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Md. Apu HOSEN[1,2], Shahadat Hoshen MOZ[1,2], Md. Mahamudul Hasan KHALID[1,2], Sk. Shalauddin KABIR[1], Dr. Syed Md. GALIB[1]

[1] ***Jashore University of Science and Technology, Jashore-7408, Bangladesh***
[2] ***Northern University of Business and Technology Khulna, Khulna-9100, Bangladesh***

FACE RECOGNITION-BASED ATTENDANCE SYSTEM WITH ANTI-SPOOFING, SYSTEM ALERT, AND EMAIL AUTOMATION

*The **subject matter** of the article is the design of an attendance system based on face recognition with anti-spoofing, system alarm, and Email Automation to improve accuracy and efficiency, highlighting its potential to revolutionize traditional attendance tracking methods. The administration of attendance might be a tremendous load on the authority if it is done manually. Therefore, **the goal** of this study is to design a reliable and efficient attendance system that can replace traditional manual approaches while also detecting and preventing spoofing attempts. Without the manual approach, attendance may be collected using many kinds of technologies, including biometric systems, radiofrequency card systems, and facial recognition systems. The face recognition attendance system stands out among the rest as a great alternative to the traditional attendance system used in offices and classrooms. The **tasks to be** accomplished include selecting appropriate facial detection and recognition technologies, implementing anti-spoofing measures to prevent intruders from exploiting the system, and integrating system alarms and email automation to improve accuracy and efficiency. The **methods used** include selecting the Haar cascade for facial detection and the LBPH algorithm for facial recognition, using DoG filtering with Haar for anti-spoofing, and implementing a speech system alarm for detecting intruders. **The result** of the system is a face recognition rate of 87 % and a false positive rate of 15 %. However, since the recognition rate is not 100 %, attendance will also be informed through email automation in case someone is present but is not detected by the system. **In conclusion**, the designed attendance system offers an effective and efficient alternative to the traditional attendance system used in offices and classrooms, providing accurate attendance records while also preventing spoofing attempts and notifying authorities of any intruders.*

Keywords: *Face Recognition; Attendance System; Anti-spoofing; DoG filtering; System Alert; E-mail Automation.*

Introduction

Our daily lives depend heavily on human faces, especially for identifying people. The process of extracting the features of a person's face and storing them as a one-of-a-kind face print enables face recognition, which is a subset of biometric identification, to be used to uniquely identify a person. Face recognition technology is better than other biometrically based recognition methods such as fingerprints, palm prints, and iris scans because the scanning process does not involve any physical contact.

Face recognition technology has recently gained a lot of interest due to the expanding number of business and law enforcement applications that require precise human recognition. The attendance system is one of them. Attendance is not merely recording the presence of people participating. An effective and precise attendance system helps establish better work atmosphere. It also fosters openness and responsibility in everyone's activities that influence the company. It is vital to guarantee that all elements of an organization accomplish their tasks. It is challenging to manually generate and analyze statistical data representing a record of attendance [1]. Additionally, these systems are more vulnerable to false proxies or attendance. On the other hand, face recognition-based attendance systems are faster, more accurate, and more secure than manual systems, making them a better choice for organizations that want to streamline their attendance tracking processes while also improving accuracy and security [2].

The effectiveness of face recognition technology is gauged by how well it can identify authorized individuals and reject those who are not. The feature extraction and classification stages are included in the primary performance criteria [3]. Numerous studies on facial recognition-based attendance systems have mostly focused on the accuracy of student recognition [4]. The current face recognition study has centered on the "image matching" element of the system regardless of whether the linked face is real or fake [5], whereas this paper concentrates on decreasing the false positive rate and bases its system on a static photo of a face that secures against spoofs. If the system detects an intruder, it will also issue a warning.

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1. Related Work

Research on face recognition has been carried out for a substantial amount of time, and this field of study is still actively being developed today. Among the previous responsibilities are the following:

V. Chaudhari et al. [6] created a video-based facial recognition system to efficiently and accurately mark participant attendance by combining facial recognition and facial recognition algorithms. Using FaceNet to extract characteristics and MTCNN to detect the image of the student for recognition are both used in this process. In the final step, the results are fed into a Support Vector Machine (SVM), which is tasked with identifying the person of interest depicted in the image. When they used their own self-generated dataset, they were able to determine the accuracy of their method to be 94.8 %.

