Investigation of Camera placement and Face Detection Methods for Automated Camera-Based Attendance Systems

Disha Giriyan
Dept. of CSE,
NIEIT,Mysore.

Chilukuri VinayKumar,
Dept. of CSE,
NIEIT,Mysore.

Brunda Somanna
Dept. of CSE,
NIEIT,Mysore.

Abhishek G R
Dept. of CSE,
NIEIT,Mysore.

***Abstract*- Face recognition of people in crowded area has always been a challenge to the computer vision community. However, the performances are found to be better when the crowd is to be analyzed in organized spaces such as class rooms or an auditorium. This helped in applications such as attendance marking in classrooms and auditoriums. State of the art camera-based attendance marking systems focus on hierarchical architecture-based classrooms but suffered in even floored classrooms due to students overlapping and variations in their head orientations. The proposal here is to investigate the best camera placement strategies to cover all the students present in a room. The proposal here is to also enhance the face detection methods for automated camera-based attendance systems such that there is more detection rate and less/no false positive detection. The intention of our project is to reduce the missing rates in detection of faces and to increase the accuracy rate in face recognition.**

Keywords: Recognition, detection, excel, attendance marking, accuracy, Hash values.

I.INTRODUCTION

Every organization uses its own method for automated attendance system. Some continue with traditional method for taking attendance which is time consuming and lead to fake attendance. To avoid such problems different biometric techniques like fingerprint, iris recognition and smart card etc have come into existence and are successfully being used in organizations. These forms of biometrics dependent on individuals so to avoid human intervention, face recognition is the used, especially video-based face recognition, because it can be implemented for many applications such as video surveillance. This paper demonstrates how face recognition technique is used in field of education for automated attendance system to record the presence of an enrolled student. The process of face recognition system is divided various steps, but the important steps are detection and recognition. The rest of the paper organizes as follows: section 2 covers Literature survey. The proposed system and methodology are described in section 3. Section 4 shows the conclusion.

II. RELATED WORK

In [1], system is proposed using video-based face recognition where they have created a database of 10 people each of 5 images with different pose. The face detection was done by the "vision.CascadeObject-Detector" command which is an inbuilt function for face detection, based on viola-jones algorithm. The viola-jones algorithm is a machine learning based approach where cascade function is trained from a lot of positive and negative samples. To execute face recognition operation PCA and LDA algorithms are used. PCA and LDA both performs well under the suitable conditions like: normal light condition, no pose variation and distance from camera should be 1-3 feet for best results. PCA takes less time for recognition compared to LDA. But LDA is preferable for its higher recognition rate.

In [2], a system is proposed using image processing. For face detection, viola jones algorithm was used which consists of Adaboost training and haar feature classifiers. Cascading classifiers were trained with hundreds of positive and negative images. Once the classifier is trained, it is applied to an image to detect the faces. Fisher face algorithm is used for face recognition. Resolution of the camera used is 1920*1088 pixels. For recognition purpose, 16 students are being registered where everyone are facing the camera. The accuracy was between 42% to 50%.

In [3], a system is proposed that takes attendance of the students who are present in the classroom after a periodic time. This system does need active participation of students. Viola Jones Algorithm - a machine learning based approach is used for face detection. PCA and LBP classifier is used for face recognition. The system is tested for a set of 40 students. But as the face orientation goes beyond 50° the detection rate reduces drastically and also as the face orientation goes beyond 35° face recognition also reduces drastically.

In [4], a system is proposed with controlled door access. Only when the face detected is matched against the face stored in the database the student is given the access to enter the classroom. This system uses Raspberry pi. Servo motor is used for controlled door access. LBP algorithm is used for face recognition and Haar Feature based Cascade Algorithm for face detection. The system consists of 11 students with 21 images each as a dataset. The system achieves accuracy up to 95%. It was found that the system

did not detect the face when the light source was facing the student's face and when there was luminous background.

