



SRI LANKA INSTITUTE OF INFORMATION TECHNOLOGY

**Automated Examination Invigilator System
(AEIS)**

**SOFTWARE REQUIREMENTS SPECIFICATION
(PROJECT ID 13-024)**

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Software Requirements Specification

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1 Introduction

1.1 Purpose

This document is intended to provide complete description on Automated Examination Invigilator System (AEIS). This document will provide descriptive explanations on different aspects of the AEIS system such as purpose and features of the system, interfaces of the system, operations and functionalities of the system, the constraints under which it must operate and how the system will react to external stimulus. Furthermore this document will describe the users of the system and the site adaption requirements for the system. This document is intended for both the stakeholders and the developers of the system.

1.2 Scope

The software system to be produced is an Automated Examination Invigilator System (AEIS) which will automate the major examination invigilation operations [3]. This document covers the requirements of Automated Examination Invigilator System for release 1.0 of June 2013. Mention will be made throughout this document of selected probable features of future releases. The purpose of this is to guide developers in selecting a design that will be able to accommodate the full-scale application.

There will be four major modules in the AIES system. The first module is a Candidate Identity Verification Module to verify the identities of candidates who enter the examination hall are valid candidates for the particular examination using face recognition techniques [2]. The second module is the Examination Invigilation Module that automatically invigilates the examination hall using video surveillance techniques and motion detection techniques [6]. The third module is Automated MCQ Paper Marking Module which will use optical mark recognition (OMR) techniques [11] to mark the MCQ answer sheet with a high accuracy level. Note that AEIS system will mark MCQ results sheets only [10]. Fourth module of AEIS system is Android based mobile application to invigilate the examination hall from mobile devices. These modules' functionality will be described in more detail in Overall Description.

The end users of the AEIS system will be Examination Invigilators, Higher Management for Examinations and Data Entry Operators as well.

The Automated Examination Invigilator System's objective is to provide an efficient and high accurate software solution to automate the high workload for the examination invigilators. The end users' day today jobs of examination invigilation [3] and paper marking will be simplified by a considerable amount through the AEIS system. The system should be user appropriate, easy to use, provide

easy recovery of errors and have an overall end user high subjective satisfaction.

1.3 Definitions, Acronyms, and Abbreviations

AEIS	Automated Examination Invigilation System.
SRS	System Requirements Specification
UML	Unified Modeling Language.
OMR	Optical Mark Recognition
MCQ	Multiple Choice Questions
OS	Operating System
AMAA	Android Mobile Assistance App.
HD	High Definition.
WLAN	Wireless Local Area Network.
LAN	Local Area Network.
RAM	Random Access Memory.
LED	Light Emitting Diode.

Table 1: Definitions, Acronyms, and Abbreviations

1.4 Overview

The remainder of this SRS Document contains two main sections. First section provides a complete description of the system for the users of the AEIS. It provides an overview of the functionality performed by the software product and describes the informal requirements. This is used to establish a context for the technical requirements specification in the next chapter.

The latter section, Requirements Specification section of this document is primarily intended for the developers and describes in technical terms and the details of the functionality of the software product. These two sections are cross-referenced by topic; to increase understanding by both groups involved. Both sections of the document describe the same software product in its entirety, but are intended for different audiences and thus use different language.

2 Overall Descriptions

The rest of the SRS examines the specifications of the AEIS in detail. Section 2 of the SRS presents the general factors that affect the AEIS and its requirements, such as user characteristics and project constraints. This section does not state

specific requirements. Instead it provides a background for those requirements, which are defined in section 3, and makes them easier to understand. Section 3 outlines the detailed, specific functional, performance, system and other related requirements of the AEIS. Supporting information about appendices is provided in Section 4.

2.1 Product Perspective

Within the current state of art there is no similar Automated Examination Invigilator System is available. But there are automated computer based exams such as Moodle online exams, Lexis examination etc. There is also video surveillance systems used in different contexts used for many different invigilation purposes. Optical Paper Marking also can be applied for different software systems for different purposes.

Automated Examination Invigilator System (AEIS) is mainly consisted of two components which is the desktop application for the use of examination invigilator and an android based mobile application to facilitate the invigilator to invigilate examination hall while walking in the hall or from a remote destination as well.

AEIS system will use several different types of hardware components to support different functionalities within the system. The main hardware devices using through the system are High Definition Video Camera, Web camera, Wi-Fi Router and Android based Mobile devices.

2.1.1 System interfaces

- Any Windows operating system Higher than Windows XP
- Microsoft .NET Framework

The .NET Framework [1] provides a comprehensive and consistent programming model for building applications that have visually stunning user experiences and seamless and secure communication.

- Visual Studio 2008 IDE to develop AEIS System

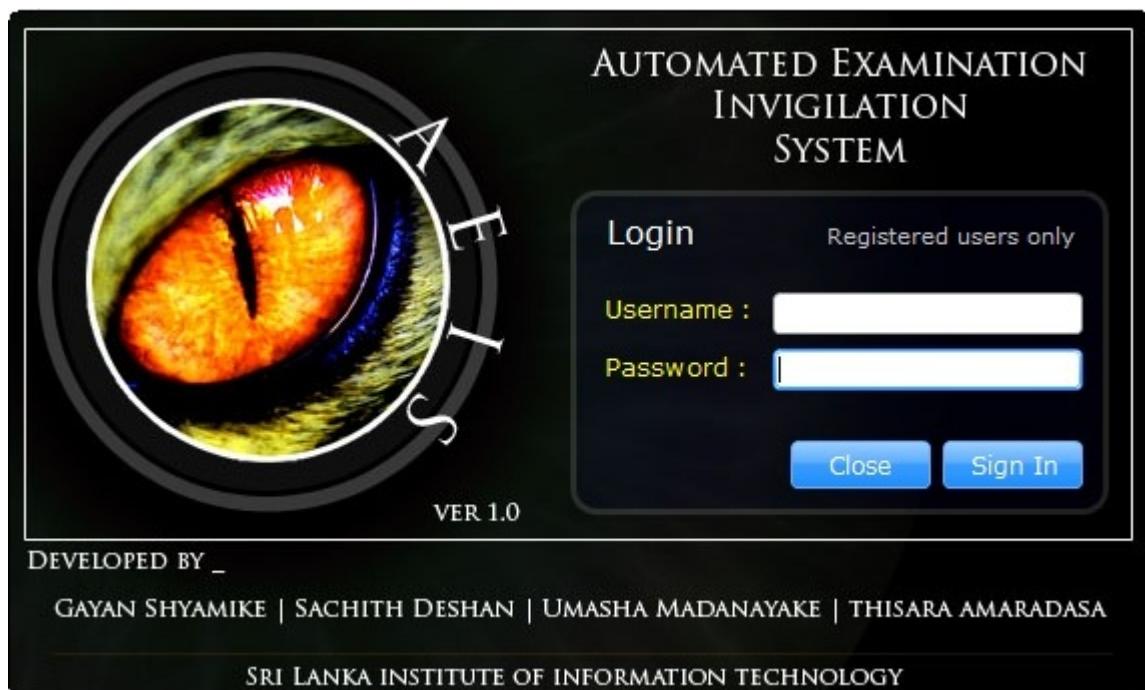
Microsoft Visual Studio is an integrated development environment (IDE) from Microsoft. It is used to develop console and graphical user interface applications along with Windows Forms or WPF applications, web sites, web applications, and web services in both native code together with managed code for all platforms supported by Microsoft Windows, Windows Mobile, Windows CE, .NET Framework, .NET Compact Framework and Microsoft Silverlight.

- **Android Mobile Assistant will receive push notifications using Google Cloud Messaging API**

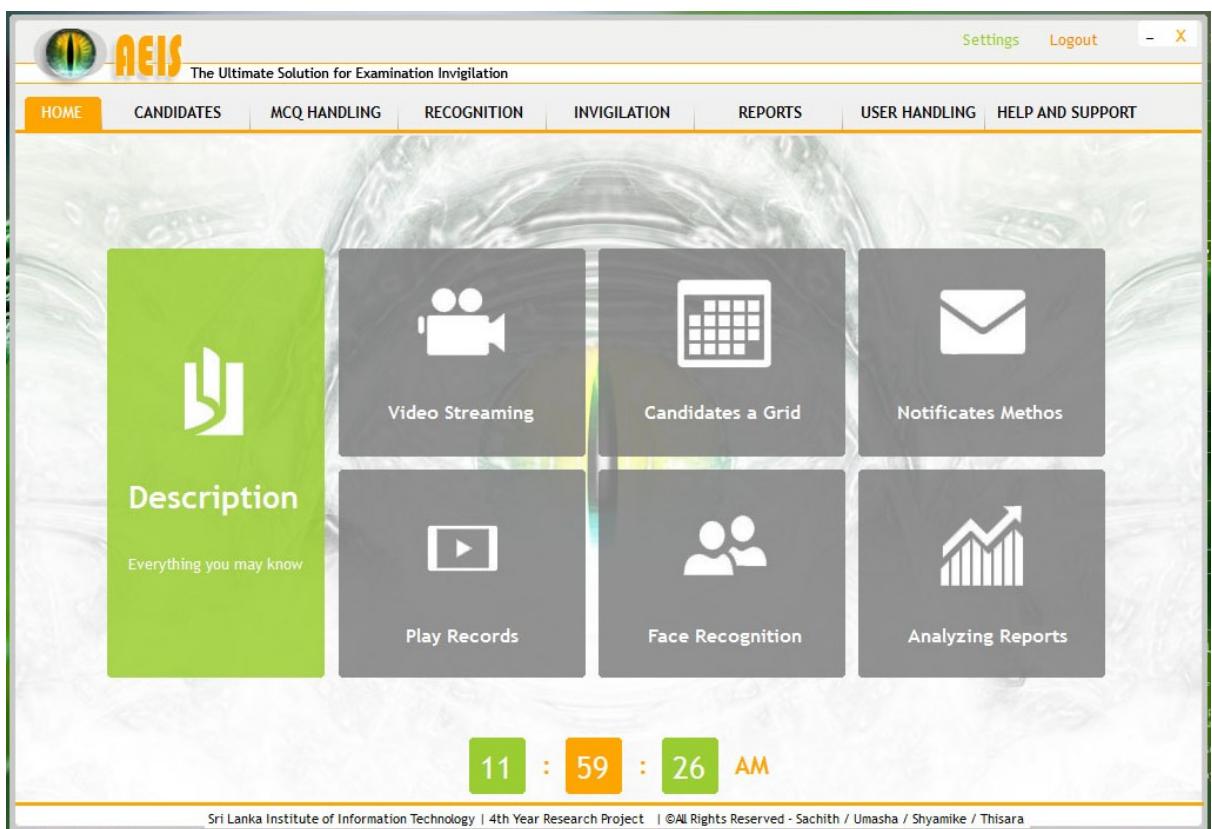
Google Cloud Messaging (GCM) [12] is a free service that helps developers to send data from servers to their Android applications.