M. Ramasane et al. [7] suggested a real-time face recognition system that is both effective and real-time, with low image resolution fluctuations and a variety of angular positions of the face. For training and classification, they used a dataset that they had previously prepared themselves. After the facial photographs have been taken with an HD 1080p camera, they are then subjected to preprocessing with CLAHE, which is followed by noise reduction involving the application of median filtering. When it comes to capture faces for the recognition process, gaussian filtering has also been used in some cases. This technology is also capable of accurately recognizing faces in environments with various levels of illumination. In the proposed system, accuracy improves with increasing pixel resolution but deteriorates with increasing face deviation angle. They applied the LBPH approach to the process of feature extraction.

V Rohini et al. [8] suggested a face-recognition–based automated attendance system as a solution to the challenges presented by manual and other types of traditional attendance systems. Face recognition would be used to verify a person's identity. The work that was planned was accomplished using face recognition and machine learning. Both the Haar cascade classifier and the LBPH method will be able to identify a face after it has been detected by the former. The experiment generates real-time facial data as part of its procedures. Face detection and recognition are carried out using a web camera that is attached to the computer. Recognized faces are then marked as having attended the event. It is possible to monitor attendance using various functions that are provided in both the admin module and the instructor module. Through using of the Haar cascade classifier and the LBPH algorithm, they are able to achieve an accuracy of 94.5 % in face detection and 98.5 % in face recognition.

R Valarmathi et al. [9] created a model to track student attendance that uses a series of constraints, such as the local binary pattern histogram approach, to identify distinct personalities' faces from a collected image. Each cell's binary pattern histograms are first computed, and the results are then concatenated to produce the final feature vector. Following this, the training data set vector and the final vector are compared using the k-nearest neighbor method. Using this method, the classification results are used to determine the value closest to the final vector. The database is updated with the individual's attendance after the person's name is obtained.

B. Tej Chinimilli et al. [10] proposed an automated attendance management system that uses the Haar cascade and LBPH algorithm to identify and recognize faces. Situations such as facial recognition rates, false positives rates, and false positives rates with and without the use of a threshold to identify obscure individuals are studied to assess the system. The facial recognition rate for students was found to be 77 % by the inventor, while the false positive rate was found to be 28 %. In any case, the system perceived the students as if they were wearing glasses or developing facial auditory growth. The recognition of the face of an obscure individual is roughly 60 % without and with imposing restricting esteem. The rate of false positives is 30 % and 14 % without and with applying the limit separately.

A. Singh et al. [11] presented a real-time system that uses deep learning and face recognition algorithms such as Convolution Neural Networks (CNN) to locate and identify individuals in live or recorded surveillance streams. The system may be used to monitor either live or recorded feeds. The VGGFace deep learning neural architecture serves as the foundation for the proposed integrated real-time database system. Transfer learning is used to retrain the model on an original tailored dataset that is more compact and consists of 7500 pictures of 26 unique individuals. Details regarding the generation of original tailored datasets as well as brief testing using a variety of machine learning and deep learning algorithms are also presented in order to examine and improve the recognition accuracy of the proposed system. The suggested technique successfully identified each of the 26 individuals with a confidence level ranging from 78.54 % to 100 %, with a mean average of 96 percent on real-time inputs, demonstrating the highest level of recognition accuracy.

A system for managing visual attendance was proposed by Harikrishnan J et al. [12] and includes 4 crucial steps: face detection and the data gathering that goes along with it, training of the recognition process, face recognition, and attendance management. The system used Haar cascade classifiers and Local Binary Patterns Histograms (LBPH) for face detection and face recognition. A CCTV camera and a Raspberry Pi may be used to power this setup. Because the system uses picture preprocessing techniques, it may be used in classrooms and lab facilities for real-time monitoring or routine attendance even when the lighting is poor. This enables the system to accommodate both normal and emergency attendance needs. Because attendance is immediately maintained on the onboard attendance server and online, this solution is user-friendly and time-saving.

The concept of face detection and identification through open computer vision is used in N. Gupta et al. [13] used a centralized server structure to handle the students class attendance documentation. For the face detection system, the manufacturer employed Haar cascade and for face recognition LBPH model. Part of the python bundles/modules employed in the endeavor is Numpy, Tkinter, OpenCv, PIL, and Pandas. The manufacturer employed a facial recognition library using KNN algorithm, which yields a precision rate 97.35 %.

