

# **CLOUD-BASED LECTURE CAPTURING SYSTEM**

Project Id: 18-072

Software Requirements Specification

IT15010322, L. C. Tennakoon

IT15021076, H. M. S. V. Mudalige

IT15087898, A. P. Jayasinghe

IT15081094, V. R. Wijayagunawardene

BSc. Special (Hons) in Information Technology (Software Engineering)

Faculty of Computing

Sri Lanka Institute of Information Technology

Sri Lanka

May 2018

# Contents

|                                                   |    |
|---------------------------------------------------|----|
| 1. Introduction .....                             | 5  |
| 1.1 Purpose .....                                 | 5  |
| 1.2 Scope .....                                   | 5  |
| 1.3 Definitions, Acronyms, and Abbreviations..... | 6  |
| 1.4 Overview .....                                | 7  |
| 2. Overall Descriptions.....                      | 8  |
| 2.1 Product perspective .....                     | 8  |
| 2.1.1 System interfaces .....                     | 11 |
| 2.1.2 User interfaces.....                        | 12 |
| 2.1.3 Hardware interfaces .....                   | 21 |
| 2.1.4 Software interfaces.....                    | 22 |
| 2.1.5 Communication interfaces .....              | 22 |
| 2.1.6 Memory constraints.....                     | 22 |
| 2.2 Product functions .....                       | 23 |
| 2.3 User characteristics .....                    | 36 |
| 2.4 Constraints .....                             | 36 |
| 2.5 Assumptions and dependencies.....             | 38 |
| 2.6 Apportioning of requirements .....            | 38 |
| 3. Specific requirements.....                     | 39 |
| 3.1 External interface requirements .....         | 39 |
| 3.1.1 User interfaces.....                        | 39 |
| 3.1.2 Hardware interfaces .....                   | 42 |
| 3.1.3 Software interfaces.....                    | 42 |
| 3.1.4 Communication interfaces .....              | 42 |
| 3.2 Classes/Objects .....                         | 43 |
| 3.2.1 User class 1 - The Administrator .....      | 43 |
| 3.2.2 User class 2 - The Lecturer .....           | 45 |
| 3.2.3 User class 3 - The Student.....             | 48 |
| 3.3 Performance requirements .....                | 48 |
| 3.4 Design constraints .....                      | 49 |

|                                      |    |
|--------------------------------------|----|
| 3.5 Software system attributes ..... | 49 |
| 3.5.1 Reliability .....              | 49 |
| 3.5.2 Availability .....             | 49 |
| 3.5.3 Security .....                 | 49 |
| 3.5.4 Maintainability .....          | 50 |
| 3.6 Other requirements .....         | 50 |
| References .....                     | 51 |

## List of Tables

|                                                                                   |    |
|-----------------------------------------------------------------------------------|----|
| Table 1 : Definitions.....                                                        | 6  |
| Table 2 : Lecture Capturing System comparison with existing systems. ....         | 10 |
| Table 3 : Use Case Scenario 01 – Lecture Movement Capture .....                   | 25 |
| Table 4 : Use Case Scenario 02 – Lecture Sharing Laptop/PC Screen.....            | 25 |
| Table 5 : Use Case Scenario 03 – Course Management – Adding a new course .....    | 26 |
| Table 6 : Use Case Scenario 04 – Offline screen capturing and uploading .....     | 27 |
| Table 7 : Use Case Scenario 05 – Video thumbnails creation .....                  | 28 |
| Table 8 : Use Case Scenario 06 – Edit the data quota of a user/users .....        | 28 |
| Table 9 : Use Case Scenario 07 – Gesture Based audience capturing .....           | 29 |
| Table 10 : Use Case Scenario 08 – Giving over video, audio control to a user..... | 31 |
| Table 11 : Use Case Scenario 09 – Facial Recognition based login.....             | 32 |
| Table 12 : Use Case Scenario 10 – Edit Profile .....                              | 33 |
| Table 13 : Use Case Scenario 11 – Modify Student Attendance .....                 | 33 |
| Table 14 : Use Case Scenario 12 – View Student Attendance .....                   | 34 |
| Table 15 : Use Case Scenario 13 – Activate Attendance Marking Camera.....         | 35 |
| Table 16 : Use Case Scenario 14 – Bandwidth Monitoring Dashboard .....            | 35 |