In [5], a system is proposed that featured histogram methods to recognize face, by using Viola Jones method with computer vision to detect face by taking features of eyes, nose and mouth. For matching factors for recognition histogram of individual feature is computed. Local features of histogram are explored from database image for face recognition based on feature. The proposed method show a result with precision of 97% for the recognition of faces. Here face detection method detect the face, their facial feature, extracted feature and their respective histogram are calculated. The algorithm used for recognition worked for face recognition with 97% success rate. Skin colour detection can detect all face images but it also contains the neck and clothing whose colour is similar to the skin. So the error rate is high. So the result is not good. By hybridizing the feature base and template based approaches it is possible to improve the accuracy of the matching method.

In [6], a system is proposed for marking and management of attendance using face detection and recognition algorithms. This proposed system aims to develop an automated system that records the student's attendance by using facial recognition of face is done by image processing techniques. The processed image is used attendance is marked in the database correspondingly. This proposed system make use of face recognition techniques and attendance are marked. Each and every entry is updated in the database in order to use in future. This system follows a modular approach, any advancement can be integrated into the system.

In [7], a system is proposed to recognize face using Eigen values and PCA. The face detection process was carried out by using haar feature classifiers and cascade concepts of Viola and Jones Algorithm which is also known as Ada-Boost Algorithm. To enhance the image quality image processing techniques like grayscale conversion and histogram equalization are used. For the recognition process Eigen Face technique along with Principal component Analysis is used. Illumination invariant algorithm is implemented to overcome light intensity problem. The system consists of 13 people of each 5 images with different poses as dataset. The accuracy and performance achieved is up to 92%. Eigen Face along with PCA doesn't holds good for conditions like occlusion and head orientation.

In [8], proposed a method to identify face using Eigen face projection. PCA was used to analyze face recognition issues also known as Eigen Face Projection. Image is preprocessed and resized into 48X64 pixels and converted them into grayscale image, full frontal images are used for face detection and recognition. Histogram equalization technique is used to improve contrast of the image. Eigen faces are generated for both test and training images of database. Face recognition is performed using Eigen face method and verified using Euclidean Distance. Faces with side poses are not detected and this system is designed for detecting individual persons. It consists dataset of 15 persons with 10 images per person.

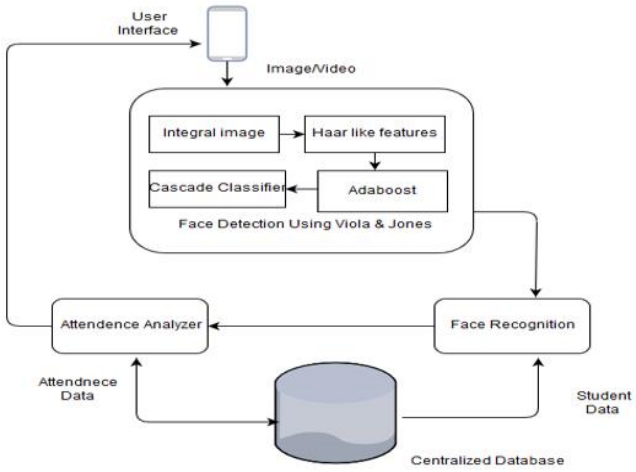


Figure 1: System Architecture

III. SYSTEM ARCHITECTURE

The process starts with training the system with student's faces for whom the attendance has to be marked in near future. Students Faces are assigned with names for specification. The time period decides the threshold time limit within student will be marked present. Once the threshold limit is crossed the student will be marked absent in the system for that particular period of time. A camera with high specifications is used as it plays a key role in face detection and recognition. Hence, better the camera used, the more is efficiency in the system attained. In camera placement strategy we have carried some of the experiments. Camera placement optimization includes placing of camera to find the best position to capture a picture where the entire classroom is covered.