Kim et al. [14] offer a method employing machine learning that can classify face expressions and then further categorize them in many layers. This is identified by Haar like characteristics. The face is initially identified using ROI configurations. The facial expression is then matched using SVM classified as HOG to match the person's expression. The phrases were then compared to assess the amount of correctness. The trials that were performed resulted in greater accuracy than the standard approaches. The ROI process participating in the FER machine might result in an excellent and appropriate alternative as it delivers greater and better input than the standard methods. The original dataset scores establish an excellent example to be used in schools, traffic systems.

Sanchez-Moreno et al. [15] proposed a face recognition system that might work in unrestricted environments. It would make use of a mixture of deep learning techniques such as FaceNet and certain standard classifiers such as SVM, KNN and RF together with moderate computer power. For face detection, the system uses YOLO-Face, which is a high-speed real-time detector based on YOLOv3. For face classification, the system uses FaceNet, which employs supervised learning algorithms such as the support vector machine (SVM). The face detector achieved an accuracy of greater than 89.6 %. The experimental results of the system demonstrated that the accuracy of the FaceNet+SVM model is 99.7 %, the FaceNet+KNN model is 99.5 % and the FaceNet+RF model is 85.1 %. on the other hand, FaceNet was able to achieve 99.6 % accuracy.

Various studies have showcased the superior accuracy of face recognition systems over traditional attendance systems, particularly when it comes to handling challenges such as varying lighting conditions, the presence of noise and distortions, occlusions, and partial face views. However, it is important to note that these studies often focus on relatively small datasets.

Despite promising results in smaller-scale experiments, limitations have been identified when scaling up face recognition systems to handle a substantial number of individuals. These limitations primarily revolve around issues of scalability and performance. As the dataset size increases, the efficiency and effectiveness of the system can be compromised, leading to reduced recognition accuracy and overall system performance.

Therefore, while face recognition systems have shown immense potential in addressing attendance-related challenges, it is crucial to further explore and address the scalability concerns associated with large datasets. This includes optimizing algorithms, developing robust feature extraction techniques, and implementing efficient models to ensure accurate and efficient recognition even when dealing with a significant number of individuals in the system. By overcoming these scalability and performance limitations, face recognition-based attendance systems can offer more reliable and practical solutions for attendance management in various settings.

2. Motivation for research

In face recognition-based attendance systems deep learning is very popular. Deep learning techniques have shown great success in facial recognition tasks, particularly in recent years with the development of more advanced deep neural networks. It has enabled the development of highly accurate and efficient face recognition systems, which can recognize faces in a wide range of conditions, such as varying lighting, facial expressions, and head poses. Deep learning models require large amounts of training data to be trained effectively. Acquiring and labeling large datasets can be a time-consuming and resource-intensive process, which can involve significant costs for data collection, annotation, and storage., and if the dataset is small or biased, the accuracy of the system may suffer.

However, Haar cascade and LBPH-based systems are simple and computationally efficient. These methods are based on traditional computer vision techniques, which are computationally less demanding than deep learning-based methods. As a result, they can be deployed on devices with limited computing resources, such as low-end computers or embedded systems.

Another advantage of Haar cascade and LBPH-based systems is their robustness to variations in lighting conditions, facial expressions, and pose. These techniques are based on handcrafted features that are designed to be invariant to such variations, whereas neural network-based systems typically require large amounts of annotated data to achieve similar robustness.

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3. Purpose and objectives of the study

Face recognition-based attendance systems have demonstrated higher accuracy compared with traditional manual attendance systems. However, several studies have highlighted certain challenges that need to be addressed for these systems to be more effective in various scenarios. These challenges include handling large datasets, addressing anti-spoofing measures, recognizing unknown individuals, and enhancing overall functionality.

To address these challenges, ongoing research and development efforts focus on implementing advanced algorithms, leveraging deep learning techniques, and integrating additional technologies. These advancements improve the accuracy, reliability, and usability of face recognition-based attendance systems in diverse scenarios. Additionally, the deployment of multifactor authentication can further enhance system security and overall effectiveness.

The primary objective of the proposed study is to develop an effective automated attendance system using facial recognition. Special emphasis is placed on addressing issues related to large datasets, anti-spoofing measures, and unknown person recognition. Furthermore, the study enhances system functionality by incorporating features such as automated email notifications, system alerts, and streamlined attendance management processes. By addressing these challenges, the study seeks to improve the overall performance and usability of facial recognition-based attendance systems, making them more robust and reliable in practical applications.

