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Student attendance with face recognition (LBPH or CNN): Systematic literature review

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Abstract

Technology growth is speedy, and more and more things can be solved easily with the existence of sophisticated technology. One of them is solving the problem of student attendance at the university. The current attendance system has developed into RFID (Radio Frequency Identification) from the previous manual. However, many things still become obstacles. For example, students who miss their cards cannot take attendance, and the problem of leaving attendance can be cheating. Now, this has developed much technology in the form of face recognition with various algorithms that can be used. The use of face recognition can overcome the previous problem because it only uses faces for attendance. However, the many algorithms for facial recognition make it difficult to determine the best algorithm to implement. The main purpose of this literature review is to compare algorithms suitable for implementation in an environment at universities, especially CNN and LBPH. Based on the literature review, it was found that CNN's accuracy is superior in terms of accuracy compared to LBPH, CNN also produces more stable accuracy if there are external factors that can affect accuracy.

Keywords: Attendance; Face Recognition; Deep Learning; LBPH; CNN

1. Introduction

Class attendance is a form of recording student attendance, a part of the university that contains attendance data. Class attendance is important for a university because it can monitor each student's progress. Therefore the data collection should not be wrong or manipulative [1, 2]. Attendance can be done in two ways, manually with a signature on paper and non-manually by using a card [3].

The procedure that is often used for the manual method is the teacher or note taker will give a paper containing a list of names, then the papers will be signed so that each student's attendance is recorded. In addition to the signature,

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another frequently used manual method is the teacher calling the student's name. Students called by name usually have to answer the teacher's call. By answering the teacher's call, the student can be recorded as attending, and those who will not be answered will be recorded as absent.

In addition to the manual procedures described above, there are also non-manual procedures, where in this non-manual procedure, the teacher uses tools that assist the attendance process. For example, many universities currently use non-manual attendance by using a card (RFID) [3]. However, along with the development of technology, there are many ways to make attendance more effective. One of them is biometric recognition, which is face recognition [4][5].

Face recognition is a technology that can recognize someone's face from video footage through a facial database usually used to identify users through ID verification services [6]. Face recognition programs can be made using many algorithms, such as the LBPH (Local Binary Pattern Histogram) algorithm and the CNN (Convolutional Neural Network) algorithm, which are included in Deep Learning.

The LBPH algorithm is a combination of Local Binary Pattern (LBP) and Histogram Oriented Gradients (HOG), which is used to change the performance of face recognition results to be more accurate [7][8]. LBPH is famous for its performance and accuracy, which can recognize a person's face from both the front and the side.

Deep Learning is a method or branch of machine learning that consists of algorithms composed of high-level abstractions on data that uses non-linear transformation functions that are laid out in layers and depth or it can be said as artificial intelligence that imitates the workings of the human brain's nerves. The structure or algorithm applied to Deep Learning uses Artificial Neural Networks (ANN), Deep Neural Networks (DNN), and Convolutional Neural Networks (CNN). For example, making face recognition with Deep Learning will use CNN as the algorithm.

Convolutional Neural Networks (CNN) is a type of Deep Learning algorithm that can accept input of images and determine what aspects or objects of an image can be used by machine learning to recognize and distinguish one image from another image [9]. The architecture of CNN is similar to the pattern of connections of neurons or nerve cells in the human brain. The Visual Cortex inspires CNN, the part of the brain that stores and processes information in visual form [10, 11].

In the era of rapid technological development, we should use it best. One of example is face recognition technology that can be used for class attendance [4, 5]. Face recognition can minimize the occurrence of fraud that can be done in attendance, such as leaving attendance and also human error [1, 2]. Therefore, the face recognition technology that will be implemented is most suitable for the university, both in terms of the technology used and the right design to implement it. The use of face recognition will minimize the possibility of errors caused by the face recognition system, and technology use will be reasonable. By using a suitable algorithm to design face recognition, the attendance process will be precise and avoid mistakes. This study analyzes the best algorithm in face recognition by conducting literature reviews and summarizes how the researchers minimize mistakes in implementing face recognition.