IV. CAMERA PLACEMENT STRATERGY

The use and placement of camera is an important part of an effective automated attendance system. The placement of camera will be based on defined requirements in terms of monitoring and information collection. However, there are a number of ideas that can be identified in the use and placement of cameras to give consistent, effective coverage and delivery. Camera placement optimization includes placing a camera to find the best position to capture a picture where the entire classroom is covered. The classroom's image is captured such that the faces of all the students are detected efficiently. We have used the smartphone camera with a resolution of 1080*1920 at 401 ppi with a 13-megapixel. For more accurate processing of a larger classroom image, we need to use a camera with higher resolution. Avoid camera placements where camera views

are too angled to identify faces clearly. In camera placement strategy we have carried some of the experiments as follows:

Figure 2: Left top corner of the classroom

Figure 3: Right top corner of the classroom

Figure 4: Left row of the classroom

Figure 5: Right row of the classroom

V. DATASET COLLECTION

Dataset collection is process of collecting required data from all the relevant sources that are needed for the research problem, test the hypothesis and evaluate the outcomes. The first step in our proposed system is creation of a database of faces that will be used. Different individual students are considered and their images with different head orientation and head position were taken and the detected faces are cropped and converted into gray scale which is considered as training set and saved in the train folder. The classroom images will be captured, which is considered as testing set and also saved in the test folder.

In our proposed system we have collected dataset of 56 individuals with 20 samples of each individual. The camera resolution used for this purpose is 1080*1920 ppi, with 13-megapixel. We have taken pictures of individuals with different head orientation such as frontal face, sideways face orientation i.e. from left to right with 15ºdifferenece between the angles, the four diagonals face and top to the bottom head orientations. The color images are cropped and converted into gray scale and resized into 64*64 pixels. Totally 1,120 images were captured and considered as the dataset. Here the individual face is considered as train images. These images will be used to train the system to learn the features which will be used for recognition purpose.

The classroom images with students seated were also clicked using the above-mentioned camera resolution. These images are considered as test image. Data augmentation can be applied as a pre-processing step to increase the size of the data set before we train the system.

Figure 6: Individual picture with different head orientation

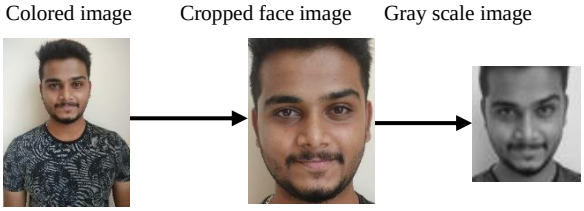


Figure7: Colour image is cropped and converted into gray scale

Data augmentation is a very powerful technique used to artificially create variations in existing images to expand an existing training data set. This creates new and different images from the existing training data set that represents a comprehensive set of possible images. This is done by applying different transformation techniques like rotating the existing image by a few degrees, zooming the existing image, shearing or cropping the existing set of

images etc. Thus, helps to increase performance of the proposed system by generalizing better and thereby reducing overfitting. Basic data augmentation techniques are Flipping, Rotation, Shearing, Cropping, zoom in, zoom out, Changing brightness or contrast, Noise.

In our project we have also used data augmentation techniques to obtain more variations for the collected individual samples that will be considered as training set.

Figure 8: Data Augmentation

Figure 9: Images stored in a folder "TrainingImages"

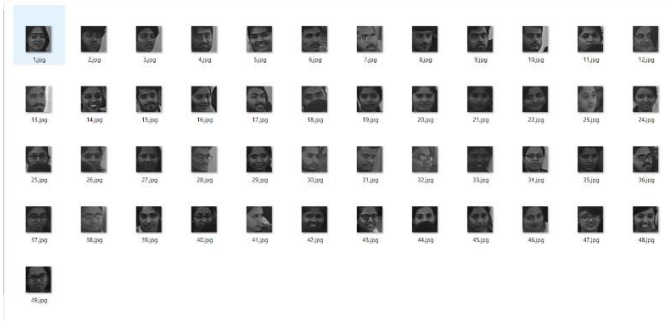


Figure 10: The images are stored in a folder named "TestImages"