4. Proposed System

The procedure kicks off with the taking of a picture of the subject's face with the use of a camera. Then, in the pre-processing stage, we use DoG filtering, and in the subsequent section, we use a strategy based on HAAR cascades. The Cascading classifier uses all of the attributes of the captured image to iteratively search through all of the images in the dataset, one at a time, in order to determine whether or not the face in question is authentic. If it finds the original face, it will use LBPH to recognize the face; based on this, the attendance sheet will be updated, and a report of attendance will be sent out through an automated e-mail system. On the other hand, if it finds a bogus image, it triggers a system alert that notifies you that an intruder has been found. The suggested system architecture is illustrated in Fig. 1, which may be found here. The details of each stage of implementation are presented in the next section.

5. Dataset and methodology

To evaluate the effectiveness of the proposed system, a data set consisting of ninety different people was built. A total of 80 photographs were taken of each individual. The images are then changed to grayscale and normalized when the preprocessing step has been completed. Fig. 2 displays some images of the dataset after converting in grayscale.

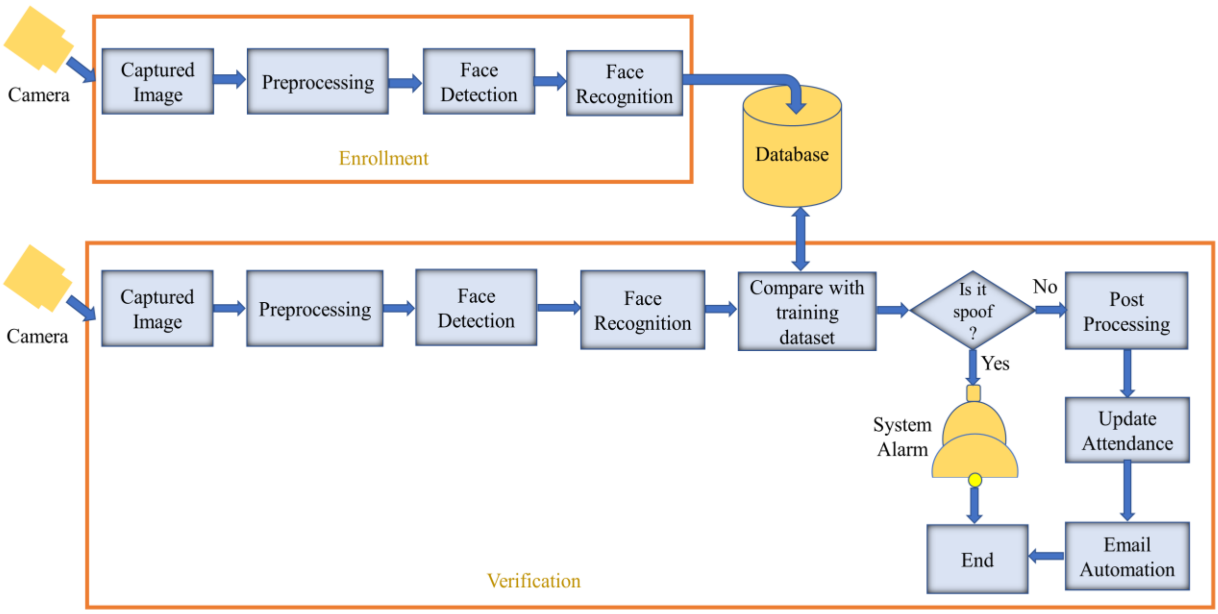

Fig. 1. System Architecture

Fig. 2. Extracted images in the dataset

5.1. Preprocessing

Face photos that are captured have better image quality than recovered face photos, therefore the recaptured photo contains fewer high-frequency materials [16]. By comparing the 2D Fourier spectra of the genuine and fake faces, this situation can be found. Thus, the frame is first converted from color to grayscale before DoG filtering is used.

The use of DoG filtering allows for the preservation of high-frequency processes such as image boundaries while removing noise [17]. Instead of examining all high-frequency bands, this method investigates the frequency spectrum of the high-middle band. A bit more outer Gaussian can be applied to eliminate erroneous low spatial frequency data. By lowering false information and noise, this pre-processing technique enhances the focus on the portion of the range that provides crucial information [18], to distinguish between authentic and fake face images that can then be seen.

