A new design for monitoring student attendance in smart classrooms

Abdul Cader Mohamed Nafrees
Office of the Dean
South Eastern University of Sri Lanka
Ampara, Sri Lanka
nafrees@seu.ac.lk

Sahabdeen Aysha Asra
Department of Information Technology
South Eastern University of Sri Lanka
Ampara, Sri Lanka
ashrasahabdeen005@seu.ac.lk

CMM. Mansoor
Department of Information Technology
South Eastern University of Sri Lanka
Ampara, Sri Lanka
mansoorr@seu.ac.lk

Ponnampalam Pirapuraj
Department of Information and Communication Technology
South Eastern University of Sri Lanka
Ampara, Sri Lanka
pirapuraj@seu.ac.lk

***Abstract*—In many areas of education, keeping track of student engagement is required. For crowded study halls, manually administering the participation forms is challenging. The first purpose of face detection and identification frameworks, one of the components of computer vision, was for surveillance purposes. In this article, an unique mechanism for monitoring student attendance is developed that combines a face detection system with support vector machines (SVM) as well as convolutional neural networks (CNN) technologies. Even if there are several automatic attendance models utilized in schools and colleges, the suggested strategy makes use of deep learning techniques to make the methods more successful. In the suggested model, numerous cameras are employed to capture the image in 360 degrees (reducing the likelihood that certain student faces will be missed), and a few machine learning techniques will subsequently be used to do face identification on the captured image. The Local Binary Patterns Histograms (LBCH) technique will be used to extract lighting, context, and position variation before CNN and SVM algorithms do facial detection. After applying the AdaBoost classification method to remove duplicate photos, the attendance report will then be created by comparing the collected photographs with the stored images. We think that our suggested method, which uses facial identification and a number of deep learning techniques, may be utilized to track student attendance and successfully deter fraudulent attendance.**

Keywords—SVM, Face recognition, CNN, Machine Learning, Deep Learning, Smart attendance

I. INTRODUCTION

Technology has made significant advances in an ever-changing environment. It has made our day-to-day life more convenient and safer. A real-time facial recognition-based attendance system is one of the most modern technologies available today. Keeping track of attendance in a school or institution is a complicated and time-consuming task [1]. Traditional methods of recording student attendance are still used. These methods are inefficient and prone to errors. Institutions can benefit from a smart attendance system that uses face recognition to automate the attendance process.

Using cutting-edge technology, a number of emerging technologies have recently emerged to improve approaches for recording attendance, among others are using the RFID card, voice print and biometric identification [2], [3]. However, each of the methods listed has advantages and disadvantages. Face Recognition research has been conducted for human interests, including identity verification, security related systems, video indexing, image related database systems, multi-media environments, surveillance, Smart Card applications, Systems of criminal justice and witness face reconstruction.

A practical option is to use facial recognition for attendance marking in an attendance management system. As instance, face recognition is more accurate and faster than other approaches [4]. Face recognition allows for passive identification, which means that the person being recognized does not have to do anything to be identified. People are recognized by facial recognition and entered into a face database by the attendance system. Face identification of the object faces captured by the camera is possible by comparing face image data recorded by the camera with face recognition data stored in the face database.

The construction and design and of facial attendance systems with cameras are critical for improving the accuracy of user data while also allowing users to move around freely. due to its great accuracy and more accurate data processing. For user identification, a face attendance system with a camera is very reliable and secure. It has the potential to develop a reliable and robust system for recognizing human faces for use as time attendance on attendance machines.

Data collection, face detection, preprocessing, feature extraction, and classification will all be part of the facial recognition process. Our system uses facial recognition to ensure that students are automatically logged in to the university or classroom without needing to interact with a human.

The proposed strategy uses effective machine learning and deep learning techniques to improve the effectiveness of the approaches. Multiple cameras are used in the proposed model to capture a 360-degree photo, and then a face identification process is used to recognize students' faces using a few machine learning algorithms.

We believe that our proposed system, which combines facial recognition with a combination of machine learning and deep learning methodologies to track student attendance and prevent fraudulent attendance, would be successful in doing so.

II. LITERATURE REVIEW

Usually, attendance tracking entails the distribution of a paper-based name list among attendees for a certain event. The traditional technique of attendance has several flaws, for example, it is difficult to ensure accuracy, difficult to implement strictly time consuming [5]. With all of the breakthroughs in facial recognition, additional study should be

done to increase the efficiency, practicality, and accuracy of the many methods that have been developed [6]. Face recognition is a good method to have both time and cost efficiency with less human participation. Further, advancements in the field of image processing, the system's efficiency continues to rise [7]. Face recognition software is one method for monitoring pupil attendance during class periods. [8]. Surveillance is a type of monitoring that also helps to keep track of activities by recording footage from the area where it is situated [9].

