ABSTRACT

This project is an insight into the design and implementation of an AI Proctoring System. The primary aim of AI-based remote proctoring and invigilation technologies is that it can be ensured that students do not get indulged in cheating or unfair means during the examination. With a combination of manual and AI-based technologies, remote proctoring offers various benefits.

AI Proctoring: an automated proctoring system –is the process of authenticating, authorizing, and controlling the online examination process in a scalable manner. It is a technology that allows organizations to enable assessment anywhere and anytime, ensuring full security standards.

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1. INTRODUCTION

The Proctoring System Software is a crucial tool for ensuring the integrity and fairness of online exams in educational settings. As more learning moves online, the need to prevent cheating and maintain exam security becomes increasingly important. Traditional methods of monitoring exams are often impractical for remote learning, making sophisticated software solutions essential.

This software offers a range of features designed to monitor students effectively during online exams. It allows instructors and proctors to observe students remotely, verify their identities, and ensure that the exam environment meets necessary standards. Additionally, the software tracks students' activities on their devices to detect any suspicious behavior indicative of cheating.

By using advanced technologies like WebRTC for camera and microphone access and OpenCV for face detection, the software provides reliable monitoring capabilities. It also records exam sessions in a secure format for later review by instructors or proctors.
This document outlines the requirements and specifications for the Proctoring System Software, providing a comprehensive guide for its development, deployment, and use. It is intended for developers, educators, and administrators involved in online education who seek to uphold the integrity of assessments in virtual learning environments.

1.1 Scope

1.1.1 Current Scope

- The Proctoring system is designed for educational Institutions (like schools, colleges, universities, training institutions).
- It can be used anywhere any time as it is a web-based proctoring application.
- Integration of identity verification measures such as facial recognition and government- issued ID scanning to ensure the authenticity of exam takers.
- Tracking of students' activity on their devices during exams, including mouse movements, keystrokes, and window switches, to detect suspicious behavior.
- Recording of exam sessions, including video, audio, and screen activity, for later review by instructors or proctors.
- This system will provide better security and transparency in the examination.

1.1.2 Future Scope

- A major area of continued focus is the test taker experience; a positive candidate experience increases your program’s marketability.
- Integration of advanced artificial intelligence algorithms for more accurate detection of suspicious behavior and anomalies during exams.
- Enhancement of the user interface to provide a more intuitive and user-friendly experience for both instructors and students.

- Integration with popular learning management systems to streamline the exam administration process and improve interoperability.
- Addition of support for multiple languages to cater to diverse student populations and facilitate global adoption.
- Implementation of real-time analytics and reporting capabilities to provide instructors with insights into exam performance and trends.

1.2 Project Summary and Purpose

1.2.1 Project Summary

The Proctoring System Software is a vital tool designed to uphold the integrity and security of online exams in educational settings. As the landscape of education continues to evolve with the increasing adoption of online learning, ensuring fair assessments and preventing cheating becomes paramount. This software offers a range of features, including remote monitoring, identity verification, environment monitoring, and activity tracking, to effectively monitor students during exams. By leveraging advanced technologies like WebRTC and OpenCV, it provides reliable monitoring capabilities while recording exam sessions for later review. The document outlines the current scope of the software, encompassing its core functionalities, as well as its future scope, which includes potential enhancements such as AI algorithms, improved user interface, and integration with learning management systems. Through continuous development and adaptation, the Proctoring System Software aims to meet the evolving needs of online education and maintain the integrity of assessments in virtual learning environments.

1.2.2 Purposes

Over the last few years, online education has advanced rapidly. More students are taking advantage of Massive Open Online Courses (MOOCS) and other online certificate courses. Colleges are also transitioning online to provide more resources to their students. There has also been a rise in individuals rolling out their courses. All of this gives students more opportunities to learn and improve themselves.

1.3 Objectives

- No dependency on exam centers.
- No requirement of physical proctoring.
- Ease of scheduling exams.
- Security of exams.
- Real time monitoring and detailed final reports for all suspicious activities by students.

2. SYSTEM REQUIREMENTS:

2.1 User Characteristics:

Analyzing user characteristics is an important aspect of any project. It allows us to clearly define and focus on who end users are for the project. The user must have following characteristics:

- Users must have a basic understanding of computers.
- Users should understand the usage of all modules.
- Users should easily interact with the proposed system.
- Users should know the technical terms used to perform different tasks.

2.2 Software Requirements:

Software Requirements define the minimum amount of software that is required to make the system work. The system requirements are defined below:

2.2.1 Python: Python is selected as the primary programming language for the backend development of the Online Proctoring System. Python is a high-level interpreted general-purpose programming language known for its versatility and readability. It supports multiple programming paradigms, including structural, object-oriented, and functional programming.

- **Minimum Version:** Python 3.x
- **Usage:** Python will serve as an integral part of the backend codebase, responsible for implementing core functionalities such as user authentication, session management, video processing and data storage.
- **Integration:** Python modules and libraries must be seamlessly integrated with other components of the system to make sure smooth interoperability.

2.2.2 WebRTC: WebRTC (Web Real-Time Communication) is an open-source project that enables real-time communication capabilities directly in web browsers and mobile applications through simple APIs (Application Programming Interfaces). It allows peer-to-peer communication for audio, video, and data sharing without requiring users to install additional plugins or software.

- **Minimum Version:** Version 1.0 or higher.
- **Usage:** WebRTC will serve as a fundamental technology for real-time communication within the Online Proctoring System. It enables browsers and mobile applications to communicate in real time via simple APIs, facilitating video and audio streaming without the need for plugins or additional software.
- **Integration**: WebRTC functionality will be tightly integrated into the system's architecture, ensuring seamless interoperability with other components such as user interfaces, backend servers, and media processing modules. This integration will enable efficient handling of audio-video streams for proctoring purposes while maintaining system stability and performance.

2.2.3 Mediapipe: Mediapipe is a framework for building multimodal applied machine learning pipelines. It provides solutions for various perceptual tasks such as face detection, hand tracking and pose estimation. Mediapipe will be utilized for facial recognition and gesture detection functionalities in the Online Proctoring System.

- **Minimum Version:** Mediapipe 0.8.7 or higher.
- **Usage:** MediaPipe will be employed to process video feeds, detect facial expressions, and analyze gestures to ensure the authenticity and attentiveness of test-takers during examinations.
- **Integration:** MediaPipe will be seamlessly integrated with other components of the system, facilitating smooth functionality and interoperability across different modules.

2.2.4 OpenCV: OpenCV (Open-Source Computer Vision Library) is an open-source computer vision and machine learning software library. It provides various tools and functions for real-time image processing and analysis. OpenCV will be utilized for image and video processing tasks within the Online Proctoring System.

- **Minimum Version:** OpenCV 4.x or higher
- **Usage:** OpenCV will be employed for tasks such as image preprocessing, object detection, and motion tracking to enhance the monitoring capabilities of the Online Proctoring System.
- **Integration:** OpenCV will be seamlessly integrated with other components of the system, ensuring smooth functionality and interoperability across different modules.

2.2.5 MongoDB: MongoDB is selected as the primary database management system for the Online Proctoring System due to its scalability, flexibility, and support for document-oriented data storage. MongoDB will facilitate efficient data management, storage, and retrieval for user profiles, examination records, and other pertinent information.

- **Minimum Version:** Mongo DB 4.x
- **Usage:** MongoDB will be utilized for storing and managing user data, examination records, video feeds, and other relevant information generated by the system during the examination process.
- **Integration:** MongoDB will be seamlessly integrated with the backend components of the system, allowing for efficient data interchange and synchronization between different modules.

2.2.6 JavaScript: JavaScript will be employed for the development of the system's application programming interfaces (APIs), enabling seamless communication between frontend and backend components of the Online Proctoring System.

- **Minimum Version:** ECMAScript 6 (ES6)
- **Usage:** JavaScript will be utilized to develop RESTful APIs for user authentication, data retrieval, and other essential functionalities required for the operation of the Online Proctoring System.

- **Integration:** JavaScript APIs will be integrated with both frontend and backend components of the system, ensuring smooth communication and data exchange between different layers of the application.

2.2.7 React.js: React.js is selected as the primary library for building user interfaces in the Online Proctoring System. React.js is a popular JavaScript library developed by Facebook, known for its efficiency and flexibility in building interactive and dynamic web applications.

- **Minimum Version:** React 16.x or higher.
- **Usage:** React.js will serve as the core technology for developing the frontend of the Online Proctoring System. It will be responsible for rendering the user interface, handling user interactions, and managing the application state.
- **Integration:** React.js components will be seamlessly integrated with backend APIs and other frontend libraries to ensure smooth interoperability and a responsive user experience.

2.3 Hardware Requirements:

The purpose of this is to outline the essential hardware prerequisites for the development and operation of the Online Proctoring System. The following are the hardware requirements:

2.3.1 Computer Desktop or Laptop: A computer desktop or laptop is required to run the system to take the test and responsible for displaying the video feeds captured by the webcam.

- **Specifications:**
  - **Processor**: Intel Core I3 or equivalent.
  - **RAM:** 6GB or equivalent.
  - **Storage:** 128 GB or equivalent.
  - **Operating System:** Windows 10 or higher, Linux, MacOS.
- **Usage**: The computer desktop or laptop will serve as the primary interface for system administrators and proctors to monitor and manage examinations conducted through the Online Proctoring System.

2.3.2 Webcam: A webcam is essential for capturing video feeds required for image processing and analysis tasks within the Online Proctoring System.