5.1.1. Difference of Gaussians (DoG)

To improve the edge characteristics of an input image, the Difference of Gaussians (DoG) algorithm subtracts one blurry version of the original image from another less blurry version of the original [19]. The original photos are convolved with two Gaussian kernels of different standard deviations to produce blurred images [20]. By convolutional blending two Gaussian kernels of differing widths, σ_1 and σ_2 where σ_2 is higher than σ_1 with the original image F, the smoothed images g1 and g2 are produced.

$$g_1(x,y) = \frac{1}{\sqrt{2\pi\sigma_1^2}} \exp\left(-\frac{x^2-y^2}{2\sigma_1^2}\right) * F(x,y),$$

$$g_2(x,y) = \frac{1}{\sqrt{2\pi\sigma_2^2}} \exp\left(-\frac{x^2-y^2}{2\sigma_2^2}\right) * F(x,y).$$

The DoG operation is then performed by subtracting the two smoothed images:

$$\mathrm{DoG}(x,y) = g_1(x,y) - g_2(x,y) = \\ = \left(\frac{1}{\sqrt{2\pi\sigma_1^2}} \exp\left(-\frac{x^2-y^2}{2\sigma_1^2}\right) - \right. \\ \left. - \frac{1}{\sqrt{2\pi\sigma_2^2}} \exp\left(-\frac{x^2-y^2}{2\sigma_2^2}\right)\right) * F(x,y).$$

The resulting image, denoted as D, is then obtained by multiplying the DoG operation by the original image F:

$$D(x,y) = \mathrm{DoG}(x,y) * F(x,y).$$

The resulting image D has enhanced edge characteristics compared to the original input image F. This is because the DoG operation produces an image that highlights the difference in pixel values between the two blurred images, which tends to correspond to edges and other high-frequency details in the original image.

5.2. Face detection

After preprocessing, the Haar Cascade classifier is used to identify the face that the viola has suggested [21]. In Haar Cascade, a trained cascade function hunts for traits in other images. It can be broken down into four steps.

5.2.1. Haar feature calculation

A Haar feature is created by performing a sequence of calculations on the successive rectangular sections of a detection window. This is the only thing that constitutes a Haar feature. In order to complete the process, the first step is to add up the pixel intensities at each point, and then the next step is to subtract the sums. The following equation, developed by Lienhart [22], can be used to determine each Haar-like feature within a W x H pixel detection window:

$$\mathrm{Feature} = \sum_{i=1}^{n} \omega_i \, \mathrm{RecSum}(r_i),$$

where $\mathrm{RecSum}(r_i)$ is the total intensity across each upright or rotating rectangle that has been placed inside a detection window, and ω_i is an arbitrarily chosen weighting factor. Fig. 3 illustrates prototypes of the Haar characteristic.

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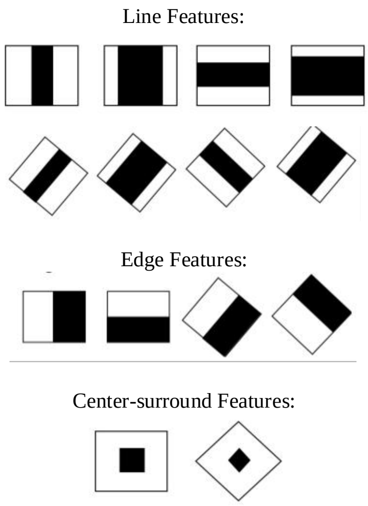

Fig. 3. Haar like features

5.2.2. Integral image creation

When integral images are used, computation of these Haar characteristics is completed at a substantially faster rate. Calculations are not performed on each individual pixel; rather, sub-rectangles and array references are constructed for each sub-rectangle. After this, the Haar properties can be computed using this information.

5.2.3. Adaboost Training

How do we determine which of the hundreds of thousands of Haar features best reflect a particular item when there are so many to choose from? Adaboost finally makes his appearance at this juncture of the action. Adaboost is used to select the most useful characteristics, and then instructs classifiers to use those characteristics. The "strong classifier" that the algorithm generates may be utilized in the process of recognition by combining "weak classifiers."

5.2.4. Implementing Cascading Classifiers

The cascade classifier is made up of numerous stages, each of which has a group of poor students. The technique of "boosting" is used to train weak learners and builds a classifier incredibly accurate on the average prediction of all weak learners. On the basis of this prediction, the classifier decides whether to report the discovery of an object (positively) or to proceed to the subsequent region (negative). Stages are created to quickly reject undesirable samples because most windows contain nothing of relevance.

5.3. Face Recognition

There are several facial recognition algorithms, among these LBPH has superiority over others because of its resilience, and ability to distinguish both front and side faces, which is why the LBPH algorithm is chosen for face recognition [23]. It is used to locate qualities in a picture that best characterize a face. This technique is simpler by describing the image within the local dataset, when a supersession unknown image transpires, an identical procedure is run and the output is compared to each of the images in the dataset. Rather than other algorithms, it performs better in various locations and lighting conditions. The Local Binary Pattern (LBP) procedure generates a picture that highlights the qualities of an image more effectively. It employs the sliding window idea and the parameters radius and neighbors [24]. Fig. 4 illustrates it.

