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Artificial Intelligence Based Real-Time Attendance System Using Face Recognition

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***Abstract*—The attendance system is important for school, college, university, office, and factory. In the academic field, attendance is recorded and updated manually in the teacher's notebook or any other application. In general, these types of systems waste time for both students and teachers. Also, other Job sectors use fingerprint attendance for arrival and departure, but the time between arrival and departure the employee can go outside anytime that he wants. So, this problem we can overcome using the unique feature of every human being on his face. In this proposed system, facial recognition technology is used to automatically take attendance. Sometimes when many people can come together. This system can able to detect multiple faces at a time. In this system, Face detection is done using DLib and ResNet-34 is used for face recognition. Using two cameras arrival and departure times of an individual are calculated sequentially. 96.03% accuracy observed by the camera-1 to recognize the face and at day time when light is off camera-2 shows the best accuracy 96.62%.**

***Index Terms*—Face Detection, Face Recognition, Real Time, Automatic Attendance**

I. Introduction

In every corporate office, taking attendance is a must to give a salary to the employees of the office. All educational institutions maintain an attendance system for evaluating student performance monitoring their presence at the institute [1]. This attendance also helps to monitor student destructive behavior, regularity towards studies, and their performance [2], [3]. Long-time nonattendance makes the early dropout and disappointments of students [4]. Nowadays many ways to take attendance. Most of the attendance systems are slow to take the attendance of the person. Generally, attendance can be taken in two forms such as the Manual Attendance System (MAS) and Automated Attendance System (AAS) [5]. The manual attendance system is taking more time than the automatic attendance system. Because the presence of each employee needs to verify a person with the stored data in the paper. Another problem is, there is no chance to verify the person really came into the office or not. Anytime anybody can give attendance of the absent person. So here is a huge chance for proxies. On the other hand, an automated attendance system is faster than a manual attendance system. Because it doesn't need to call the person for his/her attendance. When the person entry in the office, it automatically stores the presence of the person with date and time in the database. Automated Attendance Systems have been proposed using different biometric recognition like fingerprint recognition, RFID, palm vein recognition, and face recognition. Unauthorized users can use RFID card to give the attendance which may create misuse of the card and help to take fake attendance. In terms of other biometrics such as iris scan, fingerprint or voice recognition do not work 100% accurately [6]. The face recognition approach is the best approach to identify the individual to take online attendance and it is faster and more accurate than other techniques. This approach helps to reduce the proxy attendance and it provides passive identification of an individual [7]. Artificial Intelligence is one of the most powerful technologies which is used to make the decision itself rather than the direct help of a human. So, it will be very effective and time-consuming to use AI to take real-time attendance. In this paper, Instead of using the manual system for attendance, we go with the automated real-time attendance system using face recognition technology which is quite fast and more secure than other biometric approaches.

II. Related Work

In recent times, a plethora of face recognition-based management systems have been introduced for different organizations to improve the performance of individuals. Rao et al. [8] developed an attendance management system for the employee utilizing a unique finger impression recognition procedure. In this framework, to record attendance the employees needed to scan their figure in every check-in and check-out time. The main drawback of this system is when there will be a large number of individuals the system will create a long and time-consuming line. Zainal et al. [9], [10] have introduced an attendance system for the student using fingerprint recognition technique. In this system, attendance is recorded using a portable device. Whereas taking attendance this device inquired the student to scan their finger to complete the attendance process. The most drawback of this system is this device was not associated with the server. Thus, for numerous classes, numerous devices are required. Based on face recognition attendance systems have been proposed by Mehta et al. [11], Raghuwanshi et al. [12], Sayeed et al. [13], Wati et al. [14]. One by one student's faces were captured by Sayeed et al. [13], Wati et al. [14] proposed systems, and all student's faces

were captured by Mehta et al. [11], Raghuwanshi et al. [12] proposed system. Wati et al. [14]used Haar-cascade for face detection and local binary pattern (LBP) for face recognition. The proposed technique of Mehta et al. [11], Raghuwanshi et al. [12], Sayeed et al. [13], Wati et al. [14] solve the queue problem when there were a lot of students. However, face recognition accuracy was quite low in their proposed system. Raghuwanshi et al. [12] reported 53.33% accuracy on face recognition using Principal Component Analysis (PCA) and Euclidean distance and 60% accuracy using linear discriminant analysis (LDA). Group attendance System also developed by Aruna et al. [15], this face recognition-based attendance can work only with a group photo of a class. The system made for android i.e., the android app. It uses a one-shot image feature. The system gained high accuracy of 97% on the LFW dataset and 85% accuracy of the attendance system on a public student class photo dataset. An IoT Based Attendance System proposed by Dharabi et al. [16], the system taking automatic attendance of the students each and every hour from the classroom. The absentees are informed to the guardian through SMS. The attendance database and attendance percentage can be checked by the lecturer by using the IoT web page. The main contributions are summarized as follows:

1) Proposed an automated attendance system using DLib and ResNet-34. DLib is used here for face detection and ResNet-34 is used here to recognize the individual. Both are based on Convolutional Neural Network (CNN).
2) Evacuate the line issue whereas taking the attendance by permitting taking group attendance.
3) Developed a web application using Flask for ensuring the security of the system and making the system user-friendly.

III. Methodology of the Proposed System

This proposed system is helpful for any institute to take real-time attendance. The face recognition approach is used in this system to take the attendance and allows to take group attendance which makes it a fast system. This whole project will be undergoing web technology, the primary technologies are Python, OpenCV and developed by Flask. "Fig. 1" reflects the step-by-step diagram of this project. This project is executing two main cameras (Camera 1 for entry and Camera 2 for exit) when the person is facing camera 1 will capture the person's face, then the image will be processed using the NumPy module. The image will be extended to a cascade classifier that will recognize the individual's face and the model named ResNet-34 which already labeled more than 3 million datasets which will try to match the face captured by its 34 layers based on CNN. Therefore, if the face matched more than 50% with the dataset, the model produces the name. Also, this system shows the accuracy of the person below the frame. On the other hand, if the face matched less than 50% with the dataset the person will show as "Unknown Person". Therefore, the unknown individual must go through the registration process and then go back through the above steps for the 2nd time. Eventually, the time of work or class attendance will be calculated using the time recorded by Camera 1 and Camera 2, subtracting those two data times makes it possible to find the time of attendance of the person. The conclusion is the whole thing will be developed by using Flask for the website and that is the end process of the project.

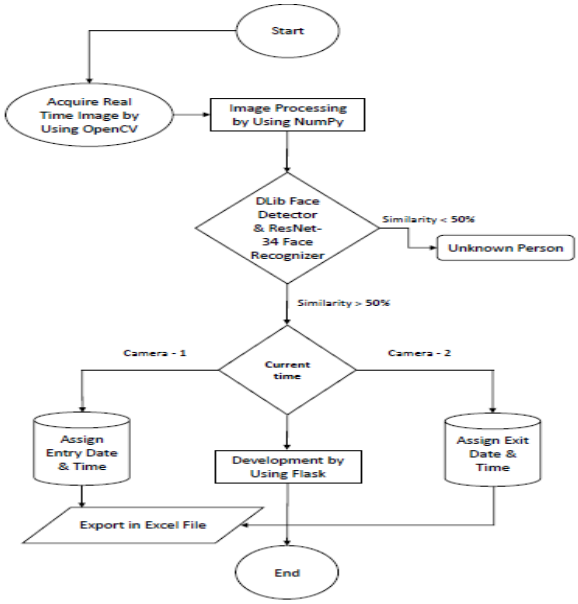

Fig. 1. Functional diagram of the real time attendance system using face recognition

A. Face Detection Localization

In this approach, for face detection and localization, CNN based face detector DLib algorithm is used. DLib can estimate the location of 68 facial points on a person's face shown in "Fig. 2" [17]. It has two shape predictor models and these models are trained on i-Bug 300-W dataset [18]. This system using face_recognition module which gives load_image_file, face_locations, batch_face_locations, face_landmarks, face_encodings, compare_faces, face_distance.

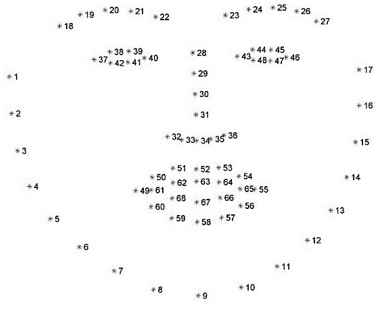

Fig. 2. Map Point [17]

The face detector used in DLib is based on Histogram of Oriented Gradients (HOG). Dalal and Triggs [19] found that for the detection of human face from an image HOG descriptor shows the better performance than others. HOG follows some steps to extract the feature which are shown in "Fig. 3".