- **Specifications:**
  - Frame Rate: 30 frames per second(fps) or higher.
  - Connectivity: USB 2.0 or higher.
- **Usage:** The webcam will continuously capture video feeds of test-takers during examinations, enabling the system to analyze facial expressions, gestures, and other relevant biometric data.
  - Frame Rate: 30 frames per second(fps) or higher.
  - Connectivity: USB 2.0 or higher.

2.4 Functional Requirements:

2.4.1 Login:

- **Overview:** The login functionality of the Online Proctoring System allows registered users, including students, faculty, and admin, to access their respective accounts securely. Upon successful authentication, users can access features such as scheduling exams, monitoring exams, and accessing exam results.

- **Preconditions:**
  - Users must have a valid account registered in the Online Proctoring System.
  - Users must have a stable internet connection.
  - The system's login service must be operational.

- **Actors:** Student, Faculty and Admin.
  - Users must have a valid account registered in the Online Proctoring System.
  - Users must have a stable internet connection.
  - The system's login service must be operational.

- **Basic Flow:**

  - User navigates to the Online Proctoring System's login page.
  - User presents the login interface, prompting the user to enter their credentials.
  - Users enter their username and password.
  - User validates the entered credentials against the database.
  - System grants access if the credentials are correct, redirecting the user to their respective dashboard.

- **Alternate Flow:**

If the entered credentials are incorrect:

  - System displays an error message indicating invalid credentials.
  - User retries entering the correct credentials.
  - The flow returns to step 4 of the basic flow.

- **Post Conditions:**
  - Upon successful login, the user gains access to their respective dashboard with relevant features and functionalities.
  - In case of unsuccessful login attempts, the system retains the user session and prompts for correct credentials.

2.4.2 Register

- **Overview:**

The registration process in the Online Proctoring System enables new users to create accounts, providing necessary information for identification and authentication purposes. This allows users to access system functionalities such as scheduling exams, monitoring exams, and accessing exam results.

- **Preconditions:**
  - Users must have a stable internet connection.
  - The system's registration service must be operational.
- **Actors:** Student

- **Basic Flow:**
  - User navigates to the Online Proctoring System's registration page
  - User presents the registration form, providing required information such as username, email, password, etc.
  - User submits the registration form.
  - The system validates the information provided.
  - If validation is successful, the system creates a new account for the user.
  - System sends a verification email to the user's provided email address.
  - Users verify their email address by clicking the verification link.
  - The registration process is complete, and the user can now log in to the system.

- **Alternate Flow:**

If the information provided is invalid or incomplete:

  - System displays error messages indicating the issues with the provided information.
  - User corrects the information as per the system's requirements.
  - The flow returns to step 4 of the basic flow.
- **Post Conditions:**

  - Upon successful registration, the user can log in to the system using the newly created account.
  - In case of incomplete or invalid registration information, the system prompts the user to correct the information and resubmit the registration form.

2.4.2.1 Fill Exam Form:

- **Overview:**

The "Fill Exam Form" functionality in the Online Proctoring System allows registered students to provide necessary details for scheduling and taking proctored exams.

- **Preconditions:**
  - Students must have a registered account in the Online Proctoring System.
  - Students must have access to the "Fill Exam Form" feature.
  - The system's exam scheduling service must be operational.

- **Actors:** Student

- **Basic Flow:**
  - Students log in to the Online Proctoring System.
  - Students navigate to the "Fill Exam Form" section.
  - Students select the exam they want to schedule from the available options.
  - Students fill out the exam form, providing necessary details such as exam date, time preferences, etc.
  - Student confirms the exam details.
  - System validates the provided information and schedules the exam accordingly.

- **Alternate Flow:**

If there are issues with filling out the exam form:

  - System displays error messages indicating the specific issues encountered.
  - Student revises the exam form details to address the issues.
  - The flow returns to the appropriate step in the basic flow.

- **Post Conditions:**
  - Upon successful scheduling, the exam details are saved in the system, and the student is notified of the scheduled exam.
  - In case of incomplete or erroneous exam form details, the system prompts the student to revise the form before scheduling.

2.4.3 Authentication:

- **Overview:**

After successful login, the authentication process in the Online Proctoring System ensures that users continue to have access to authorized functionalities based on their roles (student, faculty, admin). This includes verifying user permissions and session management to maintain security and privacy.

- **Preconditions:**
  - User must have successfully completed the login process
  - The user's session must be active.
  - The system's authentication services must be operational.

- **Actors:** Student, Faculty and Admin

- **Basic Flow:**
  - After successful login, the system prompts the user to authenticate their identity by presenting their ID.
  - The user presents their ID through a webcam or by uploading a scanned copy.
  - The system verifies the authenticity of the presented ID.
  - If the ID is verified successfully, the system identifies the user's role (student, faculty, admin).
  - The system verifies the user's permissions and access rights based on their role.
  - Access to system functionalities and features is granted according to the user's role and permissions.

- **Alternate Flow:**

If the presented ID cannot be verified:

  - The system prompts the user to present another form of identification.
  - The flow returns to step 2 of the basic flow.

- **Post Conditions:**

  - Users have access to functionalities and features appropriate to their roles and permissions.
  - In case of failed ID verification, the system retains the user's session and prompts the user to present another form of identification for authentication.

2.4.4 Set Question Paper

- **Overview:**

The "Set Question Paper" functionality in the Online Proctoring System enables authorized users to create and configure exam question papers. This includes defining the structure of the exam, adding, updating, deleting, and viewing questions within the question paper.

- **Pre-Conditions:**
  - Users must have appropriate permissions as faculty or admin.
  - The user must have access to the "Set Question Paper" module.
  - The system's question paper configuration service must be operational.

- **Actors:** Faculty

- **Basic Flow:**
  - User navigates to the "Set Question Paper" section within the Online Proctoring System.
  - User selects the option to create a new question paper.
  - User defines the structure of the exam, including sections, question types, and point values.
  - User adds questions to the question paper by selecting the "Add Question" option.
  - User selects the type of question to add (e.g., multiple-choice, essay, true/false).
  - User enters the details of the question (e.g., text, options, correct answer).
  - User saves the added question to the question paper.
  - Users may choose to update a question by selecting the "Update Question" option.
  - User selects the question to be updated from the question paper.
  - User modifies the details of the selected question.
  - User saves the updated question.
  - Users may choose to delete a question by selecting the "Delete Question" option.
  - User selects the question to be deleted from the question paper.
  - User confirms the deletion of the selected question.
  - User saves the question paper configuration after making all necessary changes.

- **Alternate Flow:**

If there are issues with adding, updating, or deleting questions:
  - System displays error messages indicating the specific issues encountered.
  - User revises the question paper configuration to address the issues.
  - The flow returns to the appropriate step in the basic flow.

- **Post Conditions**:
  - Upon successful configuration, the question paper is saved in the system with all added, updated, and deleted questions.
  - In case of incomplete or erroneous configuration, the system prompts the user to revise the question paper before saving.

2.4.4.1 Add Question:

- **Overview:**

The "Add Question" functionality in the Online Proctoring System allows authorized users to add new questions to the question bank or directly to a question paper.

- **Preconditions:**
  - Users must have appropriate permissions as faculty.
  - The user must have access to the "Add Question" feature.
  - The system's question management service must be operational.

- **Actors:** Faculty

- **Basic Flow:**
  - User navigates to the "Add Question" section within the Online Proctoring System.
  - User selects the option to add a new question.
  - User selects the type of question to add (e.g., multiple-choice, essay, true/false).
  - User enters the details of the question (e.g., text, options, correct answer).
  - User saves the added question to the question bank or directly to a question paper.

- **Alternate Flow**:

If there are issues with adding the question:
  - System displays error messages indicating the specific issues encountered.
  - User revises the question details to address the issues.
  - The flow returns to the appropriate step in the basic flow.

- **Post Conditions:**
  - Upon successful addition, the question is saved in the system and can be used in question papers.
  - In case of incomplete or erroneous question details, the system prompts the user to revise the question before saving.

2.4.4.2 Update Question:

- **Overview:**

The "Update Question" functionality in the Online Proctoring System allows authorized users to modify existing questions in the question bank or within a question paper.

- **Preconditions:**
  - User must have appropriate permissions as faculty
  - The user must have access to the "Update Question" feature.
  - The system's question management service must be operational.

- **Actors:** Faculty

- **Basic Flow:**
  - User navigates to the "Update Question" section within the Online Proctoring System.
  - User selects the question to be updated from the question bank or a question paper.
  - User modifies the details of the selected question.
  - User saves the updated question.

- **Alternate Flow:**

If there are issues with updating the question:
  - System displays error messages indicating the specific issues encountered.
  - User revises the question details to address the issues.
  - The flow returns to the appropriate step in the basic flow.

- **Post Conditions:**
  - Upon successful update, the modified question is saved in the system.
  - In case of incomplete or erroneous question details, the system prompts the user to revise the question before saving.

2.4.4.3 Delete Question:

- **Overview:**

The "Delete Question" functionality in the Online Proctoring System allows authorized users to remove questions from the question bank or from within a question paper.

- **Preconditions:**
  - User must have appropriate permissions as faculty or admin.
  - The user must have access to the "Delete Question" feature.
  - The system's question management service must be operational.

- **Actors:** Faculty

- **Basic Flow:**
  - User navigates to the "Delete Question" section within the Online Proctoring System.
  - User selects the question to be deleted from the question bank or a question paper.
  - User confirms the deletion of the selected question.
  - User saves the changes.

- **Alternate Flow:**

If there are issues with deleting the question:
  - System displays error messages indicating the specific issues encountered.
  - User revises the deletion confirmation to address the issues.
  - The flow returns to the appropriate step in the basic flow.