First, transform the frame into 3X3 pixel matrices. Put value 1 at that pixel position if a neighboring pixel in a matrix is larger than the matrix median pixel otherwise set value 0. Now, generate a binary number by adding the values of the pixels in a line adjacent to one another. This creates a new value. As can be seen in Figure 5, the binary integer should be replaced with the pixel value that corresponds to the matrix's median.

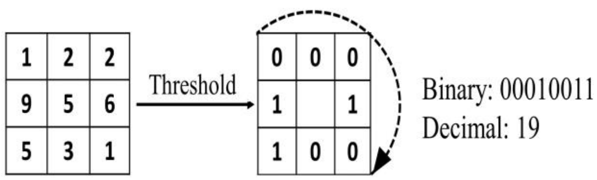

Fig. 5. LBP process on a 3x3 matrix

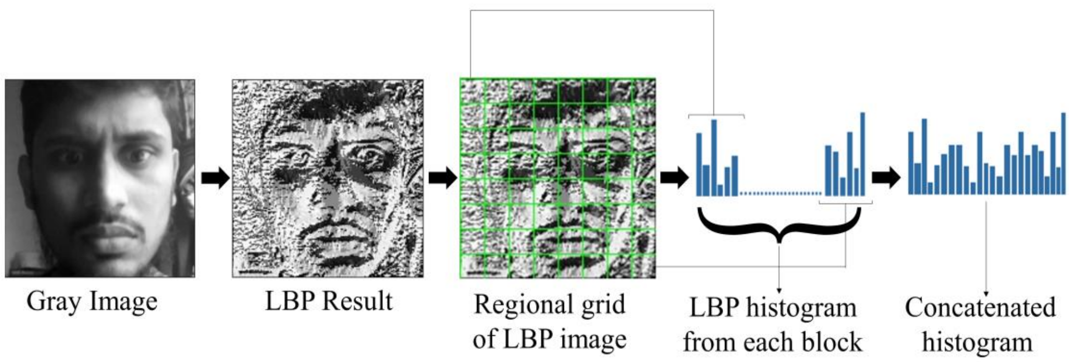

Fig. 4 Process of LBPH algorithm

After the image has been transformed into the LBP format, the histograms from each grid are extracted and combined to generate a brand new, more comprehensive histogram. The concatenated histogram indicates the characteristics that were present in the image that was first captured.

Each histogram illustrates a different face from the database. The steps that came before are repeated for the new picture, and a new histogram is produced as a result.

5.4. Anti-spoofing Checking and System Alert

After recognizing the face, the input image will be compared to every image in the dataset to determine whether or not the face in question is a fake one by passing each characteristic individually. This will be done to determine whether the face in question is real. If it is determined that the face is fake, the technology will flag it as an intruder and send out a warning. If, on the other hand, it is an actual face, it will recognize it and carry on with the processing.

5.5. Post Processing

Using Euclidean distance, the new histogram is compared to the training dataset histograms. Because lower confidences are more effective at identifying the subject of the image, the histogram with the lowest confidence or the smallest distance is chosen. It also extracts the ID that goes with that histogram. If the level of confidence becomes less than 50, the names are updated in an excel sheet and the extracted data is displayed on the frame [25], as seen in Fig. 6. To avoid the duplication, the student's name is added only to an Excel sheet if it is not already there, as seen in Fig. 7. The person's image is saved in a different folder if confidence exceeds the threshold, which has a value of 95. This makes it easier to spot any trespassers in the classroom and prevents pupils from being mistakenly labeled as strangers.

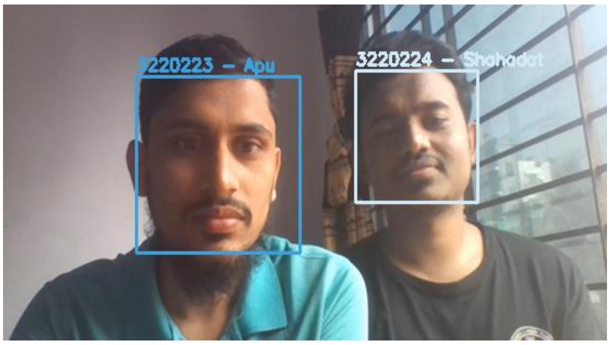

Fig. 6 Recognizing Faces

ID	Date	Name	Time	Status
3220223	8/12/2022	Apu	10:48:40 AM	Present
3220223	8/12/2022	Shahadat	10:48:40 AM	Present

Fig. 7 Attendance Sheet

5.6 Attendance Report through E-mail

At the end of the day, the daily attendance report is sent to the particular student through e-mail. So, if someone is there but is discovered to be absent, they may notify the organization and take the corrective action.

