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A Comprehensive Review for Smart Attendance Monitoring System Using Machine Learning and Deep Learning

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Abstract - *In the research of attendance monitoring systems, it is observed that on average 10-15 minutes of the lecture are wasted on taking attendance using conventional methods. These drawbacks can be solved using a facial recognition-based attendance tracking system. Face recognition can be done using different machine learning, deep learning algorithms. This paper compares various face recognition-based models which use machine learning, deep learning, OpenCV, Internet of Things (IoT) based approaches. Most of the authors used the Haar Cascade algorithm for face detection. Among all the machine learning and deep learning algorithms, Convolutional Neural Networks (CNNs) were found out to be the most accurate and reliable. According to many authors, the accuracy of CNN is found in between 95-98%.*

Key Words: Haar Cascade, Convolutional Neural Networks (CNNs), Machine Learning, image Processing, Deep Learning, Face Recognition, Attendance monitoring, Internet of Things (IoT)

1.INTRODUCTION

In every organization, attendance is really essential. This process will be more inefficient and more time consuming if it is not managed smartly and using modern technology. In educational institutes, it is intricate to use the traditional approach of calling students names and maintaining attendance records when the number of students is high. Various methods are used by organizations to mark attendance like document-oriented approach, Card swipe, Biometric fingerprint, etc. In case if the card is lost or if the student forgot the card then the student will be marked as absent. Also, the student has to wait in the queue for this process.

To overcome these drawbacks there should be a robust and reliable system to take the attendance of employees or students. Face recognition will be the more reliable approach for taking attendance. Face recognition does not necessitate a person's active participation. The primary contributors to the development of facial recognition systems are pattern recognition, face analysis, machine learning, and deep learning.

The face recognition using CNN algorithm is more efficient and reliable.

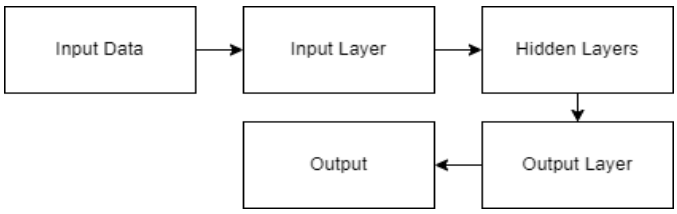

Fig -1: Basic block diagram of CNN

The data is supplied to the model in the input layer. In the input layer, the number of neurons is equal to the number of features. There might be several hidden layers depending on the model and data amount. Each hidden layer has a distinct number of neurons. The hidden layer's output is supplied into the logistic functions. Using the logistic function, the output of each Class is transformed into the probability score of each class.

This paper compares various machine learning, deep learning, IoT based approaches for face recognition. This comparative analysis of several publications will be beneficial in the implementation of a sophisticated and intelligent attendance system. For feature extraction, transformation, and recognition, deep learning approaches employ a multi-tiered course in a hierarchy of processing units. The algorithm begins to create a statistical input with each encounter and learns until the outcome reaches an acceptable degree of accuracy. The use of these modern techniques for face recognition will make the attendance system more flexible and will also reduce human errors.

2. Literature work

2.1 Technical Survey

Fig2 represents the Maximum face recognition rate using the Local Binary Pattern Histogram (LBPH) algorithm for single face, multiple faces, group faces.

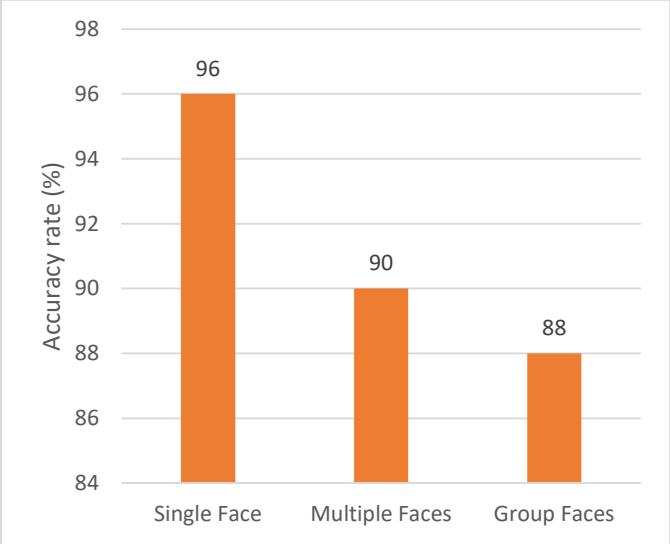

Fig -2: Maximum face recognition rate using LBPH [29]

Fig3 represents the accuracy comparison between Principal Component Analysis (PCA) and CNN-PCA with varying number of objects [6].