- **Post Conditions:**
  - Upon successful deletion, the selected question is removed from the system.
  - In case of incomplete or erroneous deletion confirmation, the system prompts the user to confirm the deletion before saving.

2.4.4.4 View Question:

- **Overview:**

The "View Question" functionality in the Online Proctoring System enables authorized users to view details of questions stored in the question bank or within a question paper.

- **Preconditions:**

  - User must have appropriate permissions as faculty or admin.
  - The user must have access to the "View Question" feature.
  - The system's question management service must be operational.

- **Actors:** Faculty

- **Basic Flow:**
  - User navigates to the "View Question" section within the Online Proctoring System.
  - User selects the question to be viewed from the question bank or a question paper.
  - System displays the details of the selected question, including text, options, correct answer, and any additional metadata.

- **Alternate Flow:**

If the selected question cannot be viewed:

  - System displays error messages indicating the specific issues encountered.
  - User revises the selection of the question or checks for system errors.
  - The flow returns to the appropriate step in the basic flow.

- **Post Conditions**:
  - Upon successful viewing, the details of the selected question are displayed to the user.
  - In case of incomplete or erroneous question details, the system prompts the user to retry viewing the question or report any issues encountered.

2.4.5.1 Face Detection

A) Overview:
The face detection module enables the system to identify and verify the presence of users in front of the webcam during examinations, ensuring compliance with proctoring requirements.

B) Preconditions:
- Users must have a functional webcam connected to their device.
- Users must have granted the system permission to access the webcam.
- The face detection algorithm must be operational.

C) Actors: Students and Proctors.

D) Basic Flow:
- The system activates the webcam when the exam session starts.
- The face detection module captures the video feed and analyzes it for faces.
- If a face is detected, the system verifies it against the registered user profile.
- The system logs the presence of the user and allows the examination to proceed.

E) Alternate Flow:
If no face is detected:

- The system prompts the user to adjust their position or check the webcam connection.
- The system continues to scan for a face until detected or until the exam session times out.

F) Post Conditions:
- The system logs all detections, including timestamps, for future auditing.
- If the user is verified, the examination session continues without interruption.

2.4.5.2 Object Detection

A) Overview:
The object detection module identifies and classifies objects in the user's environment during examinations, ensuring that prohibited items are not present.

B) Preconditions:
- Users must have a functional webcam connected to their device.
- Users must have granted the system permission to access the webcam.
- The object detection algorithm must be operational.

C) Actors: Students and Proctors.

D) Basic Flow:
- The system activates the webcam when the exam session starts.
- The object detection module captures the video feed and analyzes it for prohibited objects.
- If a prohibited object is detected, the system alerts the proctor and logs the incident.
- The system continues to monitor for additional objects throughout the exam.

E) Alternate Flow:

If no objects are detected:

- The system continues to scan the environment without interruptions.

F) Post Conditions:
- Any detected prohibited items are logged, along with the user's details for further investigation.
- The system ensures a secure examination environment.

2.4.5.3 ID Verification

A) Overview:
The ID verification module ensures that the user's identity is authenticated before the examination begins, using a combination of document scanning and facial recognition.

B) Preconditions:
- Users must have a valid identification document (e.g., ID card, passport).
- Users must have granted the system permission to access the webcam for facial recognition.

C) Actors: Students and Proctors.

D) Basic Flow:
- The user presents their identification document to the webcam.
- The system scans the document and extracts relevant information.
- The system captures the user's face and matches it with the ID photo.
- If verification is successful, the user is allowed to proceed with the examination.

E) Alternate Flow:
If verification fails:

- The system prompts the user to rescan their ID or adjust their position for better facial capture.
- The flow returns to step 1 of the basic flow until verification is successful or the session times out.

F) Post Conditions:
- Upon successful verification, the user's identity is logged for auditing.
- If verification fails, the session is terminated, and a report is generated for review.

2.4.5.4 Window Switching

A) Overview:

The window switching module allows users to switch between different application windows seamlessly during an examination, ensuring that they remain focused on the exam interface.

B) Preconditions:

- Users must have a multi-window setup or virtual desktop environment.
- The system must be configured to allow window switching.

C) Actors: Students.

D) Basic Flow:

- The user navigates between various application windows (e.g., exam interface, reference materials).
- The system tracks the focus of the user on the exam interface.
- If the user switches away from the exam interface, the system logs the action.

E) Alternate Flow:

If the user switches away from the exam interface for too long:

- The system issues a warning and prompts the user to return to the exam interface.
- Failure to comply may lead to the termination of the examination session.

F) Post Conditions:

- All window switches are logged, and any violations are flagged for review.
- The user's focus and engagement with the exam interface are monitored.

2.4.5.5 Anti-Flagging System

A) Overview:

The anti-flagging system monitors user behavior during examinations and issues warnings for suspicious activities, ensuring academic integrity.

B) Preconditions:

- The system must have access to user behavior analytics.
- The exam session must be actively monitored.

C) Actors: Students and Proctors.

D) Basic Flow:

- The system continuously monitors user actions and webcam feed for anomalies.
- If suspicious behavior is detected (e.g., looking away frequently, multiple faces), the system issues a warning.
- If three warnings are issued, the system flags the user for potential malpractice.
- A report is generated detailing the flagged behavior for review.

E) Alternate Flow:

If user behavior normalizes after a warning:

- The system resumes normal monitoring without further action.

F) Post Conditions:

- All warnings and flagged behaviors are logged for auditing purposes.
- The integrity of the examination is preserved through active monitoring.

2.4.5.6 Test Paper System

A) Overview:

The test paper testing module allows the system to administer both mock and exam papers, ensuring that users are adequately prepared for the examination.

B) Preconditions:

- Users must have access to test papers uploaded in the system.
- The system must be configured to facilitate test administration.

C) Actors: Students and Proctors.

D) Basic Flow:

- The user selects a mock or exam paper from the available options.
- The system presents the paper to the user, starting the examination timer.
- The user answers the questions within the allocated time.
- Upon completion, the system collects the answers and evaluates them

E) Alternate Flow:

If the user fails to submit their answers in time:

- The system automatically submits the answers recorded up to that point.

F) Post Conditions:

- The user's performance is evaluated, and results are stored in the database.
- Feedback is provided to help users improve their preparation.

2.4.5.7 API Integration

A) Overview:
The API integration module allows the system to interact with external applications and services, facilitating data exchange and enhancing functionality.

B) Preconditions:
- The system must have API access configured for external applications.
- Users must have permissions to access certain API functionalities.

C) Actors: System Administrator and External Services.

D) Basic Flow:

- The system establishes a connection with the external API.
- The user requests specific data or functionality from the API.
- The system sends a request to the external service and receives a response.
- The system processes the response and integrates it into the application.

E) Alternate Flow:

If the API request fails:

- The system logs the error and provides a notification to the user.

F) Post Conditions:

- All API interactions are logged for auditing purposes.
- The system maintains data integrity while integrating external functionalities.

2.4.5.8 Database Update Module

A) Overview:

The database update module ensures that all relevant data is recorded and updated in real-time throughout the examination process.

B) Preconditions:

- The database must be operational and accessible by the system.
- Users must have the appropriate permissions to modify data.

C) Actors: System Administrator and Users.

D) Basic Flow:

- The system logs user activities and relevant data throughout the examination.
- Any changes or updates to the user's information are sent to the database.
- The database records are updated accordingly to reflect real-time changes.

E) Alternate Flow:

If the database update fails:

- The system logs the error and attempts to retry the update.
- If unsuccessful after several attempts, the system notifies the administrator.

F) Post Conditions:

- All data updates are recorded with timestamps for auditing.
- The integrity and consistency of the database are maintained.

2.4.6 Answer Question:

A) Overview:

The "Answer Question" functionality in the Online Proctoring System allows registered students to provide answers to the questions presented during a proctored exam.

- **Preconditions**:
  - Students must have a scheduled exam in the Online Proctoring System.
  - Students must have access to the exam interface during the scheduled exam time.
  - The system's exam proctoring service must be operational.

- **Actors**: Student

- **Basic Flow:**
  - Students log in to the Online Proctoring System.
  - Students access the scheduled exam.
  - System presents the exam questions to the student.
  - Students read and answer each question accordingly.
  - Student submits the answers before the exam time limit expires

- **Alternate Flow:**

If there is any issue in answering a question:

- System displays error messages indicating the specific issues encountered.
- Students revise the answers to address the issues.
- The flow returns to the appropriate step in the basic flow.

- **Post Conditions:**
  - Upon successful submission, the student's answers are saved in the system for evaluation.
  - In case of incomplete or erroneous answers, the system prompts the student to review and revise before submission.

2.4.7 Submit Paper:

- **Overview:**

The "Submit Paper" functionality in the Online Proctoring System allows registered students to submit their completed exam papers for evaluation.

- **Preconditions:**
  - Students must have completed answering all questions in the exam.
  - Students must have access to the submit option within the exam interface.
  - The system's exam submission service must be operational.

- **Actors:** Student

- **Basic Flow:**
  - Students complete answering all questions in the exam.
  - Students review the answers and ensure completeness.
  - Students select the option to submit the exam paper.
  - System prompts the student to confirm the submission.
  - Student confirms the submission.
  - System saves the submitted exam paper for evaluation.

- **Alternate Flow:**

If there are issues with submitting the exam paper:
  - System displays error messages indicating the specific issues encountered.
  - Student revises the exam paper or resolves the issues.
  - The flow returns to the appropriate step in the basic flow.

- **Post Conditions:**
  - Upon successful submission, the student's exam paper is saved in the system for evaluation by instructors.
  - In case of incomplete or erroneous submission, the system prompts the student to review and resubmit if necessary.