- **API used to connect with Wi-Fi camera**

2.1.2 User interfaces



Login Interface



Home Interface

AEIS The Ultimate Solution for Examination Invigilation

Settings Logout - X

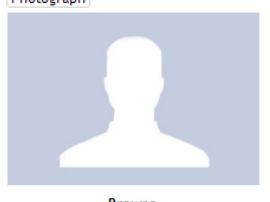
HOME CANDIDATES MCQ HANDLING RECOGNITION INVIGILATION REPORTS USER HANDLING HELP AND SUPPORT

Candidate Control

- View Candidate Details**
- Add New Candidate**
- Update / Delete Candidate**

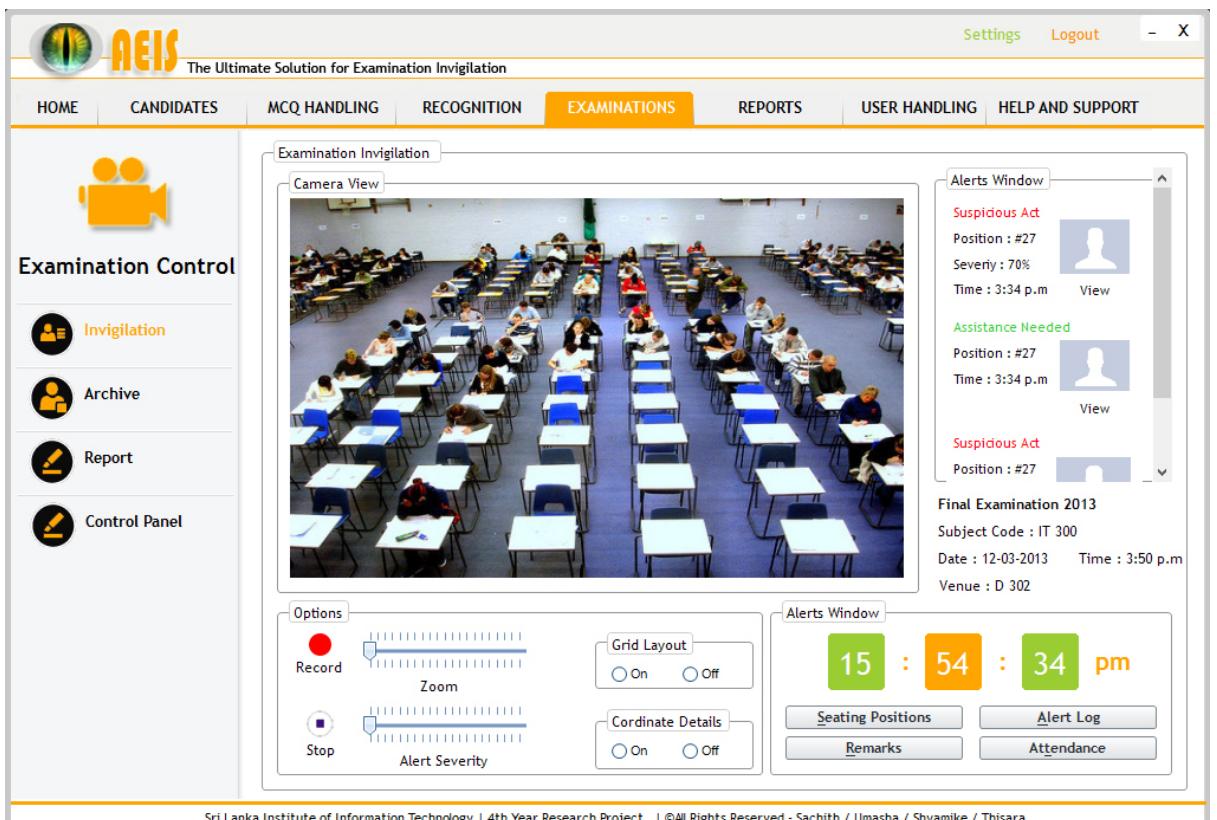
Registration Form

CAUTION : Please be kind to fill out the all field which given below. Keeping empty field may occur for warning messages.

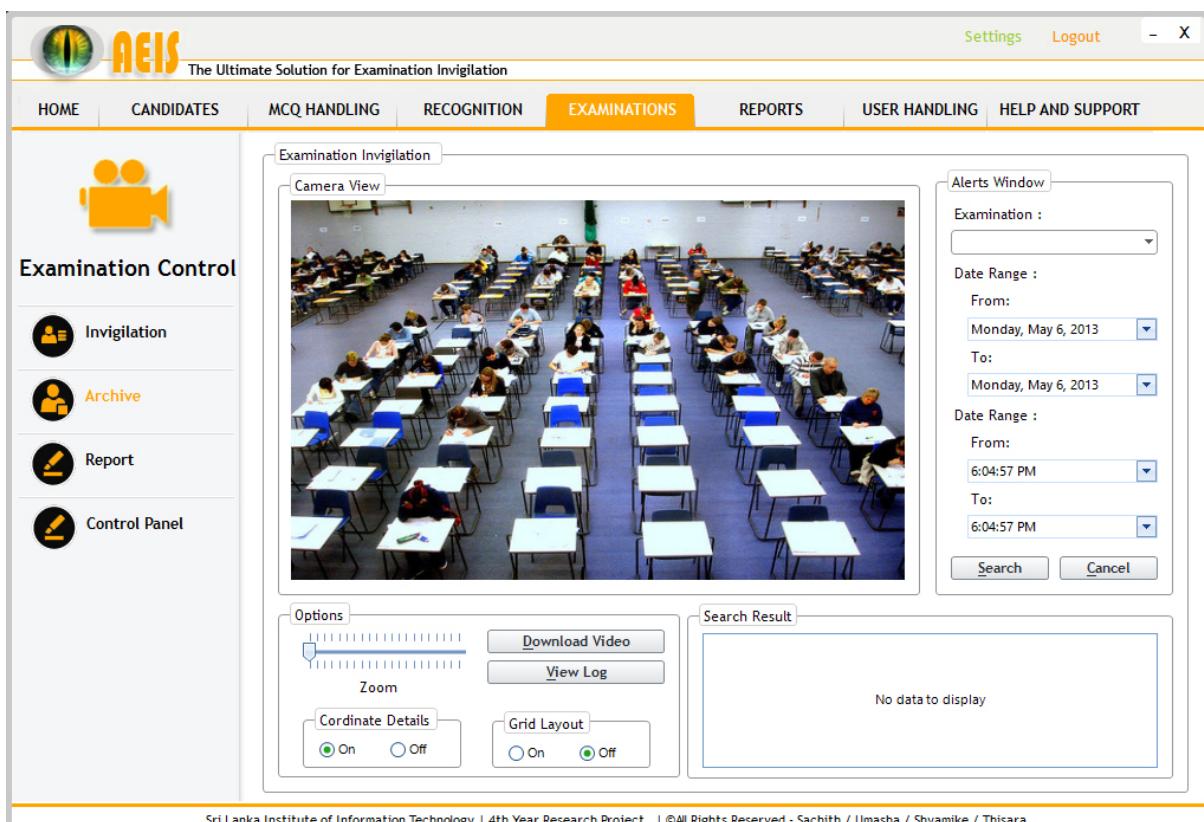
Candidate ID :	<input type="text"/>
Full Name of the candidate :	<input type="text"/>
Name with the initials :	<input type="text"/>
Title :	<input type="text"/>
Citizenship :	<input type="text"/>
NIC No :	<input type="text"/>
Date of Birth :	Sunday, March 24, 2013
Permanent address :	<input type="text"/>
Contact Numbers :	<input type="text"/>
Academic Course name :	<input type="text"/>
Subjects	
Subject 1	<input type="text"/> Subject 2 <input type="text"/>
Subject 4	<input type="text"/> Subject 5 <input type="text"/>
Subject 3	<input type="text"/>
Photograph	
	
Browse	
Payment Details (if any) : <input type="text"/>	
<input type="button" value="Reset"/> <input type="button" value="Register"/> <input type="button" value="Cancel"/>	

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Candidate Registration interface



Examination Invigilation Interface



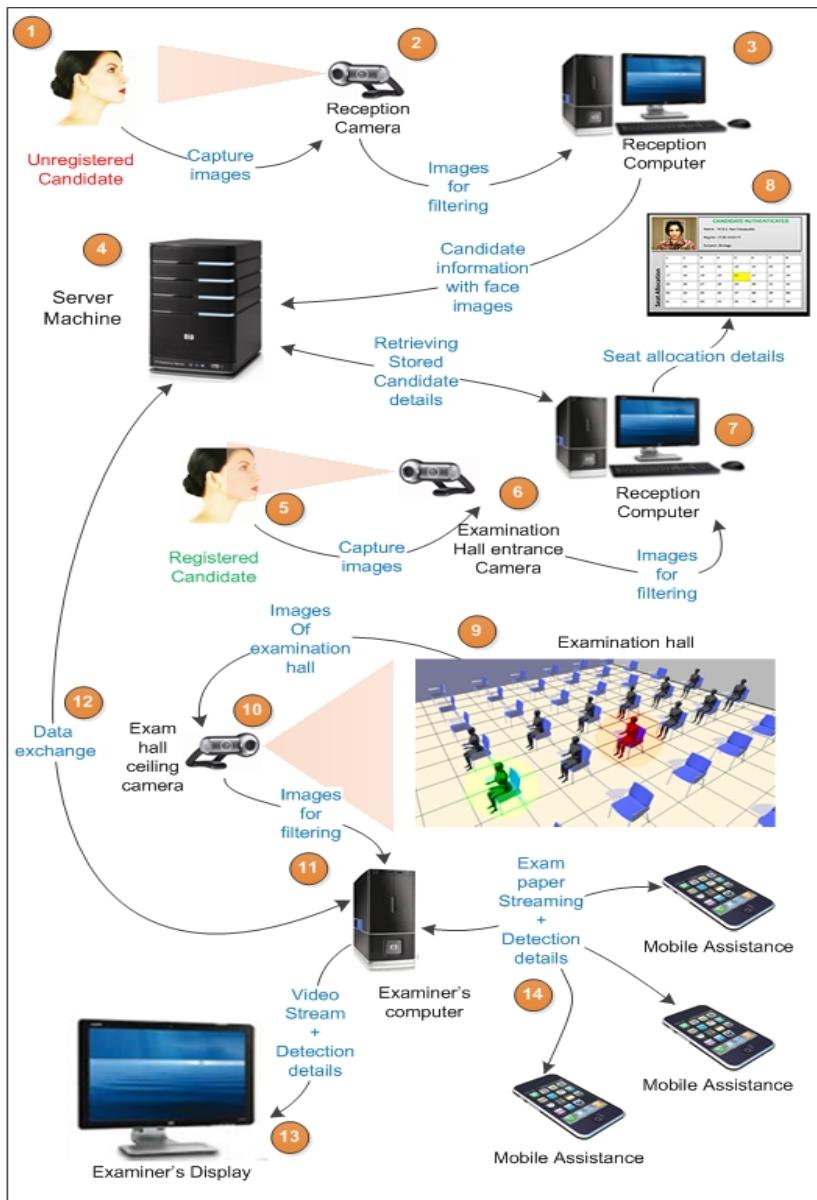
Video Archive Interface

The screenshot displays the AEIS (Automated Examination Invigilator System) software interface, specifically the MCQ Paper Handling module. The top navigation bar includes links for Settings and Logout. Below the header, a menu bar offers options like HOME, CANDIDATES, MCQ HANDLING (which is currently selected), RECOGNITION, INVIGILATION, REPORTS, USER HANDLING, and HELP AND SUPPORT. On the left, a sidebar titled 'MCQ Paper Handling' contains four items: 'MCQ Answer Sheet' (with a person icon), 'Marking Schema' (with a person icon), 'Marking MCQ' (with a pencil icon), and 'Report' (with a pencil icon). The main content area is divided into sections: 'Marking' (containing 'Details' and 'Current Answer Sheet' tabs), 'Progress of marking' (showing a green progress bar labeled 'Progress'), and input fields for 'No of papers marked' and 'No of papers to be marked'. A 'Start Paper Marking' button is located at the bottom of the marking section.

MCQ Paper Marking Interface

2.1.3 Hardware interfaces

- High Definition (HD) Video Camera
- Web Cameras
- Extra LED flashing devices
- Computer System running Windows OS
- Wi-Fi Router
- LAN Connectivity
- Android Mobile Devices with Wi-Fi supported.
- 17' or higher LCD monitors



2.1.4 Software interfaces

- AIES system will only support the windows operating systems (XP, Vista, Windows7).
- Automated Examination Invigilator System (AEIS) shall interface with SQL Server 2005 as its database component.
- AIES shall interface with Emgu CV Wrapper which essentially provides an interface between OpenCV and C#.