Face recognition algorithms include Eigen Face, PCA, and Local Haar Binary Pattern (LBPH) algorithms, among others. After the faces are detected in the LBPH method, the faces are cropped from the picture. Multiple characteristics of the face, such as the framework of the face, the distance between the nose, and the eyes, are highlighted in these cropped photographs. Each student will be tagged present or missing based on a comparison of these faces in the database [10]. The quality of the input face photos and the training images used in the face comparison phase have a significant impact on the precision of the feature extraction and comparison phases of the LBP face recognition algorithm [11]. Also LBPH, in conjunction with the Haar cascade classifier, provides excellent face identification accuracy with a smaller dataset and quicker processing rates, and is capable of accurately detecting all sorts of faces [12].

The allowed students are identified and counted as they enter and exit the classroom using radio frequency identification (RFID). Smart Attendance System maintains an accurate record of every enrolled student and considerably reduces the time-consuming activity. Furthermore, this smart system maintains the data of every student enrolled in a certain course in the attendance record [13]. With their comparative research, the K-nearest neighbor method, Convolutional neural networks, and Support vector machines (SVM) algorithm are used to recognize faces. The system produces the names and ID numbers of the students who are present and identified in the image once facial recognition is complete. Due to the fact that it requires comparatively little hardware resources, it is a cost-effective solution. [14].

The major reason to choose Python is for its image processing capabilities, since it has a large number of frameworks and a large number of packages and modules. A solution for an attendance system based on image processing is especially well integrated with open computer vision, which offers the idea a lot of potential. [15].

III. EXISTING SYSTEM

TABLE I. TECHNOLOGIES USED IN SMART ATTENDANCE SYSTEM

Cite	Technology/ Tools used	Accuracy	Implementation	Limitations
[16]	• Eigenface values • Principle Component Analysis (PCA) • Convolutional Neural Network (CNN) • Camera • PC	• High accuracy • There are 68 distinct (landmarks) features on a person's face.	• • The Viola and Jones algorithm will be used for facial recognition, as well as constrained local model-based face tracking and face landmark identification. • Face Recognition – PCA (lessening the quantity of variables • Eigenface subspace – under lying arrangement of learning pictures	-
[17]	YOLO V3 Microsoft Azure using face API Ubuntu 2.6.0 LTS over which OpenCV 2.0 runs Python 3.0 Tkinter, SQLite 3 libraries Smart Phone Camera	100% High accuracy Convolution - moving a filter over an image and capturing a dot product along the way. CNN – Every layer is reliant on an unrestricted filter, colors, edges, and gradients. Yolo - takes an input image and divides it into square grids.	• Darkflow • Alexery/ Darknet • Darknet (pre trained YOLO V3 model)	-
[18]	• CNN deep learning • UDOO X86 Ultra single board computer, mini-keyboard, 15MP Camera, 7-inch LCD, Portable power bank and 5V to 12V DC convert	• Rank 1 accuracy • Three angles to calculate the head pose: roll, yaw, and pitch. Angles are usually between -90 and +90 degrees. The coordinates of the nose tip and the location between the brows using facial landmark detection.	• Face tracking approach to generate face logs. • Utilized the Viola & Jones - identify the face and use the correlation tracker included in the dlib program to keep track of it from frame to frame. • Aid in the creation of a face-log / a compact depiction of the subject's face in a video sequence.	-
[19]	• Haar classifier • LHBP classifiers • SVM Classifier • PC • Camera	• Eigen face & Fisher face - compute dominant features • LBPH - build the local binary pattern using sample points and a radius from the central pixel.	• Train Data – Scan the faces and train data. • Haar classifier – Face detection • OpenCV – Face recognition, Eigenface and Fisherface compute the dominant feature, LHBP used to	-