VI. METHODOLOGY

Each of the existing systems has several drawbacks, so this proposed system proposes a new method to overcome all the drawbacks. In our proposed system we have used Viola Jones algorithm for face detection, an efficient and robust face detection method. For the enrollment of students, the face images of students are stored in a repository i.e. a database of all enrolled students. Only the face area is stored and not the whole-body image. For attendance marking purpose the image of a classroom with students is fed as an input to this system where the students are detected and only the face area is cropped, converted into gray scale and stored in a test folder. This system also uses PCA algorithm for face recognition. The images in the test folder are fed into the recognition part for matching the student's face image with the one already present in the repository. The main objective of the proposed system is to build an automated attendance system that is trustworthy, realistic and eradicates disruption and loss of time and the work in outdated system of attendance. The proposed automated attendance system consists of 3 main phases; Image acquisition, Face Detection, Face Recognition.

1. Image Accession:

The picture of the classroom is captured, is considered as test image and stored. And also the individual pictures of the students are taken and considered as train image and stored in a repository.

2. Face Detection:

The primary function of this step is to detect the human faces in a given input image. The expected output of this step is detected faces with better detection rate.

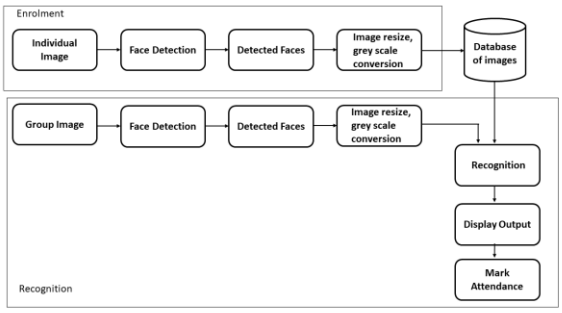


Figure 11: Block diagram of proposed system

3. Face Recognition:

After the completion of processing and detecting the face, it is compared with the faces present in the repository to write the attendance of the students in M S Excel.

Figure 11: Block diagram of proposed system

A. Face Detection

A proper and efficient face detection algorithm always enhances the performance of face recognition system. It is performed on the basis of Viola-Jones algorithm. This algorithm focusses more on speed and reliability. This detector uses Haar-like features and a cascade classifier. The cascade object detector is pre-trained to detect noses, eyes, faces and other objects.

The main characteristics of Viola Jones algorithm that makes it a better detection algorithm are: Real time – Processing must be at least 2 times per second for practical applications. Robust –high detection rate (true-positive rate) & low false-positive rate.

The algorithm has mainly four main stages:

- Haar Features Selection
- Creating Integral image
- Adaboost Training algorithm
- Cascaded Classifiers

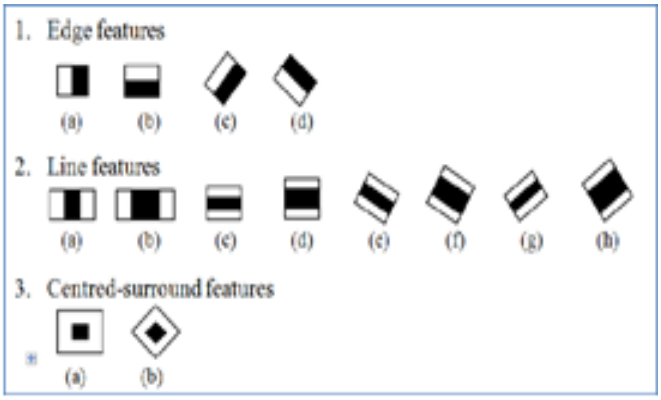


Figure 12: Feature types used by Viola and Jones

B. Face Recognition

The proposed system uses principal components analysis (PCA) for face Recognition. After detecting the faces from the input image, the feature is extracted using the Principle Component Analysis method. This method is used for the reduction of the dimensionality of data space to the similar feature space. For automatic recognition we need to create a face database. Various image samples were taken for each person and their features are extracted and stored in the database as a train image. For an input image, face detection and feature extraction are performed and features of each face class of trained image is compared and stored in the database.