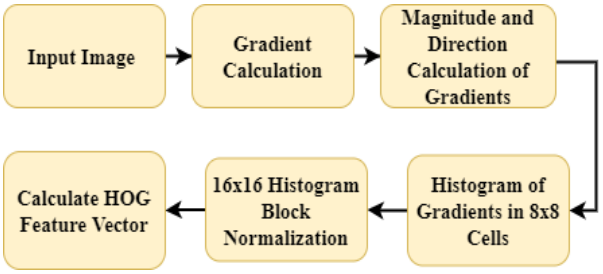

Fig. 3. Steps for feature extraction using HOG

Let, an imageI(x,y), First step is to find the vertical gradients (G_x) and horizontal gradients (G_y) by using convolution with the kernels shown in "Fig. 4". After finding the gradients whole image is divided into 8 × 8 cells. And the next step magnitude (M) and direction (D) are calculated using following the given formula.

$$M = \sqrt{(G_x^2 + G_y^2)}$$

$$D = arctan(G_x, G_y)$$

The values of M and D are represented using a 9 bin histogram which is actually a 9 element array. The direction of the gradients is defined by the bins in degree and the value between 0 to 180 is returned. Within the interim [0 180] 9 bins are similarly disseminated. Thus 9 dimension feature vector is created by 8 × 8 cells. After doing normalization each feature vector then create 16 × 16 patch and then 16 × 16 patch creates feature vector of 36 dimension. This normalization is carried out all through the entire image. Finally, a giant feature vector is created by integrating all the feature vectors. Though, HOG contains 15 vertical and 7 horizontal position that means total 105 position of a typical 64 × 128 image, it creates feature vector of 105 × 36 = 3780 dimension.

Fig. 4. Kernels which help to find the gradients of an image

B. Face Recognition

In this proposed system, face recognized by ResNet-34 model which has 34 parameters (3.6 billion FLOPs). ResNet-34 has labeled more than 3 million datasets which makes it possible to reach a high rate of accuracy 99.38%. It works with the Convolutional Neural Network (CNN) algorithm. "Fig. 5" shows the ResNet-34 model.

ResNet-34 consists of one convolution and pooling step followed by 4 layers of similar behavior. Each of the layers follows the same pattern. They perform 3x3 convolution with a fixed feature map dimension (F) [64, 128, 256, 512] respectively, bypassing the input every 2 convolutions. Furthermore, the width (W) and height (H) dimensions remain constant during the entire layer [20]. An operation here refers to a convolution a batch normalization and a ReLU activation to an input, except the last operation of a block, that does not have the ReLU.

IV. Implementation

Using OpenCV this system taking frames of the person, when the person detected in the real-time video. Frame means the image of the person's face which taken for the match with the dataset of the system for recognition. If the person's face is recognized, this system takes attendance to the database and the attendance report can be exported in a Excel file. Noted that person's face needs to match with dataset more than 50% accuracy, otherwise the person will be labeled as "Unknown Person" in the monitor. Accuracy percent also displayed on the monitor. An unknown person never recorded in the attendance sheet. The working procedure of the proposed system is depicted in "Fig.6".

A. Capture video

This system using two cameras. Camera-1 for entry data capturing and Camera-2 for exit data capturing. These two cameras are fixed in the office main door. Camera-1 fixed on the outside of the main door and Camera- 2 is fixed on the inside of the main door i.e., cameras are fixed on opposite sides of each other.

B. Separate as frames from the video

This system works only with real-time video i.e., no recorded video is allowed here. For detecting and recognizing an individual frame is generated from the real-time video.

C. Face Detection

To take the attendance of the person need to detect the face first. From the given as an input image finding the face, needs to process the image for easier recognition. Image processing means cropping, resizing, covert the image from RGB to Gray, etc. In this system, the whole image processing will be done by the NumPy library and face detection will be done by the DLib.

