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Student Information System Based on Face Biometrics with QR Code Using Machine Learning Techniques

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***Abstract*—Identifying a person's identity is deemed essential and can be confirmed through either traditional or biometric methods. The use of biometric technology is expanding due to its implementation in various industries for personal verification. Biometric recognition can be derived from either physical or behavioral traits, such as iris, voice, fingerprint, or face. While biometric recognition has the potential to enhance the process of tracking attendance in educational environments, it is underutilized, thus presenting opportunities for further exploration. Traditional attendance methods, such as calling out names or signing sheets, are often time-consuming and susceptible to fraud. To overcome these issues, there has been progress in using biometric recognition to automate the attendance process. The attendance tracking system employs face biometrics along with Quick Response (QR) codes for authentication. Student information is securely stored in a database in the form of QR codes. During attendance, students scan their QR code and their identity is verified through unique face biometrics. The face recognition is performed through a machine learning algorithm, which helps to prevent false attendance and improve the efficiency of the automated system in real-time college settings. Additionally, the system provides access to view marks and fees information. The system is designed with a .NET framework for the front-end and SQL Server for the back-end, and experimental results indicate the effectiveness of the real-time interface for student information. The student authentication system combines QR codes with face biometrics and uses HAAR Cascade for face detection and face recognition algorithms. The system allows for secure storage of student information in the form of QR codes, and during attendance tracking, students scan their code and their identity is verified through face recognition. The use of HAAR Cascade and face recognition algorithms helps to enhance the accuracy and efficiency of the authentication process.**

Keywords—Student authentication, QR code, HAAR Cascade, Face detection, Face recognition

I. INTRODUCTION

The authentication and authorization play a crucial role in maintaining computer system security by verifying users, devices, or systems identities and access privileges. In education, student authentication is essential to confirm their identity and grant credits or qualifications for their coursework. Biometrics is a commonly used authentication method that identifies individuals based on unique physiological or behavioral traits, such as fingerprints, facial recognition, and iris recognition. This field compares biometric data to stored references to confirm an individual's identity. Fingerprints are unique due to ridge patterns, facial recognition uses facial features, and iris recognition uses eye patterns for identification.

Biometrics has become a widely adopted technology for secure authentication in various industries, including law enforcement, border control, and consumer electronics. This is due to advancements in biometric technology and an increased demand for secure authentication methods. However, the widespread use of biometrics also raises privacy concerns related to the collection, storage, and usage of biometric data. These concerns have led to increased scrutiny and debate over the privacy implications of biometrics, and the need to establish guidelines and regulations to ensure the proper use of this technology.

II. RELATED WORKS

Mynavathi et al. proposed a framework for a comprehensive student information system that replaces paper records with a secure online platform accessible by college staff and students. The data is stored on SQL servers and protected by user authentication, data validation, and a logging system. The goal is to increase efficiency and reduce time and effort in accessing student records compared to paper records.

Pengtao Yang, et.al, developed a student information management system that utilizes fingerprint recognition for identification purposes. The system is composed of a terminal with a fingerprint recognition module and a microcontroller, and a host computer which can be either a personal computer or a large server, with the student information database managed by SQL Server. The system is designed to be secure, with data encryption based on an improved AES algorithm for secure transmission of sensitive information such as student fingerprints, identity information, and bank card information.The proposed encryption algorithm is optimized to improve encryption time compared to the traditional AES algorithm. The authors recognized the potential risks of data interception during transmission and emphasized the need for secure data transmission to protect students' private information.

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Anusha v pai, et.al, The authors in present the design of a simple student attendance management system using Web Services. The system is built around Web browser standards and can be accessed using any browser on any platform. The use of Web Services offers several benefits, such as increased accessibility, platform independence, longer lifespan, and the ability to choose preferred programming languages. The system allows for the recording of attendance in various ways and utilizes a web-based approach to provide worldwide accessibility. The authors aim to deploy a student attendance management system using Web Services to take advantage of these benefits.