- AEIS Mobile Application will use Android mobile platform and will only be deployed to android based mobile devices.

2.1.5 Communication interfaces

- SMS Gateways to provide periodical SMS notifications for the candidates prior the examination.
- SMTP [9] Emails to send email notifications for the registered candidates for a particular examination.
- When the Android Mobile Assistant notifies the AEIS that the MCQ answer sheet images are ready to be downloaded it will download the images and store in a secure location using the Wi-Fi connection.

2.1.6 Memory Constraints

Minimum and recommended system requirements for AEIS

Requirement	Memory Constraint
Operating System	Windows XP or Higher Windows OS
Configuration	1. Memory: 1 GB; recommend 2GB2. Available Disk Space: 200 MB3. Processor: Intel Dual Core 2.4 GHz or higher
Video	HD Video CameraWeb CamerasDirectX 9.0 or Higher

Table 2: Memory Constraints

2.1.7 Operations

1. Inserting candidate records.
2. Provide a unique identification to each candidate.
3. Updating & deleting candidate records.
4. Send notifications to candidates regarding the examination prior to each examination.
5. Verify the identity of the candidates before commencing the examination by face recognition [2].
6. Provide the seating allocation details to each candidate at the examination hall entrance.
7. Tracking the attendance of the candidates and recording the in time.

8. Verify the seated locations of candidates before commencing the examination by face recognition [2].
9. Observe the candidate activities throughout the examination.
10. Highlight the suspicious activities of candidates.
11. Highlight the candidates who are in need for instructions or additional examination materials by gesture recognition.
12. Generate alerts to invigilator regarding special circumstances as explained in 9 and 10.
13. Provide facility of invigilating the examinations to mobile invigilators through an Android phone.
14. Forward the live video stream and the generated alerts to the Android phone through the desktop application.
15. Recording the suspicious activities of candidates and providing the facility to replay them at a later time.
16. Capturing images of MCQ answer sheets by the Android application for automated marking.
17. Checking the captured images to verify that the quality of the images meets the expected quality required in further phases.
18. Send the captured images of the MCQ answer sheets to the desktop application via Android application.
19. Receive and further refine the images transmitted by the Android application.
20. Rename and Store the images refined images for later retrieval.
21. Retrieval of stored images for marking process.
22. Input the MCQ answer pattern.
23. Automated marking of MCQ answer sheets.
24. Generating the total marks for each answer sheet and storing the marked image for later retrieval.
25. Generating a summary report with total mark for each candidate.

2.1.8 Site adaptation requirements

In order to deploy Automated Examination Automation System (AEIS)

- The running computer should be connected to a Local Area Network (LAN)
- HD Video camera Devices should be placed in the correct positions and also should be connected to the (LAN)
- Examination Environment should meet the necessary lighting requirement to fetch a quality video stream through the cameras.
- Candidate Seating position Details and other Examination Data should be pre entered in order to automate the examination invigilation process [3].
- For the Candidate Identity Verification, candidate's portrait photographs should be provided to the system image database Face Recognition [2].
- Provided photographs should meet the necessary image quality in order to effectively verify the candidate's identity.
- For M.C.Q. Marking Module correct answer data should be provided prior to begin the automated paper marking process.
- Wi-Fi router should be configured to connect to the LAN and also android based mobile device which is used to deploy the AEIS mobile application must be compatible with connecting to a LAN via Wi-Fi

2.2 Product functions

Examination Invigilation Module

As the starting criteria of the examination invigilation module, the examination has to be scheduled and examination hall seat arrangement has to be defined. After examination scheduling and seat arrangement definition is completed, on the examination date at the examination hall entrance candidates has to authenticate themselves with the face authentication system. After the successful authentication of a candidate he/she will be recognized as a valid candidate for the particular examination and will be allowed to enter the examination hall. There will be an electronic display at the entrance of the examination hall for the purpose of displaying a virtual diagram of the seating arrangement for the particular examination in the particular examination hall. Along with the seating positions displayed on the electronic display, the name and the index number of the registered candidates for each and every seating position also will be displayed. As soon as the system authenticates the candidate with the face authenticating, system will validate the

details and fetch the candidate details and the seating position for the particular authenticated candidate on the particular examination hall. The exact seating position of the authenticated candidate will be highlighted in the electronic display at the examination hall entrance. Therefore the candidate won't need to bother to go through different seats to find the seat allocated for him/her.

There will be a High Quality Video Camera attached to each and every examination hall ceiling to obtain a HD live stream video of the invigilated examination hall. The proposed video camera for this process will provide a HD output. Video camera will be positioned in an angle which can clearly cover the complete examination hall. Focusing of the video camera will be fixed focus since there won't be any changes of the position of the video camera after fixing it to the ceiling. Video stream will be transferred from the camera to the system through connectivity cable.

AEIS system will facilitate the invigilator to observe the live video stream of the examination hall through the digital monitor in front of him/her. A virtual grid overlay which separates the seating positions will be added on top of the live stream of the examination hall in order to easily identify candidates in a discrete manner. Furthermore invigilator will be able to switch between multiple observing options of live video stream. Examination invigilator can observe multiple video streams in a single window as separated frame layout, separate video streams in tab based layout etc. To simplify the use of invigilating stream and make the invigilating purpose more user-friendly there will be flexible options to control the video stream such as zoom in/ zoom out, navigate in zoomed view, switch between live streams etc. While invigilating the examination hall if the invigilator needs to know information about a particular candidate the invigilator will provided the option to view information of that particular candidate just by clicking on the candidate's seating position on the live video stream. The AEIS system will locate the clicked position, identify the index number allocated for the particular location at the current examination and then query and display the information for the candidate who owns the selected index number. If the invigilator needs to know any special remark (bad reputation of examination cheatings [4], differently abled candidates etc.) on any of the candidate within the current candidate set invigilator will be able to get the necessary information through the system. AEIS system will identify the registered candidate set for the current examination and display if any candidate has any special remark.

AIES system will track the motions of the candidates in order to identify any suspected acts (examination frauds such as copying, passing chits between candidates) happening at the examination hall while the examination goes on. For the motion tracking [6] of the candidates AIES system will use a suspected act detecting algorithm which will be based on main factors.

- Tracking the motion of the candidate's head [5]

By analyzing the live stream AEIS will mathematically calculate the movements of each and every candidate's heads in order to identify whether the candidate tries to cheat by copying from other candidates. [4] Algorithm will be developed in order to detect only the considerable movements since some normal slight movements shouldn't be considered as cheatings or frauds [4].

- Tracking the movement of candidate's upper body

After analyzing several simulations of examination frauds it can be decided that considerable movement of upper body can be taken as a hint of examination fraud in most cases. In the proposed AEIS upper body of candidate will be tracked in order to detect any abnormal movement.

- Tracking the movements of candidate's eye pair [7]

Even though the position of eyes is the most accurate way of detecting examination frauds, in most cases candidate's eyes are not clearly visible at most of time in the examination duration due to bowed heads of candidates, low sensitivity of video stream etc. But still eye pair tracking plays a considerable role in examination fraud detection since there are some occasions which eye tracking can still be used such as when the candidate tries to copy from the candidate just in front of him / her.

Using these three main factors and other related factors the algorithm for identifying suspected acts will be developed to successfully identify suspected acts up to 95% of accuracy. Furthermore this algorithm will be able to calculate the severity level of suspected act based on different criteria's having different weights assigned. While the examination is on progress AEIS system will continue to analyze the video stream in order to identify any suspected acts happening at the currently invigilating examination hall. If any suspicious act happens an alert will be generated by the AEIS system to notify the invigilator on the suspicious act. For maximizing the usability of the AEIS system will use different color schemes to highlight the suspected candidates according to the suspected severity level which will be calculated by the algorithm. Furthermore the AEIS system will keep log records about the suspicious acts with the relevant details such as suspicious candidate, time which the act occurred, examination venue and seating position and the severity level. AIES system will also maintain a list of candidates who are identified as suspected for cheatings for each and every examination in case the invigilators need to pay special attention on their result sheets at the paper marking time.

AEIS system provides feature to track the candidates who are requesting for invigilator's assistance such as requesting additional examination materials. The system will be able to identify a raised hand (using a palm detection algorithm) in the live stream using hand gesture recognition techniques [8]. When a raised hand or multiple hands are detected AEIS system will be able to identify it as a request for assistance and the requesting candidate will be highlighted in the video stream with a blinking square. When the system detects that a candidate is requesting further assistance system will provide alerts to notify the invigilator on the request. With this feature examination invigilator won't miss any request of assistance and will be able to cater the candidates as soon as possible. In some case there can be more than one request for assistance may occur at the same time. To cater this type of cases AEIS system will maintain a priority based request list which will make sure the requests are assisted in first request first serve basis. It will avoid the candidates to wait longer time periods for assistance.

Function 1: Show examination hall/halls live video stream to the invigilator

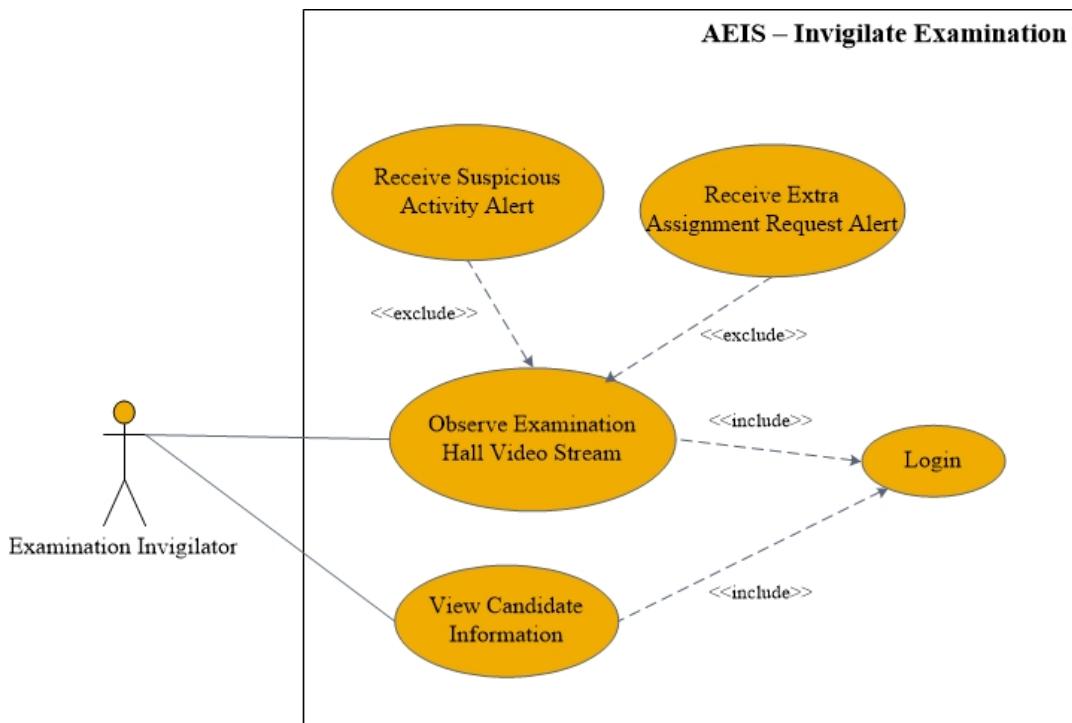
This function will provide the facility to obtain the live video stream of the examination hall through the examination invigilators computer. Invigilator will be able to use different video control options such as zoom in, zoom out and navigate in video stream etc. There will be a grid overlay on top of examination hall live stream video to identify each candidate in a separated manner. Candidate information will be able to obtain by simply clicking on the grid cell which is allocated for a particular candidate

Function 2: Highlight suspected activities of candidates

This function will be able to detect any suspected activity with the fraud detection algorithm and highlight any suspected act in the video stream. Furthermore this function will generate alerts to the invigilator about the suspicious acts. A suspicious candidate log will be maintained automatically throughout the examination.

