Proceedings of the International Conference on Smart Electronics and Communication (ICOSEC 2020)
IEEE Xplore Part Number: CFP20V90-ART; ISBN: 978-1-7281-5461-9

Student Attendance System using Face Recognition

Samridhi Dev
Department of computer science
C-DAC, Noida
Samridhi9927@gmail.com

Tushar Patnaik
Department of Computer Science
C-DAC, Noida
tusharpatnaik1108@gmail.com

***Abstract*-: Face recognition is among the most productive image processing applications and has a pivotal role in the technical field. Recognition of the human face is an active issue for authentication purposes specifically in the context of attendance of students. Attendance system using face recognition is a procedure of recognizing students by using face biostatistics based on the high definition monitoring and other computer technologies. The development of this system is aimed to accomplish digitization of the traditional system of taking attendance by calling names and maintaining pen-paper records. Present strategies for taking attendance are tedious and time-consuming. Attendance records can be easily manipulated by manual recording. The traditional process of making attendance and present biometric systems are vulnerable to proxies. This paper is therefore proposed to tackle all these problems. The proposed system makes the use of Haar classifiers, KNN, CNN, SVM, Generative adversarial networks, and Gabor filters. After face recognition attendance reports will be generated and stored in excel format. The system is tested under various conditions like illumination, head movements, the variation of distance between the student and cameras. After vigorous testing overall complexity and accuracy are calculated. The Proposed system proved to be an efficient and robust device for taking attendance in a classroom without any time consumption and manual work. The system developed is cost-efficient and need less installation.**

Keywords – KNN, SVM, VIOLA-JONES, HAAR classifiers, CNN.

I. INTRODUCTION

Attendance being a very necessary side of administration may normally become an arduous, redundant activity, pushing itself to inaccuracies. The traditional approach of making roll calls proves itself to be a statute of limitations as it is very difficult to call names and maintain its record especially when the ratio of students is high. Every organization has its way of taking measures for the Attendance of students. Some organizations use document-oriented Approach and others have implemented these digital methods such as biometric fingerprinting techniques and card swapping techniques. however, these methods prove to be a statute of limitations as it subjects students to wait in a time-consuming queue. if the student fails to bring his id card then he will not be able to get attendance. evolving technologies have made many improvements in the changing world.

The system of intelligent attendance is generally implemented with biometrics help. Recognition of face is one of the Biometric ways of improving this system. Face recognition proved to be a productive method for taking attendance. The normative face recognition techniques and methodologies fail to tackle challenges like scaling, pose, illumination, variations, rotation, and occlusions. The framework proposed is designed to solve the drawbacks of current systems. there has been a lot of advancement in face recognition but the vital steps are face detection, feature extraction, and face recognition. firstly, two or more cameras depend on the need, and the size of the classroom has to be installed on the ceiling of the classroom from where it covers the entire area. image captured from these cameras will be considered as an input to the system. There may be a possibility of getting image blurred due to movements of students, for better efficacy image can be upgraded using Generative Adversarial Networks. A newly generated ameliorated image will be passed to the system for face detection. process of face detection is accompanied by feature extraction and face recognition these process makes the use of Gabor filters. face recognition is done using the K-nearest neighbor algorithm, Convolutional neural networks, and SVM algorithm with their comparative studies. post-completion of face recognition, the system generates the name and identification number of the students who are present and identified in the image. then attendance is marked in front of the student names in the excel format with respective date and subject of a lecture in an institution. It requires very few hardware resources hence it is a cost-friendly system.

Above statement can be illustrated as figure 1 below

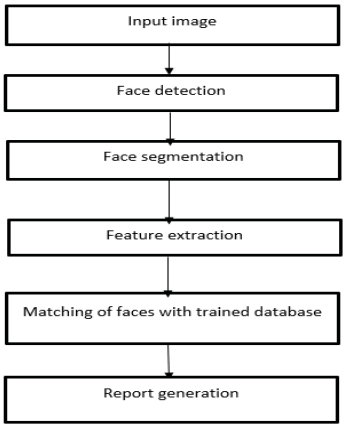


Figure 1 operating process of attendance system

II. LITERATURE REVIEW

The primary aim of this paper is to study the different approaches given by authors and to develop a real-time attendance system which overcomes the shortcomings of previous methods and to give the best solution.