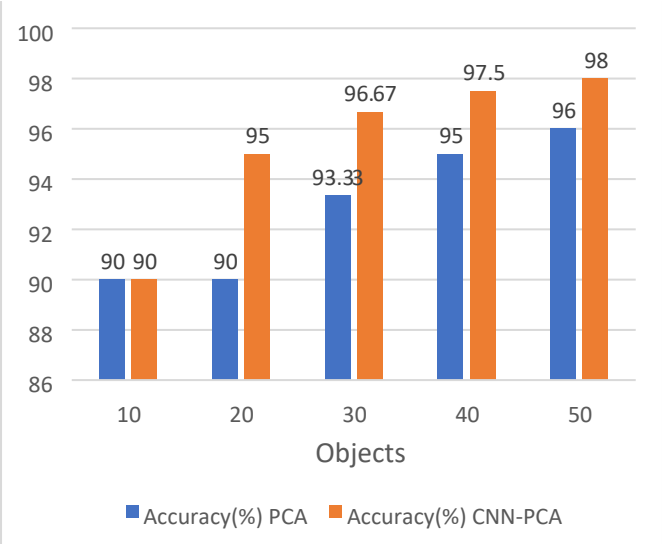

Fig -3: Comparison between PCA and CNN-PCA[6]

Fig4 represents the comparison of time taken by Histogram of Oriented Gradients (HOG) and CNN [31].

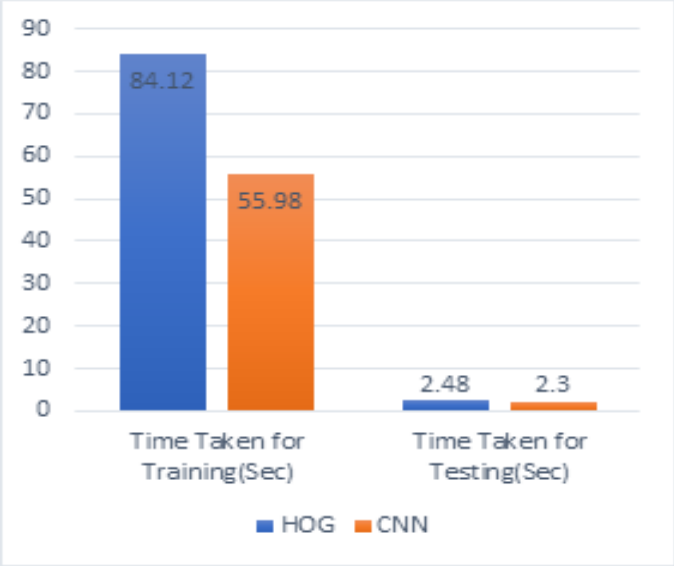

Fig -4: Comparison of time taken by HOG and CNN [31]

Table 1 represents the comparison of accuracies of some models [11].

Model	Images(M)	Accuracy
DeepID2+	0.3	98.70%
Baidu	1.3	99.13%
FaceNet	200	99.63%
Centre Face	0.7	99.28%
DeepFace	4	97.35%

Table -1: Comparison of accuracies of models [11].

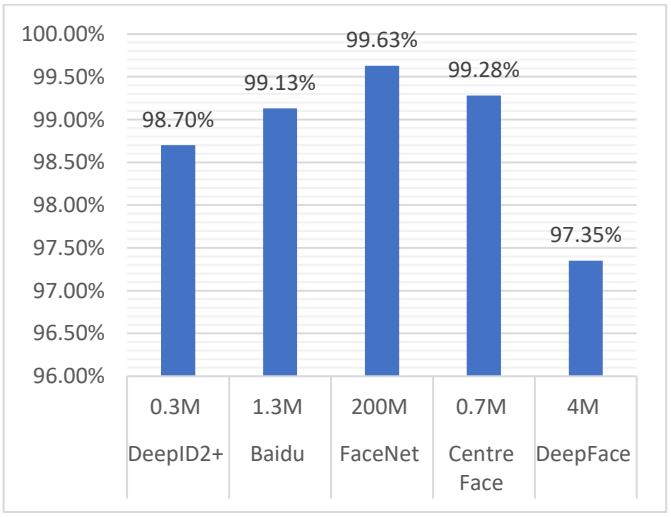

Fig -5: Comparison of different models[11]

Fig.6 shows the comparison of True Positive (TP), True Negative (TN), False Positive(FP), False Negative (FN)

values of K-Nearest Neighbour (KNN) and Support Vector Machine (SVM) classifier with 190 images [10].