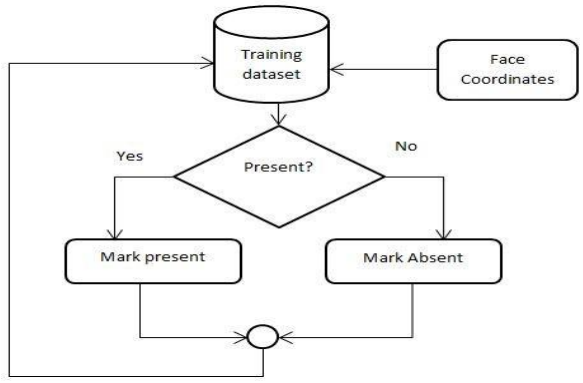


Figure 13: Face identification

C. Marking the attendance

The post-processing mechanism involves the updating of the names of the student into an excel sheet. After recognizing the faces of the students, a hash table is created with student's names and their image file name. If the recognized image file name matches any of the key in hash table, value of that key is retrieved. This retrieved value is written to MS EXCEL with current date and time of the system as a file name. The excel sheet is generated by exporting mechanism present within the database system. It also has the ability to generalize student's attendance records. Each and every entry is updated in the excel sheet. The privilege of modification of the excel sheet is provided to the administrators.

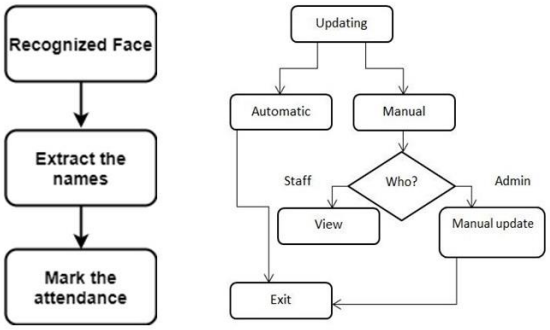


Figure 14: (a) Marking the attendance (b) Updating Excel sheet

VII. EXPERIMENTS AND RESULTS

This project mainly has three modules, Detection of human faces, Recognition of the detected Faces and Marking the attendance of recognized faces to MS Excel. For our experiments we have considered 5 group images i.e. students seated in a classroom, for detection purpose. We have considered 2 separate sets of datasets as training dataset for experiment on recognition. The first set contains 50 images each of 56 students and the second set contains 20 images each of 56 students.

A. Detection Results

The detection results were found to be better when the lightings are from the same side as the camera placed. The detection rates were also found to be better when the images clicked were from top extreme corners. Lighting plays an important role in false detection. The average detection rate is 90.40%.

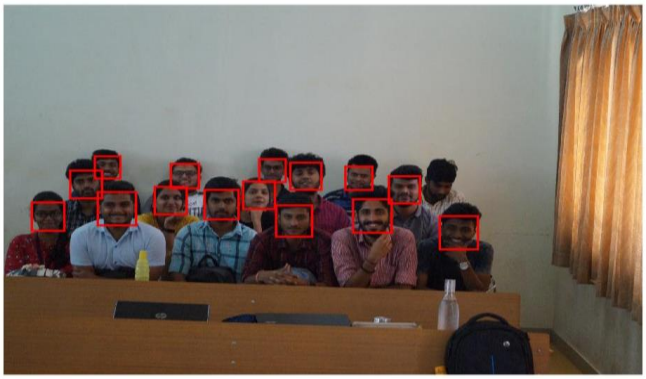


Figure 15: Detected faces of image

Figure 16: Capturing of the classroom image and face

Figure 17: Detection of image1

Image	No of students	Detected	False detection	Detection Rate (%)
Img1	51	49	0	96%
Img2	51	45	1	86%
Img3	40	36	0	90%
Img4	24	21	0	87%
Img5	16	15	0	93%

