Face detection for Exam conducting and monitoring using Machine learning

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Date of Submission

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Declaration

I hereby declare that the entire work embodied in this research work has been carried out by me. The extent of information derived from the existing literature has been documented and fully acknowledged at the appropriate places, the work is original and has not been submitted in part or full for any Diploma or Degree in this or any other University. I confirm that there is no plagiarism in this document and if detected, I abide by the action that will be taken for such plagiarism by the Faculty of Applied Science, Eastern University, Sri Lanka.

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Certification of the Supervisors

This is to certify that this research report entitled "**Face detection for Exam conducting & monitoring using Machine learning**" submitted by **A.M.R.M.T.B. Abeykoon** for the degree of Bachelor of Science in Computer Science is a record of research work carried out by him under our guidance and direct supervision and that it has not been previously formed the basis for the award of any degree, diploma, associateship, fellowship or any other similar title.

This is also to certify the document represents the original independent work of the candidate.

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Abstract

In the contemporary landscape of online education, the need for robust authentication mechanisms during online exams has become paramount. The advent of machine learning technologies has paved the way for innovative solutions, and this project endeavors to contribute to the academic integrity of online assessments. Titled "Face Detection for Exam Conducting & Monitoring using Machine Learning," the proposed system leverages Python, OpenCV, and Tkinter to develop a desktop application that integrates facial authentication into the online examination process. The primary objective of this project is to address the burgeoning concerns related to impersonation and unauthorized assistance during online exams. The proposed system employs cutting-edge machine learning techniques to implement a face authentication mechanism that ensures the actual candidate is participating in the examination. By analyzing real-time image streams and detecting crucial facial features, the system aims to enhance the integrity of online exams, thereby fostering a secure and trustworthy environment for both educators and students. The project utilizes Python as the primary programming language, harnessing the power of OpenCV for efficient image processing and Tkinter for developing an intuitive desktop interface. The combination of these tools enables the creation of a seamless and user-friendly application that can be easily integrated into existing online examination platforms. To store and manage candidate information, the system employs both MySQL and Firebase databases. MySQL provides a robust relational database structure for secure and organized storage of candidate data, while Firebase enhances real-time data synchronization, enabling seamless updates and retrieval of information. This dual-database approach ensures data integrity and accessibility, crucial factors in the success of any examination monitoring system. The heart of the system lies in its ability to detect and analyze facial features in real time. Leveraging machine learning algorithms, the system goes beyond traditional authentication methods by examining dynamic facial expressions and features unique to each individual. The project addresses the problem of impersonation during online exams, a prevalent issue that compromises the credibility of the assessment process. By utilizing machine learning, the system offers a non-intrusive yet highly effective means of verifying the identity of candidates. This not only safeguards the integrity of online exams but also instills confidence in educators and institutions regarding the authenticity of the evaluation process. In conclusion, the "Face Detection for Exam Conducting & Monitoring using Machine Learning" project aims to make a significant contribution to the field of online education by introducing a reliable face authentication system. The use of Python, OpenCV, Tkinter, MySQL, and Firebase collectively forms a robust framework that addresses the complexities of online exam security. As technology continues to reshape education, this project stands at the forefront, offering a proactive solution to ensure the trustworthiness of online examinations in the digital era.

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Chapter 01: Introduction

1.1 Project Overview

The Face Detection for Exam Conducting & Monitoring project is a desktop application designed to bolster the security of online exams through robust face authentication using machine learning. The primary goal is to develop a system that verifies candidate identity during online exams by analyzing real-time image streams and detecting facial features.

Targeting educational institutions and exam conducting bodies, the project utilizes Python, OpenCV, and Tkinter for face detection and a user-friendly interface. The system integrates with MySQL and Firebase databases to store and retrieve candidate information and facial images captured during lectures and exams.

The approach involves capturing facial images during lectures through the webcam, saving them in the database, and later comparing them with real-time images taken during exams. Machine learning algorithms ensure that the candidate facing the exam is the same individual who attended the lectures, enhancing the overall integrity of the examination process.

Assumptions include a stable internet connection for real-time image comparison and candidate cooperation with webcam capture during lectures and exams.

In summary, the Face Detection for Exam Conducting & Monitoring project aims to provide a reliable and secure solution for authenticating candidates during online exams. Anticipated outcomes encompass increased confidence in online exams, minimized identity fraud instances, and an improved, trustworthy environment for remote learning and assessment.

1.2 Background

The surge in online education and remote learning has brought forth a pressing concern - the integrity of online exams. As educational institutions transition to virtual assessment platforms, the potential for identity fraud during exams has become a significant challenge. Traditional methods of exam invigilation are inadequate in the online environment, necessitating the development of a secure and reliable solution.