6. Results and Discussion

This system initially proposed a method for detecting fakes that involved DoG filtering and a classifier known as the Haar-Cascade. The accuracy of the method can be evaluated based on the ratio between the number of false positives and false negatives. The accuracy, as well as the false rejection and acceptance rates, for liveness recognition of faces on the test sets included in the dataset are displayed in Table 1. The findings show that the proposed system works better at spoof detection and is effective at detecting intruders.

Table 1

Performance of DoG-Haar-Cascade in face detection on the dataset

Performance	Result
Accuracy	98.36 %
False acceptance rate	0.72 %
False rejection Rate	0.92 %

Here the system recognizes the face using the LBPH algorithm from varying distance with different expressions. The results mentioned in Table 2, show that the LBPH algorithm gives 87 % recognition rate varying distances up to 100 cm with different facial expressions.

Table 2

Performance evaluation of face recognition

Performance	Result
Recognition Rate	87 %
False Positive Rate(FPR)	15 %
Unknown People Recognition Rate	68 %

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Conclusions

This study describes an automatic facial recognition-based attendance system that identifies face-checking anti-spoofing. For a better result in face detection and recognition, DoG filtering is used in the preprocessing stage, and then the Haar Cascade classifier is applied for the detection of faces with anti-spoofing. Anti-spoofing is done by comparing the contrast and textures of the original and fake photos and using the DoG filtering method. Here, the database comprises photos of diverse facial expressions. This system correctly detects a kid with inadvertent modifications such as wearing glasses or growing a beard. Based on the comparative analysis with other studies, the system under investigation exhibits its commendable detection and identification rate with superior performance in spoof detection. Notably, this higher identification rate is achieved by leveraging a relatively large dataset compared to the datasets used in other studies. This finding highlights the importance of dataset size in achieving robust and accurate face identification outcomes. By employing a larger dataset, the proposed system demonstrated superior performance in terms of identification accuracy, further solidifying its effectiveness in face recognition tasks. As the recognition rate is not 100 %, the system provides the report of the individual student so that if someone is present but is determined to be missing, they may alert the organization and take corrective action.

The proposed facial recognition system faces challenges in effectively recognizing faces when there are rapid changes in frame rates. When individuals are moving quickly or when the video feed is captured by cameras with high frame rates. In such cases, the system may struggle to accurately detect and recognize faces, leading to reduced performance and lower recognition accuracy. This limitation suggests a potential area of improvement and future scope for the system, which involves adapting it to handle high frame rate changes.

Contribution of authors: **Md. Apu Hosen** was the author of the research proposal, the coding analysis, and the manuscript draft; **Shahadat Hoshen Moz** completed the coding, analysis, and drafting of the manuscript; by **Md. Mahamudul Hasan Khalid**, the manuscript's coding, analysis, and drafting were completed; **Sk. Shalauddin Kabir** was in charge of the overall monitoring, revision, and drafting of the document; **Dr. Syed Md. Galib** completed the whole supervision, editing, and mentoring of the article.

All the authors have read and agreed to the published version of the manuscript.

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СИСТЕМА ОБСЛУГОВУВАННЯ НА ОСНОВІ РОЗПІЗНАВАННЯ ОБЛИЧЧЯ З АНТИСПУФІНГОМ, СИСТЕМНИМ ПОВІДОМЛЕННЯМ ТА АВТОМАТИЗАЦІЄЮ ЕЛЕКТРОННОЇ ПОШТИ

Мд. Апу Хосен, Шахадат Хошен Моз, Мд. Махамудул Хасан Халід, Ск. Шалауддін Кабір, Др. Саїд Md. Галіб

Предметом статті є розробка системи відвідуваності на основі розпізнавання обличчя з антиспуфінгом, системною сигналізацією та автоматизацією електронної пошти для підвищення точності та ефективності,