D. Face Recognition

When the image processing and detection of the face are completed, the frame needs to compare with the dataset for marking attendance of the employees. For face recognition, this system used the ResNet-34 model during comparison frame with the dataset. The system shows a person's name and the accuracy in percentage in the display ("Fig. 7" "Fig. 8"). If the accuracy is more than 50%, the person is detected and labeled the name in the display. Else labeled "Unknown Person" ("Fig. 7 "). The similarity threshold is set to 50% because if we set the percentage more than 50% sometimes the system fails to detect side faces from the frame and also takes much time to recognize the face.

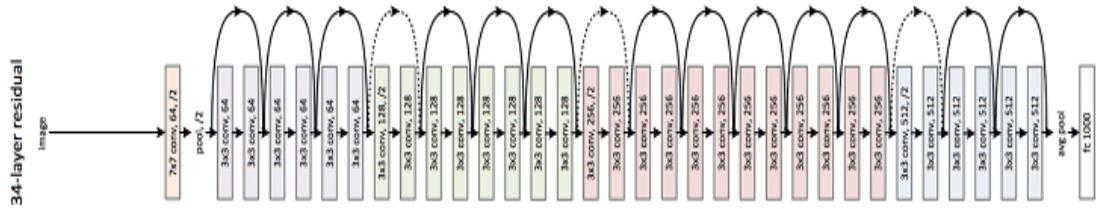

Fig. 5. ResNet-34 model [20]

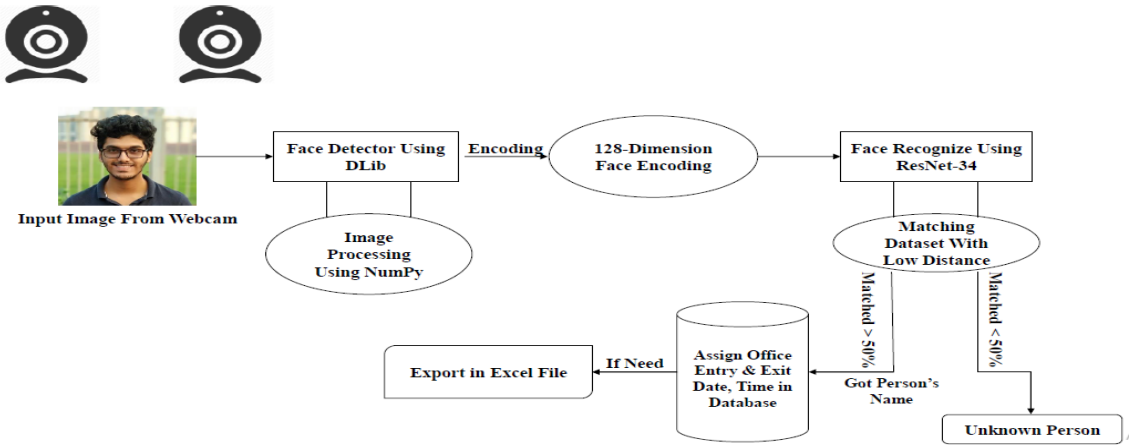

Fig. 6. Working procedure of the system

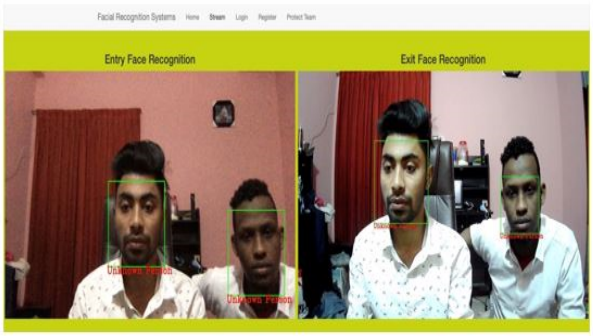

Fig. 7. Unknown person detected after face recognize

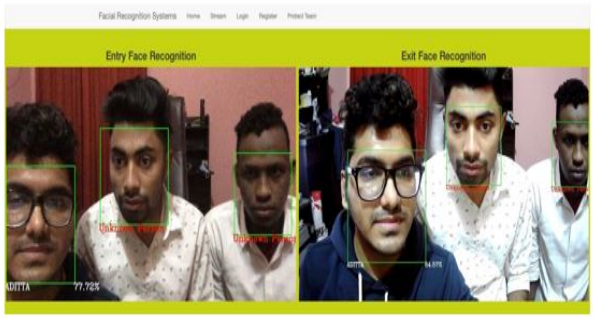

Fig. 8. Known and Unknown Person Recognized

E. Taking Attendance

After successfully face recognizing, the system generates the name of the recognized person from each frame to mark the attendance of the person and insert the corresponding value to the database. In the entry face recognition, this system called entryAttendance(name) function. Same for the exit face recognition system called exitAttendance(name) function. These two functions saving person name, entry date with time, and exit date with time in the database directly. This system using a MySQL database to store data. If an unknown person detected in the frame, then the system not mark the attendance of the unknown person. "Fig. 9" shows the attendance records of the individuals in the MySQL database.