While various online proctoring solutions exist, the proposed project stands out in its focus on face detection using machine learning. Existing solutions often rely on manual proctoring, biometric authentication, or simple webcam monitoring. However, these methods have limitations in accurately verifying candidate identity and ensuring the integrity of the examination process. The integration of machine learning algorithms for facial feature analysis provides a more sophisticated and adaptable solution, addressing the shortcomings of conventional methods.

Though numerous tools and platforms assist in online exam proctoring, there remains a gap in achieving a foolproof system that precisely verifies the identity of candidates by analyzing facial features. Existing solutions may lack the ability to adapt to changing environmental conditions, leading to false positives or negatives. The Face Detection for Exam Conducting & Monitoring project aims to fill this gap by employing machine learning techniques to enhance the accuracy, reliability, and adaptability of face authentication during online exams.

The project acknowledges the challenges associated with real-time image processing and the need for candidate cooperation in webcam capture during lectures and exams. Additionally, considerations for a stable internet connection for seamless image comparison have been factored into the project's approach.

In essence, the project background emphasizes the critical need for a more advanced and reliable face detection system to address the unique challenges posed by online exams, showcasing the project's innovation in bridging existing gaps in the realm of online exam proctoring.

Chapter 02: Related Work

The research emphasizing "Face Recognition in Mobile-Based Test Systems Using FaceNet" offers valuable insights into online exam systems. Amid the surge in online exams during the COVID-19 pandemic, the research, anchored by the FaceNet method boasting 85.7% accuracy, showcases a commitment to streamlining online assessments. Leveraging mobile devices, the emphasis is on accessibility and reduced infrastructure demands, presenting a noteworthy contribution to the evolving landscape of online education. [1]

The "Face Recognition Method for Online Exams" research stands as a pertinent related work in the landscape of biometric systems, specifically exploring facial recognition technology's application in online examination contexts. Exploring advancements in biometric systems, the Eigenface method is employed to develop a prototype for a face-based online exam application with attendance tracking. With a projected accuracy of 70%, this research contributes to the growing field of facial recognition technology, particularly in education, where attendance systems play a pivotal role in effective teaching and learning assessments. [2]

The research centered on eigenspace-based face recognition demonstrates a significant stride in computational face recognition with an impressive accuracy of 81%. Commencing with the Eigenface-Algorithm, the research diverges in its methodology, encompassing different eigenspace-based approaches. This study contributes to the field by independently comparing various methods, considering theoretical aspects, and conducting simulations using the Yale Face Database and FERET. The robust accuracy underscores the research’s efficacy in enhancing face recognition methodologies within digital images. [3]

The research "FaceTime — Deep learning based face recognition attendance system" stands out as a substantial advancement in the domain by leveraging deep convolutional neural networks (CNNs) for face detection and recognition. The integration of a CNN cascade for face detection and a CNN for generating face embeddings demonstrates a holistic approach. Notably, the research addresses the practical challenges of applying deep learning to smaller datasets in real-world production environments. The introduction of a novel image augmentation technique contributes to an impressive

95.02% accuracy in real-time scenarios, specifically on a limited dataset of original employee face images. The adaptability of the model for seamless integration into diverse systems further enhances its applicability for monitoring purposes, showcasing its versatility and real-world efficacy. [4]

Addressing the pivotal role of regular class attendance in academic performance and quality monitoring, this research introduces an automatic attendance management system, countering the inefficiencies of traditional methods like name-calling or paper signing. The system integrates ubiquitous components, creating a portable device for streamlined attendance management utilizing Face Recognition technology. Notably, with an accuracy level of 84%, this initiative contributes to enhancing data reliability and convenience in the academic context, signaling a progressive step towards efficient attendance tracking in educational institutions. [5]

The research, "Vision-Face Recognition Attendance Monitoring System for Surveillance using Deep Learning Technology and Computer Vision," presents an innovative real-time attendance and surveillance system powered by Artificial Neural Networks. Notably, it exploits the capabilities of deep learning for efficient face detection and recognition. From face attendance using smartphones in university classes to real-time facial recognition surveillance in various settings, the project serves as a potent defense against unauthorized access. The user-friendly graphical interface enhances the adaptability of these face recognition algorithms. With a maximum recognition accuracy of 74 percent in real-time surveillance, this project contributes as a robust solution to the need for user-friendly face recognition attendance systems. [6]

The research, centered on image processing techniques for automated attendance through face detection and recognition, aligns with contemporary technological trends. In the era dominated by image processing applications, the research addresses challenges in face recognition related to illumination, orientation, size, clarity, expression, and image intensity. Focused on developing an automated system for recognizing faces in videos and recording student attendance, the initiative employs the Viola-Jones algorithm for human face detection and the Fisher Face algorithm for recognition, achieving an accuracy range of 45% to 50%. This underscores its contribution to the evolving landscape of automated attendance systems. [7]

Chapter 03: Tools and Techniques

3.1. Python

Python serves as the backbone of the application, providing flexibility and ease of development. The core logic of the system is written in Python, encompassing modules for face detection, recognition, GUI development, and database interactions. Its simplicity and extensive libraries make it an ideal choice for orchestrating the various components of the application.