In [1] Yohie Kawaguchi et.al proposed a system based on continuous observation and using face recognition. The author presented a system with an active student detecting method (ASD) having two cameras placed on the wall in which one is a sensing camera which is used for estimating seat inside the class and the other is capturing camera which is used for face detection. They have proposed a shooting plan in which one seat is estimated from the seating area obtained by ASD and then directs the capturing camera to the seat and captures an image. The existence of students is estimated using background subtraction and inters frame subtraction. The author has solved the linear sum assignment problem to give the correspondence of students and seats.

Paper proposed by [2] introduced an automated system based on convolutional neural networks. The author has used the GSM module to send the generated attendance report to an authorized person. The author proposes the modified convolutional neural network by adding two normalization operations to two of the layers. This operation provides the batch normalization acceleration of the network. The face recognition system is designed using the SIFT algorithm. This system will take attendance using MATLAB. The image will be captured and matched with the database and SMS is sent to the authorized number. major steps performed in this approach for generating the features are scale-space extreme detection, keypoint localization, orientation assignment, keypoint descriptor. As soon as the face is recognized by the system LED on the Arduino board will start blinking.

In [3] author studied [6] two-stage hybrid face detection scheme which uses the probability-based Face Mask Pre-Filtering (PFMPF)and the pixel-based hierarchical Feature Ad boosting (PBHFA) method. This approach is aimed to solve the problem in Haar cascade. The author proposed a system with two phases, training phase, and testing phase. In the training phase, they presented two main steps first is face detection in which they have used the viola jones algorithm. the second step which is feature extraction after detecting faces from a video feature is extracted using the PCA algorithm. in the testing phase, the data set is partitioned into two parts named training dataset and testing dataset.

In [4] the author used the convolutional neural network (CNN) to obtain low dimensional features as the pre-processed images are too high dimensional for a classifier to take it as input directly. For face detection, they have used the viola and jones algorithm and then used correlation tracker to track face from frame to frame. In this paper, the author has worked on several parameters like pose estimation, sharpness, resolution, and brightness. The head position is determined using three-angle roll, yaw, and pitch. Then approach includes final score calculation named face quality assessment by assigning weights to each of the normalized parameters.

In [5] the author presented the system which used the Eigenfaces approach for face recognition. They have performed face detection followed by a cropping of faces then worked on background subtraction for greyscale images and binary images. The author has used the Eigenface method due to its simplicity, speed, and learning capability.

In [7] Savitha et al proposed the system which uses skin detection technique for face detection. after the skin is detected skin pixels are taken and the rest of the pixels in images will be made black. Then these skin pixels will be used for face detection authors have used two databases, the first database is for storing faces of students and the second database is for storing data of students.

III. PROPOSED SYSTEM

A. Architecture

The proposed system is very simple, effortless, and manageable with lucid operations. It embraces a database of student's faces and their details like name, enrolment number, course. two or more cameras depending on the need and size of the classroom are to be accommodated on the ceiling of the classroom covering the entire area. these cameras will capture images several times during a lecture. this will increase the efficiency of the system because if the camera will not cover some students then other cameras will capture their faces. there are numerous expressions and poses possible which a student can perform. if at a particular instance system fails to detect faces due to unfavorable poses then the system can detect those faces at another instance of image acquisition. Once the image acquisition is done when the teacher triggers the system by making a click on the start button thereafter system will undergo face detection. after the faces are detected in an image taken by all cameras at all given instances then detected faces will be compared with stored images of the students in the database. Once the face is matched then present is marked in front of its corresponding enrolment number and name in excel format. though there are multiple cameras and multiple instances, there is a possibility of redundant faces. collaborated results will be generated by excluding redundant faces of the same student so that single attendance is given to that student during a lecture.

B. methodology

Developing an intelligent attendance management system, some steps need to be followed to achieve this Successful task. The steps are definable as follows:

- Database creation
- Image amelioration
- Face detection
- Feature extraction
- Face recognition
- Redundancy removal
- Report generation

Database creation

In the first step, the database will be created at the time of enrollment of students. The database will store generic information of students like name, identification number, course, semester subjects. alongside the image of the student is to be captured by the system for training of the proposed system. This system captures single image for a student for training purpose.
With the aid of all the pictures the student has stored in the database, facial recognition for all of the students attending a lecture. It can be accomplished.

Image amelioration

Due to the movements of a student in a classroom, the image captured by the camera may get blurred. the image can be ameliorated using Generative Adversarial Networks. GANs are known for their ability to retain texture information in images, create solutions similar to the actual range of aspects, and look perceptibly convincing.

$$I_B = k(M) * I_s + N$$

where I_B is a distorted image, $k(M)$ is referred to as unknown blur kernels identified by motion field M. I_s is the sharp latent image and * symbolizes convolution whereas N denotes an additive noise.