2.4.8 View Exam Result:

A) Overview:

The "View Exam Result" functionality in the Online Proctoring System allows registered students to access and view their exam results once they have been evaluated by instructors.

B) Preconditions:

- Students must have completed the exam and submitted the exam paper.
- Instructor must have evaluated the exam paper and entered the result in the system.
- Students must have access to the exam result section within the system.

C) Actors: Student

D) Basic Flow:

- Students log in to the Online Proctoring System.
- Student navigates to the "View Exam Result" section.
- System displays a list of exams for which results are available.
- Students select the exam for which they want to view the result.
- System retrieves and displays the exam result to the student.

E) Alternate Flow:

If the exam result is not available or there are issues with accessing it

- System displays error messages indicating the specific issues encountered.
- Students check for any notifications or contact the instructor for assistance.
- The flow returns to the appropriate step in the basic flow.

F) Post Conditions:

- Upon successful access, the student can view their exam result including scores, grades, and feedback provided by the instructor.
- In case of incomplete or unavailable exam result, the system prompts the student to check back later or contact support for assistance

2.4.9 Review Student Application:

A) Overview:

The "Review Student Application" functionality in the Online Proctoring System allows faculty members to review and manage student applications for enrollment or participation in proctored exams. This includes verifying student information, approving or rejecting applications, and updating application statuses.

B) Preconditions:

- Faculty members must have appropriate permissions.
- Faculty members must have access to the "Review Student Application" module.
- There must be pending student applications awaiting review.

C) Actors: Faculty

D) Basic Flow:

- Faculty members log in to the Online Proctoring System.
- Faculty members navigate to the "Review Student Application" section.
- System displays a list of pending student applications.
- Faculty members select an application for review.
- Faculty member verifies the information provided in the application.
- Faculty members decide whether to approve or reject the application.
- If approved, faculty members update the application status accordingly.
- If rejected, the faculty member provides reasons for rejection and updates the application status.
- Faculty members save the changes and updates.

E) Alternate Flow:

If there are issues with the application review process:

- System displays error messages indicating the specific issues encountered
- Faculty members take corrective actions as necessary.
- The flow returns to the appropriate step in the basic flow.

F) Post Conditions:

- Upon completing the review process, the application status is updated in the system.
- In case of incomplete or erroneous review decisions, the system retains the application for further review or correction.

2.4.10 Declare Result:

A) Overview:

The "Declare Result" functionality in the Online Proctoring System allows faculty members to enter and finalise exam results for students. This includes entering scores, grades, and providing feedback.

B) Preconditions:

- Faculty members must have appropriate permissions.
- Faculty members must have access to the "Declare Result" module.
- Exams must have been conducted and student submissions must be available for evaluation.

C) Actors: Faculty

D) Basic Flow:

- Faculty members log in to the Online Proctoring System.
- Faculty members navigate to the "Declare Result" section.
- System displays a list of conducted exams with pending results.
- Faculty members select the exam for which they want to declare results.
- Faculty members enter scores, grades, and feedback for each student.
- Faculty member verifies the entered information.
- Faculty member finalises the result declaration.

E) Alternate Flow:

If there are issues with entering or finalising exam results:

- System displays error messages indicating the specific issues encountered.
- Faculty members revise the entered information or resolve the issues.
- The flow returns to the appropriate step in the basic flow.

F) Post Conditions:

- Upon successful declaration, the exam results are saved in the system and students can view their results.
- In case of incomplete or erroneous result declaration, the system prompts the faculty member to review and revise before finalising.

2.4.9.1 Publish Result:

A) Overview:

The "Publish Result" functionality in the Online Proctoring System allows faculty members to make exam results available to students for viewing.

B) Preconditions:

- Faculty members must have appropriate permissions.
- Faculty members must have declared and finalised the exam results.
- Students must be allowed to view their exam results.

C) Actors: Faculty

D) Basic Flow:

- Faculty members log in to the Online Proctoring System.
- Faculty members navigate to the "Publish Result" section.
- Faculty members select the exam for which they want to publish results.
- Faculty member confirms the decision to publish results.
- System makes the exam results available to students for viewing.

E) Alternate Flow:

If there are issues with publishing the exam results:

- System displays error messages indicating the specific issues encountered.
- Faculty members revise the publication settings or resolve the issues.
- The flow returns to the appropriate step in the basic flow.

F) Post Conditions:

- Upon successful publication, students can view their exam results through their respective accounts.
- In case of incomplete or erroneous result publication, the system prompts the faculty member to review and rectify before proceeding with publication.

2.4.11 Recordings:

A) Overview:

The "Recordings" functionality in the Online Proctoring System allows authorised users (faculty and admin) to access and manage recorded sessions of proctored exams. These recordings include camera footage and voice recordings captured during exam sessions.

B) Preconditions:

- User must have appropriate permissions as faculty or admin.
- Recorded sessions of proctored exams must be available in the system.

C) Actors: Faculty and Admin

D) Basic Flow:

- User logs in to the Online Proctoring System.
- User navigates to the "Recordings" section.
- The system displays a list of recorded sessions available for viewing.
- User selects a recorded session to view or manage.

E) Alternate Flow:

If there are issues with accessing or managing recorded sessions:

- The system displays error messages indicating the specific issues encountered.
- Users take corrective actions as necessary.
- The flow returns to the appropriate step in the basic flow.

F) Post Conditions:

- Upon successful access, the user can view or manage the selected recorded session.
- In case of incomplete or erroneous access, the system prompts the user to retry or contact support for assistance.

2.4.10.1 Camera Recording:

A) Overview:

The "Camera Recording" functionality in the Online Proctoring System allows authorized users (faculty and admin) to access and manage camera footage captured during proctored exam sessions.

B) Preconditions:

- Users must have appropriate permissions as faculty or admin.
- Camera recordings of proctored exams must be available in the system

C) Actors: Faculty, Admin.

D) Basic Flow:

- User logs in to the Online Proctoring System.
- User navigates to the "Camera Recording" section within the "Recordings" module.
- System displays a list of camera recordings available for viewing.
- User selects a camera recording to view or manage.

E) Alternate Flow:

If there are issues with accessing or managing camera recordings:

- The system displays error messages indicating the specific issues encountered.
- Users take corrective actions as necessary. iii. The flow returns to the appropriate step in the basic flow.

F) Post Conditions:

- Upon successful access, the user can view or manage the selected camera recording.
- In case of incomplete or erroneous access, the system prompts the user to retry or contact support for assistance.

2.4.10.2 Voice Recording:

A) Overview:

The "Voice Recording" functionality in the Online Proctoring System allows authorized users (faculty and admin) to access and manage voice recordings captured during proctored exam sessions.

B) Preconditions:

- User must have appropriate permissions as faculty or admin.
- Voice recordings of proctored exams must be available in the system.

C) Actors: Faculty, Admin.

D) Basic Flow:

- User logs in to the Online Proctoring System.
- User navigates to the "Voice Recording" section within the "Recordings" module.
- System displays a list of voice recordings available for viewing.
- User selects a voice recording to view or manage.

E) Alternate Flow:

If there are issues with accessing or managing voice recordings:

- System displays error messages indicating the specific issues encountered.
- User takes corrective actions as necessary.
- The flow returns to the appropriate step in the basic flow.

F) Post Conditions:

- Upon successful access, the user can view or manage the selected voice recording.
- In case of incomplete or erroneous access, the system prompts the user to retry or contact support for assistance.

2.4.12 View Flagged Items:

A) Overview:

The "View Flagged Items" functionality in the Online Proctoring System allows authorized users (faculty and admin) to access and review flagged items during proctored exam sessions. These flagged items may include suspicious behaviors, violations, or anomalies detected during exam monitoring.

B) Preconditions:

- User must have appropriate permissions as faculty or admin.
- Flagged items from proctored exam sessions must be available in the system.

C) Actors: Admin, Faculty.

D) Basic Flow:

- User logs in to the Online Proctoring System.
- User navigates to the "View Flagged Items" section.
- System displays a list of flagged items detected during proctored exam sessions.
- User selects a flagged item to view details and take appropriate actions.

E) Alternate Flow:

If there are issues with accessing or reviewing flagged items:

- System displays error messages indicating the specific issues encountered.
- User takes corrective actions as necessary.
- The flow returns to the appropriate step in the basic flow.

F) Post Conditions:

- Upon successful access, the user can review flagged items and take appropriate actions such as further investigation or resolution.
- In case of incomplete or erroneous access, the system prompts the user to retry or contact support for assistance.

2.5 Non-Functional Requirements:

2.5.1 Performance:

- The system should remain accessible 24x7 without any significant downtime.
- The system should be capable of handling concurrent access by at least 1000 users simultaneously.
- Response times for critical actions such as authentication and examination monitoring should be within acceptable limits to ensure seamless user experience.

2.5.2 Security:

- User passwords shall not be stored in plain text format within the database.
- Passwords shall be encrypted using cryptographic algorithms to enhance security.
- Access to sensitive data and system functionalities shall be protected through role- based access control mechanisms to prevent unauthorized access.

2.5.3 Reliability:

- The system should be highly reliable and available for end-users 24x7, ensuring uninterrupted access to examination functionalities.
- Redundancy and failover mechanisms shall be implemented to mitigate the risk of system failures and ensure continuous operation.

2.5.4 Availability:

- The system shall be deployed on a robust infrastructure with redundant components to ensure high availability.
- Internet connectivity for the nodes with the database server shall be ensured to always maintain system availability.

2.5.5 Portability:

- The developed applications shall be portable across different operating systems, including Android and iOS.
- Users shall be able to access the system from any device with a compatible web browser and internet connection, ensuring flexibility and accessibility.