2. Literature Review

Face recognition is a technology created by Woodrow Wilson Bleadsoe in 1966 that works to match human faces through digital images or video footage through a facial database. Face recognition became an idea to allow computers to find and recognize human faces quickly and precisely. Many algorithms have been developed to improve the performance of face recognition [12]. In general, facial recognition algorithms are divided into two: algorithms whose facial features are regulated by humans and algorithms that let the system choose the best facial features themselves [3]. Good face recognition can contribute to high feature extraction, and better classification [13]. Currently, face recognition can be used for many things, one of which is student attendance at universities [14, 15]. Face recognition can improve and manage the attendance system, reduce errors in the manual recording process by providing an automatic and reliable attendance system, increase privacy and security, prevent fake attendance, and provide regular attendance reports [1]. Such face recognition can be used to save time for educators and students and to stop false attendance [2]. The steps taken in facial recognition include recording student videos, converting them into frames, connecting them to a database to ensure their presence or absence, and marking the presence of certain students to maintain records [16]. All the data will be stored and displayed using the display screen. One of the examples is a web page [17].

In general, the use of an attendance system with facial recognition is influenced by many things, such as the database and algorithm. Research [18] suggests providing more precise specifications on our database to improve the training of our facial recognition system. In addition, in paper [19], the data/images that we enter in the database affect

our facial recognition systems, such as the use of makeup, glasses, or hairstyle changes. The traditional algorithm widely used is LBPH, a combination of LBP with an Oriented Gradient Histogram (HOG). Local Binary Patterns (LBP) is a visual descriptor used for computer vision classification. LBP was first described in 1994 by Timo Ojala and David Harwood at the University of Maryland and has since been found to be a powerful feature for texture classification. This amalgamation significantly improves the detection performance across multiple data sets [11, 20]. According to Sanyukta Santosh Pawaskar and Ashwini Mandar Chavan, performing attendance automatically using face recognition and detection algorithms such as LBPH and Haar Cascade is a reliable and efficient system. Haar Cascade provides a high degree of accuracy regardless of lighting. The system can provide an accuracy of about 96.68% [21]. In the paper [6, 22], it can be seen that the accuracy of LBPH has been seen to be superior to the other two facial recognition algorithms whose facial features are set by humans (Eigenface, Fisherface). According to Mohd Suhairi Md Suhaimin et al., LBPH outperformed Eigenfaces for face recognition with 100% accuracy compared to Eigenfaces which only got 73.3% [23]. According to Onur Sanli and Bahar Ilgen, Face recognition using PCA and Viola-Jones algorithms obtained from 10 images of students' faces showed 75-95% results [24]. In the paper, [20, 5], when the three face recognition algorithms (LBPH, Eigenface, Fisherface) were compared with external factors, such as expression, angle, position, light, and other factors, the LBPH algorithm itself was still superior to the two. Other facial recognition algorithms whose facial features are set by humans (Eigenface, Fisherface).

One algorithm that is currently widely used is CNN. In this paper, we will use CNN because we want to get the best accuracy. CNN has proven to be very effective in various fields, such as facial recognition and classification, compared to other methods. In addition, CNN also extracts features automatically, so there is no need to select features manually [10]. The primary purpose of a CNN is to extract features from the input data, i.e., images. By studying the image characteristics using the small squares of the input image, CNN maintains the spatial distributions between pixels, such as rotation, translation, compression, and geometric transformation [4, 8]. In general, the CNN layer is divided into two, the first is the convolution layer, where this layer is the layer that extracts the image layer, and the second is the sampling layer [9].