Face detection

For detection of faces 68 landmarks of faces are taken into account. with the help of these landmarks, faces are detected.
For face detection, Haar classifiers have been used. It is an approach based on machine learning in which a cascade function is trained from many positive and negative images. This is then used on other images to detect images. These classifiers are simply the subtraction of the sum of pixels under the black area from the sum of pixels under the white area. applying 6000 features on each window frame was found to be difficult. features were grouped into stages which are known as cascades of a classifier.
AdaBoost is used for removing redundant features and for selecting only appropriate features. These features are known as weak classifiers. A weighted combination of weak classifiers is used to detect faces. using the AdaBoost linear combination of weak classifiers is constructed known as a strong classifier.

$$P(Y) = \sum (S_i * p_i(Y))$$

Here, $P(Y)$ is a strong classifier and s_i are corresponding weights to each weak classifier $p_i(Y)$.

Feature extraction

For feature extraction, Gabor filters are used to lay hold on facial features inclined at various angles. It is a very critical step since it is believed that a successful feature extractor

selects a function that is not prone to occlusion, lighting, context, and pose variance. 2D Gabor filters are used to resolve spatial distortions caused by position and lighting variances.

$$W(x,y,\theta,\lambda,\varphi,\sigma,\gamma) = e^{\left(-\frac{x^2+\gamma^2y^2}{2\sigma^2}\right)}\cos\left(2\prod\prod\frac{x^2}{\lambda}+\varphi\right)$$

$$x' = x\cos\theta + y\sin\theta$$

$$y' = -x\sin\theta + y\cos\theta$$

here (x, y) defines the situation of a light impulse and μ, ϕ, γ, λ, σ are parameters of the sinusoidal wavelet.

Face recognition

For face recognition, the K-nearest neighbor algorithm have been used, convolutional neural networks, and support vector machine. These three algorithms are compared on the grounds of accuracy, robustness, time complexity.

A. K-nearest neighbor algorithm

KNN is called memory-based or lazy learning since it only preserves the interpretations of the training examples as a result of the way it learns.
The Euclidean distance metric is often selected to Determine the location of data points within KNN. An object is classified according to the Voting done by the majority of its neighbors, with the object delegated to the most common class of its nearest neighbors (k Is a positive integer). If k = 1, the object is then it is allocated to his closest neighbor's family.

$$d(x.y) = \sqrt{(x_1-y_1)^2 \dots\dots\dots (x_n-y_n)^2}$$

$d(x.y)$ is the euclidean distance which is by default used by KNN to find the nearest class.

B. Convolutional neural networks

Convolution Neural Networks allow us to derive from images a large variety of features. This concept of extracting the functionality for face recognition can also be used. CNN uses 68 facial landmarks to generate 128-dimensional encodings which are facial features encoded in RGB format. These encodings are compared to match faces. The strictness of face comparison can be manipulated by tolerance value.

Redundancy removal

As the system encompasses multiple cameras. there might be a possibility of the presence of the face of a single student in different images. redundant faces will be removed and single faces will be considered to mark single attendance for a student during a lecture.

Report generation

Trailing face recognition reports are generated by marking present in front of the student name and enrollment number in excel format during a lecture.

IV. RESULTS

the system was tested on three different algorithms out of which the KNN algorithm proved to be better with the accuracy of 99.27 %. The system was tested on various conditions which include illumination, head movements, expressions, the distance of students from the camera. The system stands up to the expectations even when the image contains faces with beards and spectacles and without beard and spectacles. proposed system evinced to be magnificent to recognize faces having two years of difference. Being tested on these conditions KNN proved to be better by achieving the overall accuracy of 97 %. when tested on conditions listed above CNN achieved the overall accuracy of 95 % and SVM achieved an accuracy of 88 %. viewing the aspect of time complexity, CNN exposed to have low time complexity. It was found that SVM has the highest time complexity among these three listed algorithms. The proposed system is tested on 200 real-time images of a classroom with a maximum strength of 70 students. The proposed system is robust enough to take attendance of 70 students in a classroom.

The figure below shows the result of our proposed system

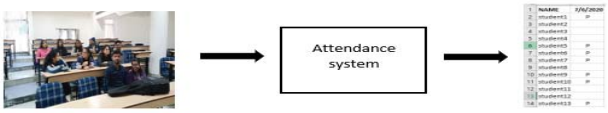


Figure 4 Proposed system

V. COMPARISON

In our proposed system Haar cascades are used for face detection and generative adversarial networks for image amelioration and for feature extraction Gabor filters were used. For face recognition, different algorithms were used. These

algorithms have been compared on the grounds of time complexity accuracy in various conditions.