Table 1: Detection Results

B. Recognition Results

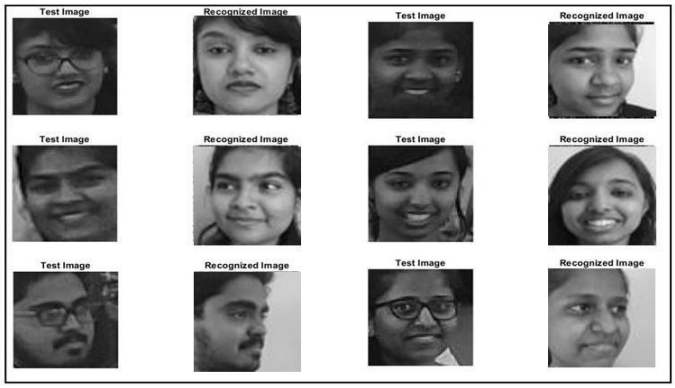
As mentioned above two separate datasets were considered for experiments on recognition. The first dataset contained 50 images each of 56 students and the second dataset contained 20 images each of 56 students. The detected faces from the group image were saved to a folder "testimages". The individual images of 56 students were saved continuously in a folder "trainingimages1" and "trainingimages2" respectively. The dataset2 gave better results when compared to dataset1 and the time taken by dataset2 to train and display the results were much less when compared to dataset1. The average recognition rate for dataset1 and dataset2 are 69.21% and 92.87% respectively.

Image	Detected	True Recog	False Recog	Recognition Rate (%)
Img1	49	32	17	65.30%
Img2	44	31	13	70.45%
Img3	36	26	10	72.22%
Img4	21	15	6	71.42%
Img5	15	10	5	66.66%

Table 2: Recognition Results of Dataset1 (50 Imgs each of 56 students)

Image	Detected	True Recog	False Recog	Recognition Rate (%)
Img1	49	49	0	100%
Img2	44	40	4	90.90%
Img3	36	34	2	94.44%
Img4	21	18	3	85.71%
Img5	15	14	1	93.33%

Table3: Recognition Results of Dataset2 (20 Imgs each of 56 students)



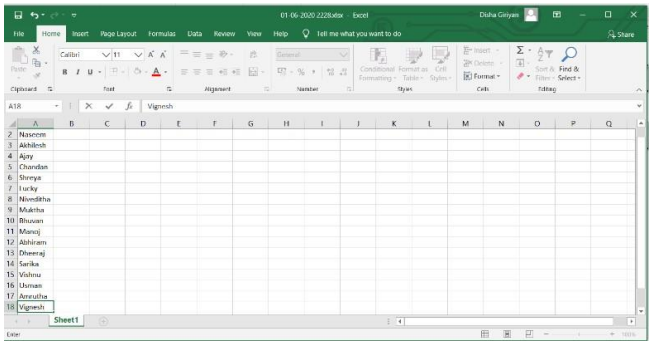


Figure 19: Attendance recorded in Excel Sheet

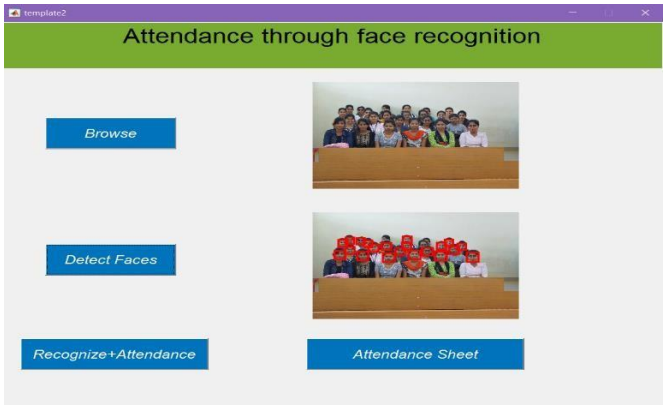


Figure 20: Graphical User Interface for the system

VII. CONCLUSIONS

There may be various types of seating arrangements, lighting conditions and environments in various classrooms. The system has been tested for most of the cases. There may also exist students portraying beards, varying hair styles, various facial expressions, spectacles etc. All of these cases are considered and also tested to obtain a high level of efficiency and accuracy. The performances were found to be better when the camera is place on the top corners or the top center of the wall. The lightings play a major role in false detection and hence the lightings must always be from the direction same as the camera placed and not opposite to the camera placed. The results were found to be accurate and the system gave faster results when the pictures were augmented and when 10 samples

for each individual were considered as training images. Thus, it can be concluded from the above experiments that a fast, secure, reliable and an efficient system has been developed replacing the unreliable manual system. The amount of work the administration has to do will be reduced by the system, saves time and will replace the stationery material with electronic apparatus and reduces the amount of human resource required for the purpose. Hence a system with expected results and accuracy has been developed. But the system still has some room for improvement.