In CNN, there are several pre-trained models. Pre-trained CNNs have different important features when selecting a network to address a particular problem. For people who want to learn algorithms or test existing systems, already trained models are an excellent source of support [25]. Through this paper, it is seen that a large number of datasets strongly influences CNN's accuracy for training and a large number of training epochs, the more datasets taken and the training, the better the accuracy [26]. Research [27] presents a method by using video recording in class to deal with the problem of finding, so that image collection is not done individually. However, datasets will be collected simultaneously in one class. In addition, based on the experiment of this paper, the direction of the face also affects the accuracy that will be generated, such as pointing forward, downward, or sideways [7]. Dhanush Gowda H. L. et al. compared CNN with two different types of algorithms, namely SVM and MLP, with CNN having an accuracy rate of 98%, SVM 87%, and MLP 86.5% [28]. According to Shyam Sunder Bahety, the use of CNN with the OpenCV technique has an accuracy of 82%, and the application should train the model and make it able to identify students' faces [29].

The accuracy obtained for Face Recognition in the class attendance system from several papers is for LBPH to get 77.55% accuracy, Eigenfaces get 85% accuracy, PCA gets 80% accuracy, Haar Cascade gets 92.9% accuracy, and CNN gets 95% accuracy [30]. CNN is still the best of all the algorithms used in capturing facial recognition in all situations. The system proposed in these results can provide comprehensive and accurate detection and recognition of human faces against a given data set for a certain time [30].

3. Methodology

The method used for this study is a Systematic Literature Review or SLR. We will complete the method we used in our study in the PRISMA diagram, which can be seen in the image below. PRISMA is a valuable guide in the Systematic Literature Review or SLR, where PRISMA itself is in the form of a diagram containing what actions and what attributes must be completed in collecting literature sources. The PRISMA Diagram can be seen in Figure 1.

First, in the identification in Figure 1, we searched for literature/articles through the google scholar website (scholar.google.com) using the string "Face Recognition" AND ("CNN" OR "LBPH") AND "University" AND "Attendance" AND "Class". The search at this identification stage resulted in 1130 articles. Then, in the second stage, we

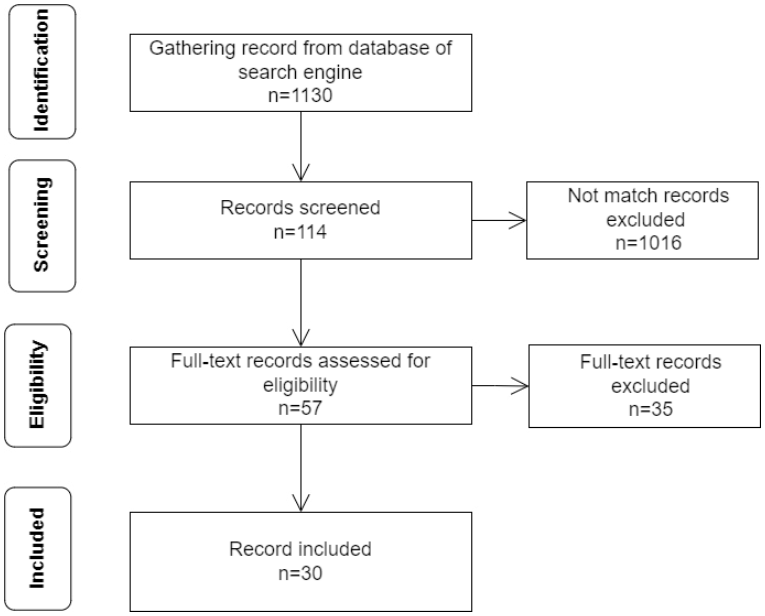

Fig. 1. PRISMA Flowchart

carried out the screening stage. At the screening stage, we conducted a literature search by changing the search string back to ”Face Recognition” AND (”CNN” AND ”LBPH”) AND ”University” AND ”Attendance” AND ”Class”. We do this to trim the literature so that we can read more than 1000 articles. This search produces 114 articles.