Using the Flask framework of Python, a web application is developed for the admin and the registered user. Using a user name and password one can Login the system to see one's attendance report. After doing login, the member can see his/her profile information on this dashboard page. "Fig. 10" shows the dashboard screen for a user. Admin has the extra power to see all the reports of the registered user.

V. Result and Discussion

This system is developed by the Flask framework of Python. So, the login system is included here. For the login, a person must be registered in this system. A person may log in as "Admin" or "User" mode. After login, if the person's role is "Admin", he/she can see every person's attendance on the

id	name	entryDT	entryTime	exitDT	exitTime
1	ADITTA	16 Jan 2021	12:46PM	16 Jan 2021	01:48PM
2	JILANI	16 Jan 2021	12:57PM	16 Jan 2021	02:17PM
3	ELIAS	16 Jan 2021	01:26PM	16 Jan 2021	02:21PM
4	ADITTA	17 Jan 2021	10:03AM	17 Jan 2021	11:34PM
5	ARJU	17 Jan 2021	12:46PM	17 Jan 2021	03:09PM
6	SHAJJAD	17 Jan 2021	12:50PM	17 Jan 2021	04:34PM
7	ADITTA	18 Jan 2021	11:18AM	18 Jan 2021	12:14PM

Fig. 9. Attendance records in MySQL Database

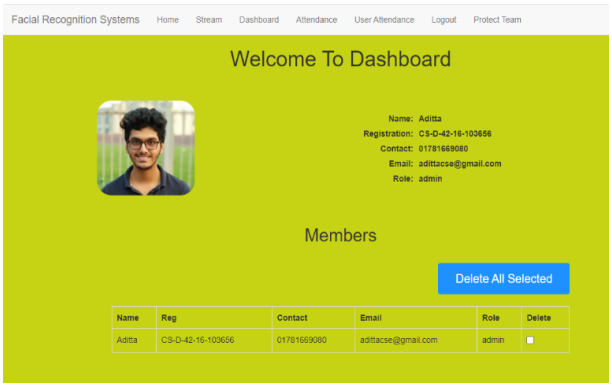

Fig. 10. Dashboard Screen

"Attendance" web page. Else "User", can see only own attendance in the "User Attendance" webpage. "User" can't see other person's attendance. Noted that besides showing every person's attendance, "Admin" can see own attendance in the "User Attendance" webpage also. "Fig. 11" shows all person's attendance information. "Fig. 12" shows the attendance report of a user or admin.

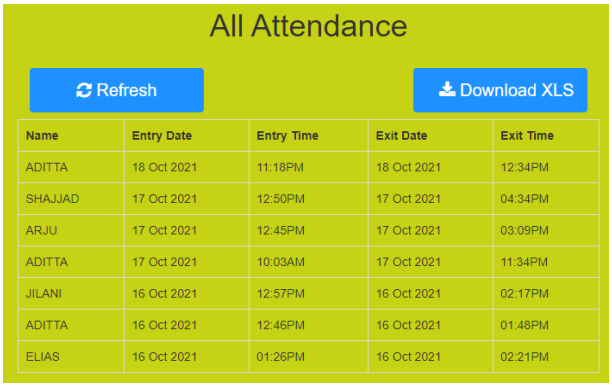

Fig. 11. Displaying every person's attendance in the webpage as "Admin" role

Not only displaying attendance log in the web pages, this system also giving download access to the attendance log as MS Excel file too. From the "Attendance" webpage, all

Fig. 12. Displaying own attendance in the webpage as "Admin" and "User" role

TABLE I
FACE DETECTION AND RECOGNITION RATE AT DAY TIME.