VIII. FUTURE ENHNACEMENTS

The future work is to improve in the recognition rate when there are changes in a person such as using scarf, different head position, beard, glasses etc. The system developed detects and recognizes face up to 15 degrees' angle variations considering the left direction as 0 degree, which has to be improved further. In order to achieve better performance of the system Gait recognition can be fused with face recognition systems. The concept of SURF features can be implemented to increase the detection rate. For security purposes, a Login functionality can be implemented on the system. The system will be deployed which could be used by other schools.

IX. ACKNOWLEDGEMENT

This project was completed under the guidance of Smt. Roopa S N, Assistant Professor, Nie Institute of Technology, Mysore. The Authors would like to extend their heartfelt gratitude to Smt. Roopa SN, Shri. Vinay Kumar Venkataramana, Researcher, University of Mysore, and all the people who are directly or indirectly involved, advised and coordinated in collecting data and software information for the support of this paper.

REFERENCES

[1] Anshun Raghuwanshi, Dr. Preeti D Swami:" An Automated Classroom Attendance System Using Video Based Face Recognition" 2017 2nd IEEE International Conference on Recent Trends in Electronics Information & Communication Technology (RTEITC), May 19-20, 2017, India.

[2] Smit Hapani, Nikhil Parakhiya, Mayur Pagdhal, Nandana Prabhu:" Automated Attendance System Using Image Processing" 2018 4th International Conference on Computing Communication Control and Automation (ICCUBEA).

[3] Nilesh D. Veer, B. F. Momin:" An automated attendance system using video surveillance camera" IEEE International Conference on Recent Trends In Electronics Information Communication Technology, May 20-21, 2016, India.

[4] Omar Abdul Rhman Salim, Rashidah Funke Olanrewaju, Wasiu Adebayo Balogun:" Class Attendance Management System Using Face Recognition" 2018 7th International Conference on Computer and Communication Engineering (ICCCE).

[5] Madhulakshmi, Abdul Wahid Ansari:" Face Recognition Using Featured Histogram" International Journal of Emerging Technology and Advanced Engineering (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 3, Issue 8, August 2013).

[6] Jenif D Souza WS, Jothi S, Chandrasekar A: "Automated Attendance Marking and Management System by Facial Recognition Using Histogram" 2019 5th International Conference on Advanced Computing and Communication Systems (ICACCS).

[7] Jagruti Chaudhari, Shweta Patil, Roshani Thakare, Priyanka Wagh, "Attendance System based on Face Recognition using Eigen face and PCA Algorithms" 2015 International Conference on Green Computing & Internet of Things (ICGIoT).

[8] Rekha E, Dr. Ramaprasad P: "An Efficient Automated Attendance Management System Based on Eigen Face Recognition" 2017 7th International Conference on Cloud Computing Data Science & Engineering -Confluence.

[9] X. Zhao, W. Zhang, G. Evangelopoulos, D. Huang, S. Shah, Y. Wang, I. Kakadiaris and L. Chen, "Benchmarking Asymmetric 3D2D Face Recognition Systems." Pattern Analysis and Machine Intelligence, pp. 218–233, 2013.

[10] J. Khorsheed and K. Yurtkan, "Analysis of Local Binary Patterns for face recognition under varying facial expressions." 24th Signal Processing and Communication Application Conference (SIU), pp. 2085-2088, 2016.

[11] V. Mohanraj, V. Vaidehi, S. Vasuhi and R. Kumar, "A Novel Approach for Face Recognition under Varying Illumination Conditions." International Journal of Intelligent Information Technologies, pp. 218–233, 2018.