2.6 Constraints:

2.6.1 Parallel Operations: The project is based on a multi-user system to prevent data redundancy during updating and entry processes.

2.6.2 Reliability Requirements: The system must deliver robust performance and be highly reliable. Reports should be generated within 5 seconds to meet reliability standards.

2.6.3 Criticality of Application: The system may experience disruptions on mobile devices with very low internet connectivity. Regular updates must be made to maintain system functionality and performance.

2.6.4 Safety and Security Consideration: Safety and security are paramount, especially for a mobile application vulnerable to internet-based security threats. All code must be encrypted, and transactions should be securely processed to safeguard user data and system integrity.

2.6.5 Hardware: Overcoming hardware limitations is crucial for optimizing system performance. Utilizing only essential hardware components can enhance system efficiency and responsiveness.

2.6.6 Regulatory Policies: The system development process must adhere to regulatory policies, laws, and regulations to achieve organizational objectives. Compliance with regulatory requirements ensures better economic and social outcomes and enhances the company's reputation.

2.7 Assumptions and Dependencies:

2.7.1 Assumptions:

- Database transactions are assumed to be secure and reliable.
- User is the person who has enough knowledge for the traversing operation.
- A user-friendly interface will be provided so that any user can easily navigate through the system.

2.7.2 Dependencies:

- The system is dependent upon the user's valid credentials. If a user inputs the wrong username or password, he/she will not be allowed to login to the system.
- This application depends on the server and internet as all the information is collected and then stored in the server through secure internet connection.
- All the users of the system will be assigned a specific role. According to these rules each user will be allowed to access a predefined set of features.

3. SYSTEM ANALYSIS

3.1 Study of Current System

In the current system, human proctors manually monitor exams, which is time-consuming and prone to errors. The manual process lacks efficiency, especially in result generation.

3.2 Feasibility Study

Operational Feasibility:

- The proposed proctoring system aims to streamline the monitoring process, enhancing operational efficiency.
- Remote monitoring and identity verification features ensure the system's functionality.
- The system's ability to monitor exam environments remotely contributes to its operational feasibility.

Technical Feasibility:

- The proctoring system utilizes modern technologies like WebRTC for camera and microphone access, OpenCV for face detection, and HLS format for video and audio recording.
- Compatibility with various browsers and platforms ensures technical feasibility.
- Backend support using technologies like MongoDB adds to technical viability.

Economic Feasibility:

- The system's reliance on freely available technologies like WebRTC and ASP.NET reduces development costs.
- Cost-effectiveness is further enhanced by leveraging open-source libraries like OpenCV.
- The broad scope and potential impact of the system justify its economic feasibility.

3.3 Requirements Validation

- User authentication ensures the integrity of the system, allowing access only to authorized individuals.
- Mandatory fields in forms prevent the submission of incomplete or inaccurate information.
- Error handling mechanisms notify users of incorrect inputs, maintaining data accuracy.

3.4 System Activity (Use Case Diagram)

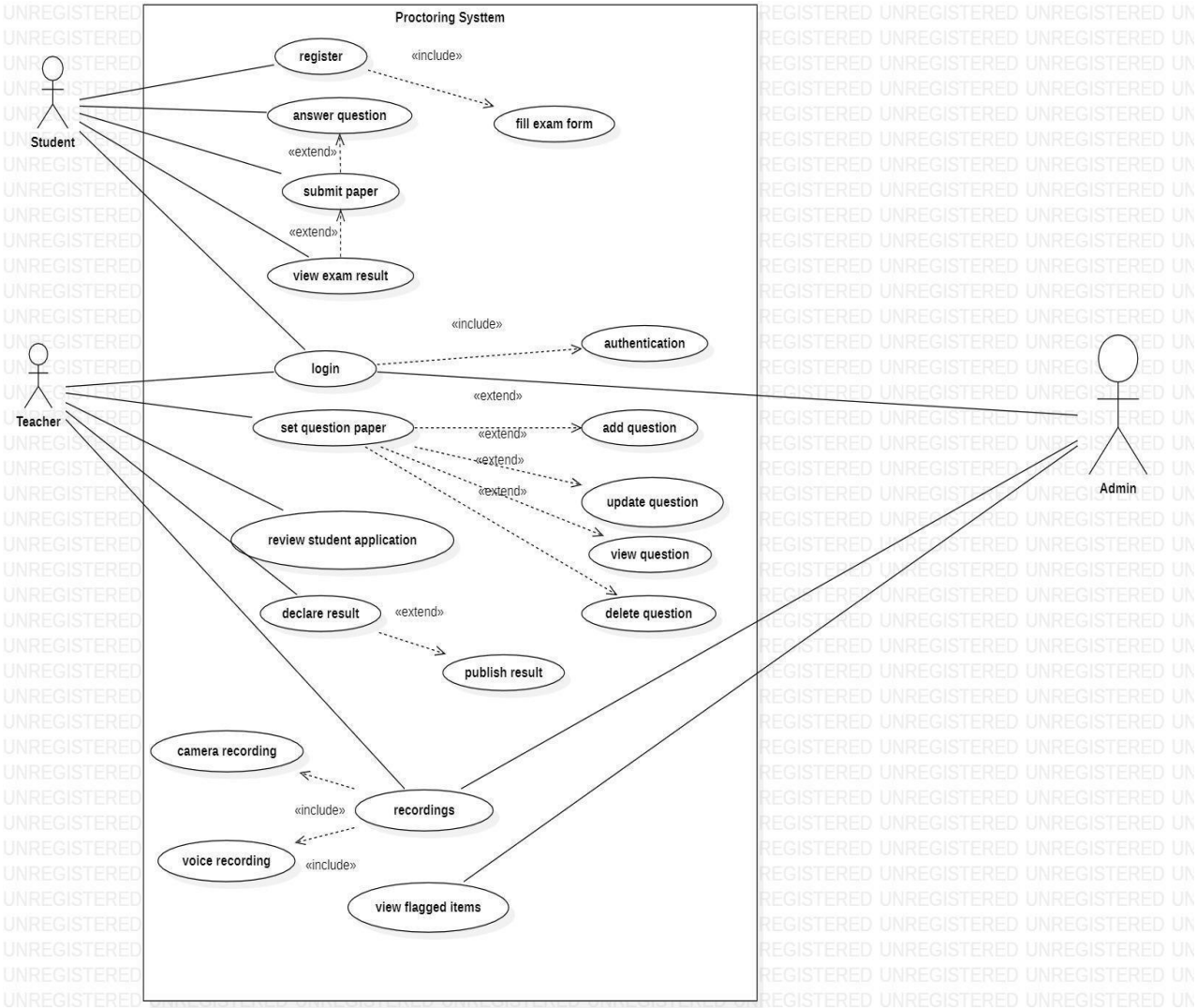

Fig.3.4 Use Case Diagram

- **Actors:** Admin, Teacher, Student
- **Use Cases:**
    - Registration
    - Answer Tracker
    - Submit Paper
    - View Exam Result
    - Login
    - Authentication
    - Set Questions
    - Review application.
    - Declare Result
    - Publish Result
    - Recordings

3.5 Proctoring System Development

1. Set Up Development Environment:
    - Install Node.js, npm, OpenCV, and HLS.js.
    - Initialize a Node.js project.
2. Implement WebRTC for Camera and Microphone Access:
    - Use WebRTC APIs to capture video and audio.
3. Integrate OpenCV for Face Detection:
    - Utilize OpenCV for real-time face detection.
4. Record Video and Audio in HLS Format:
    - Use MediaRecorder API to record streams.
    - Convert recordings to HLS format.
5. Implement Proctoring Logic:
    - Define rules for detecting suspicious behavior.
    - Utilize face detection data to monitor anomalies.
6. Develop JavaScript Library for Embedding:
    - Create a modular JavaScript library for integration.
    - Ensure compatibility with various frameworks.
7. Testing and Debugging:
    - Thoroughly test the system in different scenarios.
    - Debug issues related to camera access and face detection.
8. Documentation and Deployment:
    - Document usage and integration.
    - Optimize code and configurations.
    - Deploy the system for standalone or library usage. By following these steps, a robust proctoring system can be developed, ensuring integrity and security in online assessments.

4. PLANNING (COST BENEFIT ANALYSIS)

Function Point Analysis

Identified Function Points:

1. **External Inputs (EI)**:
    - **User Registration**: Users enter details like name, date of birth, etc.
    - **Test Submission**: Students submit their test responses.
    - **Permissions**: Grant permission for video and microphone recording.
    - **Estimated EI Count**: **3**.
2. **External Outputs (EO)**:
    - **Test Results**: The system generates test results.
    - **Malpractice Reports**: The system flags malpractice.
    - **Estimated EO Count**: **2**.
3. **External Inquiries (EQ)**:
    - **Flagging System**: System checks for malpractice flags.
    - **Student Information Inquiry**: Fetch student data from external sources.
    - **Estimated EQ Count**: **2**.
4. **Internal Logical Files (ILF)**:
    - **Student Information**: Stores details like name, university, etc.
    - **Test Information**: Stores test papers and results.
    - **Estimated ILF Count**: **2**.
5. **External Interface Files (EIF)**:
    - **University Systems Interface**: External interaction with universities/companies.
    - **Estimated EIF Count**: **1**.

Unadjusted Function Points (UFP) Calculation:

Type	Count	Complexity Weight	Total Function Points
External Inputs (EI)	3	3 (Low)	9
External Outputs (EO)	2	4 (Medium)	8
External Inquiries (EQ)	2	4 (Medium)	8
Internal Logical Files (ILF)	2	7 (Medium)	14
External Interface Files (EIF)	1	5 (Medium)	7

(Assumption)

Total UFP: 9 (EI) + 8 (EO) + 8 (EQ) + 14 (ILF) + 7 (EIF) = **46 UFP**

Complexity Adjustment:

Considering the high complexity of the proctoring system (security, performance), we'll use a complexity adjustment factor (CAF) of **1.2**.