	Camera 1	Camera 2	Pass/Fail
Day Detection	Succeed	Succeed	Cam 1: Pass Cam 2: Pass
Day Recognition (Light ON)	96.03%	94.78%	Cam 1: Pass Cam 2: Pass
Day Recognition (Light OFF)	94.78%	96.62%	Cam 1: Pass Cam 2: Pass

person's attendance can be download by clicking "Download XLS" button. But from the "User Attendance" webpage, can download only own attendance sheet. "Fig. 13" shows the excel file after downloading the attendance report from the webpage attendance log.

	A	B	C	D	E
1	Name	Entry Date	Entry Time	Exit Date	Exit Time
2	ADITTA	18 Jan 2021	11:18AM	18 Jan 2021	12:14PM
3	SHAJJAD	17 Jan 2021	12:50PM	17 Jan 2021	04:34PM
4	ARJU	17 Jan 2021	12:46PM	17 Jan 2021	03:09PM
5	ADITTA	17 Jan 2021	10:03AM	17 Jan 2021	11:34PM
6	JILANI	16 Jan 2021	12:57PM	16 Jan 2021	02:17PM
7	ADITTA	16 Jan 2021	12:46PM	16 Jan 2021	01:48PM
8	ELIAS	16 Jan 2021	01:26PM	16 Jan 2021	02:21PM
9					

Fig. 13. Excel file after downloading attendance log from webpage

This system is executed using two computers. One is MacBook Pro 2017 (Core i7, 16GB RAM, 1536 MB Graphics) and another is a normal PC (Windows 10, Core i5, 16 GB RAM, 2 GB Graphics). On a normal PC, real-time video is too much slow and the frame rate is decreasing.

However, for real-time video MacBook Pro performs awesome because no frame is being lost here and MacBookPro can capture/process the video in real-time. Face recognition

TABLE II
FACE DETECTION AND RECOGNITION RATE AT NIGHT TIME.

	Camera 1	Camera 2	Pass/Fail
Night Detection	Succeed	Succeed	Cam 1: Pass Cam 2: Pass
Night Recognition (Light ON)	76.99%	80.36%	Cam 1: Pass Cam 2: Pass
Night Recognition (Light OFF)	0.00%	0.00%	Cam 1: Fail Cam 2: Fail

happens when we click on the stream page. But the streaming starts sometimes later though the camera starts when this project runs. To get the recognition rate, we test our system 20 times for each result. "Table-I" and "Table-II" shows the performance of 2 cameras for recognizing the face in daytime and nighttime. Camera-1 shows the best accuracy 96.03% when light is on at day time and camera-2 shows the best accuracy 96.62% when light is off at day time. Both cameras are failed to detect the face at night.

VI. CONCLUSION

This paper proposes an artificial intelligence-based real-time attendance system using face recognition. To provide the security of the proposed system, a web application is developed to restrict unauthorized access. Only admin and authenticated participants can see their attendance information anywhere. Though, multiple faces can be detected and recognized by this system it eliminated the waiting time to give the attendance. Besides, face recognition helps to eliminate proxy data entries to the database which generally occurred manual attendance system. To get a better performance in this proposed system CNN-based face detector DLib algorithm is used and ResNet-34 is used for face recognition. Two cameras are used in this system one is for capturing the entrance and another is used for capturing the departure of the individuals. At day time when the light is off the first camera shows 96.03% accuracy and the second camera shows 96.62% to recognize an individual.

REFERENCES

[1] F. Alassery, "A Smart Classroom of Wireless Sensor Networks for Students Time Attendance System," 2019 IEEE Integrated STEM Education Conference (ISEC), 2019, pp. 324-331, doi: 10.1109/ISECon.2019.8881998.

[2] R. A. Abbas Helmi, S. Salsabil bin Eddy Yusuf, A. Jamal and M. I. Bin Abdullah, "Face Recognition Automatic Class Attendance System (FRACAS)," 2019 IEEE International Conference on Automatic Control and Intelligent Systems (I2CACIS), 2019, pp. 50-55, doi: 10.1109/I2CACIS.2019.8825049.

[3] Y. Xing, "A Class Attendance System Based on SL4A," 2019 IEEE 4th International Conference on Cloud Computing and Big Data Analysis (ICCCBDA), 2019, pp. 368-372, doi: 10.1109/ICCCBDA.2019.8725656.