Function 3: Highlight students who are requesting for assistance

This function will be able to identify any candidate who is requesting for assistance of the examination invigilator by raising his/her hand and will highlight the candidate in the video stream in a predefined color. Furthermore this function will provide alerts for invigilator on requests of assistance. This function will also maintain priority list based on the time of the request of the candidate.

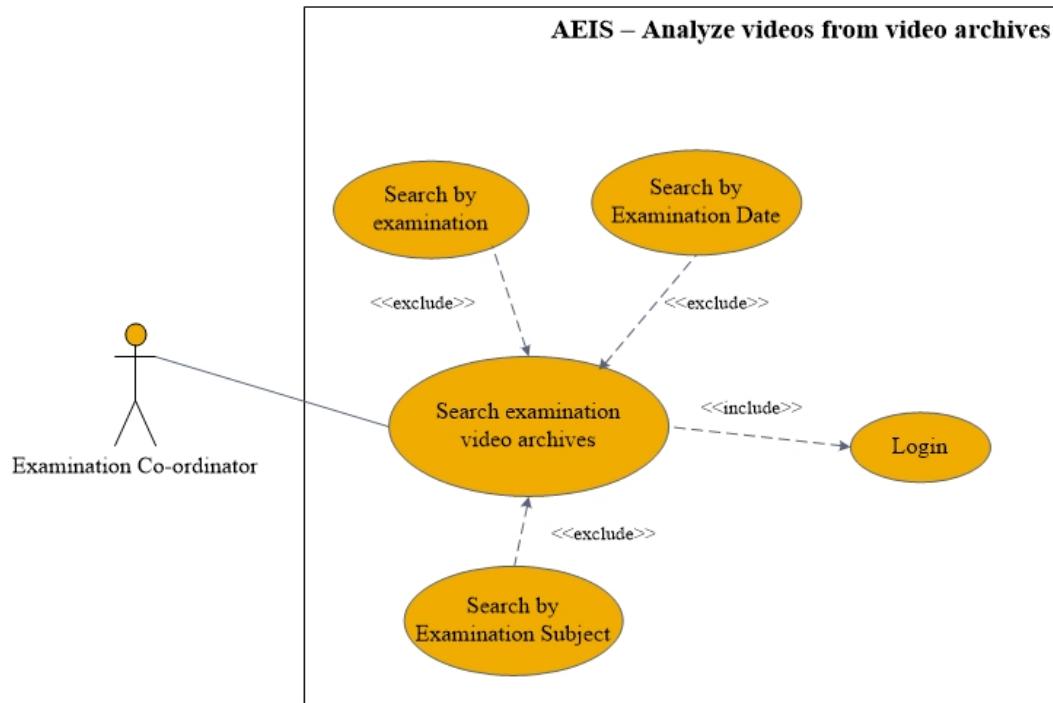


Examination Invigilation Module Video Archive

AEIS system will also facilitate the invigilators to save the whole examination video for archival purposes in case that there will be a need to watch the video at a later time. The archiving location, video formats, video quality can be changed according to the need of the invigilator or the using organization. Further the AEIS system will provide the facility to search the achieved videos based on different search criteria such as examination date and time, examination date range or even using the subject of examination. There will be an option to watch all the suspicious acts occurred in a particular examination at a later time.

Function 4: Enable to analyze examination video at a later time

Examination Invigilator will be able to analyze the examination videos at a later time using the video archive. Invigilator will be able to search videos by the examination, examination date and examination subject etc. Invigilator will be able to analyze the suspicious act occurred in a particular examination with this function.

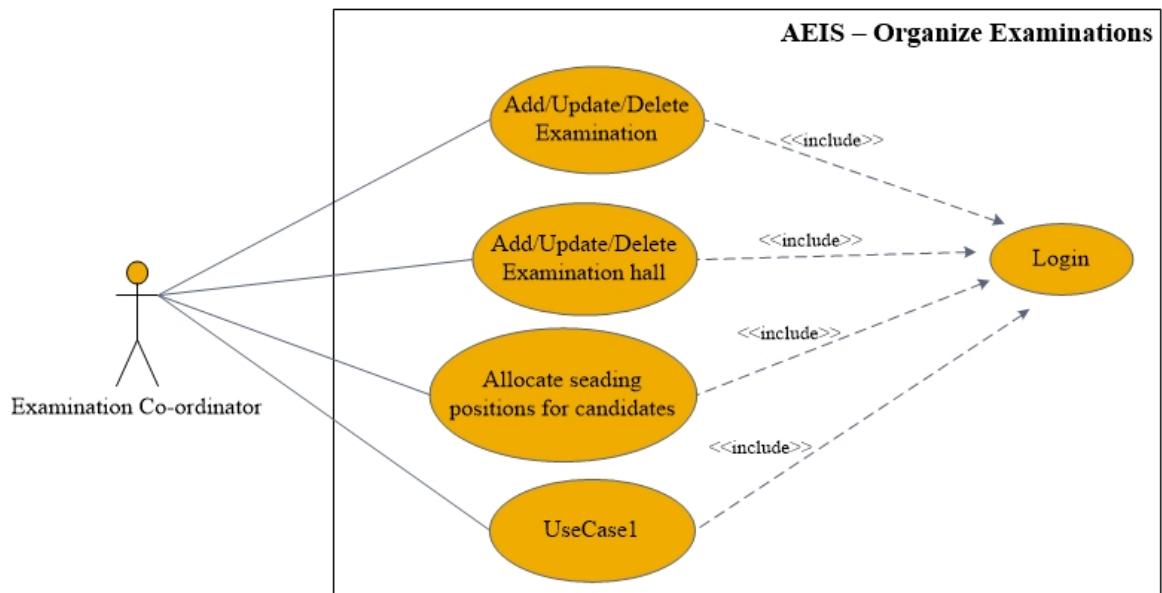


Video Archive Organize Examinations

Function 5: Schedule Examinations

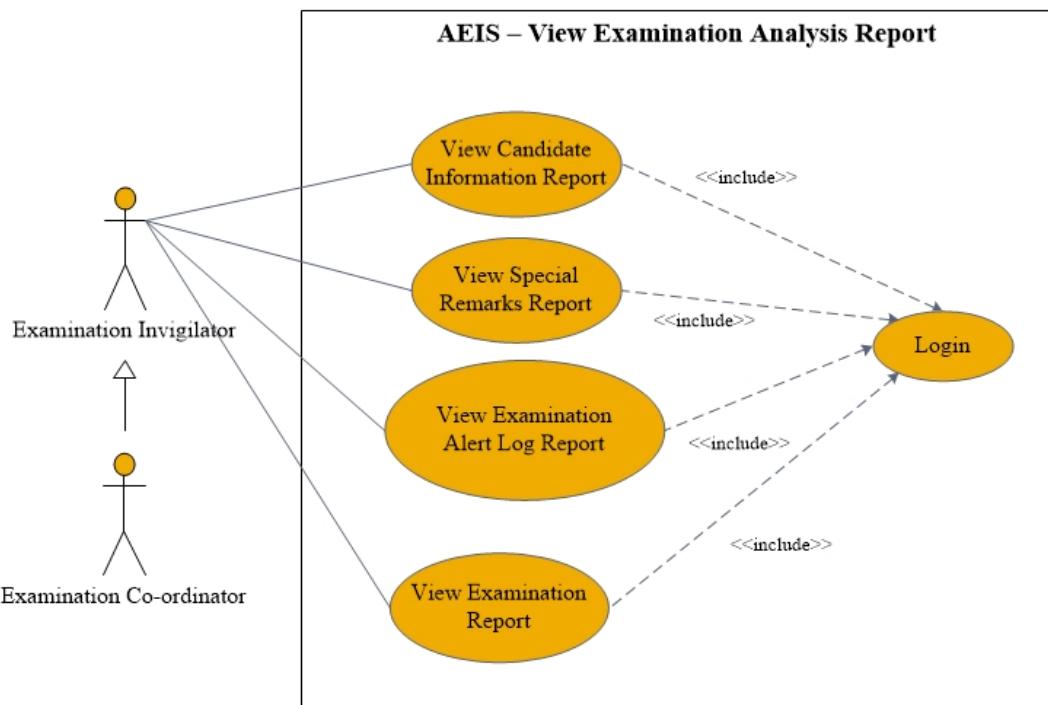
Examinations Coordinator or Management of the organization will be able to use this function to schedule a new examination, update and delete scheduled examinations as well. This function will also facilitate to allocate examination halls for examinations and also updating the allocated examination halls as well. Organize Examination Function will also provide the facility to allocate seating positions for the candidates in the examination halls to sit for the registered examinations.

tions.



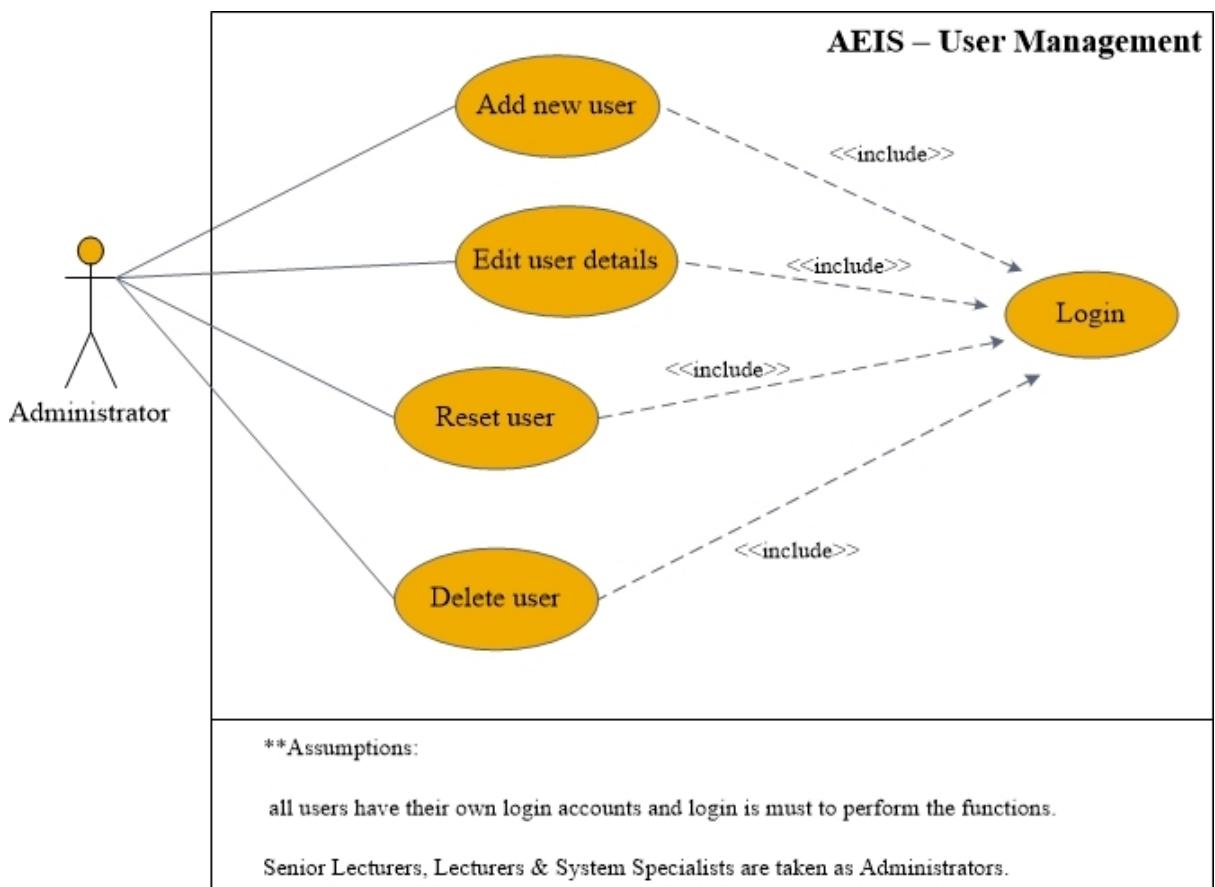
Organize Examinations
Generating Examination Analysis Reports
Function 6: View Examination Analysis Reports

Examination Invigilator as well as Examination coordinator will be able to use this function to generate different types of examination analysis reports. Invigilator can generate candidate information report in order to retrieve information on a group of candidates who face for a particular examination. Invigilator will also be able to generate candidates special remarks report to check any special remarks about the candidates who face for a particular examination. Invigilator will also be able to generate examination alert log report which will contain all details about the suspicious acts occurred in a particular examination will all the relevant details.