Adjusted Function Points (AFP) = 46 × 1.2 = **55.2 AFP**.

2. <u>COCOMO (Constructive Cost Model)</u>

Convert Function Points to Lines of Code (LOC):

Using the average productivity for medium complexity systems, where **1 Function Point =100 LOC**:

- **Estimated LOC** = 55.2 × 100 = **5,520 LOC**.

COCOMO Effort Estimation (Semi-Detached Model):

- Effort (Person-Months) = 3.0 × (KLOC)^1.12
    - **KLOC = 5.52**.
    - Effort = 3.0 × (5.52) ^1.12 = 3.0 × 6.14 = **18.42 person-months**.

COCOMO Time Estimation:

- Time (Months) = 2.5 × (Effort)^0.35
    - `Time = 2.5 × (18.42) ^0.35` ≈ **7.35 months**.

COCOMO Staff Estimation:

- Staff (Number of People) = Effort / Time
    - `Staff = 18.42 / 7.35` ≈ **2.5 people**.

Thus, the system requires **2-3 full-time people** for about **7.35 months**.

3. Cost Benefit Analysis

Development Costs (Based on COCOMO Estimation):

- **Manager**: ₹3,00,000.
- **Developer**: Reduced by leveraging open-source components: ₹3,00,000.
- **Tester**: Reduced by using part-time/outsource resources: ₹1,50,000.

Infrastructure Costs:

- **Cloud Storage/Hosting/API:** Optimized pay-as-you-go model: ₹50,000.

Contingency:

- **Miscellaneous Costs**: ₹50,000.

Total Optimized Cost:

- **Total Development + Infrastructure + Contingency** = **₹8,50,000**.

1. Licensing:

- The system is now expanded to three additional institutions.
    - **Licensing Revenue**: 3 institutions × ₹1,00,000 = ₹3,00,000.

2. Scalability:

- Scaling to handle more students and exams saves the client significant costs.
    - **Scalability Savings**: ₹6,00,000 per year.

3. Time Efficiency & Malpractice Reduction:

- **Time Savings**: ₹1,50,000.
- **Malpractice Savings**: ₹50,000–₹1,00,000.

4. Additional Revenue from Features:

- The system can add advanced analytics and other features for an extra fee.
    - **Revenue from Added Features**: ₹2,00,000.

Total Benefits Estimate:

- Licensing: ₹ 3,00,000.
- Scalability: ₹6,00,000.
- Time & Malpractice Savings: ₹2,50,000.
- Additional Features Revenue: ₹2,00,000.

Total Benefits: **₹13,50,000**.

Step 5: ROI and Payback Period

Return on Investment (ROI):

Formula:

ROI = (Net Benefit /Total Cost)x100

Calculation:

- **Total Benefit**: ₹13,50,000.
- **Total Cost**: ₹8,50,000.
- **ROI**:
    - Net Benefit = ₹13,50,000 – ₹8,50,000 = ₹5,00,000.
    - ROI = (5,00,000/8,50,000)x100= 58.8 %

Payback Period:

Formula:

Payback Period= (Total Investment/Annual Benefit)

Calculations:

- **Total Investment**: ₹8,50,000.
- **Annual Benefits**: ₹13,50,000.
- **Payback Period**:(8,50,000/13,50,000) =0.63 years or 8 months

Conclusion:

- **Total Costs**: ₹8,50,000.
- **Total Benefits**: ₹13,50,000.
- **ROI**: **58.8%** (positive).
- **Payback Period**: **8 Months**

UFP(Unadjusted Function Point)-The Unadjusted Function Points are calculated based on the external inputs, outputs, inquiries, files, and interfaces as extracted from the Data Flow Diagram (DFD).

Adjusted Function Point (AFP)-The Adjusted Function Points(AFP) are calculated by applying the CAF to the UFP i.e. AFP=UFPXCAF

Return on Investment (ROI)- ROI measures the profitability of the project relative to its cost.

Complexity Adjustment Factor (CAF)-The CAF accounts for the complexity of the system, such as security, performance, and other non-functional requirements. In this case, the system is moderately complex due to security and real-time performance needs.

Payback Period: The payback period represents the time it takes to recover the initial investment.

Constructive Cost Model (COCOMO)- It is a software cost estimation model that helps predict the effort, cost, and schedule required for a software development project.

5. System Design

1. **ACTIVITY DIAGRAM**
2. **SEQUENCE DIAGRAM**
3. **DATA FLOW DIAGRAM**

5.1 Activity Diagram

An activity diagram is a special case of a state diagram in which all (or at least most) of the states are action states and in which all (or at least most) of the transitions are triggered by completion of the actions in the source states.

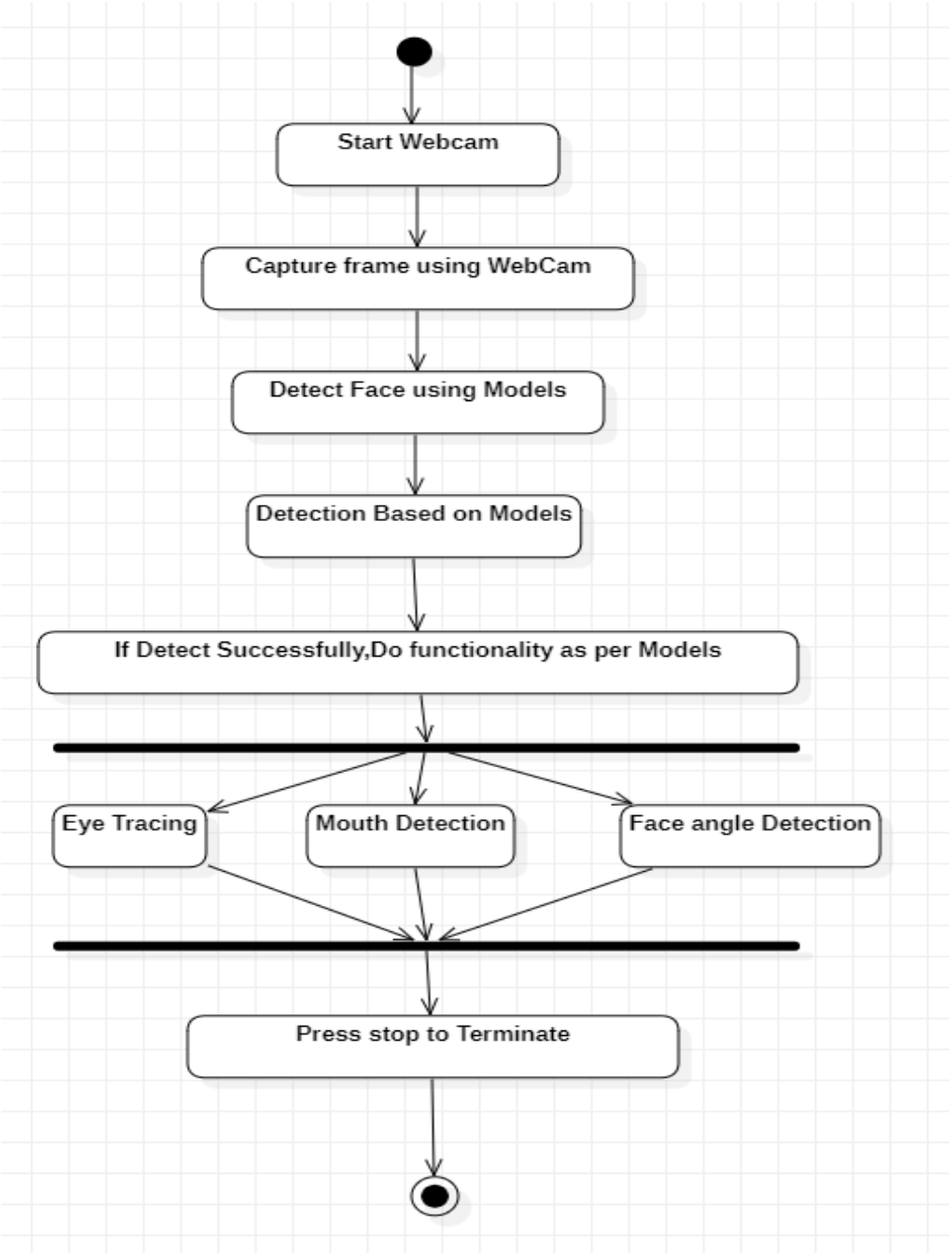

Fig.5.1 Activity Diagram of System

5.2 Sequence Diagram

A sequence diagram simply depicts interaction between objects in a sequential order i.e., the order in which these interactions take place. We can also use the terms event diagrams or event scenarios to refer to a sequence diagram. Sequence diagrams describe how and in what order the objects in a system function.