[12] Viola, Paul, and Michael J. Jones, "Robust real-time face detection", International journal of computer vision 57.2 (2004):137-154.

[13] Lei, Zhen, et al, "Real-time face detection and recognition for video surveillance applications", Computer Science and Information Engineering, 2009 WRI World Congress on. Vol. 5. IEEE, 2009.

[14] Degtyarev, Nikolay, and Oleg Seredin," Comparative testing of face detection algorithms", Image and Signal Processing. Springer Berlin Heidelberg 2010. 200-209.

[15] Faruqe, M.O. and Hasan, M. A. M.(2009). "Face recognition using PCA and SVM. " Proceedings of the 3rd International Conference on Anticounterfeiting, Security and Identification in Communication, Aug. 2022, Hong Kong, pp: 97-101.

[16] Ojala, T., Pietik¨ainen, M., Harwood, D.: " A comparative study of texture measures with classification based on feature distributions. Pattern Recognition" 29 (1996) 51–59.

[17] S. Kadry and K. Smaili," A design and implementation of a wireless iris recognition attendance management system", Information Technology and control, vol. 36, no. 3, pp. 323329, 2007

[18] T. Lim, S. Sim, and M. Mansor," RFID based attendance system", in Industrial Electronics and Applications, 2009. ISIEA 2009. IEEE Symposium on, vol. 2. IEEE, 2009, pp. 778782.

[19] Liao S, Jain AK, Li SZ (2016) A fast and accurate unconstrained face detector. IEEE Trans Pattern Anal MachIntell 38(2):211– 223

[20] Dhivakar B, Sridevi C, Selvakumar S, Guhan P (2015) Guhan, face detection and recognition using skincolor. In: Proceeding of IEEE 3rd international conference on signal processing, communication andnetworking, pp 1–7

[21] Da'san M, Alqudah A, Debeir O (2015) Face detection using Viola and Jones method and neural networks. In: Proceeding of IEEE international conference on information and communication technology research.

[22] K. H. Pun, Y. S. Moon, C. C. Tsang, C. T. Chow, S. M. Chan, "A face recognition embedded system." Biometric Technology for Human Identication, vol. 5779, no. 2, p. 390, 2005.

[23] J. Joseph and K. P. Zacharia, "Automatic Attendance Management System Using Face Recognition." International Journal of Science and Research (IJSR), ISSN (Online), pp. 2319 7064, 2013.

[24] S. Lukas, A. Mitra, R. Desanti and D. Krisnadi, "Student attendance system in classroom using face recognition technique." International

[25] Conference on Information and Communication Technology Convergence (ICTC), pp. 1032-1035, 2016.

[26] V. Mohanraj, V. Vaidehi, S. Vasuhi and R. Kumar, "A Novel Approach for Face Recognition under Varying Illumination Conditions." International Journal of Intelligent Information Technologies, pp. 218–233, 2018

[27] J. Khorsheed and K. Yurtkan, "Analysis of Local Binary Patterns for face recognition under varying facial expressions." 24th Signal Processing and Communication Application Conference (SIU), pp. 2085-2088, 2016

[28] H. Ebrahimpour and A. Kouzani, "Face Recognition Using Bagging KNN." 2018.

[29] Parameshachari B D et. al "Controlled Partial Image Encryption Based on LSIC and Chaotic map", 4th International Conference on Multimedia and Image Processing (ICMIP 2019), University of Malaya, Kuala Lumpur, Malaysia, during January 19-21, 2019. © 2019 Association for Computing Machinery.

[30] Prabu Subramani, Ganesh Babu Rajendran, Jewel Sengupta, Rocío Pérez de Prado, and Parameshachari B D "A Block Bi-Diagonalization-Based Pre-Coding for Indoor Multiple-Input-Multiple-Output-Visible Light Communication System", Energies 2020, 13(13), 3466 PP 1-16; https://doi.org/10.3390/en13133466 www.mdpi.com/journal/energies