Then, we read the abstract from each article at the eligibility stage. Abstracts from articles that we think have succeeded in mentioning the CNN or LBPH algorithm will be included as literature that has passed the eligibility stage. We did this stage to produce 57 articles. The last stage, namely the include stage, is carried out by thoroughly reading the literature that has passed the eligibility stage. The criteria for literature that successfully passed eligibility is that it includes the results of their experiments using the CNN algorithm, LBPH, or both and writes an explanation regarding the experiment. Through the include stage, we managed to select 30 articles for us to use as our reference.

4. Result

From the literature we received as our study material, we got several questions that can be answered with the literature that aims to complete our study.

RQ1: How to apply face recognition to class attendance?

Applying face recognition for attendance requires several stages. The first stage is to enter the face image of the student into the system as a dataset. The student’s face image can be obtained from the camera capture programmed to take pictures and entered into the database [4]. The second stage is conducting dataset training using a face recognition algorithm determined from the data in the database [13]. The third stage applies a face recognition system using a camera placed in the classroom to record and detect students’ faces and then compare them with facial images in the database. For students who are supposed to be present but are not detected, the student’s presence will be recorded as absent [26]. The attendance data will be automatically recorded in the university attendance system.

RQ2: Which face recognition algorithm is more effective to be applied to class attendance?

The Face Recognition algorithm that we know is divided into two: algorithms that work traditionally and algorithms that use deep learning [12]. The working principle of the traditional method is to take an image as input, then resize the image to fit the algorithm. After that, the image that was originally RGB will be changed to gray or according to the filter in the algorithm. Then, a face detection algorithm is needed so that the face recognition algorithm can recognize

the faces that are successfully detected. The datasets were obtained from the predefined number of the image that was taken by the camera. Comparison of the accuracy between traditional facial recognition algorithms from research [15] can be seen in table 1.

Table 1. Accuracy of Traditional Facial Recognition Algorithms

Algorithm	Accuracy
Eigenface	15.09%
Fisherface	36.4%
LBPH	86.47%

As seen from table 1, the LBPH algorithm is proven better than the fisherface and eigenface algorithms. Furthermore, it has been explained in [15] that the LBPH Algorithm accuracy is better than the other because the LBPH Algorithm can recognize not only the front face but also the side face and also the faces under any light.

Another method to use Face Recognition is to use deep learning methods. Deep learning uses the performance of the device's CPU and GPU to maximize the performance of Face Recognition. CNN is one way to apply deep learning that can give good results. The advantage of the CNN algorithm is that it has many layers that can get the best features from an image through the learning process, so we don't need to enter these features manually. Another advantage of using CNN is that the more datasets used, the greater the level of learning carried out by the algorithm so that the accuracy obtained can also grow [9]. The dataset is created by taking videos of different persons facing in different directions. Comparison between deep learning facial recognition algorithms from research [8] can be seen in table 2.

Table 2. Deep Learning Facial Recognition Algorithm Accurracy

Algorithm	Accuracy
SVM	88%
MLP	87%
CNN	98%

Viewed from table 2, the CNN algorithm is proven to be better than the SVM and the MLP. In [29] it has been explained that in literature [15], the accuracy of CNN is higher than the rest because of the extraction algorithm. The SVM and MLP use extraction algorithms to extract PCA and LDA a feature. Instead, the CNN algorithm has been fed images directly as a feature.

The statement above shows that the best traditional facial recognition algorithm is LBPH, while the best deep learning algorithm is CNN. Based on this statement, we can summarize the best accuracy achieved by each algorithm in table 3.

Table 3. Highest Accuracy of Each Algorithm

Algorithm	Number of Datasets	Accuracy	Papers
CNN	1050	99%	[10]
LBPH	165	92%	[22]

Through table 3, we can see that the best accuracy achieved by CNN is in the literature [10] with 99% accuracy using a dataset from a collection of images arranged in 53 directories, each directory represents one person, and each person dataset must consist of 15 image data with different conditions, while the best accuracy achieved by LBPH is in the literature [22] is 92% using 165 images with 15 different subjects, and each subject has 11 images.

RQ3: What are the external factors that affect accuracy?