Table 1 shows the comparison of algorithms under listed conditions.

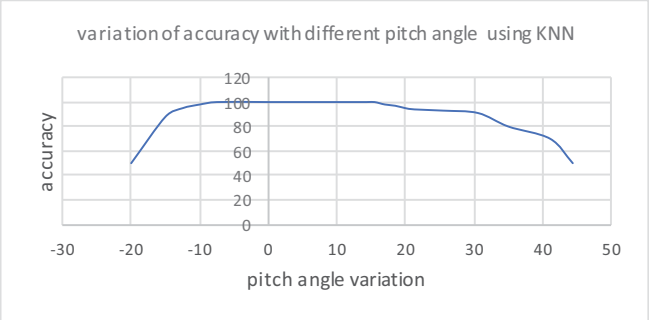
Conditions under testing	Accuracy		
	KNN	CNN	SVM
Normal	99.27	95.54	89.15
With age difference (2yrs)	97.90	95.00	86.75
With beard	90.00	90.00	80.00
With different expressions	92.00	90.00	78.00

Table 1 Comparison

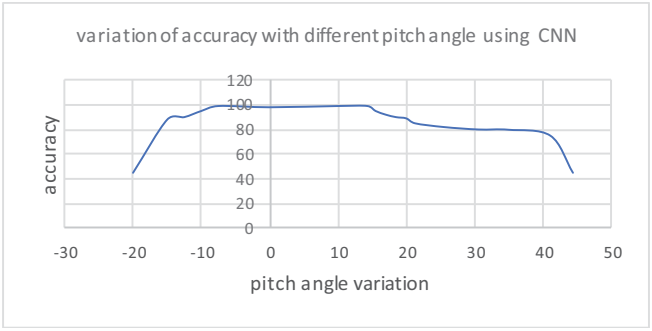
A. Head movements

In a classroom head movements at different angles is possible during a lecture. Head movements can be categorized into three categories measured in angles which are pitch, yaw, and Roll at the respective x-axis, y-axis, and z-axis.
Above listed algorithms were tested with different head movements. Graphs below show the variation of algorithms accuracy with a variety of angles.
For Roll and Yaw angles, the negative x-axis shows the head movement in the left direction and the positive x-axis shows the head movement in the right direction.
For the Pitch angle, the negative x-axis shows the head movement in the downward direction and the positive x-axis shows the head movement in the upward direction.