3.2. OpenCV (Open-Source Computer Vision Library)

OpenCV is instrumental in image processing and plays a vital role in face detection. The system leverages OpenCV's Haar cascades or other pre-trained models for efficient face detection, ensuring accuracy and speed. Image processing techniques from OpenCV enhance the quality of captured facial images, addressing challenges like illumination and pose variations. Real-time video capture and processing are seamlessly integrated using OpenCV functions.

3.3. Tkinter (Python GUI Toolkit)

Tkinter empowers the creation of a user-friendly and interactive GUI. The application's interface is designed with Tkinter, incorporating buttons, labels, and entry fields to enhance the user experience. Users can initiate face detection, review captured images, and access authentication features seamlessly through the Tkinter-based GUI.

3.4. MySQL

MySQL serves as the relational database management system for structured data storage. A well-designed database schema includes tables for candidate information, lecture details, and authentication records. Python's MySQL connector establishes a connection, enabling the system to perform CRUD operations on the database efficiently.

3.5. Firebase

Firebase provides real-time data synchronization and secure authentication. Firebase Authentication is implemented for secure user login, ensuring authorized access to the system. Firebase Realtime Database synchronizes data across devices in real-time, maintaining consistency and integrity.

3.6. Face Recognition

Face recognition involves verifying identity based on facial features. Real-time images captured during exams are processed using OpenCV. Face recognition algorithms, whether traditional (Eigenfaces, Fisherfaces) or modern (FaceNet), are implemented to ensure accurate authentication. Real-time images are compared with stored images to identify candidates and prevent unauthorized access.

3.7. Visual Studio Code

Visual Studio Code (VSCode) is a feature-rich code editor that supports various programming languages, including Python. VSCode serves as the primary coding environment for my project, providing a user-friendly interface for writing, editing, and debugging Python code. Its built-in terminal facilitates the execution of scripts, and extensions enhance functionality for a seamless development experience.

3.8. Git Integration

VSCode seamlessly integrates with version control systems like Git. Leverage VSCode's Git integration to manage version control for your project. Track changes, commit updates, and collaborate with team members efficiently through the built-in Git functionalities.

Chapter 04: Methodology

The methodology employed in this research outlines the systematic approach taken to develop the Face Detection for Exam Conducting & Monitoring system using machine learning techniques. The objective was to create a reliable face authentication system for online exam conducting and monitoring. The methodology can be replicated by other researchers interested in implementing a similar solution.

4.1. Literature Review

Conducted an extensive review of existing literature on face detection, recognition, and online exam monitoring systems. Studied relevant works on machine learning algorithms, specifically those applicable to facial feature analysis. Examined current practices in online exam systems, focusing on security and authentication measures.

4.2. Problem Definition

Clearly defined the problem statement, emphasizing the need for a robust face authentication system in the context of online exams. Established the goals of the project, including enhancing exam integrity and ensuring the identity of candidates during online assessments.

4.3. Tools and Technologies Selection

Chose Python as the primary programming language due to its versatility and extensive libraries. Selected OpenCV for image processing and face detection. Utilized Tkinter to develop a user-friendly graphical user interface. Employed MySQL and Firebase for database management and secure authentication.

4.4. System Architecture Design

Developed a detailed system architecture, outlining the components and their interactions. Designed the database schema, specifying tables for candidate information, lecture details, and authentication records.

4.5. Face Detection Algorithm Implementation

Implemented face detection algorithms using OpenCV. Utilized Python within Visual Studio Code (VSCode) as the coding environment.

4.6. User Interface Development

Designed the graphical user interface using Tkinter to facilitate user interaction. Integrated Tkinter components seamlessly with the face detection algorithms for a cohesive user experience.

4.7. Database Integration

Established connections to MySQL and Firebase databases within the Python code. Implemented SQL queries for storing and retrieving data related to candidate profiles, lectures, and authentication.

4.8. Face Recognition Algorithm Implementation

Implemented face recognition algorithms, exploring machine learning models for accurate identity verification. Utilized Python within VSCode for coding and debugging purposes.

4.9. Testing and Validation

Conducted rigorous testing to validate the functionality of face detection and recognition algorithms. Emphasized real-world scenarios to ensure robust performance during online exams.

4.10. Documentation

Documented the abstract, tools/techniques, system architecture, and methodologies used. Provided detailed comments within the code to facilitate understanding and future enhancements.

4.11. Review and Iteration

Periodically review the progress against the project goals. Iteratively refined the system based on testing feedback and identified areas for improvement.