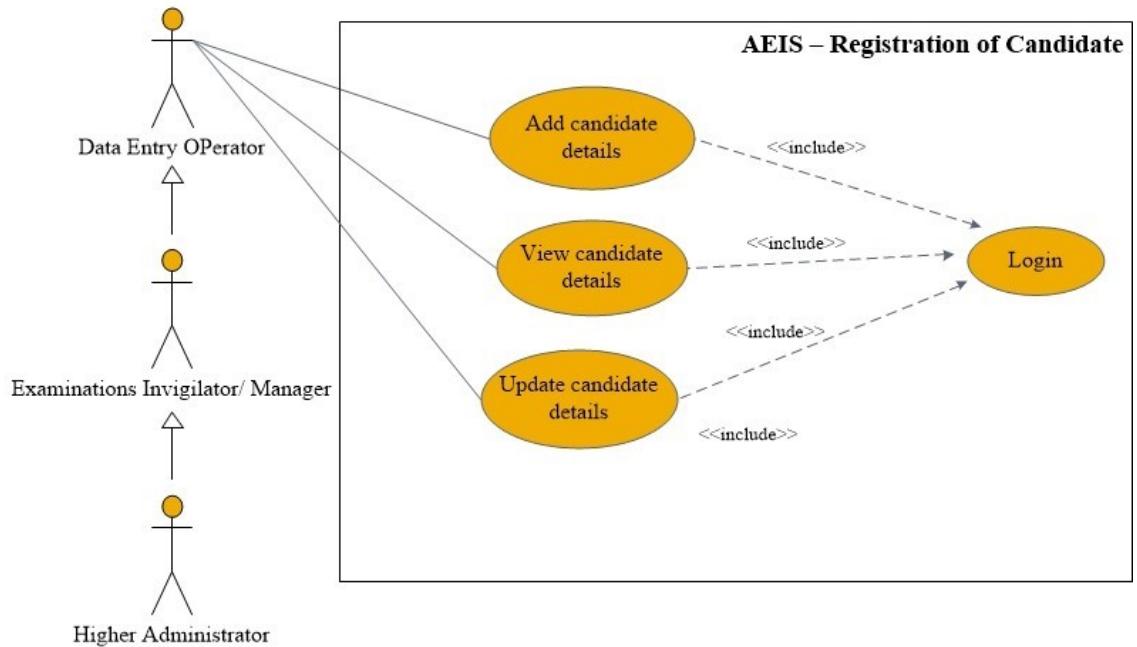
Generating Examination Analysis Reports System User Management

- Add new users to the system.
- Edit existing user information.
- Reset user password.
- Delete existing users.
- System Login.
- Manage user levels & function categories.



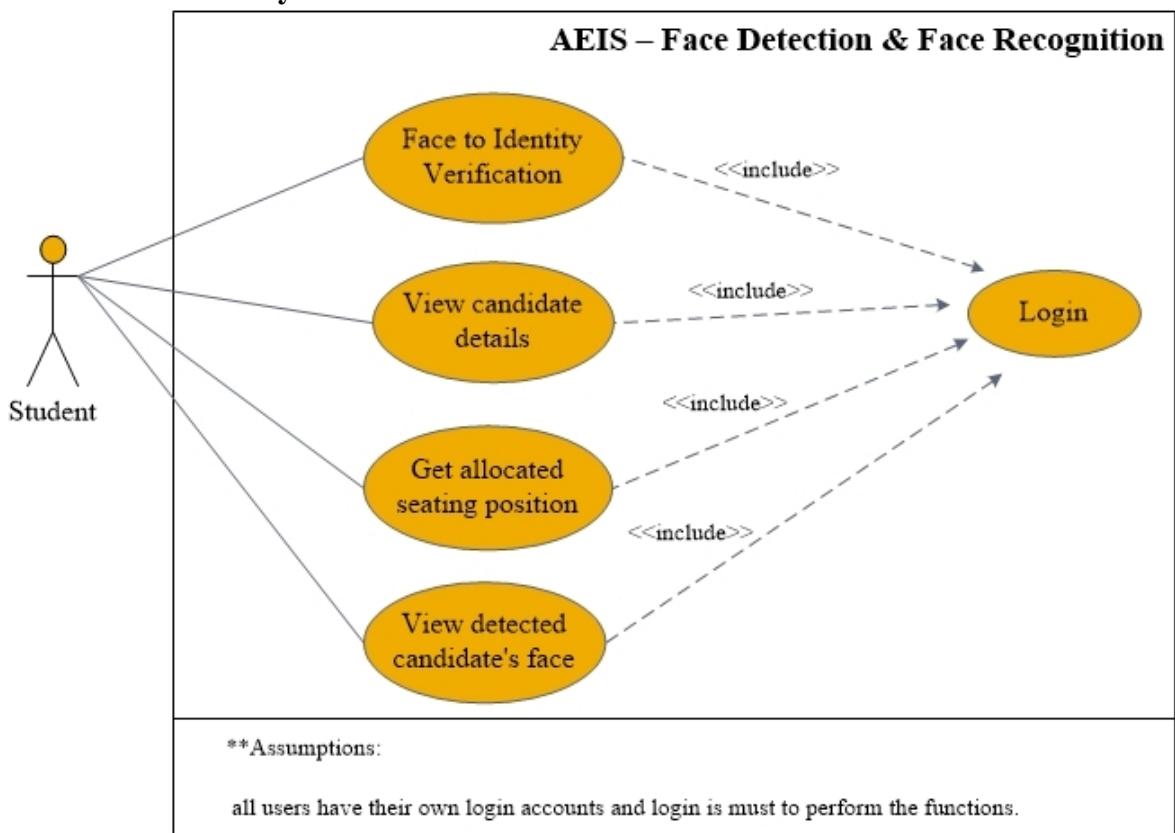
System User Management

Registration of Candidates



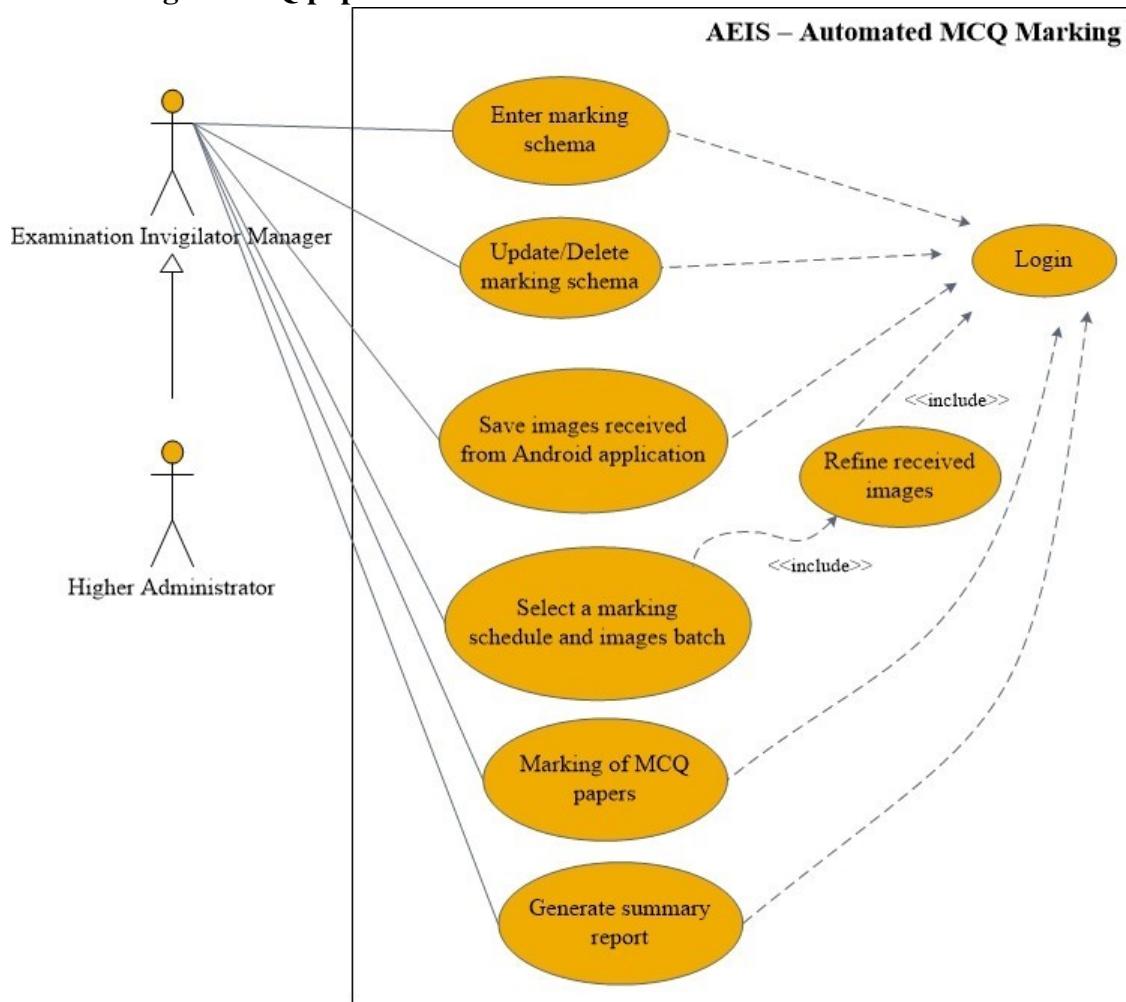
Registration of Candidates

Candidate Identity Verification



Candidate Identity Verification

Marking of MCQ papers



Marking of MCQ papers

2.3 User Characteristics

Users of AEIS system can be any authorized personnel related to the examination management process. Mainly the users can be categorized as Examination Invigilators, Examination Coordinators, Data Entry Operators and Management of the Organization.

Examination Invigilators

Examination Invigilators user group includes teachers, lecturers, instructors and other academic staff. This user group obtains a high computer literacy and ability to get along with the system within a short time period. Examination Invigilators will be able to invigilate the examination hall and identify the illegal activities through the system as well as providing instant assistance for the candidates with the help of extra assistance request alerts. This user will have to use both AEIS desktop and mobile applications.

Examination Coordinators

Examination coordinators user is a higher level academic staff member such as principal and examination manager etc. This user also obtains a high computer literacy and ability to get along with the system within a short time period. Examination coordinators will be able to schedule examinations and update the scheduled examination as well.

Data Entry Operators

Clerks, receptionists or similar office staff will act as data entry operator users for the AEIS system. This user obtains a lower computer literacy. Therefore this user should be properly trained for the system prior to the deployment. This user is provided a simple user interface in order to minimize the usability problems faced by the user.