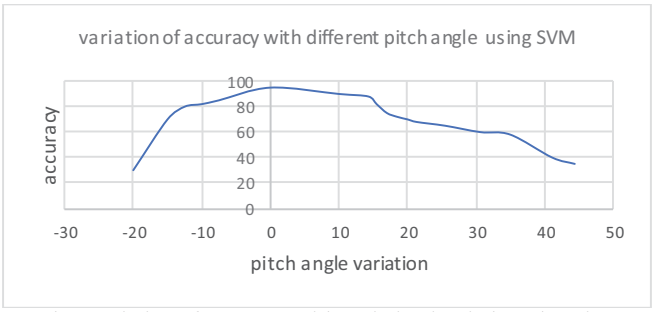
1) Pitch angle variation



Graph 1 Variation of accuracy with variation in pitch angle using KNN

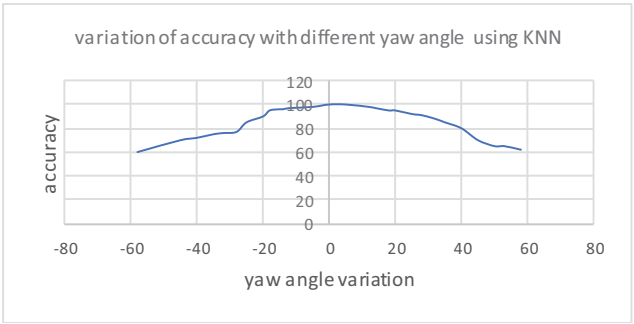


Graph 2 Variation of accuracy with variation in pitch angle using CNN

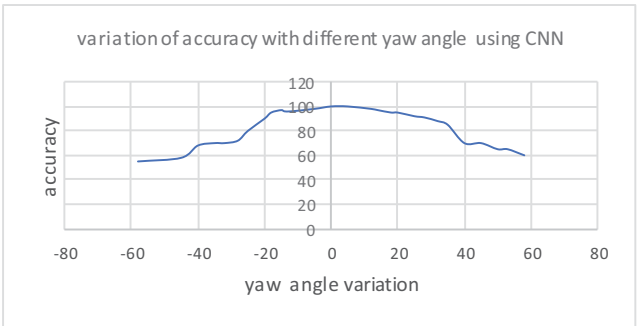


Graph 3 Variation of accuracy with variation in pitch angle using SVM

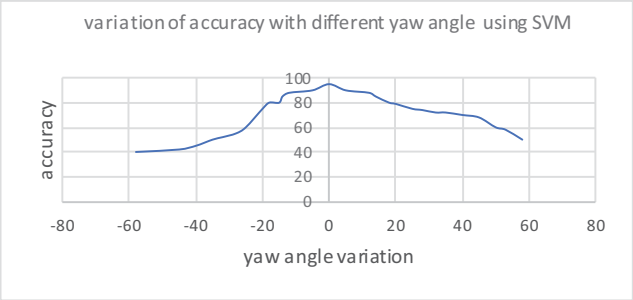
2) Yaw angle variation



Graph 4 Variation of accuracy with variation in Yaw angle using KNN

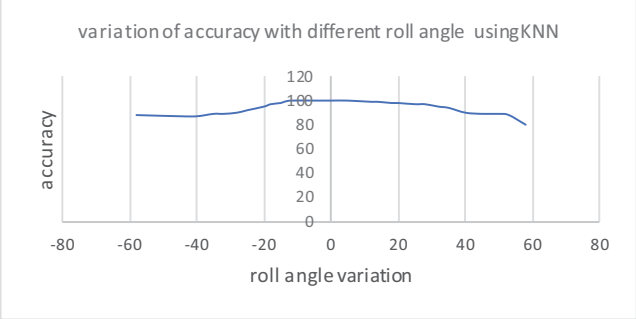


Graph 5 Variation of accuracy with variation in Yaw angle using CNN

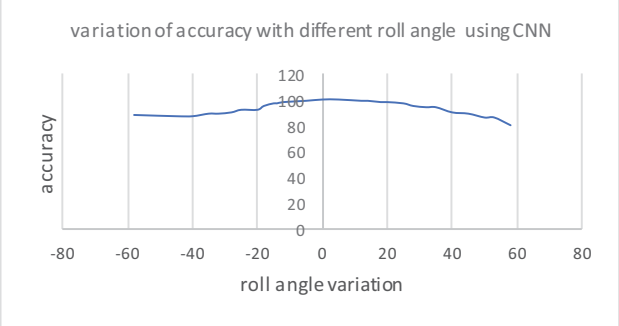


Graph 6 Variation of accuracy with variation in yaw angle using SVM

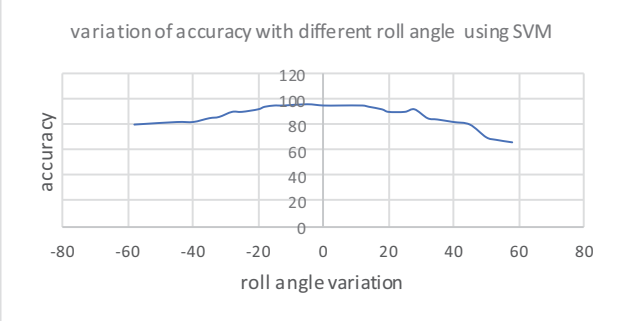
3) Roll angle variation



Graph 7 Variation of accuracy with variation in roll angle using KNN



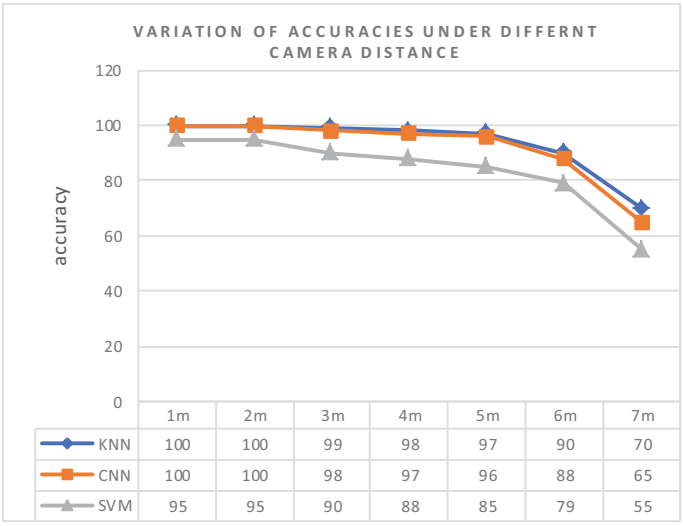
Graph 8 Variation of accuracy with variation in roll angle using CNN