			analyze individually.	
[20]	• Raspberry Pi (runs Raspbian (Linux) Operating System installed on micro SD card) • Raspberry Pi Camera • 5-inch screen (connected to the Raspberry Pi)	• Accuracy 95% • LBS divided in to 7 x 7 size cell on image. The centered pixel has 8 pixels with surrounding 3 x 3 neighbor (present binary). Values turns to histograms. Then algorithm encode spatial information (eyes, mouth, nose etc…) by computing histogram.	• The camera will capture image and pass to Raspberry Pi. • The prototype door will open using Servo Moto (when the students' details matches with trained dataset). • The attendance results reachable to web browser (online).	Pixel may increase or decrease (light on / off).
[21]	• OpenCV Algorithm • Camera	• Captured image - gray scale image of 50x50 pixels	• Detect the task and extract of face image (stored in xml file). • Learn and training of face image Computing Eigen and value of image. • Recognize the image by comparing in xml.	-
[22]	• CNN • PCA • Viola-Jones (OpenCV) • RoI • Camera	• Accuracy up to 98% • 2D to 3D image reconstruction • The position of the RoI coordinate point of the facial marks.	• Viola-Jones (OpenCV) - detecting face features. • Lens (raw image) containing background image and a face image. The position of the RoI coordinate point of the facial picture marks the camera lens. • To improve facial identification employed cropping, resizing, RGB-Gray, and histogram equalization as a contrast-brightness modification. • • The preprocessing	-
			technique is used to sharpen the image and account for various differences in lighting that frequently occur when taking pictures of faces.	
[23]	• Eigenface • PCA • Computer • Camera	• 90 % of accuracy	• Face dataset - training. • Eigenface – Compute the face. • The system then compares the current face's eigenvectors with the stored face image to determine.	-
[24]	• Haar cascade • LBPH	• Haar features - edge, line, and four rectangle.	• Convert each RGB picture to a grayscale version. • Haar Cascade: get the ROI with face recognition. • LBPH algorithm - RoI to get the features. • features are stored in the database (for enrollment) • Post-processing (verification)	Dataset is small
[25]	• Face Net • SVM	• 99.6% of accuracy. • FaceNet - feature extraction by embedding 128 dimensions per face	• Preprocessing - Face recognition – PIL and face recognition library, FaceNet - feature extraction from preprocessed images, resize the image size as 160 x 160 x 3, SVM - classification Feature extraction - FaceNet – enhance Inception embed facial image into 128 dimensions using resnet design and weight of facenet optimized using triple loss function. The Triplet Loss reduces the distance between a favorable input, such as the CNN input image, and an anchor. The activation layer (Relu) regulates how the information flows from one layer to the next, and the 55 or 77 matrix is frequently used as a feature detector.	-

			The pooling layer always reduces the size of each feature map. • Classification - SVM - data mining Separate the classes from the extracted feature by FaceNet by calculating the distance	
[26]	• Python • Java • C++ • Open CV • MySQL Database • ODBC • SQL • Real-Time Video Processing • Camera	• Accuracy 82% • The side profile of a human face was the first to be described and recognized using geometric characteristics. It calculates a number of feature points based on the person's side profile line, and then uses feature (eyes, nose, ears, mouth, etc) points to produce a set of feature values for recognition, such as angle and distance.	• Face recognition • Face detection - collect information to determine human face image in the image, the size and position and detect in the repository. • Face feature extraction - LDA method - a group of linear changes can be located. • Geometric feature - description & recognition of the side profile of a human face. • Subspace analysis method - To reduce the dimensionality of facial data, spatial transformation is used to map face image data into a specific subspace. • Neural network - membrane recognition • Video image recognition system - find and separate a portion of the face picture from the image.	-
[27]	• Haar-cascade classifiers • LBPH • Raspberry Pi 3 • Pi Camera • LDA • OpenCV	• Detect Haar Features used in Viola and Jones with different orientation	• Pre-processing (conversion of the image into gray scale) - cvtColor (OpenCV) • Haar Cascade Classifier – detect face • Viola and Jones - giving input of faces, non • AdaBoost - eliminate redundant and irrelevant features of the face • LBPH - improves the detection performance on the datasets	-
			• Histogram of the picture - portrays the face in terms of its retrieved facial traits. • LDA - gender categorization method, performed using the Fisherfaces algorithm (OpenCV).	
[28]	• Python, OpenCV, Haar-cascade classifier, LBPH • PHP script, Node.js, MySQL, Raspberry Pi 3 model B+, 5MP camera	-	• Haar cascade and LBPH - face detection, recognition and combination • SFTP server - make sure security of the system • Raspberry pi • PHP and SQL	-
[29]	• Haar-like features • Bilateral Filter • Raspberry Pi 3 B, Raspberry Pi Wide Angle Fisheye Lens Camera, web camera, Memory Micro SD, monitor, keyboard, mouse, Power adapter, HDMI cable, Converter HDMI	• Bilateral Filter, Haar-like features to recognize the face	• Face Recognition (extraction, training and database matching) • Haar-like features Method – gives a specific indication to the image • Cascade Classifier AdaBoost – improve the accuracy of the given learning algorithm.	-