## List of Figure

|                                                                    |    |
|--------------------------------------------------------------------|----|
| Figure 1 : Starting a new Session.....                             | 12 |
| Figure 2 : Sharing Laptop/PC Screen.....                           | 13 |
| Figure 3 : Live Camera View .....                                  | 13 |
| Figure 4 : Course Management Window .....                          | 14 |
| Figure 5 : OBS Studio Plugin .....                                 | 14 |
| Figure 6 : Create Thumbnail Chapters from recorded videos.....     | 15 |
| Figure 7 : View thumbnail chapters of the video .....              | 15 |
| Figure 8 : User login selection .....                              | 16 |
| Figure 9 : Facial Recognition based login .....                    | 16 |
| Figure 10 : Attendance Analysis .....                              | 17 |
| Figure 11 : View User .....                                        | 17 |
| Figure 12 : Add User.....                                          | 18 |
| Figure 13 : Bandwidth Monitoring Dashboard .....                   | 18 |
| Figure 14 : Quota Management Dashboard .....                       | 19 |
| Figure 15 : Enterprise Dashboard .....                             | 19 |
| Figure 16 : Live video streaming Interface with ask question ..... | 20 |
| Figure 17 : Give Control Interface .....                           | 20 |
| Figure 18 : PTZ Camera.....                                        | 21 |
| Figure 19 : Class Diagram .....                                    | 23 |
| Figure 20 : Use Case Diagram .....                                 | 24 |

## **1. Introduction**

### **1.1 Purpose**

This document provides all of the requirements for the Lecture Capturing System. All parts are intended primarily for customers of the application but will also be interest to software engineers building or maintaining the software.

### **1.2 Scope**

The scope of this system is distributed in such a way that it covers a range of operations related to a smart lecture capturing system. As the system is cloud based, it has a main cloud enterprise dashboard which contains all the administrative functions, namely: user management, course management, bandwidth management, and quota management. The idea behind user management is that there can be many educational organizations registered in the system, with their own set of students and lecturers, independent of other organizations. Each organization can have different courses that they offer, and they are managed under course management. As the system is based mainly on live video sharing, bandwidth and quota are some of the main concerns, and should be intelligently managed. These are done under bandwidth management and quota management respectively.

Moving on to the core functionality of the system, by automatically focusing on the lecturer in real-time, the lecturer is framed well at any moment so that the audience cannot be distracted. By taking cinematographic rules into account, Pan Tilt Zoom cameras that are set up in the classroom will track the lecturer's movements precisely while keeping the lecturer focused, to give the audience a clear view.

When the session is going on, in any classroom it is normal for the audience to have doubts and difficulties in understanding the content. In this situation, there are two sets of audiences, namely: students in the classroom, and the remotely logged in students. The system follows different approaches for these two situations.

When a student in the classroom indicates that he/she has a doubt, the lecturer will perform a predefined gesture towards the camera which will recognize it and turn towards the audience. Then, the person having the doubt will again perform a gesture for the camera to zoom in to him/her so that the remote users will get a clear picture. The main objective of having gesture-based recognition is ensure remote users get the feeling of being in a real classroom, other than getting the feeling of watching a conventional video.

In the case of remote users, they can signal the lecturer of their requirement by clicking a specific button in the interface. When the lecturer gets notified, he/she can choose whether to give video and/or audio control over to the remote user. Here, we are trying to achieve interactivity of system with both remote students and the physical audience equally.

Logging into the system plays a major role when marking the attendance for a relevant lesson. To ensure authentication, biometric authentication is used in terms of facial recognition. By doing this, we ensure that only the owner of the login account can log in to the system, but not anyone else.

Once the session is over, the system will prepare a collection of thumbnails containing the lecture slides used, along with all the voice recordings relevant to that session. This is to make sure that all the lecture materials and sessions are available offline for further reference of students.

### 1.3 Definitions, Acronyms, and Abbreviations

*Table 1 : Definitions*

| Term       | Definition                          |
|------------|-------------------------------------|
| OBS Studio | Open Broadcaster Software Studio    |
| SRS        | Software Requirements Specification |
| DB         | Database                            |

|      |               |
|------|---------------|
| PTZ  | Pan Tilt Zoom |
| DESC | Description   |
| IN   | Input         |
| OUT  | Output        |
| PR   | Processing    |
| DEP  | Dependents    |