Based on the literature study that we did, we found several factors that affected the accuracy of an algorithm. In the literature, several factors affect the accuracy of the algorithm in the literature, [20], which applies the LBPH algorithm,

and [7], which applies the CNN algorithm, several factors. For example, the datasets used in [17] are images or videostaken from surveillance cameras that are integrated with the database on the server. The datasets used in [7] are takenin 2 ways: training data that takes student photo data from the system and actual data that lecturers take from lecturesthrough the system for attendance.

The results of the facial identification test carried out according to the literature [20] stated that the accuracy obtained when the room was bright showed an accuracy of 92%. When the room was dim, it showed an accuracy of 88%.

The results of facial identification tests carried out according to the literature [20] state that the level of accuracy obtained if the distance between the face and the camera is 100-250 cm it will get an accuracy result of 90.67% and if the distance between the face and the camera is 300-500 cm it will get the results of the accuracy of 83.33%.

The results of facial identification tests carried out according to the literature [20] state that the accuracy obtained when the user uses the head covering attribute results in an accuracy of 85.33% and when the user is wearing glasses, the accuracy obtained is 84.67%.

Table 4. Research Whose Accuracy is Influenced by Position

Algorithm	Position	Effect	Papers
CNN	Straight	81.25%	[7]
CNN	Sloping	75%	[7]
CNN	Looking down	43.75%	[7]
LBPH	Straight	86%	[20]
LBPH	Sloping	80%	[20]

Table 4 shows that according to the literature [20] states that the accuracy obtained when the straight position shows an accuracy of 86% and the sloping position shows an accuracy of 80%. The same thing can also be found in the literature [7], which applies the CNN algorithm. The results of tests carried out according to the literature [7] stated that the accuracy obtained when the straight position showed an accuracy of 81.25%, the sloping position showed an accuracy of 75%, and the looking down position showed an accuracy of 43.75%.

Based on the studies that have been conducted, there is a gap found that only some of the papers use the same system that is used in training the data. A combination of face detection and face recognition is also a problem in analyzing CNN and LBPH because some algorithms of face recognition are better when using compatible face detection. The external factor also affects the accuracy of face recognition, but some of the papers are not included with external factor tests. Implementing face recognition as an attendance system is not too difficult, so many universities should consider implementing face recognition. The use of face recognition can save time and can also avoid the occurrence of errors such as human error and even fraud that may be carried out, such as leaving an absence. In addition, the cost for the required hardware is not too expensive, such as a webcam camera is also sufficient to be able to implement it. Making the system is also relatively easy because it can be seen in many examples via the internet. The most important thing is to be able to understand the flow from collecting datasets to conducting trials.

5. Discussion

Face Recognition algorithms are very diverse, but Face Recognition algorithms can be divided into two types, namely traditional algorithms, and deep learning algorithms. The traditional algorithm requires us to determine the features of the image ourselves so that the algorithm can recognize the image. Unlike the case of deep learning algorithms, deep learning algorithms will automatically learn to extract features from an image. The criteria for these two algorithms are undoubtedly different, as in [10, 22], the CNN algorithm requires 1050 datasets, while the LBPH algorithm only requires 165 datasets. However, this dataset is undoubtedly very useful for the CNN algorithm. The dataset serves to train the CNN algorithm so that at [10], the accuracy, which was only 5% can continue to grow until it gets 99% accuracy. As with LBPH, the accuracy obtained from various articlessuch as, [18, 30] is constant.

Accuracy in traditional and deep learning algorithms is, of course, also influenced by several factors. For example, in [20], it is explained that the accuracy of the LBPH algorithm will vary when considering the factors of light,

position, distance, and attributes. Meanwhile, in [7], the accuracy of the CNN algorithm will only vary if the position factor is considered. This can mean two things, first is that there needs to be further research related to whether these factors affect CNN accuracy or not. The second is that the CNN algorithm can overcome these factors by using datasets as a learning tool. Thus, there is still a lot to learn about the factors that affect the accuracy of the CNN algorithm. However, judging by the same factors, the CNN algorithm looks more stable in variation than the LBPH algorithm, this means that the CNN algorithm itself can overcome several conditions of images that have a tilted or bent position, so it can be said that the CNN algorithm is more stable than the LBPH algorithm.