	to VGA			
[30]	• Cpp software - Visual Studio 2013 • LBPH algorithm • Haar Cascade algorithm • web camera / CCTV	• 98.2% of accuracy • The process of locating the placements of the eyes (user's eye position), lips, and facial boundaries	• Face identification - skin color detection and the Haar Cascade technique, followed by an alignment procedure that included face feature normalization • LBPH algorithm - feature extraction, classification	distance – face, camera detection accuracy will decrease
[31]	• Open CV. • The eigenfaces and fisher faces • Camera	• 97%.	• Pre-processing an image entails taking a single picture of each face, turning it into grayscale, and storing it in the database. Facial detection involves the camera placing a frame over the subject's face, converting the subject to grayscale, and then moving on to the next stage. • Fisher face is used for feature extraction in this process. • Face Recognition: this involves matching the results to database entries.	Impossible every photograph of a person is taken under good lighting. This may result in a lack of response
[32]	• Haar Cascade classifier • PCA • LBPH, KNN • High resolution camera	• 93.1% • Detecting face	• Haar Cascade classifier, after capturing the RoI from the individual students' face picture and resizing it to a set size. • The database's recorded characteristics are compared to the facial photos of the students. • Students' attendance is recorded in the database.	It is noise intolerant, vulnerability to assaults, certain security measures

IV. PROPOSED SYSTEM

A. Tools Selection

The above table comprises technologies used to develop, equipment, accuracy level of the existing system, implementation as well as limitations. According to the table there are several technologies used for the system development such as CNN, PCA, YOLO, Haar Classifier, LHBP classifier, Raspberry Pi, etc. Although the main part of the system is face detection and face recognition. Almost every referred system has implemented these part carefully and authentically. When comparing these technologies with the accuracy, we have suggested reference [22] to implement the system. The recommended system has implemented using CNN and PCA combination technology. This combination helps to detect and recognize more accurate feature extraction.

This existing system provide the systematic process to recognize the face accurately. The process includes Training face, face detection, normalization, feature extraction, classification and face identification. To create 3D face pictures from 2D face photographs, the CNN technique is employed. In this case, PCA is a technique for reducing the dimensionality of a facial image's resolution In order to determine how similar two faces are, we compare the training features of a face stored in the database with the traits of a facial image taken during the testing period.. These findings will be used to generate identity data, which will be saved as attendance data. The accuracy level of the system is 98%. When analyze with other technologies and techniques this CNN-PCA and Real-time Camera attendance system is more convenient and accurate. Furthermore, a few limitations from the existing systems are also considered while proposing the new automatic attendance system concept design.

B. Architecture

The proposed automatic attendance system is very simple, manageable, less human interaction, quick report generation, and user-friendly.

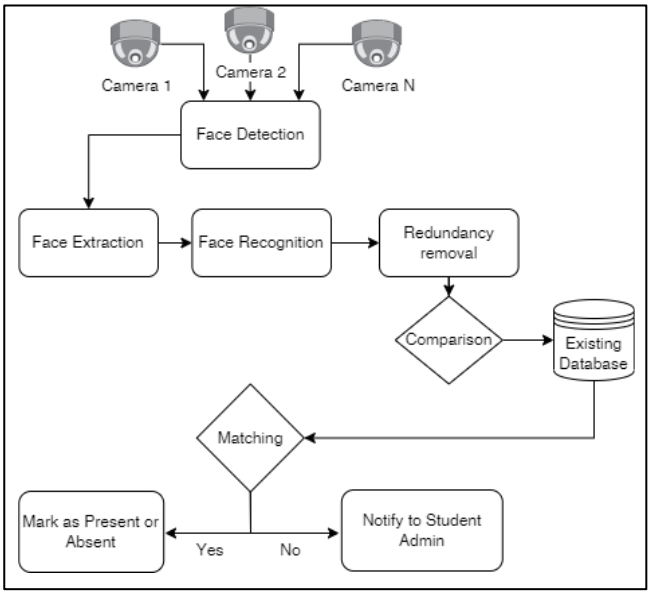

Fig.1 . Proposed System

A few high-resolution 360-degree cameras will be fixed in the lecture halls according to the number of students; those cameras will automatically capture student faces at a particular time or different times during the class hour, where these captured students' faces will be compared with the students' faces that are used to store during student intake. Students' attendance will be recorded in the system if there is a matching in the captured face and stored face image, else, notification will be sent to the student administration department via email. Furthermore, these cameras will be programmed to function based on the timetable, otherwise, cameras will be on-off mode to reduce the power