#### 1.4 Overview

The proposed system is a smart cloud-based lecture capture system, which facilitates enhanced e-learning. The system allows a lecturer to give out lectures in the usual way with real-time video recording, so that students can remotely log in and attend the lecture with real-time video streaming. In addition to login details of the participants, there is facial recognition to ensure attendance verification and authentication. The audience comprises of basically two groups of people, namely: the students present in the lecture hall and online users. Both these parties can interact with the lecturer if they have any doubts or if in need of any clarification regarding the lecture. Online participants can simply make a request to ask a question and the lecturer can then decide whether to give audio and/or video control over to the participant. When it comes to the students who are physically present in the lecture hall, they can show a predefined gesture to the lecturer to ask a question, so that the camera which captures the audience will focus on that student. This way, the online participants also will be able to get a clear view and feel like they are also a part of the very classroom. The lecturer can share his/her with the audience depending on the situation. Additionally, the lecturer can also share his/her screen with the students when necessary. PTZ cameras are used to capture the lecturer and the audience to give a clear view of what is going on and to make sure the focus is given to the center of attention. As sharing videos is the main concern of the system, special attention is given to bandwidth and quota management to ensure data usage fruitfully. Once a particular session is over, the relevant slide set used in the session will be used to generate thumbnails, along with the audio recordings related to each of them, for later reference by the students.



## **2. Overall Descriptions**

This section will give an overview of the Lecture Capturing System. It will describe the main functionalities of the system, similarities and differences to other systems in the marketplace, basic sketches of user interfaces, hardware interface, and the type of stakeholders that will use the system and at last, the constraints and assumptions will be presented.

### **2.1 Product perspective**

#### **1. Panopto - Lecture Capture Software**

Panopto is an easy-to-use video platform for training, presenting, and communicating that enables users to record videos and rich media presentations and push out to subscribers in many different formats. Panopto is built with the flexibility to record any combination of video sources, in any configuration, in classrooms of any size. And Panopto scales with ease to meet institution's needs from small departmental deployments to campus-wide installations. [7]

#### **2. BigBlueButton**

BigBlueButton is an open-source web collaboration software utilized by education organizations for e-learning and training. The software offers [6]

- Numerous options for customization and integration as per requirements of the users.
- Enables users to conduct web-conferencing and share documents, audio and video files for online learning.
- The software's "whiteboard" feature allows presenters to mark valuable topics in the presentation.
- In addition, its "polling" feature engages learners and helps the presenter to receive feedback.

- BigBlueButton’s “desktop sharing” feature extends beyond slides and allows moderators to share their screen with the audience enabling a better understanding of topics.
- BigBlueButton supports multiple users in a video conference with no cap on numbers of active webcams.
- The software also supports voice conferencing via Voice Over IP (VOIP) without additional hardware requirements.

### 3. Echo360

Echo360 is a platform which combines video management with lecture capture and active learning to increase student success. Echo360 offers [8]

- High-quality live streaming supports remote learners and classroom overflow situations. The streaming experience leverages Echo360’s engagement tools so students can engage with classmates and the instructor no matter where they are.
- Echo360 keeps notes linked to class presentations and videos so that students can jump straight from their own words to those of the instructor and replay the entire learning experience.
- Built on a scalable cloud architecture, the platform allocates the resources needed to process peak loads automatically. Videos are uploaded and processed in real time so the optimized version is available as soon as class is over

### 4. Kaltura

The Kaltura Video Player SDK includes a rich set of APIs for player embedding, customization, white-labeling and integration via JavaScript or ActionScript 3.0. By leveraging the Kaltura Player you can create your own custom players with less effort and at no cost! [9]

- Endless flexibility for creating your own custom design and playback experiences
- Automatically switch between HTML5 video and Flash, maintaining a unified look & feel

- Work with any type of streaming protocols, from adaptive streaming, HTTP streaming and DRM
- Increase engagement with smart and dynamic playlists, related, and more
- Optimize SEO using Kaltura's SEO best practices embedding guidelines.

## 5. Open Broadcaster Software (OBS) (Software Tool)

OBS is a free and open-source streaming and recording program maintained by the OBS Project. The program has support for Windows 7 and later, OS X 10.10 and later, and Ubuntu 14.04 and later. [4]

OBS is a free and open-source software suite for

- recording and live streaming.
- real-time source and device capture
- scene composition,
- encoding, recording, and broadcasting.
- Transmission of data is primarily done via the Real Time Messaging Protocol (RTMP) and can be sent to any RTMP supporting destination, including many presets for streaming websites