DipinBudhrani and team designed and implemented a student information system to replace paper records. The system offers an online platform for students, faculty, and college administration to access student information such as academic progress, attendance, and activities. The data undergoes thorough review and validation for security before any changes are made. The system also has a logging system to track user access and maintain data security. The goal is to improve the efficiency of college record management, reduce time to access and deliver student records, and decrease time spent on non-value added tasks. The focus is on the students who can access information about the college, courses, faculty, exams, and more, as well as ask queries to staff through the system.

Symon C. Lubanga and his colleagues developed an Online Student Information System (OSIS) for academic institutions. The aim was to centralize all student records into one database using internet technology. The advantages of the Online Student Information System (OSIS) are widely acknowledged, but its implementation has proven challenging for African universities due to inadequate Information and Communication Technology (ICT) infrastructure. In Malawi, a study was performed to evaluate the Mzuzu University Student Online Management System (SOMS) from the perspective of the students. The study used both qualitative and quantitative research methods, including questionnaires and follow-up interviews with third-year students and the Director of ICT services. The data was analyzed using Microsoft Excel and the thematic analysis technique. The system has replaced paper-based systems, but with increasing numbers of students, it has become challenging to manage student records effectively. The advent of ICT applications and databases has presented opportunities to manage student records in academic institution.

SudhirBussa and others have implemented a facial recognition system for marking attendance in academic institutions. The system uses computerized biometric software to determine or validate a person based on their facial features. The system is designed to be used in security systems and commercial operations, and is considered a resourceful application of attendance systems. The system uses a webcam to capture images of students or employees and compares their facial features with those stored in a database to mark attendance. The advantages of using facial recognition include its natural, feasible and non-invasive nature. The system aims to automate the attendance process without requiring manual intervention.

ArunaBhat and team developed a face recognition-based attendance system for educational institutions using one-shot learning. This solution offers an efficient and secure way to take attendance by processing a group photo of a class and producing a list of present students. The system is a fully functional Android app and backend architecture, requiring no expensive setup, and has demonstrated an accuracy of 97% on the LFW dataset and 85% on a public student class photo dataset. The authors believe this system is more secure and can prevent fake or proxy attendance.

Sharanya et al. [8] developed a framework for organizations to track and monitor the attendance of staff and students to improve their performance. The traditional method of manually recording attendance is prone to errors and consumes a lot of time, leading to the need for an automated attendance management system. The new system will utilize biometric processes, with face recognition being the most effective, to replace the manual, time-consuming process of taking attendance in the classroom. The advancement of technology and the concept of "smart classrooms" have revolutionized the education system, but the attendance system remains primitive and in need of modernization.

Shamsul J. Elias and team designed a face recognition system to improve the traditional method of taking attendance in universities. The system uses face recognition to record student attendance data in a database. The paper discusses student attendance systems, image processing, face detection, and face recognition, and employs the Viola-Jones algorithm for face detection and the Local Binary Pattern (LBP) method for face recognition. The goal is to make the attendance-taking process faster and more accurate. Historically, attendance has been recorded through a paper-based system, but there are technologies like barcode readers, RFID, and Bluetooth that can automate the process. However, these technologies often require expensive equipment and have limited usage, as the devices can easily be damaged.

Harikrishnan et al. developed a face recognition system that tackles the challenges posed by multiple face recognition algorithms in real-world situations, such as changes in lighting and low image quality. With the improvement of machine learning and AI, computers have become capable of processing vast amounts of data with high efficiency, and deep learning algorithms have enhanced image processing and computer vision, making face recognition more effective and overcoming previous limitations. The system, known as "Vision," runs on a Raspberry Pi and can be managed through network communication with the PI server. The attendance records are kept on the onboard and online attendance server. Artificial neural networks trained on billions of images can now detect and recognize faces with ease and accuracy, and this technology was utilized in the implementation of a real-time attendance and monitoring system. The user-friendly GUI makes it easy to use the powerful face recognition algorithms powered by deep learning, achieving a maximum recognition accuracy of 74% during real-time monitoring.