6. Conclusion

The study focused more on good algorithms to be applied in class attendance in each class so that attendance was more effective in all aspects. The method used in this study is a Systematic Literature Review. From the search carried out, 30 articles have been obtained. The literature obtained discusses the use of the CNN or LBPH algorithm. From all 30 articles, there are many that convey the advantages and disadvantages of the two algorithms, so it can be said that CNN is a better algorithm to be applied in class attendance. Facial recognition with the CNN algorithm is a better choice to be implemented in class attendance due to its high accuracy and stability when external factors influence it. Besides that, the implementation method is not much different from LBPH. The main difficulty in using the CNN algorithm is that many datasets are required, so an efficient way of collecting datasets is needed. External factors, such as face position, lighting, and background, still influence model performance. Things can still be developed in the future, such as choosing the suitable face detection algorithm to match the face recognition algorithm used. Using face detection algorithms that can work well with face recognition can increase the system's accuracy so that it can produce optimal accuracy. In addition, research can also be carried out to determine whether the factors that can change the accuracy of the LBPH algorithm can also affect the accuracy of the CNN algorithm.

References

[1] Anitha G, Devi PS, Sri JV, Priyanka D. Face Recognition Based Attendance System Using Mtcnn and Facenet. Zeichen Journal. 2020;6(1):189- 95.

[2] Gornale B, Kiran P. Classroom Attendance Management System Using Camera. International Journal of Research in Engineering, Science and Management. 2020;3(8):327-30.

[3] Khan MZ, Harous S, Hassan SU, Khan MUG, Iqbal R, Mumtaz S. Deep unified model for face recognition based on convolution neural network and edge computing. IEEE Access. 2019;7:72622-33.

[4] Goyal A, Dalvi A, Guin A, Gite A, Thengade A. Online Attendance Management System Based on Face Recognition Using CNN. In: 2nd International Conference on IoT Based Control Networks and Intelligent System (ICICNIS 2021); 2021. .

[5] Phankokkruad M, Jaturawat P. Influence of facial expression and viewpoint variations on face recognition accuracy by different face recognition algorithms. In: 2017 18th IEEE/ACIS International Conference on Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing (SNPD). IEEE; 2017. p. 231-7.

[6] Saxena N, Shukla S. LBPH based Enhanced Technique For Multiple Face Detection.

[7] Setialana P, Jati H, Wardani R, Indrihapsari Y, Norwawi NM, et al. Intelligent Attendance System with Face Recognition using the Deep Convolutional Neural Network Method. In: Journal of Physics: Conference Series. vol. 1737. IOP Publishing; 2021. p. 012031.

[8] Damale RC, Pathak BV. Face recognition based attendance system using machine learning algorithms. In: 2018 Second International Conference on Intelligent Computing and Control Systems (ICICCS). IEEE; 2018. p. 414-9.

[9] Yuan L, Qu Z, Zhao Y, Zhang H, Nian Q. A convolutional neural network based on TensorFlow for face recognition. In: 2017 IEEE 2nd Advanced Information Technology, Electronic and Automation Control Conference (IAEAC). IEEE; 2017. p. 525-9.

[10] Pratama Y, Ginting LM, Nainggolan EHL, Rismanda AE. Face recognition for presence system by using residual networks-50 architecture.International Journal of Electrical and Computer Engineering. 2021;11(6):5488.

[11] Chhangani A, Benadikar VN, Vakharia MS. Biometric Attendance Management System. IOSR J Comput Eng. 2019;21(5):25-32.

[12] Jayaswal R, Dixit M. Comparative analysis of human face recognition by traditional methods and deep learning in real-time environment. In:2020 IEEE 9th International Conference on Communication Systems and Network Technologies (CSNT). IEEE; 2020. p. 66-71.