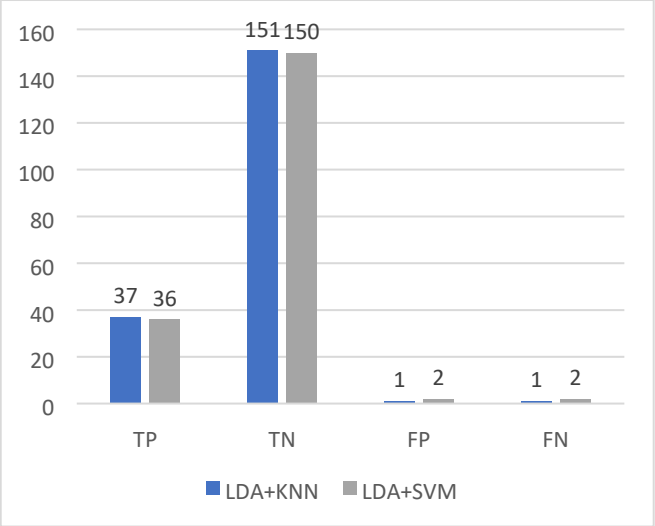

Fig -6: TP, TN, FP, FN comparison for KNN & SVM [10]

Table 2 represents the comparison of Rank face verification accuracy with the face matching and Open Face Methods. Rank 1 shows the correct face is the closest face to the predicted face position likely, rank 2 shows the two nearest faces to the predicted face position. In the face matching method, the face verification is performed manually with rank conditions [26].

Rank	Accuracy using Face matching(%)	Accuracy using OpenFace(%)
1	33	17
2	66	44
3	80	65
4	93	87
5	100	100

Table -2: Comparison of Rank face verification[26]

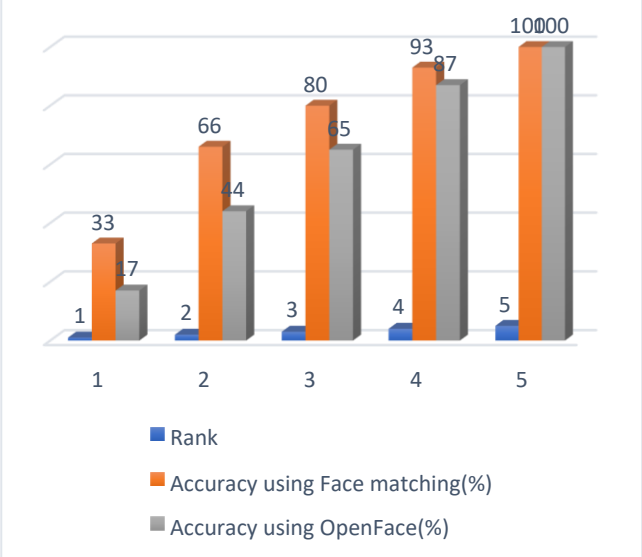

Fig -7: Comparison of Rank Face verification [26]

Table 3 represents the graph between the different algorithms used by authors and their accuracy

References	Algorithms	Accuracy
[10]	LDA+KNN	97.00%
[10]	LDA+SVM	95%
[9]	Facenet	98.87%
[6]	PCA	96%
[6]	CNN-PCA	98%
[4]	KNN	99.27%
[4]	CNN	98.54%
[4]	SVM	80.15%
[29]	LBPH(Single face)	96%
[12]	MLP-PCA	86%
[12]	MLP-LDA	87%
[7]	HMM	99.5%

Table -3: Algorithms and their Accuracies

The fig.8 represents the graph between the different algorithms used by authors and their accuracy

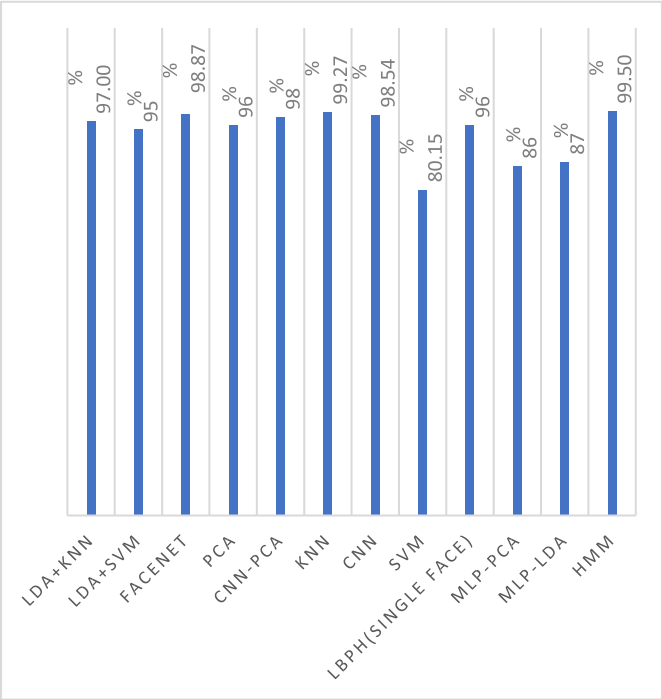

Fig -8: Algorithms and their Accuracies

2.1 Non-Technical Survey

Shubhobrata Bhattacharya et. al [3] created a portable gadget that works well and can be used even when the sessions are running. The authors utilised the following characteristics to assess face quality: pose estimation, sharpness, image size or resolution, and brightness. Also, they have discussed how to calculate the parameters and how to normalize these parameters. The authors calculated the final score by assigning the weights to the parameters. They have used CNN algorithm to extract low-dimensional distinct features from the face images. They used the viola and jones algorithm for face detection.