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The system provides a solution to the shortage of robust and user-friendly face recognition attendance systems.

III. Existing System

The concept of multi-view face recognition refers to using multiple images or videos from different angles to recognize faces. In some cases, the term is used for simultaneous acquisition with multiple cameras, while in others, it refers to recognizing faces across different poses. The recognition process may involve looking up a collection of images to align the appearance of the face, and this method also requires estimation of poses and illumination conditions for both images. The manual approach of taking and maintaining attendance records was challenging, which led to the development of biometric devices like fingerprint scanners for student attendance measurement in institutions and organizations where attendance is important.

IV. Proposed System

The proposed student attendance system utilizes the concept of multi-view face recognition and leverages the benefits of HAAR cascade algorithm and neural network algorithms to improve accuracy. The system captures the QR code along with the face of each student and stores the information in a database for attendance tracking. The system also provides an SMS and email-based alert system with real-time implementation, and students can view their fee details and overall report. The spherical harmonic representation of the face is a novel approach to face recognition in video scenes, which addresses the challenge of unlimited orientations and positions of human faces. This approach maps the face texture onto a sphere, which allows for the construction of a texture map for the entire face by back-projecting image intensity values from each view onto the surface of the spherical model. The use of this method can lead to improved accuracy and robustness in face recognition systems, making it a promising solution for student attendance systems in educational organizations. The proposed framework for student authentication is shown in Fig 1.

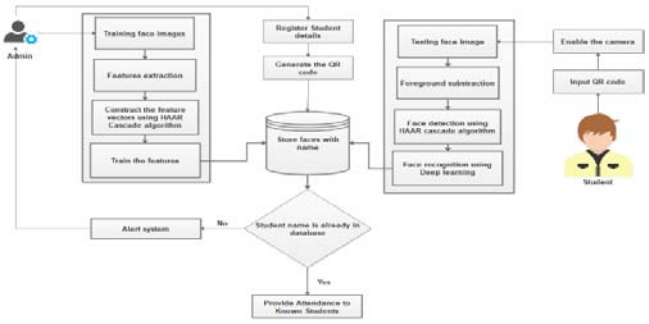

Fig 1: Proposed framework

The process of proposed work shown as follows

Framework construction

In the past 20 years, advances have been made in the field of personal identification. Biometrics, which refers to the identification of an individual through their physical traits that can be both seen and measured, is the term used to describe this. However, traditional biometric methods such as fingerprint and signature recognition have been found to be unreliable when dealing with large amounts of data. In this module, both administrative and student interfaces have been developed, with the administrative interface allowing for the storage of student information for future reference.

QR Code Generation

This QR code-based student information system aims to provide a secure way to store and access student information. By encoding the information in a QR code, the system can reduce the risk of data loss or alteration, and make it easier to access the information by simply scanning the code. The system uses four different encoding modes to ensure efficient storage of the data and to accommodate various types of information, such as names, phone numbers, email addresses, and class information. By using a QR code-based system, the student information can be stored and accessed in a quick, secure, and convenient manner.

Facial Features Extraction

In this module, student faces are captured in real-time for registration and the camera is used to distinguish the face pixels from the background. Preprocessing steps are implemented to identify the foreground pixels, which are then subtracted from the entire image. The HAAR cascade algorithm is used to extract key facial features such as skin tone, eyes, and others, which are then represented as feature vectors.

Label the Details

In this module, feature vectors are created for each student. A feature vector is an array of values that describes an object and multiple feature vectors can form a feature space. The elements in a feature vector can range from representing a single pixel to an entire image, depending on what information is being captured about the student. The granularity of the feature vectors is determined by what is being studied or represented about the student.