4.12. User Interfaces

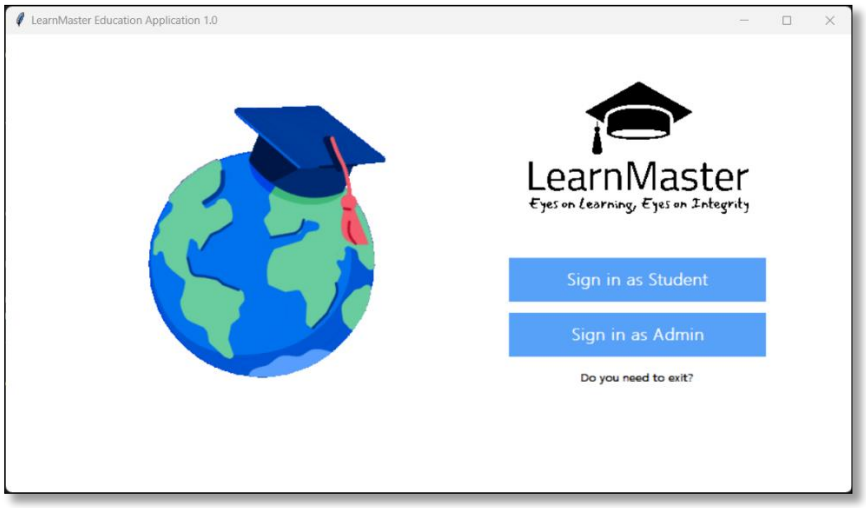

Figure 1 – View Selection Window

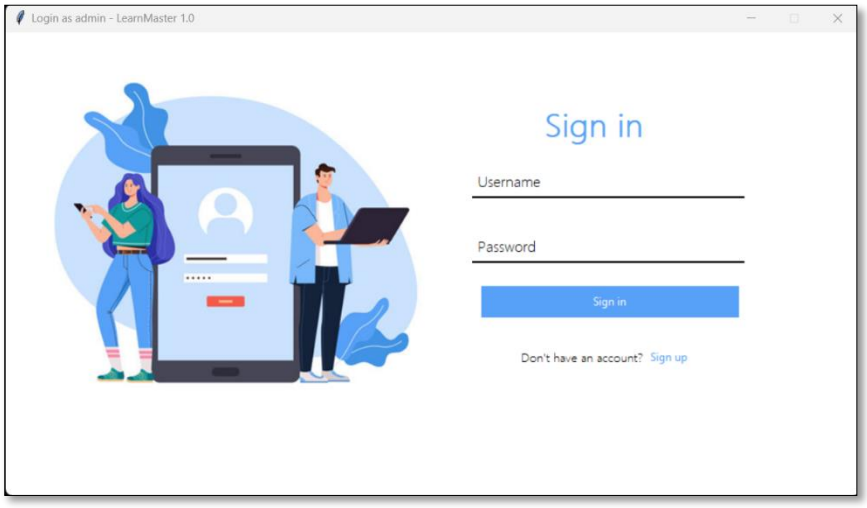

Figure 2 – Admin Sign in Window

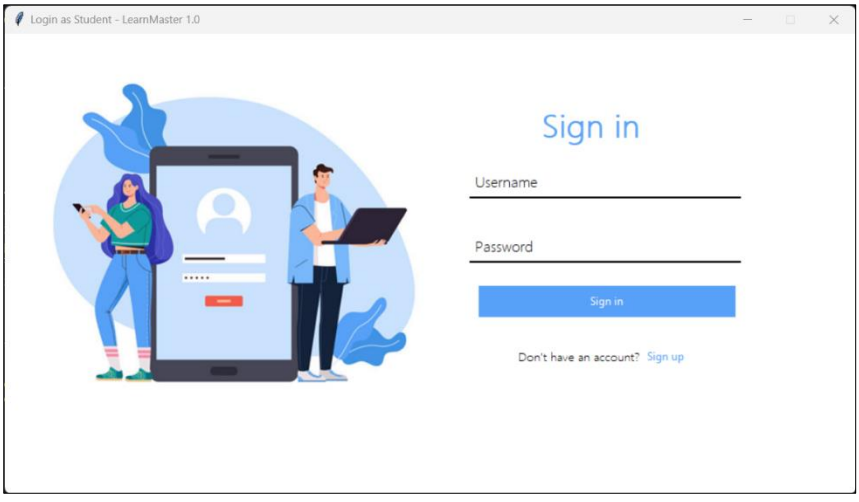

Figure 3 – Student Sign in Window

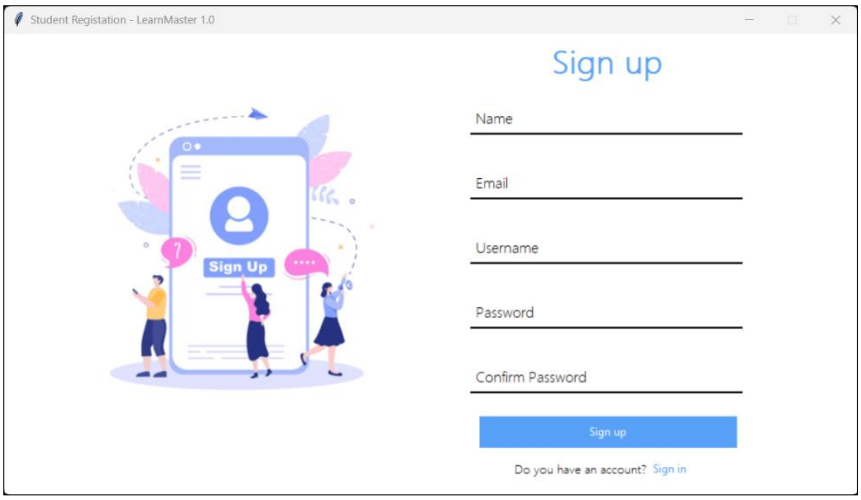

Figure 4 – Student Sign up Window

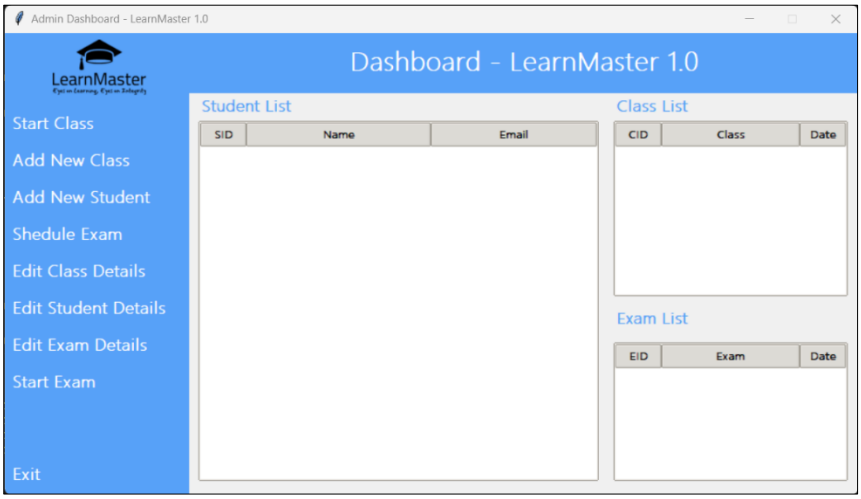

Figure 5 – Admin Dashboard

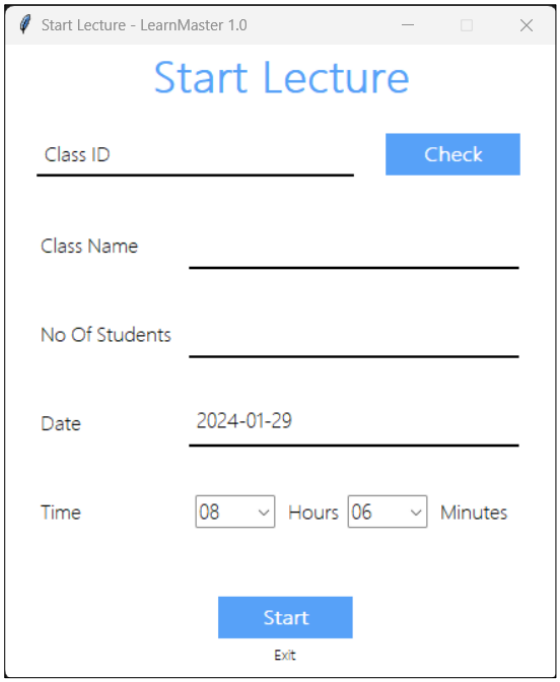

Figure 6 – Start lecture window