Organizational Management

Organizational Management user will most probably be principal, CEO, Dean, Chairman etc. These users obtain a high computer literacy and ability to get along with the system within a short time period. Organizational Management user will be able to view examination analysis report, video archive and other management functions. This user is provided the access for all the functionalities of the system though only the management functions are commonly used by them.

2.4 Constraints

- AEIS shall operate on PCs running Windows XP or later windows operating system which the speed is higher than 2.4 GHz.
- Wi-Fi range of the router will limit to only 100m and invigilator will not be able to use Android client application outer from this range.

- AEIS System will need .NET framework to operate on invigilators system.
- AEIS system will work only with Microsoft SQL server database management system as its database component.
- HD video camera will generate video stream which is clear enough for the system operations within 15m range. Examination halls with a length more than 15m will not be invigilated meeting the expected accuracy.
- Examination hall should be maximum 10m wide to be covered from a single HD video camera.
- Network data transfer rate should be higher than HD video camera data transfer rate (40 Mbit/s)
- Examination hall should not have any obstacles within the camera range. Otherwise faulty results will be generated.
- For testing purposes sample videos will be used since using live streams of examinations for testing is not practical.

2.5 Assumptions and dependencies

- AEIS system will run only on windows operating systems.
- Assume that examination hall will have the necessary lighting conditions while the examination takes place.
- Assumed that network communication availability is 100%
- Assumed that examination hall environment (position of seats etc.) will remain unchanged over time.
- Assumed that more than two choices as a MCQ question answer is considered invalid answer.

2.6 Apportioning of requirements

It is possible in the future that a few additional features be implemented into this system.

- Automatically read data from filled candidate registration forms and add them to the AEIS using Optical Character Recognition (OCR) techniques
- Online registration of candidates

- Setting up cameras for each candidate table to observe them individually.
- Online Results Distribution System
- QR Code based Candidate ID System

3 Specific requirements

3.1 External interface requirements

3.1.1 User Interfaces

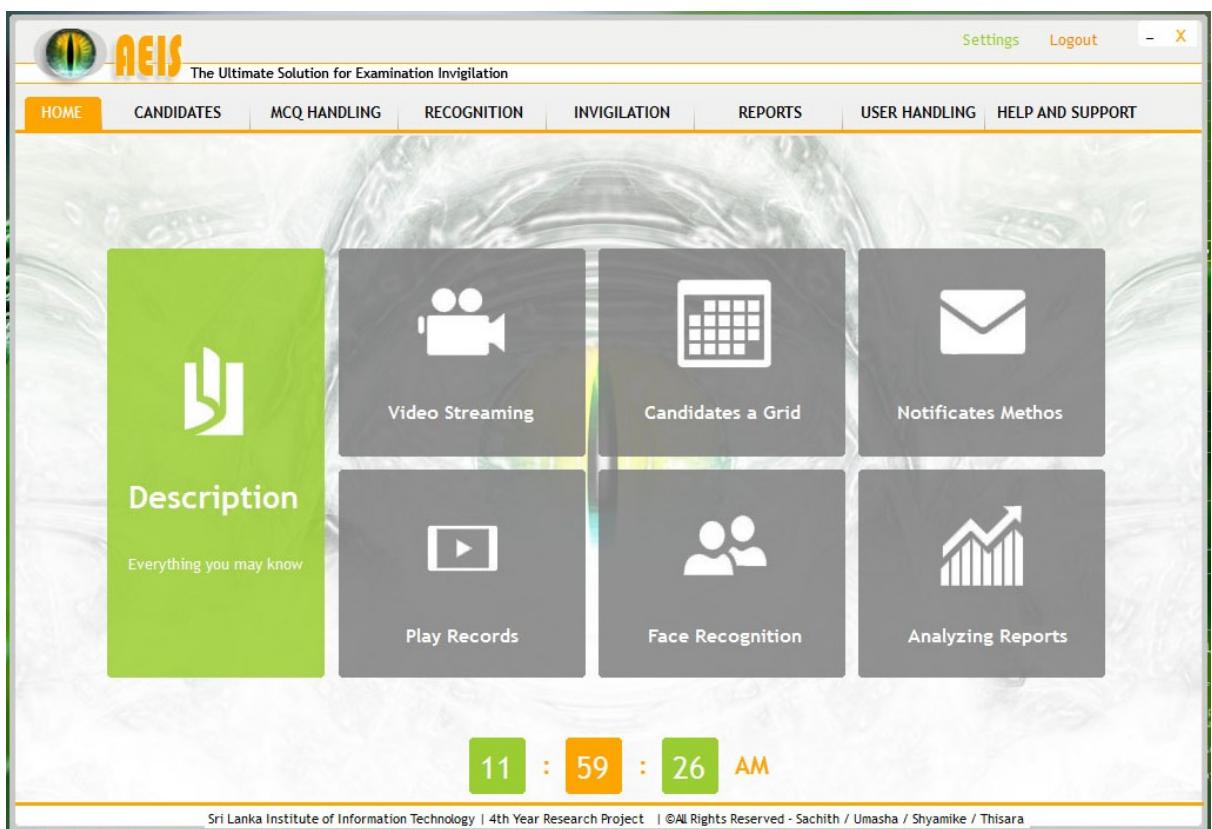
Login Interface



Login Interface

Login interface allows the user to log in to the AEIS system to use its functionalities. User has to provide username and password as inputs to login process.

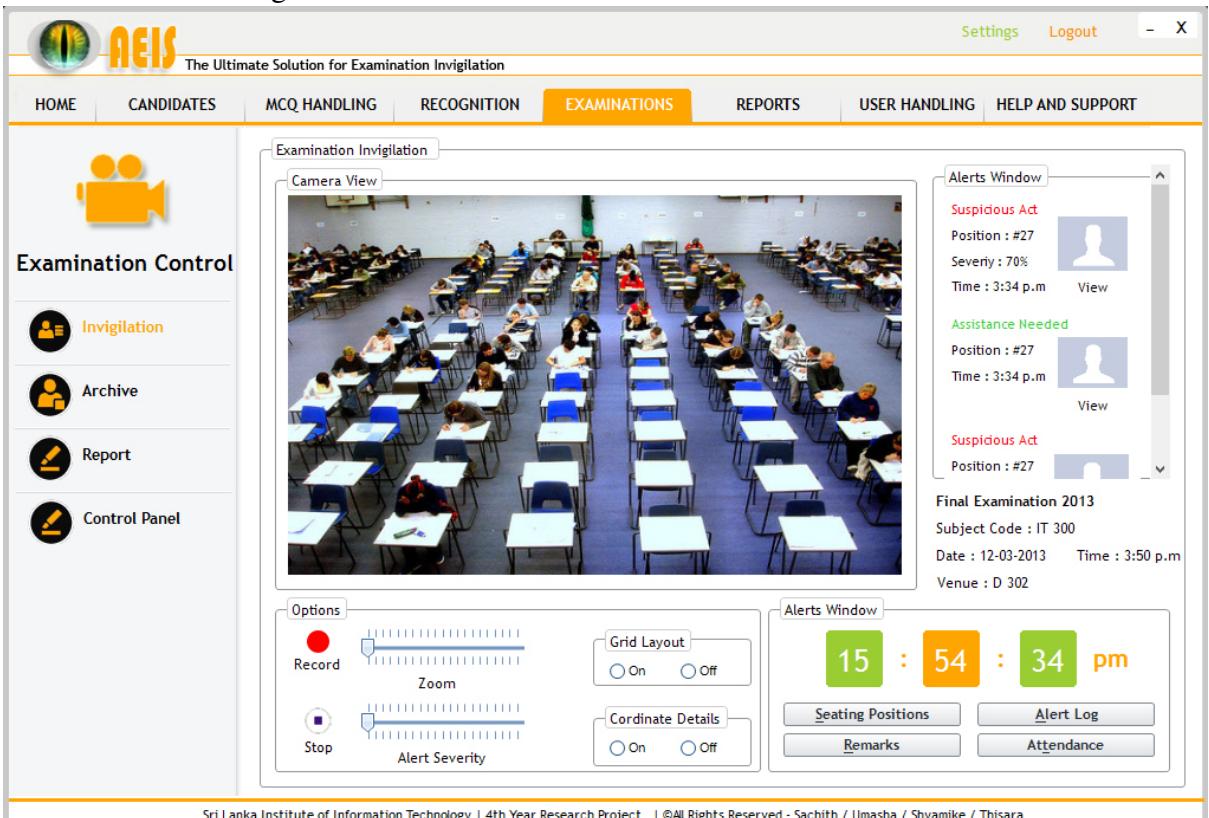
Home Interface



Home Interface

Home Interface is the main interface which enables the navigation to the other interfaces and functions of the AEIS system. When the user logs in to the system user will be navigated to this interface. The top horizontal menu will provide the access to the other functionalities of the system. This home interface will allow the user to navigate to the settings interface and also facilitates the user to log out from the system.

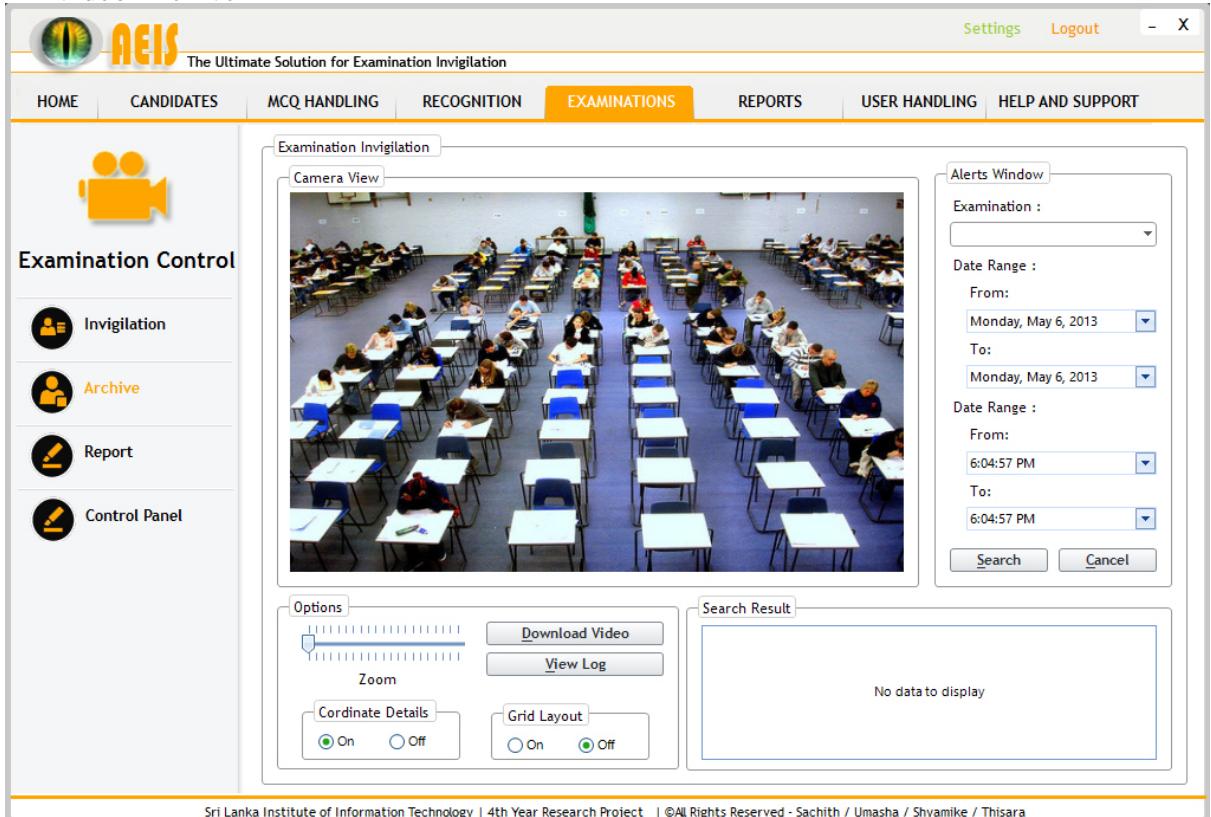
Examination Invigilation Interface



Examination Invigilation Interface

Examination Invigilation interface is the main window of the examination invigilation module. After a successful login examination invigilator can navigate to this interface in order to begin an invigilation process. The live video stream will be provided in the camera view panel. There are video controllers such as record/ stop button, zoom slider, grid layer on/off toggle etc. to maximize the customizing according to the users requirements. There will be option to control the severity of a suspected act which generates an alert. There will be Alerts window which shows latest alerts for the invigilator with the relevant details.

