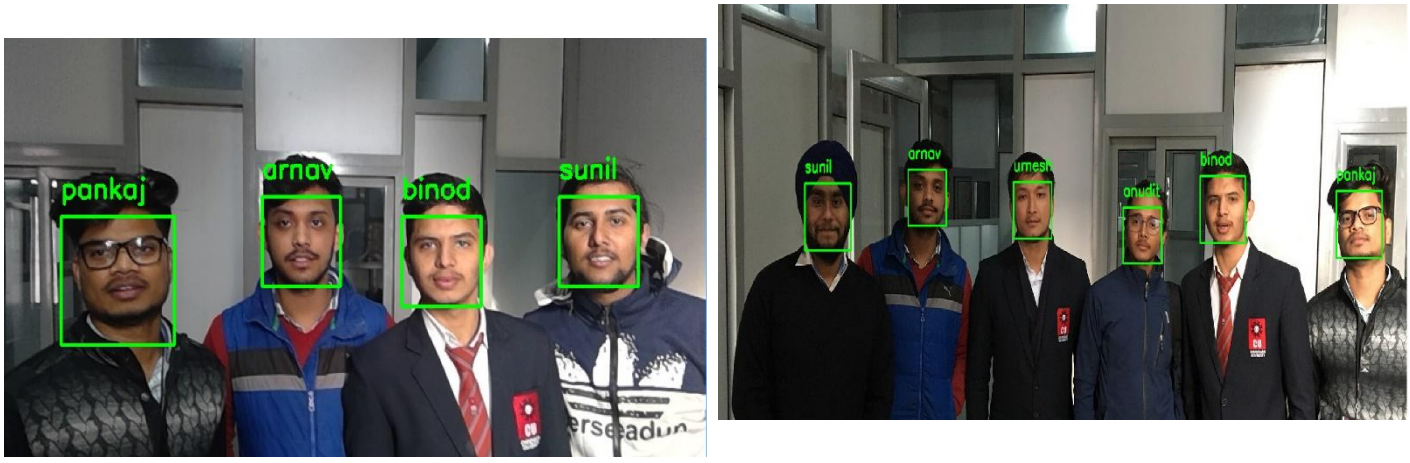

Fig 10: Multiple Face Being Detected

5.1 Table 1:

deep metric learning

	name	accuracy
0	pankaj	94.53
1	arnav	96.44
2	binod	88.34
3	sunil	97.55
4	umesh	94.23
5	anudit	96.34

Eigen faces

	name	accuracy
0	pankaj	66.34
1	arnav	82.88
2	binod	77.54
3	sunil	92.45
4	umesh	56.78
5	anudit	66.32

Fig 11: Engen Face VS Deep Matric Learning

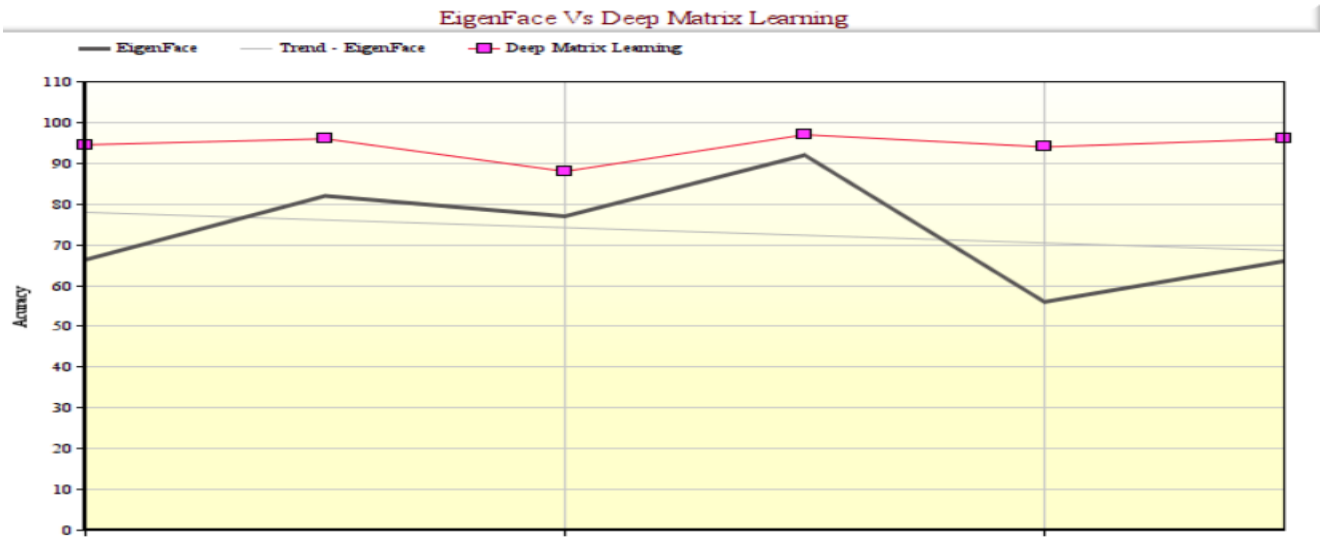

Fig 12: Eigenfaces Vs Deep Matrix Learning

Conclusion and Future Work:

An automatic attendance system is a one of the most necessary tools for any organization. Most of the today's system are time taking and require somehow manual intervention of either student or teacher. Our approach targets to solve the problems by face recognition in the process. Even this system cannot completely identify each student present in class and has lot of space of improvement on basis and time of computation and accuracy. Since our system is implemented on modular approach, we can keep improving until we reach acceptable accuracy. As our system is only concerned on marking attendance automatically there is no module that deals with security which is one of the most important room for improvement in next phase. Whenever an image is stored on our servers, it must be impossible for a person to use that image.

As our system is live based system, we can use this system for live surveillance as well keeping point in consideration that data is to be secured in all way possible. We too have room for improvement whether face is a face or a 2D picture which would be another consideration for improving of the system in another phase.

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