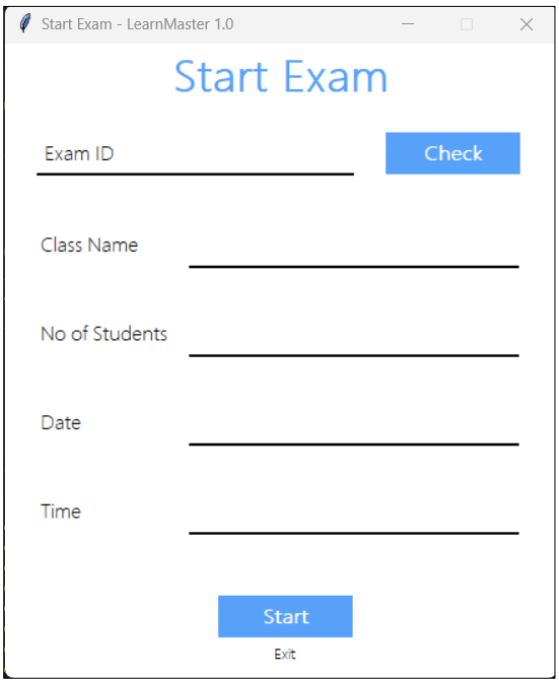

Figure 7 – Start exam window

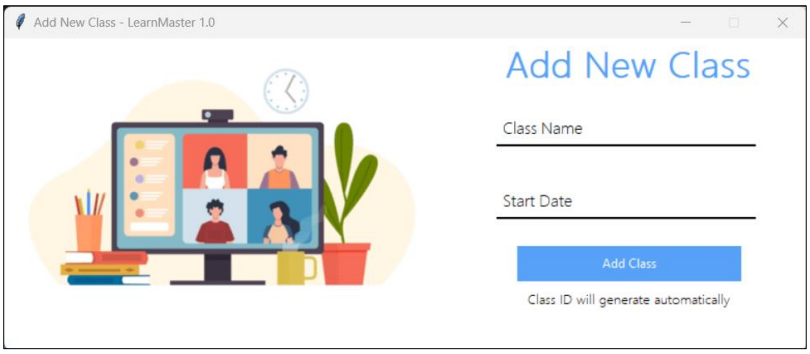

Figure 8 – Add new class window

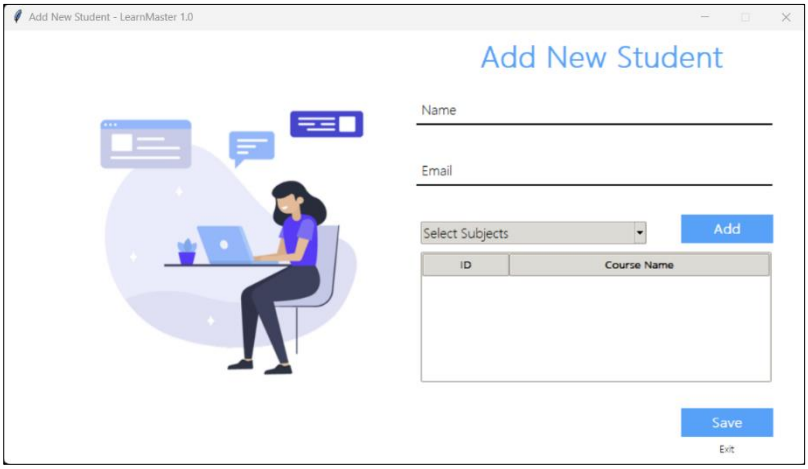

Figure 9 – Add new student window

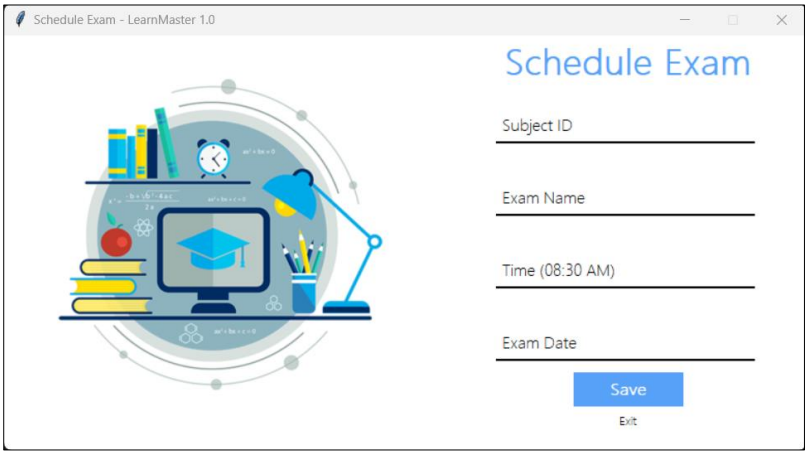

Figure 10 – Schedule exam window

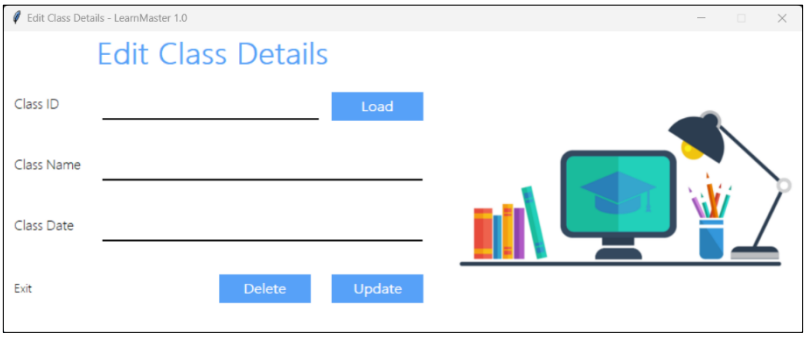

Figure 11 – Edit class details window

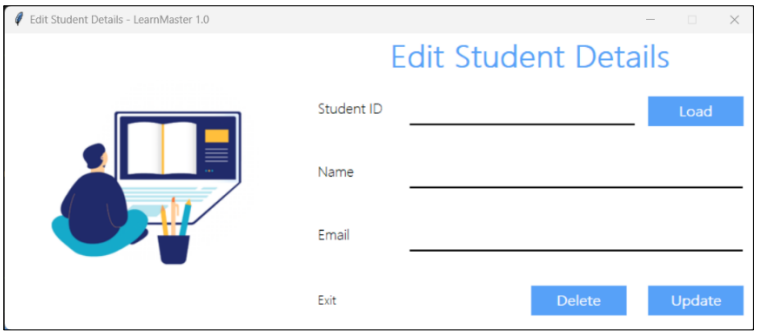