Graph 9 Variation of accuracy with variation in roll angle using SVM

B. Different camera positions

Although cameras are to be fixed at the ceiling of classrooms, there may be a possibility of the varying distance between student and camera as students can sit at different seats. A system using three different algorithms were tested under the situation of the varying distance between student and cameras. The graph below shows the variation inaccuracy of the above-mentioned algorithms.



Graph 10 Variation of accuracy with variation in distance

C. Overall result

Taking into account all the above-mentioned conditions and situations overall accuracy, precision, recall, F1 score, and time complexity of the algorithm are calculated.

The table listed below describes the above statement.

Algorithm	KNN	CNN	SVM
Overall accuracy	99.27	98.54	80.15
Overall time complexity	124 seconds	120 seconds	480 seconds
Precision	0.99	0.98	0.78
Recall	0.98	0.97	0.75
F1 score	0.984	0.974	0.764

Table 2 result

VI. CONCLUSION

The proposed system meets the objective of achieving high precision and less computational complexity. This system is cost-efficient and less manual work is needed. Using Gabor filters accuracy is highly improved. For face recognition, Three algorithms have been used which are K-nearest neighbor, convolutional neural networks, and support vector machine, among these, the KNN algorithm proved to have the highest accuracy of 99.27 %. Convolutional neural networks evinced to have low computational complexity. SVM algorithm proved to be less efficient

VII. REFERENCES

[1] Yohei Kawaguchi, Tetsuo Shoji, "Face Recognition-based Lecture Attendance System", "3rd AERU…", 2005.

[2] B. Kavinmathi, S.Hemalatha, "Attendance System for Face Recognition using GSM module", 4th International Conference on Signal Processing and Integrated Networks", 2018.

[3] Ketan N. Mahajan, Nagaraj V. Dharwadkar," Classroom attendance system using surveillance camera", International Conference on Computer Systems, Electronics and Control",2017.

[4] Shubhobrata Bhattacharya, Gowtham Sandeep Nainala, Prosenjit Das, Aurobinda Routray "Smart Attendance Monitoring System (SAMS): A Face Recognition based Attendance System for Classroom Environment", IEEE 18th International Conference on Advanced Learning Technologies, 2018.

[5] E.Varadharajan, R.Dharani, S.Jeevitha,., "Automatic attendance management system using face detection", 2017.

[6] Guo, Jing-Ming, "Complexity reduced face detection using probability-based face mask prefiltering and pixel-based hierarchical-feature Ada boosting", Signal Processing Letters, IEEE 2011.

.

[7] K.Senthamil Selvil, P.Chitrakala, A.Antony, Jenitha S, "face recognition based attendance marking system", International Journal of Computer Science and Mobile Computing, 2014.

[8] Chen, Joy Iong Zong. "Smart Security System for Suspicious Activity Detection in Volatile Areas." Journal of Information Technology 2, 2020.

[9] Jacob, I. Jeena. "Capsule network based biometric recognition system." Journal of Artificial Intelligence 1,2019.

[10] Kirtiraj Kadam, Manasi Jadhav, Shivam Mulay, Tushar Indalkar, "Attendance Monitoring System Using Image Processing and Machine Learning", International Journal of Advance Engineering and Research Development, 2017.

[11] Rajat Kumar Chauhan, Vivekanand Pandey, Lokanath M, "Smart Attendance System Using CNN", International Journal of Pure and Applied Mathematics,2018.

[12] Mayank Yadav, Anmol Aggarwal, "Motion based attendance system in real time environment for multimedia application", 2018.

[13] Wei Wu, Chuanchang Liu, Zhiyuan Su, "Novel Real-time Face Recognition from Video Streams", International Conference on Computer Systems, Electronics and Control, 2017.

[14] Changxing Ding, Dacheng Tao, "Trunk-Branch Ensemble Convolutional Neural Networks for Video-Based Face Recognition", IEEE transactions on pattern analysis and machine intelligence, 2018.

[15] Aziza Ahmedi, Dr Suvarna Nandyal, "An Automatic Attendance System Using Image processing", The International Journal of Engineering and Science, 2015.