Video Archive



Video Archive

This interface provides the facility for the examination invigilators, examination coordinator as well as the higher management to retrieve and watch the videos of the past examinations. With the several search criteria such as examination date range, examination subject etc. will provide user friendly searching facility for the user to find a particular examination video easily. The user will be provided the option to download the video from the video archive or play it in the interface there itself. For the playing purpose there are media player options too. Other than these the alert log generated at the particular examination also will be able to inspect with this interface.

Candidate Registration Interface

The screenshot displays the Candidate Control section of the AEIS system. On the left, there is a sidebar with icons for 'View Candidate Details', 'Add New Candidate', and 'Update / Delete Candidate'. The main area contains a 'Registration Form' with the following fields:

- Candidate ID : [Text Input]
- Full Name of the candidate : [Text Input]
- Name with the initials : [Text Input]
- Title : [Text Input]
- Citizenship : [Text Input]
- NIC No. : [Text Input]
- Date of Birth : [Text Input] (set to Sunday, March 24, 2013)
- Permanent address : [Text Input]
- Contact Numbers : [Text Input]
- Academic Course name : [Text Input]
- Subjects :
 - Subject 1 : [Text Input]
 - Subject 2 : [Text Input]
 - Subject 4 : [Text Input]
 - Subject 5 : [Text Input]
 - Subject 3 : [Text Input]
- Photograph : [Placeholder Image] (Browse button available)
- Payment Details (if any) : [Text Input]

At the bottom right are three buttons: 'Reset', 'Register', and 'Cancel'.

Candidate Registration Interface

The following interface will be used to register a new candidate. The Data entry Operator has to enter the details in the registration form filled by the candidate.

Update/ Delete existing candidate record

The screenshot shows the 'CANDIDATES' tab selected in the top navigation bar of the AEIS application. On the left, a sidebar titled 'Candidate Control' lists three options: 'View Candidate Details', 'Add New Candidate', and 'Update / Delete Candidate'. The main area contains a search section with a 'Candidate ID' input field and a 'Search' button, which displays the message 'No data to display'. Below this is a 'Registration Form' section containing fields for Candidate ID, Full Name of the candidate, Name with the initials, Title, Citizenship, NIC No., Date of Birth (set to Sunday, March 24, 2013), Permanent address, Contact Numbers, Academic Course name, Gender (with radio buttons for Male and Female), and a placeholder for a photograph. At the bottom of the page, a footer bar includes the text 'Sri Lanka Institute of Information Technology | 4th Year Research Project | ©All Rights Reserved - Sachith / Umasha / Shyamika / Thisara'.

Update/ Delete existing candidate record

The above interface is for updating and deleting existing candidate records. First the particular candidate record should be search and selected among the search results. Once the candidate record is selected, all the text boxes will be filled with the details of the particular candidate.

View candidate details

The screenshot shows the AEIS Candidate Details interface. The top navigation bar includes links for HOME, CANDIDATES (which is highlighted in orange), MCQ HANDLING, RECOGNITION, INVIGILATION, REPORTS, USER HANDLING, and HELP AND SUPPORT. The CANDIDATES section has a sub-menu titled 'Candidate Control' with three options: 'View Candidate Details' (selected), 'Add New Candidate', and 'Update / Delete Candidate'. The main content area is titled 'Candidate Information' and contains a search bar with fields for 'Candidate ID' and a 'Search' button. Below this is a message 'No data to display'. To the right, there is a 'Photograph' placeholder with a 'Browse' button. A detailed list of candidate information follows:

Candidate ID :	3424234
Full Name of the candidate :	Jhone Smith
Name with the initials :	J. Smith
Title :	Mr.
Citizenship :	American
Gender :	Male
Date of Birth :	12/03/1988
Permanent address :	Chicago
Contact Numbers :	xxxx-xxxxxx
Academic Course name :	Software Engineering
Payment Details (if any) :	Rs. 70,000.00
Subjects applied	CDAP , AIES, MTIT

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View candidate detail

The above interface is for displaying the details of a particular candidate. First the particular candidate record should be search and selected among the search results. Once the candidate record is selected, all the text boxes will be filled with the details of the particular candidate.

MCQ marking module

MCQ Answer Sheets

The screenshot shows the AEIS software interface for managing MCQ answer sheets. The main menu bar includes HOME, CANDIDATES, MCQ HANDLING (which is highlighted in orange), RECOGNITION, INVIGILATION, REPORTS, USER HANDLING, and HELP AND SUPPORT. On the left sidebar under 'MCQ Paper Handling', there are four options: 'MCQ Answer Sheet' (selected), 'Marking Schema', 'Marking MCQ', and 'Report'. The central panel is titled 'MCQ Answer Sheets' and contains three sections: 'Save', 'Open', and 'Delete'. Each section has a dropdown menu for 'Select Examination' and a text input field for 'Location', with a 'Browse' button. In the 'Open' section, there are 'Open' and 'Delete' buttons. In the 'Delete' section, there are two 'Delete' buttons. At the bottom of the interface, a footer bar displays the text 'Sri Lanka Institute of Information Technology | 4th Year Research Project | ©All Rights Reserved - Sachith / Umasha / Shyamika / Thisara'.

MCQ Answer Sheets

This interface will be used to specify a location to save the images of MCQ answer sheets received from the Android Mobile Assistant and save the images accordingly. By using the options Open and Delete, the saved images can be opened and deleted if necessary at a later time.

Marking Schema

The screenshot shows the AEIS software interface with the 'MCQ HANDLING' tab selected. On the left, there's a sidebar titled 'MCQ Paper Handling' with icons for 'MCQ Answer Sheet', 'Marking Schema' (which is highlighted in orange), 'Marking MCQ', and 'Report'. The main panel has two main sections: 'Add' and 'Update'. The 'Add' section contains fields for 'Marking Schema ID' (text input), 'Examination' (dropdown), 'Marking Schema Image' (file input with 'Browse' button), and 'Gender' (radio buttons for 'Paper is marked' or 'Paper is not marked'). The 'Update' section contains similar fields for editing existing data, along with a 'Status' section (radio buttons for 'Paper is marked' or 'Paper is not marked') and an 'Update' button. At the bottom, there's a 'Delete' section with a dropdown for selecting a marking schema and a 'Delete' button.

Marking Schema

The following interface will be used to handle all the tasks related to handling Marking Schemes. Through this interface marking schemes can be uploaded, edited and deleted.

Marking MCQ

The screenshot shows the 'MCQ HANDLING' section of the AEIS software. The 'Marking MCQ' option is selected in the sidebar. The main panel contains fields for selecting a marking schema and answer sheet, and a progress bar indicating the number of papers marked and total to be marked. The right side shows a preview of the current answer sheet.

Marking MCQ

The following interface is the most important user interface related to MCQ Handling module, which performs marking of MCQ papers. First the user will have to select the answer sheet batch, marking scheme and the examination ID. Then by pressing the Start paper marking button the process will get started. In the right panel of the interface, the image of the currently marking answer sheet will be displayed. At the bottom of the interface summary of the progress is shown with the details such as number of papers already marked and number of papers remaining to be marked. The progress bar will indicate the progress of the currently marking answer sheet.

Report Generation

The screenshot shows the AEIS software interface. At the top, there is a logo with the text "AEIS The Ultimate Solution for Examination Invigilation". The top navigation bar includes links for Settings, Logout, and other system functions. Below the navigation bar, a horizontal menu bar has tabs for HOME, CANDIDATES, MCQ HANDLING (which is currently selected), RECOGNITION, INVIGILATION, REPORTS, USER HANDLING, and HELP AND SUPPORT. On the left side, there is a sidebar titled "MCQ Paper Handling" with four items: "MCQ Answer Sheet", "Marking Schema", "Marking MCQ", and "Report". The main content area is titled "Marking" and contains a "Details" section with three radio button options: "Select Examination" (selected), "Select Date", and "Select Date range". Under "Select Date", a dropdown menu shows "Monday, May 6, 2013". Under "Select Date range", two dropdown menus show "From : Monday, May 6, 2013" and "To : Monday, May 6, 2013". A "Generate Report" button is located at the bottom of the "Details" section. To the right of the "Details" section is a "Report Viewer" panel which is currently empty. At the bottom of the interface, there is a footer with the text "Sri Lanka Institute of Information Technology | 4th Year Research Project | ©All Rights Reserved - Sachith / Umasha / Shyamika / Thisara".

Report Generation

Through this interface reports containing details of MCQ paper marking can be generated easily. The user just has to select the examination, date of examination or a range of dates and click on Generate Report button. In the right panel of the interface there is a report viewer which contains the generated report. These reports will be in PDF format and thus saving and printing options are available.

3.1.2 Hardware Interfaces

- High Definition (HD) Video Camera**

Video Mode: 720p

Frame in Pixels: 1280 x 720

Pixels per image: 920600

Scanning type: Progressive

Frame rate (Hz): 24 or Higher

- Web Camera**

Resolution: 640x480 pixels

Photo: Up to 1.3 megapixels

Video capture: 640x480 pixels

- Extra LED flashing devices**

Light: 200 Lumens

Range: 10 M

- Wi-Fi Router/ Access Point**

Standards: IEEE 802.11g / IEEE 802.3 /IEEE 802.3u

Device Interface: 10/100 LAN Port, 10/100 WAN Port

Security: Wi-Fi Protected Access (WPA, WPA2)