Figure 12 – Edit students details window

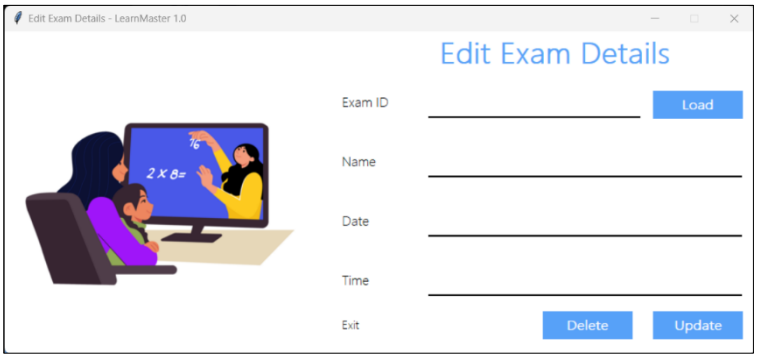

Figure 13 – Edit exam details window

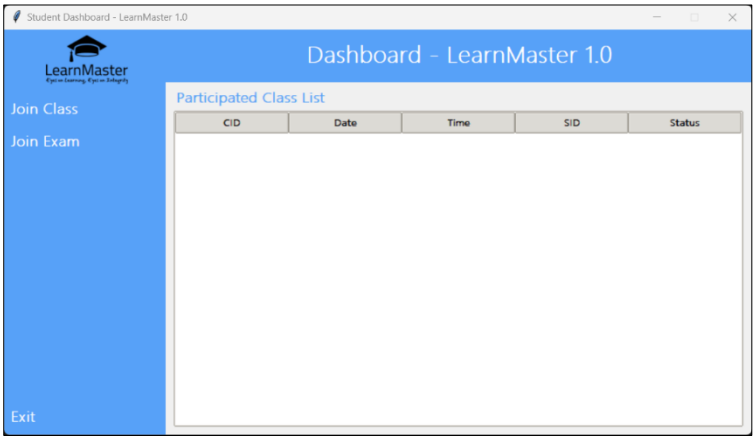

Figure 14 – Students dashboard window

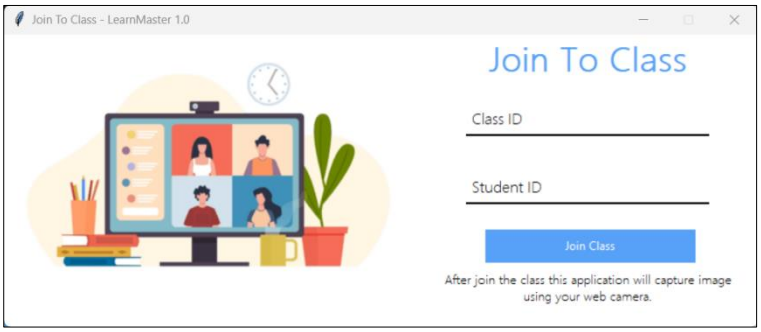

Figure 15 – Join class window

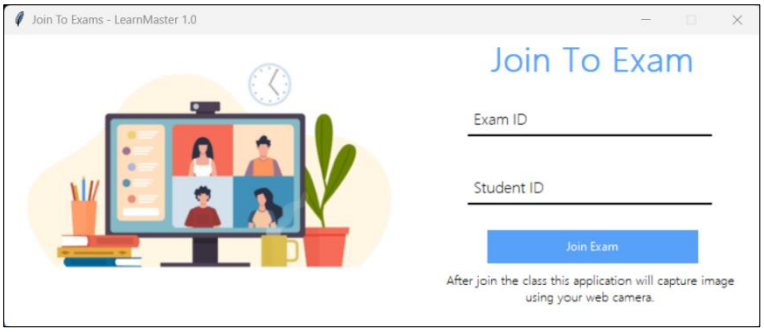

Figure 16 – Join exam window

Chapter 05: Results and Discussion

The "Face Detection for Exam Conducting and Monitoring using Machine Learning" system exhibited robust performance, maintaining an accuracy range of 65% to 85%. The core functionality involves capturing and processing facial images, triggering email notifications to the admin upon successful face detection, along with pertinent student ID and details. A critical inclusion is the imposition of a minimum accuracy threshold of 65%, ensuring that only high-confidence facial detections are processed, enhancing the overall reliability of the system.