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підкреслюючи її потенціал для революції в традиційних методах відстеження відвідуваності. Адміністрування відвідуваності може стати величезним навантаженням на органи влади, якщо це робити вручну. Отже, мета дослідження полягає в тому, щоб розробити надійну та ефективну систему відвідування, яка може замінити традиційні ручні підходи, а також виявляти та запобігати спробам спуфінгу. Без ручного підходу відвідуваність може бути зібрана за допомогою багатьох видів технологій, включаючи біометричну систему, систему радіочастотних карток і систему розпізнавання обличчя. Система відвідування з розпізнаванням обличчя виділяється серед інших як чудова альтернатива традиційній системі відвідування, яка використовується в офісах і аудиторіях. Завдання, які необхідно виконати, включають вибір відповідних технологій виявлення та розпізнавання обличчя, впровадження заходів проти спуфінгу, щоб запобігти використанню системи зловмисниками, а також інтеграцію системної сигналізації та автоматизації електронної пошти для підвищення точності та ефективності. Використовувані методи включають вибір каскаду Хаара для виявлення обличчя та алгоритму LBPH для розпізнавання обличчя, використання DoG-фільтрації з Хааром для захисту від спуфінгу та впровадження мовної сигналізації системи для виявлення зловмисників. Результатом роботи системи є рівень розпізнавання обличчя 87 % і рівень хибнопозитивних результатів 15 %. Однак, оскільки коефіцієнт розпізнавання не є 100 %, присутність також буде проінформована через автоматизовану електронну пошту, якщо хтось присутній, але не виявлений системою. Підсумовуючи, розроблена система відвідуваності пропонує ефективну альтернативу традиційній системі відвідуваності, що використовується в офісах і аудиторіях, забезпечуючи точні записи відвідуваності, а також запобігаючи спробам підробки та сповіщаючи органи влади про будь-яких зловмисників.

Ключові слова: розпізнавання обличчя; система відвідуваності; захист від спуфінгу; фільтрація DoG; системне сповіщення; автоматизація електронної пошти.

Мд. Апу Хосен – магістрант з комп’ютерних наук та інженерії, Науково-технічний університет Джашор, Бангладеш; викладач комп’ютерних наук та інженерії, Північний університет бізнесу та технологій Хульна, Бангладеш.

Шахадат Хошен Моз – магістрант з комп’ютерних наук та інженерії, Науково-технічний університет Джашор, Бангладеш; викладач комп’ютерних наук та інженерії, Північний університет бізнесу та технологій Хульна, Бангладеш.

Мд. Махамудул Хасан Халід – магістрант з комп’ютерних наук та інженерії, Науково-технічний університет Джашор, Бангладеш; викладач комп’ютерних наук та інженерії, Північний університет бізнесу та технологій Хульна, Бангладеш.

Ск. Шалауддін Кабір – магістр з комп’ютерних наук та інженерії, викладач комп’ютерних наук та інженерії, Джашорський університет науки та технологій, Бангладеш.

Др. Саїд Md. Галіб – PhD з інформаційних комунікаційних технологій, проф. комп'ютерних наук та інженерії, Джашорський університет науки та технологій, Бангладеш.

Md. Apu Hosen – MSc Student of Computer Science and Engineering, Jashore University of Science and Technology, Bangladesh; Lecturer of Computer Science and Engineering, Northern University of Business and Technology Khulna, Bangladesh,
e-mail: apu.cse.just@gmail.com, ORCID: 0000-0003-1192-9133.

Shahadat Hoshen Moz – MSc Student of Computer Science and Engineering, Jashore University of Science and Technology, Bangladesh; Lecturer of Computer Science and Engineering, Northern University of Business and Technology Khulna, Bangladesh,
e-mail: shahadat.cse.just@gmail.com, ORCID: 0000-0002-3023-5703.

Md. Mahamudul Hasan Khalid – MSc Student of Computer Science and Engineering, Jashore University of Science and Technology, Bangladesh; Lecturer of Computer Science and Engineering, Northern University of Business and Technology Khulna, Bangladesh,
e-mail: khalid.just.cse@gmail.com, ORCID: 0000-0002-1651-3981.

Sk. Shalauddin Kabir – M.Sc. in Computer Science and Engineering, Lecturer of Computer Science and Engineering, Jashore University of Science and Technology, Bangladesh,
e-mail: sks.kabir@just.edu.bd, ORCID: 0000-0002-0031-8807.

Dr. Syed Md. Galib – PhD in Information Communication Technology, Professor of Computer Science and Engineering, Jashore University of Science and Technology, Bangladesh,
e-mail: galib.cse@just.edu.bd, ORCID: 0000-0002-5708-727X.