consumption. Furthermore, cameras will be placed in different places to capture the students' faces accurately due to students' different poses or expressions. In addition to these, the system will be designed to eliminate redundant faces that are captured from all the cameras inside the classroom to conclude a single attendance entry as the proposed system suggested using multiple cameras in a single classroom.

C. Methodology

The CNN will be used for developed the proposed system by train the machine for facial recognition process, and the capturing new students' face for automatic facial expression by comparing them. In this section, we explained the methods and functions of the proposed system.

As we are proposing a novel automatic attendance system, we have to develop all the required components of this system from the scratch; such as database creation for the attendance report and face image selection for student identification from the captured images. Therefore, we divide the process as follows;

- Database development
- Face detection
- Face extraction
- Face recognition
- Duplicate face removal
- Attendance report generate.

1) Database development: A new database will be developed that includes a table for recording students' attendance. It is receiving students' attendance from the captured images and taking more details of students from the existing student's registration table, such as students' registration numbers. We have suggested using MySQL or SQL lite for the database development.

2) Face detection: The face detection is done by Viola-Jones and Haar-cascade classifier under the OpenCV package, which is a machine learning based approach where this is focus on 68 points of a captured face to increase the efficiency and it is trained using both positive and negative images; also it is used to detect images. Also the real time cameras used to capture the face as well. The placement point and size of the RoI face picture created are determined by the RoI coordinate point of the face image. Furthermore, AdaBoost can be used to identify required features. To detect faces, a weighted mixture of weak classifiers is utilized that can be used to face quality assessment.

3) Face extraction: LBPH algorithm will be used to extract the facial features such as lightning, context, and pose variation. Real-time applications frequently experience lightning circumstances, in which case applying local feature extraction to brighter faces is simpler than to darker faces.

4) Face recognition: PCA and CNN will be used for the face recognition process to complete this task with higher accuracy and within a short period of time. In this step, captured images will be compared with existing students' faces to recognize the studentship for a particular session. Once the comparison succeeds the attendance will be marked as present for the student. There are four parameters that need to be considered during face recognition processes such as pose, sharpness, captured image resolution, and brightness which help to increase the accuracy of the smart attendance system.

5) Duplicate face removal: AdaBoost will be used to eliminate redundant and irrelevant features of the captured faces to select the best face of the student to compare with existing stored students' face images. It will be done during the face recognition step.

6) Attendance report generate: After all the all above steps, selected captured faces matching with stored images of the students and attendance will be marked present and uncaptured students automatically marked absent in the database. It is suggested to use MySQL reporting tool or SQL Server Reporting Services for report generation due to its process speed and user-friendliness.

V. Conclusion

In this study, an automated attendance tracking approach is proposed with several machine learning and deep learning algorithms is proposed for smart class room context. The proposed approach includes modular architecture with many components such as database development, face detection, face extraction, face recognition, duplicate face removal and attendance report generate. The first module of our proposed approach is database development, in which a database of student details with their image will be developed. The face detection module is developed using two widely used machine learning algorithms, namely Viola-Jones and Haar-cascade classifier under the OpenCV package. In order to remove lightning, context, and pose variation, a module named as face extraction is included in our proposed approach, which is developed using Local Binary Patterns Histograms (LBCH) algorithm. The main module of the proposed approach is face recognition, which is the module for recognizing the face of student whether he is assigned to a particular session or not. For the recognition process, the captured images will be compared with existing students' faces and the attendance report will be generated. The Principle Component Analysis (PCA) Convolutional Neural Network (CNN) algorithms are used to develop the face recognition module. The accuracy of the proposed system will be high, as we are using several machine learning and deep learning algorithm for developing all the module. We think that our suggested method, which uses face detection and a number of machine learning and deep learning algorithms, can be used to monitor student attendance and successfully thwart fake attendance. As future work, the suggested database development process of the proposed system is manual process which is done by the instructor of the particular session which can be converted as an automated process in future. Moreover, the suggested approach can be used to track the attendance of staffs of the University and can be used to track the book borrowers in Library by incorporating a minor change in the suggested approach.

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