[13] Shrestha R, Panday SP. Face Recognition Based on Shallow Convolutional Neural Network Classifier. In: Proceedings of the 2020 2ndInternational Conference on Image, Video and Signal Processing; 2020. p. 25-32.

[14] Kamencay P, Benco M, Mizdos T, Radil R. A new method for face recognition using convolutional neural network. Advances in Electricaland Electronic Engineering. 2017;15(4):663-72.

[15] Panditpautra V, Goswami A, Khavare A, Ambadekar S. Biometric Attendance Management System Using Raspberry Pi. In: 2nd InternationalConference on Advances in Science & Technology (ICAST); 2019. .

[16] Mansoora S, Sadineni G, Kauser SH. Attendance Management System Using Face Recognition Method. In: Journal of Physics: ConferenceSeries. vol. 2089. IOP Publishing; 2021. p. 012078.

[17] Kakarla S, Gangula P, Rahul MS, Singh CSC, Sarma TH. Smart attendance management system based on face recognition using CNN. In:2020 IEEE-HYDCON. IEEE; 2020. p. 1-5.

[18] Sylaj A. STUDENT ATTENDANCE SYSTEM USING FACE RECOGNITION. 2019.

[19] Deniz S, Lee D, Kurian G, Altamirano L, Yee D, Ferra M, et al. Computer vision for attendance and emotion analysis in school settings. In:2019 IEEE 9th Annual Computing and Communication Workshop and Conference (CCWC). IEEE; 2019. p. 0134-9.

[20] Ramdhon AN, Febriya F. Penerapan Face Recognition Pada Sistem Presensi. Journal of Applied Computer Science and Technology.2021;2(1):12-7.

[21] Pawaskar SS, Chavan AM. Face recognition based class management and attendance system. In: 2020 IEEE Bombay Section SignatureConference (IBSSC). IEEE; 2020. p. 180-5.

[22] Chaudhry A, Elgazzar H. Design and implementation of a hybrid face recognition technique. In: 2019 IEEE 9th Annual Computing andCommunication Workshop and Conference (CCWC). IEEE; 2019. p. 0384-91.

[23] Suhaimin MSM, Hijazi MHA, Kheau CS, On CK. Real-time mask detection and face recognition using eigenfaces and local binary patternhistogram for attendance system. Bulletin of Electrical Engineering and Informatics. 2021;10(2):1105-13.

[24] Sanli O, Ilgen B. Face detection and recognition for automatic attendance system. In: Proceedings of SAI intelligent systems conference.Springer; 2018. p. 237-45.

[25] Alhanaee K, Alhammadi M, Almenhali N, Shatnawi M. Face Recognition Smart Attendance System using Deep Transfer Learning. ProcediaComputer Science. 2021;192:4093-102.

[26] Chowdhury S, Nath S, Dey A, Das A. Development of an automatic class attendance system using cnn-based face recognition. In: 2020Emerging Technology in Computing, Communication and Electronics (ETCCE). IEEE; 2020. p. 1-5.

[27] Pei Z, Shang H, Su Y, Ma M, Peng Y. Convolutional neural networks for class attendance. In: 2017 13th International Conference on NaturalComputation, Fuzzy Systems and Knowledge Discovery (ICNC-FSKD). IEEE; 2017. p. 809-14.

[28] Hl DG, Vishal K, Dubey NK, Pooja M. Face recognition based attendance system. International Journal of Engineering Research & Technology(IJERT). 2020;9(6).

[29] Bahety SS, Tejaswi V, Kumar K, Balagar SR, Anil B. Implementation of Automated Attendance System using Facial Identification from DeepLearning Convolutional Neural Networks.

[30] Limkar S, Hunashimarad S, Chinchmalatpure P, Baj A, Patil R. Potential of Robust Face Recognition from Real-Time CCTV Video Streamfor Biometric Attendance Using Convolutional Neural Network. In: Intelligent Data Engineering and Analytics. Springer; 2021. p. 11-20.