*Table 2 : Lecture Capturing System comparison with existing systems.*

| <b>Features</b>                                                 | <b>BigBlueButton</b> | <b>Panopto</b> | <b>Kaltura</b> | <b>Echo360</b> | <b>Lecture Capturing System</b> |
|-----------------------------------------------------------------|----------------------|----------------|----------------|----------------|---------------------------------|
| Support one to many users to concurrently access a live stream. | ✓                    |                | ✓              | ✓              | ✓                               |
| Convert the lecturer's voice into text after recording.         |                      | ✓              | ✓              | ✓              | ✓                               |

|                                                                 |   |   |   |   |   |
|-----------------------------------------------------------------|---|---|---|---|---|
| Screen sharing window for share laptop screen                   | ✓ |   |   | ✓ | ✓ |
| Handle multiple users and course management                     | ✓ | ✓ | ✓ | ✓ | ✓ |
| Biometric facial recognition for authenticate users             |   |   |   |   | ✓ |
| Capture the audience if required and focus on a guest speaker   |   |   | ✓ | ✓ | ✓ |
| Intelligently manage data usage for minimum data usage          |   |   |   |   | ✓ |
| Facial recognition based Attendance Marking                     |   |   |   |   | ✓ |
| Gesture based system to detect the speaker, pan, tilt and zoom. |   |   |   |   | ✓ |

### 2.1.1 System interfaces

Windows 10 operating system will be used as the main development platform. Ubuntu 16.04 will also be used in the developing and testing process. Kurento which is a WebRTC (Web Real-Time Communications) media server will be used to facilitate live streaming.

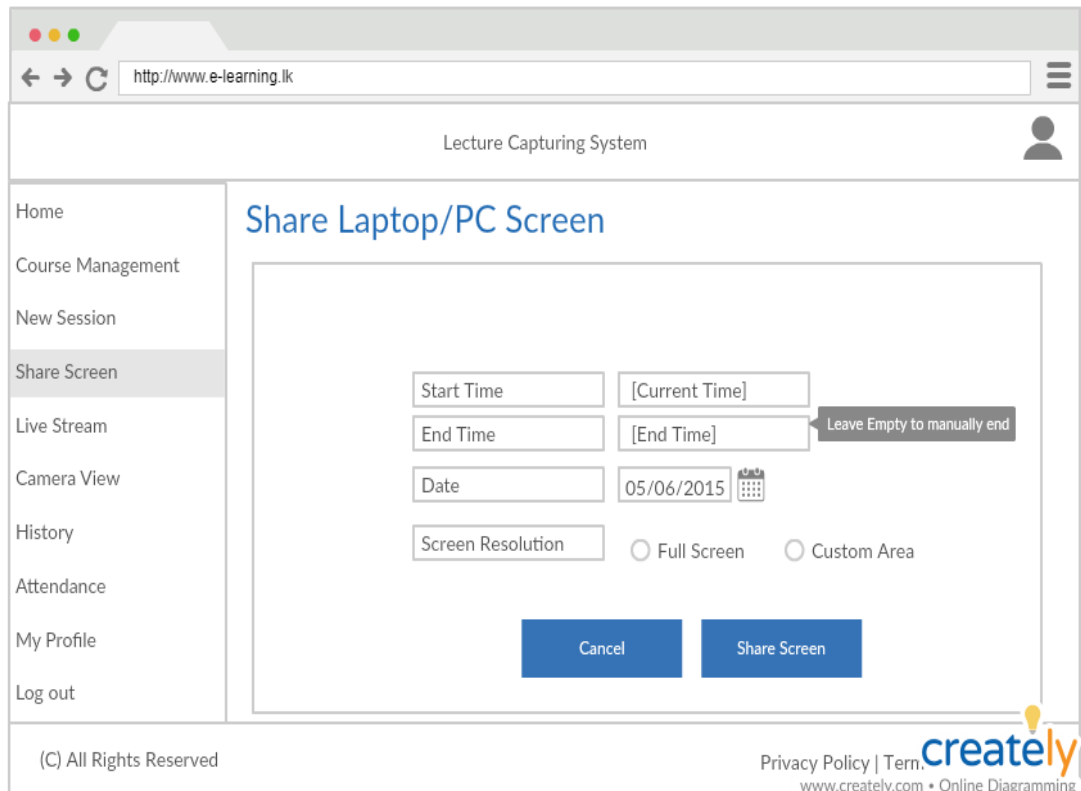
## 2.1.2 User interfaces

The screenshot shows a web browser window with the URL <http://www.e-learning.lk>. The page title is "Lecture Capturing System". On the left is a sidebar menu with the following items: Home, Course Management, New Session (highlighted), Share Screen, Live Stream, Camera View, History, Attendance, My Profile, and Log out. The main content area is titled "New Session" and contains a form with the following fields:

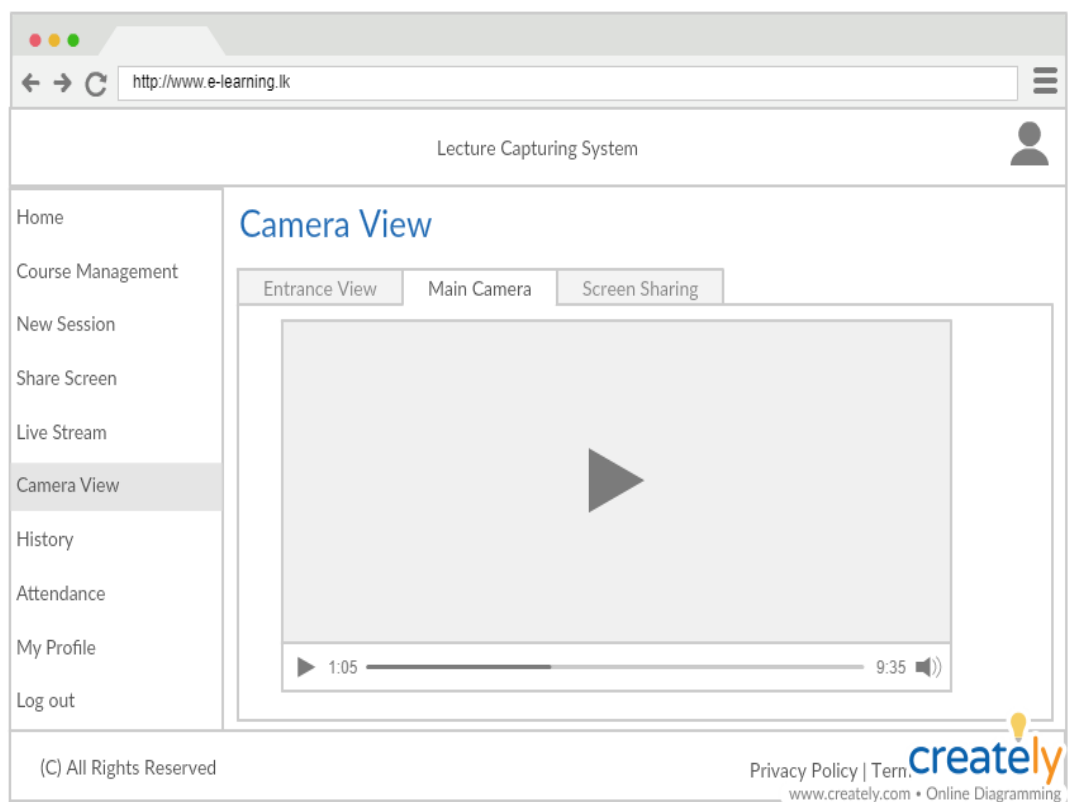
- Session ID: [AutoID]
- Session Location: [ ]
- Start Time: [ ]
- Date: 05/06/2015 (with a calendar icon)
- Course Name: [Search Box] (with a search icon and a "Search" button)

At the bottom of the form are two buttons: "Cancel" and "Start Session". The footer of the page includes the text "(C) All Rights Reserved" on the left and "Privacy Policy | Tern. **creately** www.creately.com • Online Diagramming" on the right.