One key requirement for optimal performance is the provision of good lighting conditions during image capture. This underscores the importance of a well-lit environment to achieve accurate and reliable facial recognition results. Additionally, the system demands users to log in to “LearnMaster - 1.measures,e accessing online lectures or exams, reinforcing security measures and contributing to a more controlled examination environment.

The system's reliance on a webcam or any connected camera-equipped device facilitates ease of use, making it adaptable to various setups. This flexibility allows users to utilize their existing devices without the need for specialized equipment. The system is designed to prioritize user convenience while maintaining a high level of accuracy in facial recognition.

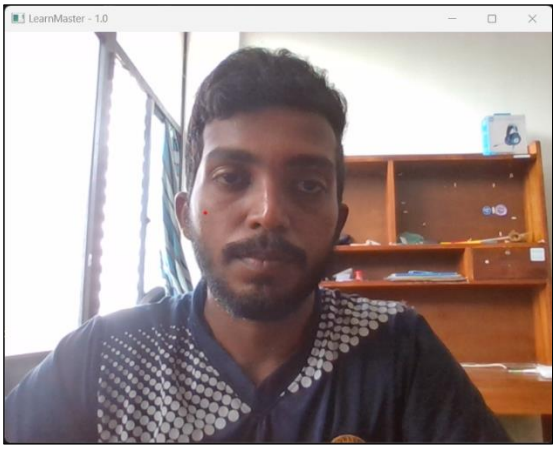

Figure 17 – Image Capturing window

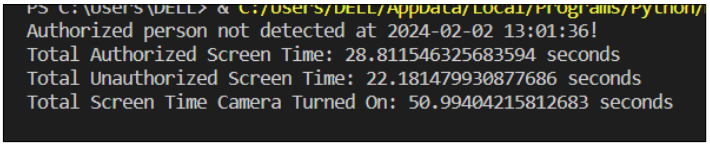

Figure 18 – Terminal Output

Figure 19 – Captured Images

Chapter 06: Future Work

The completion of the "Face Detection for Exam Conducting & Monitoring using Machine Learning" project opens avenues for future enhancements and expansions. Several features and functionalities are envisioned to further enrich the capabilities of the system,

Recognition of Student Behaviors

Future efforts will focus on incorporating advanced machine learning algorithms to recognize and analyze student behaviors during online exams. This could include detecting patterns related to attentiveness, engagement, or potential malpractices.

Classes and Exams Conduct via Application

Expanding the system to facilitate online classes and exams are prospective development. Integrating features for conducting secure and authenticated virtual meetings can leverage the existing infrastructure, providing a versatile tool for educational and professional interactions.

Web-Based Application

The project's evolution is anticipated to involve the development of a web-based application. Transitioning the system to a web platform would enhance accessibility, allowing users to utilize the face detection and authentication features seamlessly through standard web browsers.

Mobile Application Development

Envisioned as a natural progression, the future work includes the development of a dedicated mobile application. This would empower users to engage with the authentication system using their mobile devices, further expanding the reach and flexibility of the application.

As these future developments unfold, they aim to enhance the overall functionality and versatility of the system, aligning with the dynamic requirements of online education and collaborative environments. The envisioned features not only extend the system's applicability but also contribute to a holistic approach in leveraging facial recognition and authentication technologies for diverse scenarios.

Chapter 07: Conclusion

In summary, the "Face Detection for Exam Conducting and Monitoring using Machine Learning" system has demonstrated substantial success in fortifying the integrity of online examinations. With an accuracy range of 65% to 85%, the system provides dependable facial recognition, effectively mitigating concerns related to exam impersonation. The implementation of a minimum accuracy threshold at 65% enhances the reliability of the system by filtering out lower-confidence detections. Emphasizing optimal lighting conditions and requiring users to log in to LearnMaster - 1.0 further bolsters security measures.

The system's adaptability to standard webcams or connected camera-equipped devices ensures accessibility and user convenience. Successfully achieving research objectives and addressing critical considerations, this system stands as a resilient and user-friendly solution for secure online examination processes. Continuous refinements and updates hold the potential to expand its applications, further cementing its role in upholding the trustworthiness and integrity of online exams in educational settings.

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