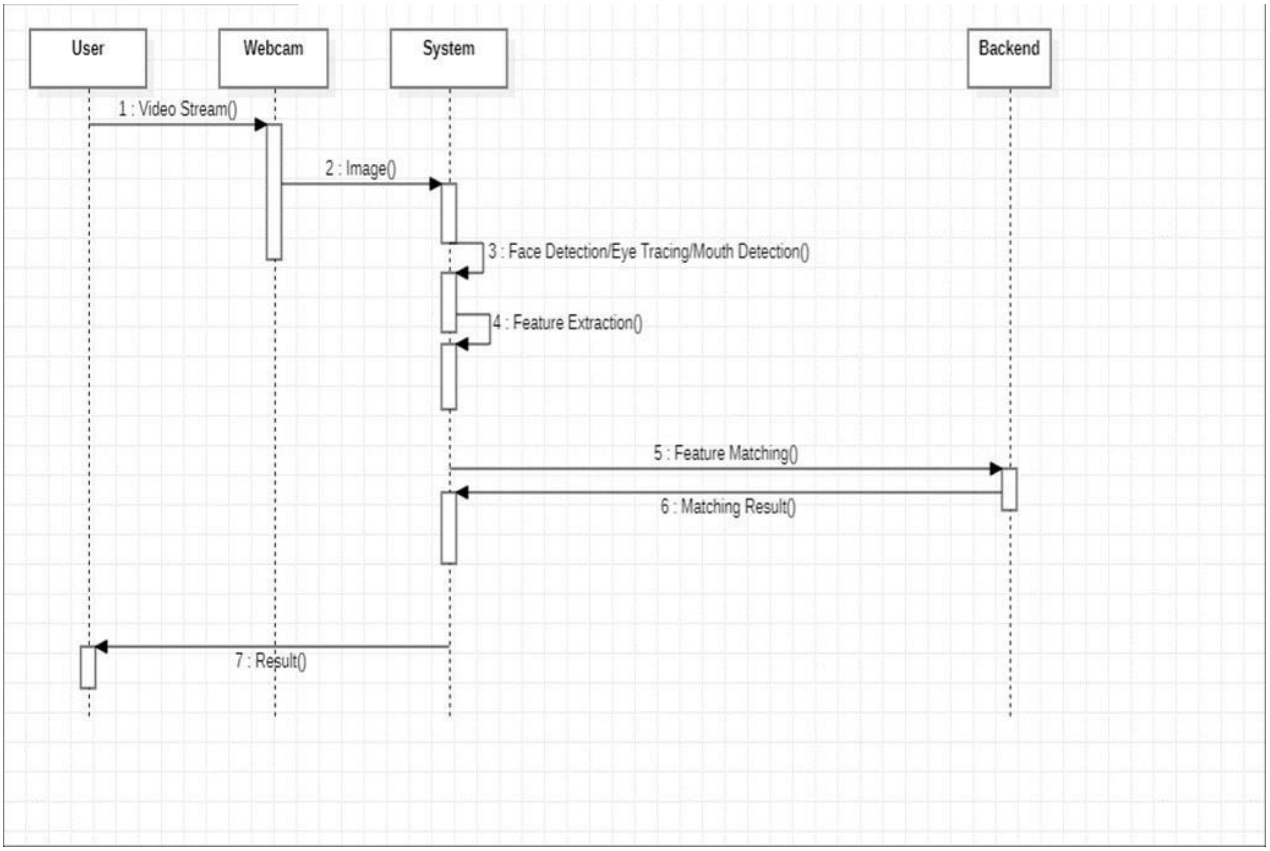

Fig.5.2 Sequence Diagram of System

5.3 System Data Flow Diagram

DFD graphically represents the functions, or processes, which capture, manipulate, store, and distribute data between a system and its environment and between components of a system. Visual representation makes it a good communication tool between User and System designer. Structure of DFD allows starting from a broad overview and expanding it to a hierarchy of detailed diagrams. DFD has often been used due to the following reasons:

- Logical information flow of the system
- Determination of physical system construction requirements
- Simplicity of notation
- Establishment of manual and automated systems requirements.