[4] D. Mijić, O. Bjelica, J. Durutović and M. Ljubojević, "An Improved Version of Student Attendance Management System Based on RFID," 2019 18th International Symposium INFOTEH-JAHORINA (INFOTEH), 2019, pp. 1-5, doi: 10.1109/INFOTEH.2019.8717750.

[5] R. Nandhini. N. Duraimurugan and S. P. Chokkalingam, "Face Recognition Based Attendance System, " Journal of Engineering and Advanced Technology (IJEAT), ISSN: 2249 – 8958, Volumn - 8, Issue - 3S, February 2019.

[6] P. Mehta and T. Pankaj, "An Efficient Attendance Management Sytem based on FaceRecognition using Matlab and Raspberry Pi2," International Journal of Engineering TechnologyScience and Research IJETSR, 2016, pp. 71-78.

[7] J. G. RoshanTharanga, S. M. S. C. Samarakoon, T. A. P. Karunarathne, K. L. P. M. Liyanage, M. P. A. W. Gamage, and D. Perera. "Smart attendance using real time face recognition (smart-fr)," Department of Electronic and Computer Engineering, Sri Lanka Institute of Information Technology (SLIIT), Malabe, Sri Lanka, 2013.

[8] S. Rao, and K.J. Satoa, "An attendance monitoring system using biometrics authentication," International Journal of Advanced Research in Computer Science and Software Engineering, 3(4), pp.379-383, 2013.

[9] N.I. Zainal, K.A. Sidek, and T.S. Gunawan," Portable anti forgery recognition for attendance system using fingerprint based biometric," ARPN Journal of Engineering and Applied Sciences, 11(1), pp.396-403, 2016.

[10] N. I. Zainal, K. A. Sidek, T. S. Gunawan, H. Manser and M. Kartiwi, "Design and development of portable classroom attendance system based on Arduino and fingerprint biometric," The 5th International Conference on Information and Communication Technology for The Muslim World (ICT4M), 2014, pp. 1-4, doi: 10.1109/ICT4M.2014.7020601.

[11] D.P. Tomar, and P. Mehta, "An Efficient Attendance Management System based on Face Recognition using Matlab and Raspberry Pi 2." 2394-3386, 2016.

[12] A. Raghuwanshi and P. 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 (RTEICT), 2017, pp. 719-724, doi: 10.1109/RTEICT.2017.8256691.

[13] S. Sayeed, J. Hossen, S. M. A. Kalaiarasi, V. Jayakumar, I. Yusof, and A. Samraj, "Realtime face recognition for attendance monitoring system, " Journal of Theoretical Applied Information Technology 95(1), 2017.

[14] Y. W. M. Yusof, M. M. Nasir, K. A. Othman, S. I. Suliman, S. Shahbudin, and R. Mohamad, " Real-time internet based attendance using face recognition system," International Journal of Engineering Technology, 7(3.15), pp.174-178, 2018.

[15] A. Bhat, S. Rustagi, S. R. Purwaha and S. Singhal, "Deep-learning based group-photo Attendance System using One Shot Learning," 2020 International Conference on Electronics and Sustainable Communication Systems (ICESC), 2020, pp. 546-551, doi: 10.1109/ICESC48915.2020.9155755.

[16] D. Devi, A. Devi and V. Piriyyadarisani, "IoT Based Automatic Attendance System," 2019 International Conference on Communication and Electronics Systems (ICCES), 2019, pp. 151-154, doi: 10.1109/ICCES45898.2019.9002030.

[17] José, I., 2018. Facial mapping (landmarks) with Dlib + python. [online] Medium. Available at: https://towardsdatascience.com/facial-mapping-landmarks-with-dlib-python-160abcf7d672 [Accessed 19 May 2021].

[18] E. K. Davis, Dlib-models, [online] Medium. Available at: https://github.com/davisking/dlib-models [Accessed 19 May 2021].

[19] N. Dalal and B. Triggs, "Histograms of oriented gradients for human detection," 2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'05), 2005, pp. 886-893 vol. 1, doi: 10.1109/CVPR.2005.177.

[20] K. He, X. Zhang, S. Ren, and J. Sun, "Deep residual learning for image recognition," In Proceedings of the IEEE conference on computer vision and pattern recognition, pp. 770-778, 2016.