Classification

Deep learning is a cutting-edge approach to enhancing face recognition technology. The process involves extracting unique face embeddings from images containing faces. Training a deep neural network is the most effective way to perform this task. In this module, a deep learning algorithm is implemented to classify the feature vectors, which includes a neural network capable of classifying multiple features at once. Convolutional Neural Networks (CNNs) enable the extraction of a broad range of features from images. The algorithm classifies students during attendance and authorized students can also view their fee information.

Alert system

In this module, we can recognize known individuals and provide attendance for students based on recognition. If an unknown face is detected, an alert will be issued. A comprehensive report on attendance details is also generated.

V. Experimental Results

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To evaluate the system, a set of faces is necessary. There are various standard face databases available for testing and evaluating face detection algorithms. A standardized database of facial imagery is crucial for supplying consistent imagery to algorithm developers and for providing a sufficient number of images for testing. Without these databases and standards, it is not possible to accurately evaluate or compare facial recognition algorithms. The experiments in this module were primarily conducted using the real-time face database.

Accuracy

The accuracy (ACC) is a common performance metric used in machine learning and artificial intelligence to measure the performance of a model. It represents the ratio of correctly predicted outcomes (true positive and true negative predictions) to the total number of predictions made by the model. The accuracy is usually expressed as a percentage, with 100% accuracy representing a perfect model that makes no errors in its predictions. A lower accuracy score indicates that the model is making more errors in its predictions and may need to be improved or re-evaluated.

The accuracy (ACC) is expressed as a percentage and calculated as the sum of true positive (TP) and true negative (TN) predictions divided by the sum of all true and false predictions (TP, TN, false positive (FP), and false negative (FN)). It is given as:

$$ACC = (TP + TN) / (TP + TN + FP + FN) * 100$$

TP: True positive, the number of cases where the model predicted positive (e.g. presence of a face in an image) and it was actually positive.

TN: True negative, the number of cases where the model predicted negative (e.g. absence of a face in an image) and it was actually negative.

FP: False positive, the number of cases where the model predicted positive but it was actually negative.

FN: False negative, the number of cases where the model predicted negative but it was actually positive.

ALGORITHM	ACCURACY
PRINCIPAL COMPONENT ANALYSIS	65%
LINEAR DISCRIMINATIVE ANALYSIS	85%
HAAR CASCADE ALGORITHM	98%

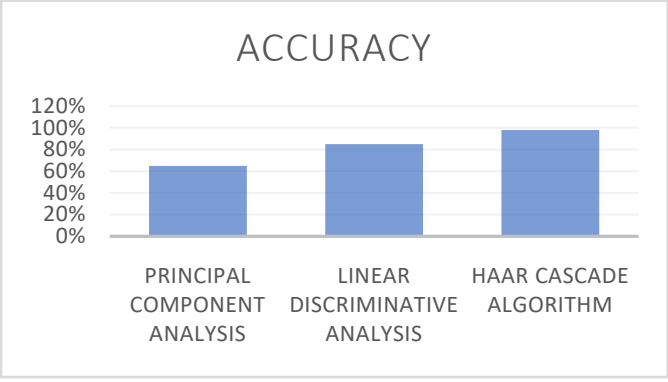

Fig 2: Experimental analysis

From the above graph, proposed system provide improved accuracy rate than the existing PCA and LDA algorithm.

VI. Conclusion

This paper presents a comprehensive review of face recognition techniques for still images and video sequences. Conventional methods, which require well-aligned face images and only perform either still image recognition or video-to-video matching, are not appropriate for face recognition under surveillance scenarios. The limitations of these existing techniques include a limited number of face images extracted from each video due to pose and lighting variations, poor video quality, and limited computational resources for real-time processing. Therefore, we propose a local facial feature-based framework for still image and video-based face recognition under surveillance conditions. This framework is capable of video-to-face matching in real-time and is trained using static images but applied to video sequences, resulting in higher recognition rates. Our approach also includes a QR code-based authentication system with fee information and an SMS alert system for evaluation using real-time image datasets.

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