0-Level Data-Flow Diagram of system

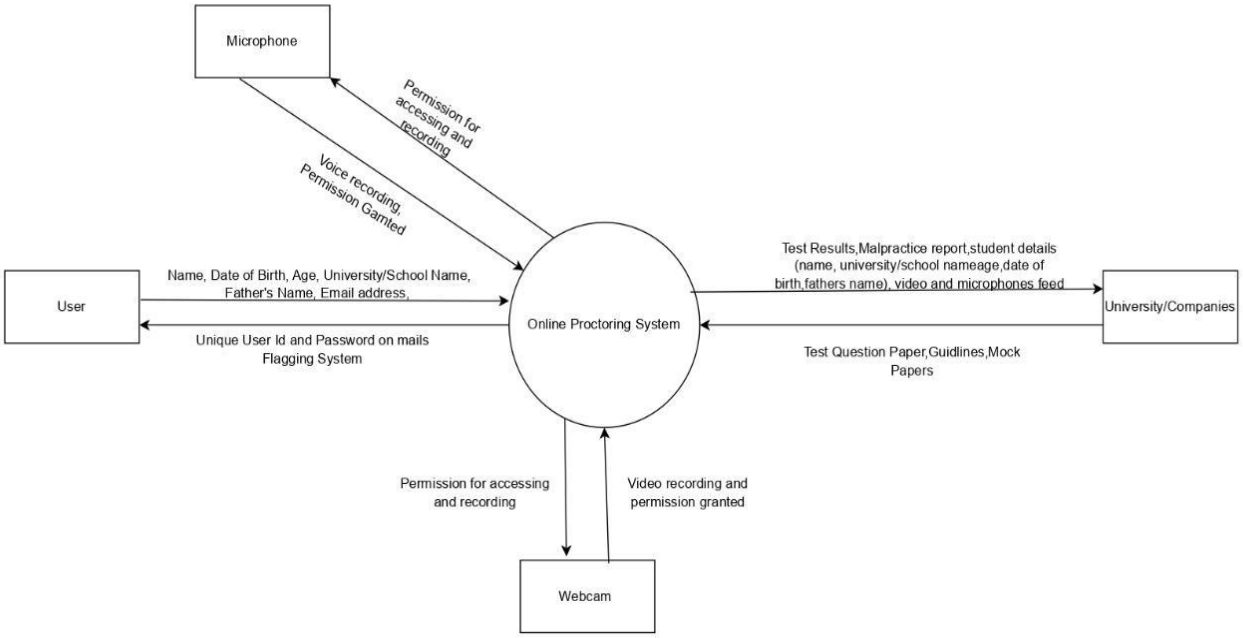

Fig.5.3.1 0-Level Data-Flow Diagram of system

1-Level Data-Flow Diagram of system

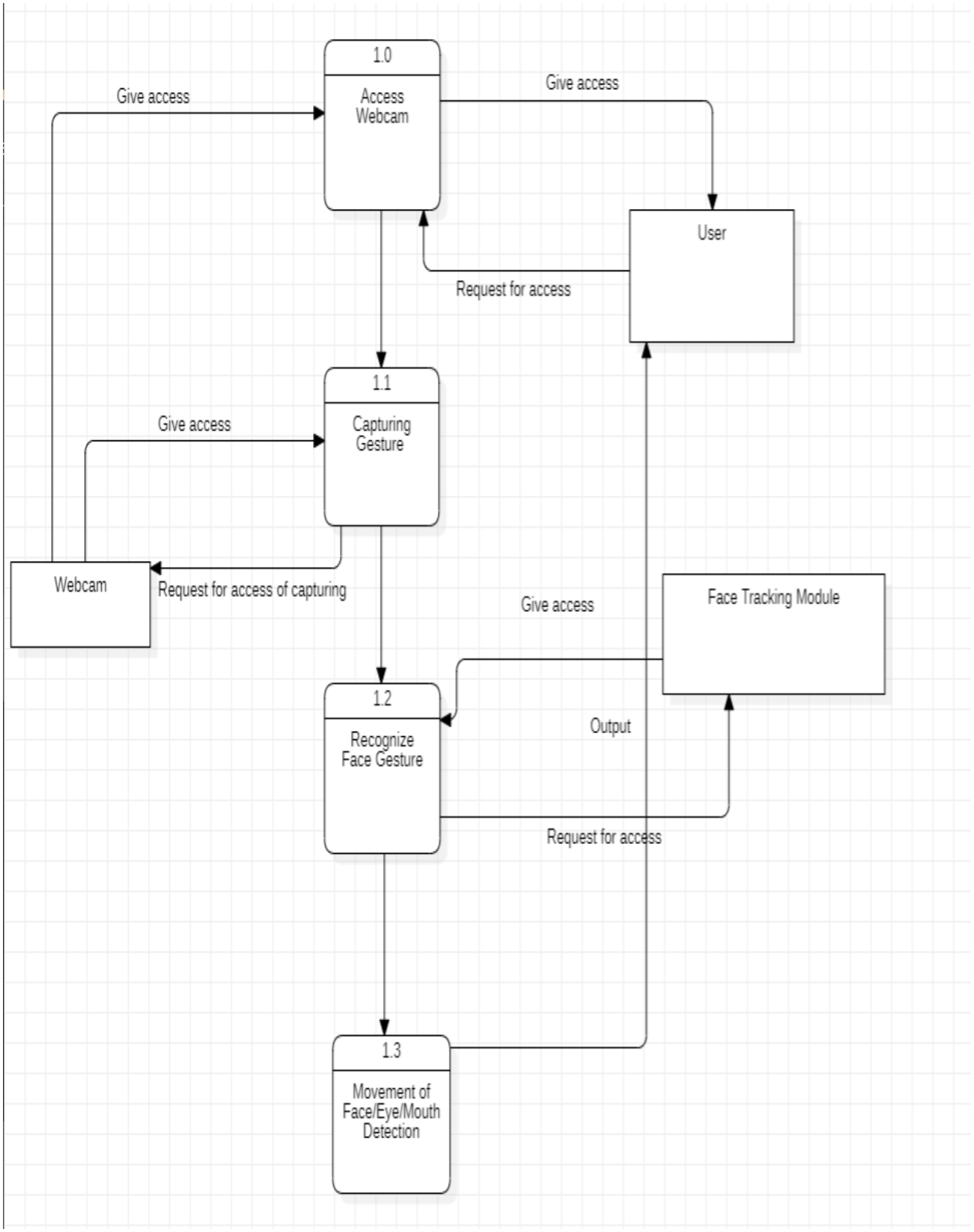

Fig.5.3.2 1-Level Data-Flow Diagram of system

2-Level Data-Flow Diagram of system

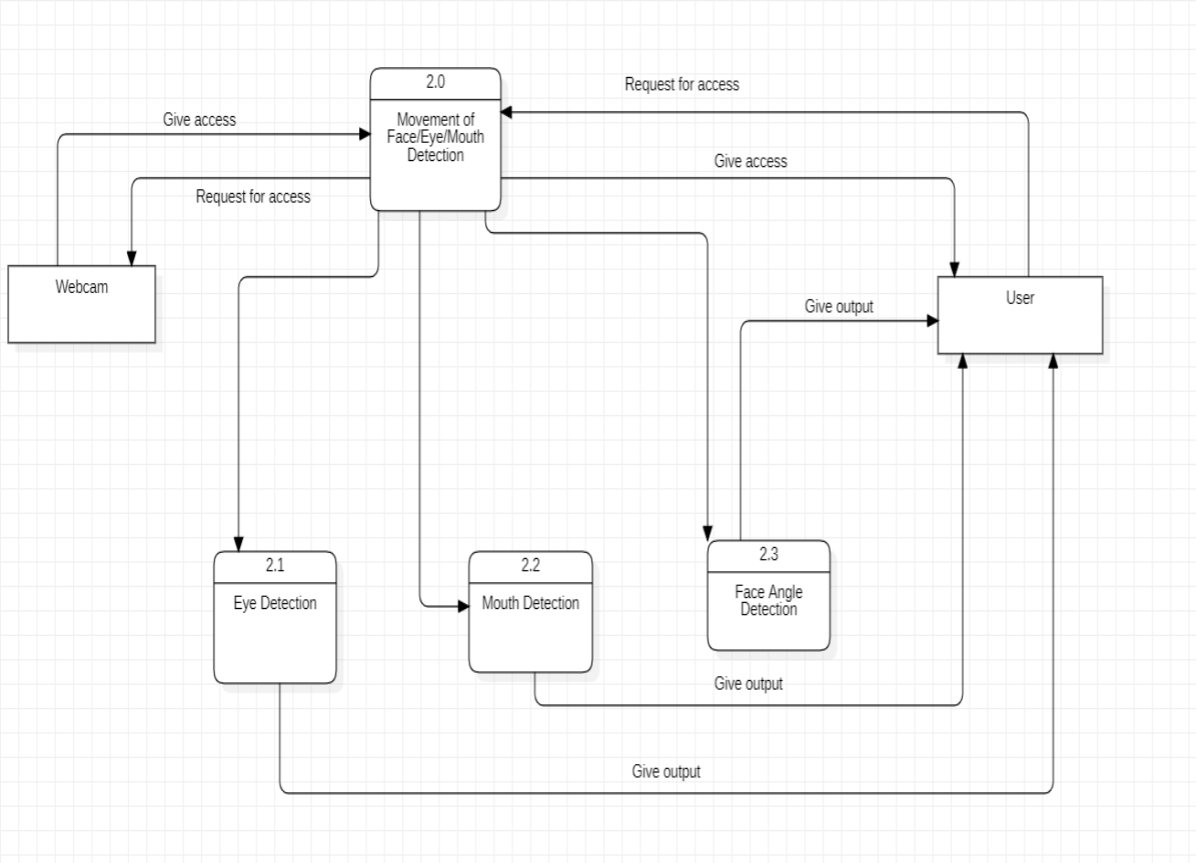

Fig.5.3.3 2-Level Data-Flow Diagram of system

6. Limitations and Future Enhancements

6.1 Limitations:

A proctoring system, designed to monitor and supervise students during exams to prevent cheating, may face several limitations. These limitations can be broadly categorized into technical, privacy, security, and usability challenges. Here are some common general limitations:

Technical Limitations:

1. **Internet Connectivity:**
    - Reliable and high-speed internet is required for continuous monitoring. Students in areas with poor connectivity may face difficulties.
2. **System Requirements:**
    - Proctoring software often requires specific system specifications, which might not be available on all students' devices.
3. **False Positives:**
    - Proctoring systems can sometimes incorrectly flag normal behavior as suspicious, leading to false accusations of cheating.
4. **Environmental Constraints:**
    - Students' testing environments vary widely. Noise, lighting conditions, and interruptions can affect the proctoring software's effectiveness.
5. **Technical Glitches:**
    - Software bugs, crashes, or other technical issues can disrupt the examination process.

Privacy Concerns:

1. **Data Security:**
    - Proctoring systems collect a significant amount of personal data, including video, audio, and screen recordings. Ensuring this data is secure from breaches is critical.
2. **Intrusiveness:**
    - Continuous monitoring can feel intrusive to students, raising concerns about privacy and the extent of surveillance.
3. **Data Retention:**
    - Policies on how long the collected data is stored and who has access to it can be a point of contention.

Security Issues:

1. **Cheating Detection:**
    - Despite advanced monitoring, determined students may find ways to cheat using sophisticated methods that bypass detection.

2. **Authentication:**
    - Ensuring that the person taking the test is the actual student remains a challenge. Methods like ID verification can be circumvented.

Usability Challenges:

1. **Accessibility:**
    - Students with disabilities might face additional challenges with proctoring software if it's not designed with accessibility in mind.
2. **Stress and Anxiety:**
    - The presence of monitoring software can increase stress and anxiety among students, potentially affecting their performance.
3. **User Experience:**
    - Complex or cumbersome software interfaces can lead to difficulties in usage, causing delays and frustrations.

Ethical and Legal Considerations:

1. **Consent:**
    - Students must give informed consent for monitoring, and institutions need to ensure that this process is transparent.
2. **Fairness:**
    - Ensuring that all students have equal access to the required technology and environment for proctored exams is crucial for fairness.
3. **Compliance with Regulations:**
    - Proctoring systems must comply with various local and international data protection regulations, such as GDPR (General Data Protection Regulation) in Europe.

6.2 Future Enhancement:

The future enhancements for proctoring systems are likely to focus on improving reliability, security, user experience, and ethical considerations. Here are some potential advancements:

1. Advanced AI and Machine Learning:

- **Enhanced Cheating Detection:**
    - More sophisticated AI algorithms to detect subtle cheating behaviors, such as eye movement tracking and contextual analysis of student actions.
- **Behavioral Analytics:**
    - Using machine learning to analyze patterns and behaviors over time to identify anomalies and potential cheating incidents more accurately.

2. Improved User Experience:

- **Seamless Integration:**
    - Better integration with various Learning Management Systems (LMS) to provide a more cohesive and user-friendly experience.
- **Less Intrusive Monitoring:**
    - Development of less intrusive monitoring techniques that balance security with student comfort and privacy.

3. Enhanced Security Measures:

- **Biometric Verification:**
    - Utilizing advanced biometric methods (e.g., facial recognition, voice recognition) to ensure the identity of the test-taker.
- **Secure Browser Environments:**
    - Developing more robust secure browser environments that prevent students from accessing unauthorized resources during exams.

4. Privacy and Data Protection:

- **Data Anonymization:**
    - Implementing techniques to anonymize personal data collected during proctoring to protect student privacy.
- **Transparent Data Practices:**
    - Clear and transparent data usage policies that inform students about how their data is collected, stored, and used.

5. Scalability and Accessibility:

- **Global Scalability:**
    - Ensuring the proctoring system can handle a large number of users simultaneously, accommodating institutions with extensive online testing needs.
- **Accessibility Features:**
    - Enhancing accessibility features to support students with disabilities, ensuring equitable access to proctored exams.

6. Integration of Multi-modal Proctoring:

- **Hybrid Approaches:**
    - Combining different proctoring methods (e.g., live proctors, AI-based monitoring, and recorded sessions) to create a more robust and flexible proctoring system.
- **Contextual Proctoring:**
    - Using contextual information (such as the type of exam and subject matter) to adjust the level and type of proctoring applied.

7. Real-time Feedback and Support:

- **Immediate Assistance:**
    - Providing real-time support for technical issues or clarifications during the exam to minimize disruptions.
- **Instant Feedback:**
    - Offering instant feedback on potential issues detected during the exam, allowing students to address them immediately if they are false positives.

8. Ethical and Fairness Enhancements:

- **Bias Mitigation:**
    - Ensuring AI algorithms are free from biases that could unfairly target certain groups of students.
- **Fairness Audits:**
    - Regularly conducting fairness audits to ensure the proctoring system treats all students equally and ethically.

9. Enhanced Reporting and Analytics:

- **Detailed Reports:**
    - Providing detailed, actionable reports to educators, highlighting potential issues and suggesting areas for improvement.
- **Predictive Analytics:**
    - Using data analytics to predict and prevent potential cheating behaviours before they occur.

10. Legal and Compliance:

- **Regulatory Compliance:**
    - Continuously updating the proctoring system to comply with evolving data protection regulations such as GDPR and other local privacy laws.
- **Ethical Standards:**
    - Adopting and adhering to high ethical standards to gain trust from educational institutions and students.

7.Conclusion

Remote proctoring using AI can transform the education sector and has made everything possible virtually. AI-integrated computer systems can ensure the authenticity of the test by preventing the candidate from cheating and indulging in unfair means during the assessment. With Remote Proctoring, educational institutes don’t need to delay or postpone examinations amid the COVID-19 outbreak.