The system proposed by Samridhi Dev et. al [4] employed Generative Adversarial Networks (GANs). Face detection was done using the Haar classifier method, while feature extraction was done with Gabor filters. For face recognition, they utilised three algorithms: K-nearest neighbour (KNN), Convolutional Neural Networks (CNN), and Support Vector Machine (SVM) (SVM). They compared these algorithms on various conditions like Head movements, different camera positions, and overall results. KNN proved to be the best algorithm with the highest accuracy.

Priya Pasumarti et. al [25] suggested a Raspberry Pi-based face detection and recognition approach. The authors used Haar's Cascades algorithm proposed by Viola-Jones for face detection.For face recognition, they used the LBPH algorithm. For updating the database SQLite along with MYSQL was used.

Prayag Bhatia et. al [28] recognized the individual from the local database, with the help of a model based on Local Binary Pattern Histograms. A Raspberry Pi 3 CPU, external web camera, speaker, and stepper motor are required to construct this system. The LBPH algorithm is used in this system to recognize faces.

The system proposed by Mayank Yadav et. al [7] used motion-based detectors and a camera that records video and recognizes faces using HMM for marking attendance. It marks attendance and keeps the record of whether a person is attending a complete lecture or not.

Harish M et. al [9] developed an application that sends images captured by phone by faculty to google drive. A system fetches it for recognizing it using FACENET then attendance is marked. The accuracy of this model was 100%. The authors discussed the FACENET algorithm and how to integrate Google Drive with the system. The storage requirements are a bare minimum, as the data gets stored on google drive.

Vidya Patil et. al [10] proposed a model in which has a camera for acquiring student's images. The Viola Jones method is used to detect the face, and features are retrieved using LDA and identified using KNN. The authors used Histogram Equalization to enhance the contrast of the images. This model has an accuracy of 97%.

Harsh Nagoriya [22] developed a model based on a Raspberry PI system to detect and recognize human faces quickly and accurately. This project was implemented using the Eigen matrix concept for easy recognition of student's faces. This system is developed on an Open Source image processing library hence, it is not hardware nor software dependent.

Mohd.Aquib Ansari et. al [20] did a comprehensive analysis on several edge detection techniques such as Prewitt, Sobel, Canny, Roberts, and Laplacian of Gaussian. They utilized MATLAB R2015a to develop these approaches and measured the performance of each edge detection technique using PSNR and MSE. After the experimental analysis, the authors found that the Canny edge detector works well than other techniques.

3. Common Methodology

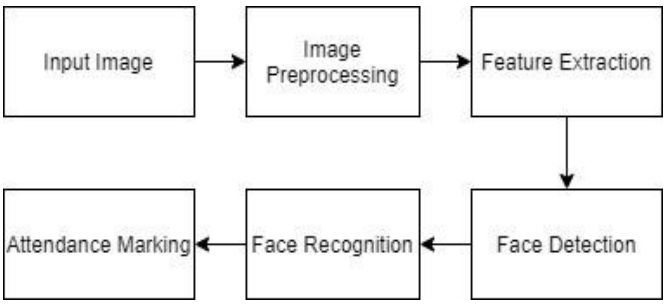

Fig -9: Block diagram of face recognition system

The input image is the initial stage of a facial recognition-based attendance system. The supplied image is subjected to image preprocessing. The feature extraction stage extracts all of the face's characteristics.

Using various machine learning and deep learning techniques, a face detector locates the faces in a picture and gives the bounding box coordinates for each of them.

ML and Deep Learning algorithms are used to detect the face. The attendance was recorded after the facial recognition.

4. CONCLUSION

Different facial recognition-based algorithms have been explored and compared in this literature study for smart attendance monitoring systems. This survey is for people interested in using Machine Learning, Deep Learning, IoT, and Image Processing to create a smart attendance tracking system. Based on the work done by writers in the articles, it can be determined that CNN beats every other method in the vast majority of instances. This states that CNN should be preferred over other algorithms when implementing smart attendance monitoring systems. Face recognition accuracy for the CNN algorithm is between 95-98 percent. The purpose of this article is to improve the correctness.

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