- LAN Connectivity**

Standard: IEEE 802.3

Cable Connectivity: Ethernet CAT 6

- 17' or Higher Display devices**

Type: LCD/LED/CRT

Resolution: 1024 x 768 or Higher

- Android Mobile Devices with Wi-Fi supported**

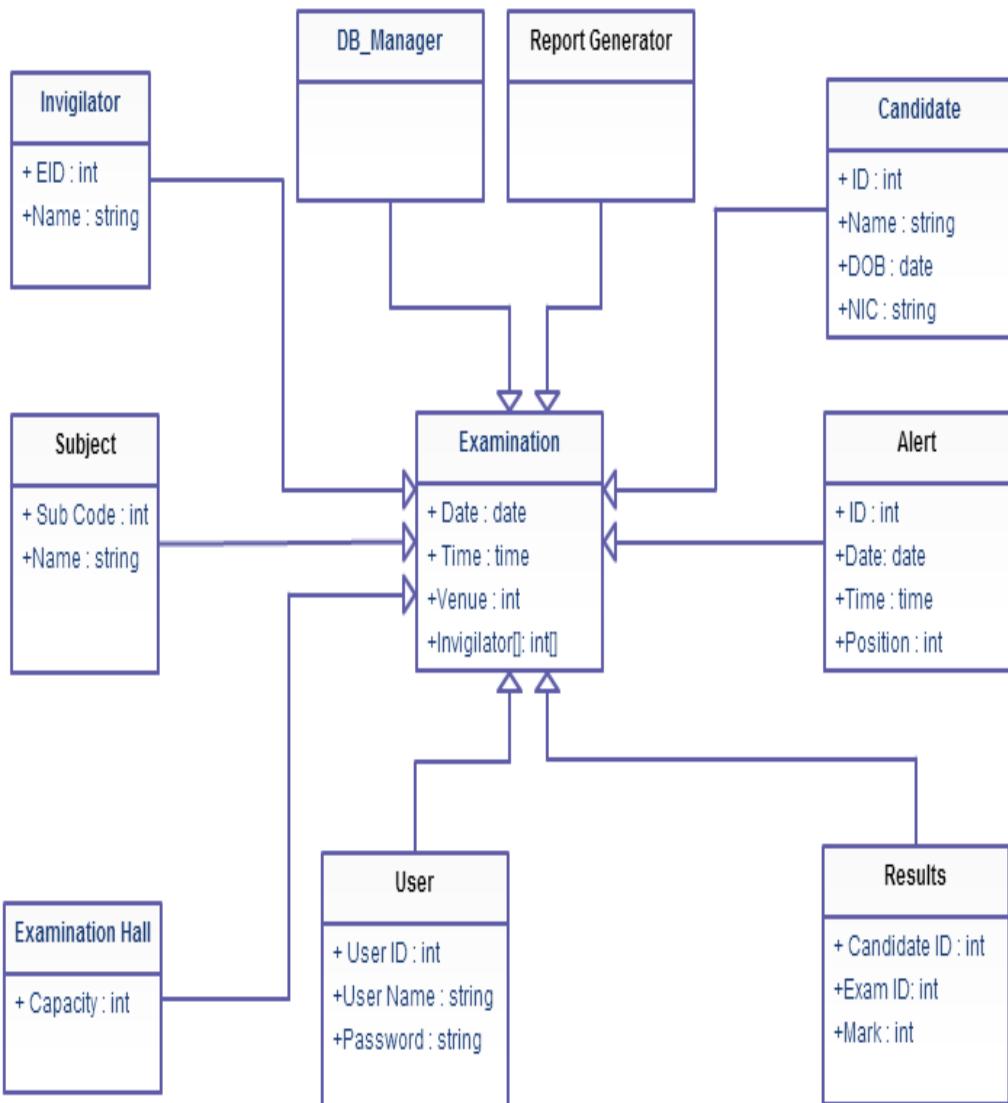
3.1.3 Software interfaces

- AIES system will only supports the windows operating systems (XP, Vista, Windows7).
- Automated Examination Invigilator System (AEIS) shall interface with SQL Server 2005 as its database component.
- AIES shall interface with Emgu CV Wrapper which essentially provides an interface between OpenCV and C#.
- AEIS Mobile Application will use Android mobile platform and will only be deployed to android based mobile devices.

3.1.4 Communication interfaces

- SMS Communication Gateways has to be used for implementing periodic notification SMS for the candidates regarding the examination.
- SMTP [9] mail servers have to be used for email communication which is used for email notifications of the system.
- Wi-Fi Access Point is used to communicate with android mobile client application of the AEIS system.

3.2 Classes/Objects



Classes/Objects

3.3 Performance requirements

- AEIS is mainly an image processing and video surveillance base software system; therefore the performance of the system is almost based on the efficiency of image processing and video analyzing processes.

- In the Identity verification process at the entrance to the examination hall face will be identified within 5 seconds if the predefined environment facts are met (lighting, distance to the face from camera etc.)
- The video analyzing will depend on the quality of video frame and video frame rate. When there is 720p HD video and 24 fps video is streamed the maximum acceptable delay will be 2 seconds.
- Android client application will be able to upload an image of MCQ answer sheet to the desktop application within 5 second time if the distance between android device and Wi-Fi access point is below 20 meters and no other uses connected to the access point.
- The maximum number of simultaneous users for AEIS will be 10 users.
- AEIS system should have enough hard disk space in order to save all examination videos in HD format.

3.4 Design constraints

- The database component of the AEIS system is Microsoft SQL server 2005 and therefore all the databases should be designed in relational database design approach.
- AEIS system will use a centralized database server and all the clients should use the same central database for their functionalities.
- The examination video analyzing should happen real-time, therefore highly efficient video analyzing algorithms has to be used for that purpose.
- Examination videos, MCQ answer sheets scanned copies and other multimedia files will not be stored in the database since system need speedy access of the multimedia files.
- User interfaces should be designed in a manner which both high and low technical people can use the system without a problem
- Android mobile client has to be designed in a way that constant connection between mobile application and server is maintained. Otherwise mobile application will not be able to respond for the alerts generated by the desktop application.

3.5 Software system attributes

3.5.1 Reliability

- Only 1 out of 50 runs can crash down without a human error.
- Minimize the error with high level of data validation.
- False face verification probability is 99.9%
- False suspected activity detection probability is 95%

3.5.2 Availability

- The system will be 99.99% (4 nine) available within the examination hours except there is a planned downtime.
- All cached data will be rebuilt during every startup. There is no recovery of user data if it is lost. Default values of system data will be assigned when necessary.

3.5.3 Security

- AEIS system will use user login to enter the system in order to use any functionality of AEIS
- Passwords and other sensitive details will be stored in the database in encrypted format using MD5 encryption technique.
- Only the database administrators will have the access to the central database which contains the system data.
- External requests via internet or outer from the network will not be catered by the system since the AEIS system is completely internal system
- Network will have firewall in order to block external intruders.
- The PC on which the AEIS resides will have its own security with OS level security and domain user control.

3.5.4 Maintainability

- AEIS use object oriented approach for its development which supports easy maintenance.
- AEIS will have a central database which makes the maintenance easy in database point of view.
- AEIS is highly modularized and have low coupling between modules as well in order to support easy maintenance.

4 Supporting information

4.1 Appendices

- **AEIS** (Automated Examination Invigilator System) is an Information System focused on automating the examination process and minimizing the difficulties faced by examination invigilators as well as candidates of the examination.
- **Invigilator** is someone who watches examination candidates to prevent cheating.
- **Face Recognition** given still or video images of a scene identify or verify one or more persons in the scene using a stored database of faces.
- **Motion Detection** in video surveillance, motion detection refers to the capability of the surveillance system to detect motion and capture the events.
- **Inter-Class Similarity** is the similarity of the faces in a single context.
- **Intra-Class variability** is the variations of human faces due to head pose illumination conditions, expressions, facial accessories and aging effects.
- **Microsoft SQL Server** is a relational database management system (RDBMS) that runs as a server providing multi-user access to a number of databases.
- **Wi-Fi** is a popular technology that allows an electronic device to exchange data wirelessly (using radio waves) over a computer network.
- **Software Developer** is a person or organization concerned with facets of the software development process wider than design and coding, a somewhat broader scope of computer programming or a specialty of project managing including some aspects of software product management.

- **Microsoft Visual Studio** is an integrated development environment (IDE) from Microsoft.
- **Integrated Development Environment (IDE)** is a software application that provides comprehensive facilities to computer programmers for software development.
- **Android** is a Linux-based operating system designed primarily for touch screen mobile devices such as smart phones and tablet computers.
- **Operating System** (commonly abbreviated *OS* and *O/S*) is the software component of a computer system that is responsible for the management and coordination of activities and the sharing of the resources of the computer.

4.2 Research Problems

4.2.1 Considerable amount of time taken to verify the identity of the candidates

In the process of invigilating the examinations, verifying the identity of the candidates is a mandatory task. Currently, at most of the government examinations National Identity Card (NIC) is the unique identifier used to verify the identity of the candidate. During the examination the invigilator has to collect NIC's from all the candidates under his supervision and manually compare the details of the candidate with the NIC details, the details available in the candidate's admission and the candidate details provided by the Department of the Examinations. This process consumes a considerable amount of time as it has to be done completely manually by the invigilator. Since the NIC's and Admissions are collected from the candidates during the examination it will bring about disturbances to the candidates. Also while the invigilator is involved in this identity verification process, he may not be able to swiftly response to the candidates who are in need of additional materials or any instructions.

4.2.2 Impersonation

Impersonating is a situation where another person is trying to attend the examination instead of the real candidate. This is also another major problem experienced at the examinations as the invigilator may not know the real candidate prior to the examination and maybe the very first time of seeing the candidate would be in real time at the examination. Therefore it is very difficult to avoid impersonation in the manual process.

4.2.3 Tracking attendance manually, consumes considerable amount of time

Tracking attendance of the candidates is also another problem which consumes a considerable amount of time. Currently the process of tracking attendance is done as a paper based work. The department of Examination will provide a list of names of the candidates assigned to a specific examination hall and their registration numbers to the invigilator. He has the responsibility of ensuring that all the candidates have put their signatures properly in the attendance sheet. At most of the time this process is also performed during the examination, so that the valuable time of candidates will be wasted uselessly. Further there is no efficient way of tracking the in and out times of the candidate when entering into the examination hall and when leaving the examination hall.

4.2.4 Ensuring that candidates are seated according to the set seating arrangements

Before commencing the examination, finding the correct seats allocated for all candidates in a particular examination hall and ensuring that the all are seated according to the arrangement is another major responsibility of the invigilator. At most of the time finding the correct seat allocated for a particular student is much confusing as there is no efficient solution used at the present. The invigilator has to refer to the list of candidates assigned to that particular examination hall to make sure the examination hall, to which the candidate is assigned and then discover the correct seat of the candidate by manually checking the available free seats. This may causes in commencing the examination at the desired time. Once each candidate is seated, the invigilator must check that each candidate is sitting in the correct desk, by checking each candidate's name against his/her registration number. (Attendance Register)

4.2.5 Avoiding examination malpractices

The incidence of examination malpractice is multi-dimensional in nature. Leakage of examination papers, Smuggling of prepared notes into examination hall, external assistance, copying, and smuggling of foreign materials substitution of script and improper assignment are some of the common ways used to cheat at examinations. Most of the time examination malpractice is coupled with dishonesty. Pupils and students devise as a daily routine, new tricks to beat genuine supervisors and examiners. Currently this has become a growing concern since cheating is such a longstanding and global problem inherent by human beings. Therefore there are so many difficulties in identifying and controlling cheating behaviors at the exams. The occurrence of examination malpractice at any level of educational

possess the greatest threat to the validity and reliability of any examination and consequently to the authenticity and recognition of certificate issued.

4.2.6 Respond promptly to candidate requests

The invigilator has the responsibility to supervise candidates in a quiet and unobtrusive manner and respond to candidate's queries promptly and distribute additional paper/equipment immediately as required. Several candidates may make requests at once, for exam-specific instructions, for a graph paper and any other additional materials, permission to use devices such as calculators. But a single invigilator cannot notice all candidates' requests in a one sight and serve them all immediately. May be he has to go several times to collect required materials and thereby it may lead to generate delays in responding to candidate requests promptly.

4.2.7 Keeping constant watch on candidates throughout the examination

The invigilator is required to keep constant watch on candidates and walk around the room, sitting both at the front and the back of the room throughout the examination to avoid examination malpractices and to identify immediately the candidates who needs instructions or additional examination materials. Invigilators may not write, read or knit as usual invigilators are used to do at exams.

4.2.8 Maintaining efficient time keeping

A large wall clock and/or black board must be provided. If a clock is used, candidates must be verbally told as each half-hour passes. If a board is used, chalk will be required and the time must be marked off in half-hours and these crossed out as the time passes. Candidates must be verbally told as each hour passes and when they have 30 minutes left. When there is only one invigilator assigned for the entire examination hall it may be very difficult to handle all the aspects of invigilating efficiently and effectively.

4.2.9 Inefficient and inaccurate marking of MCQ papers

It is very difficult to maintain consistency and accuracy in the marking of Multiple Choice Question (MCQ) answers with so many limitations. It consumes a lot of time to mark the papers manually and requires human resources significantly to perform the marking of papers. The cost engaged in this process is also very high. Degree of accuracy is very less and the error rate can be very high due to the illusion of human eye when following the same pattern of answers for a long

period of time. This situation becomes even more complicated when the number of answer sheets to be corrected is a very large amount.

4.3 Further Readings

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