*Figure 1 : Starting a new Session*



*Figure 2 : Sharing Laptop/PC Screen*



*Figure 3 : Live Camera View*

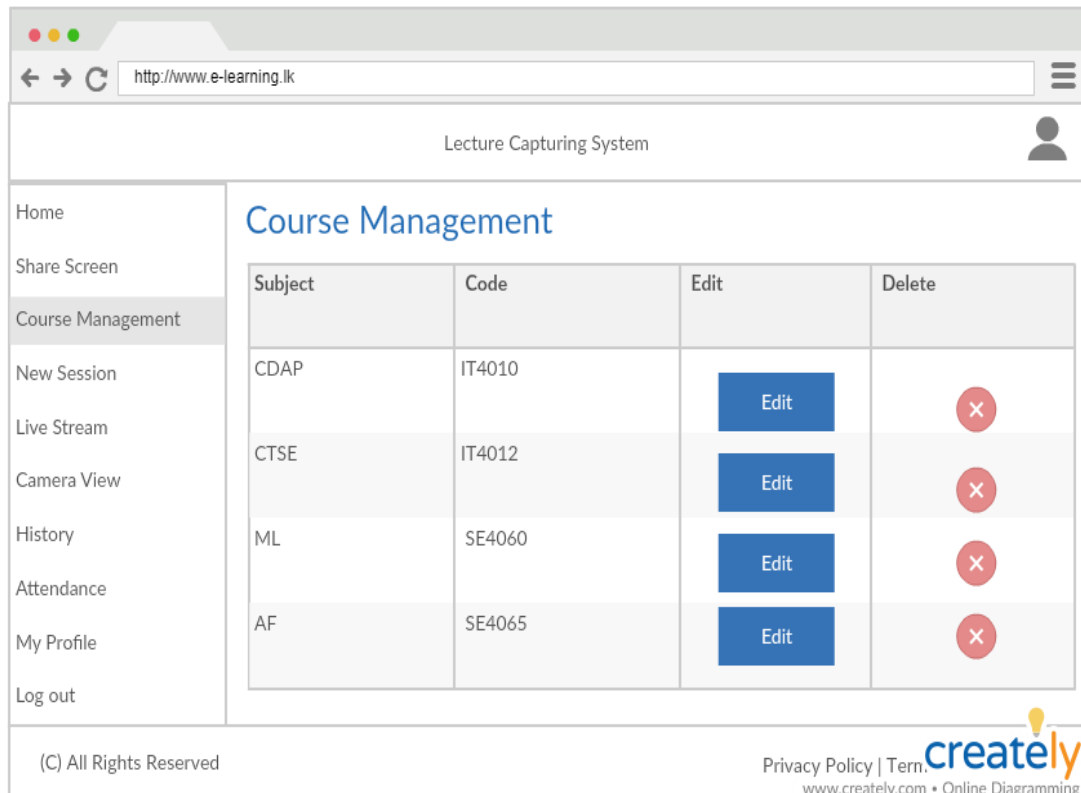


Figure 4 : Course Management Window

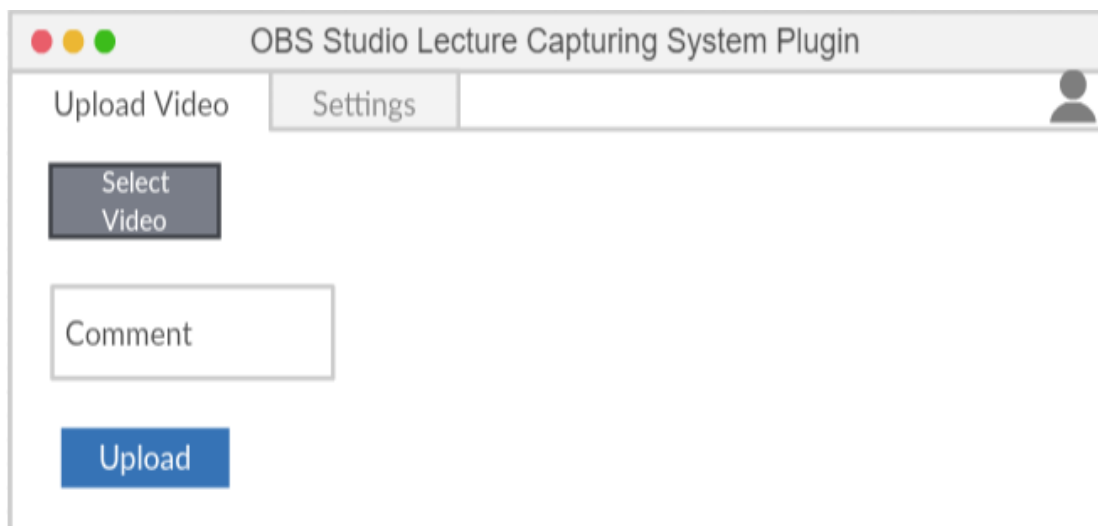


Figure 5 : OBS Studio Plugin

http://www.elearning.lk

Lecture Capturing System

Dashboard  
Live Stream  
Attendance  
All Lectures  
Settings  
Contact  
About Us

## Recorded Lectures

| Subject     | Video Name         | Action                            | Status    |
|-------------|--------------------|-----------------------------------|-----------|
| CDAP-IT4010 | CDAP Lecture 1.mp4 | <a href="#">View</a>              |           |
| CDAP-IT4010 | CDAP Lecture 2.mp4 | <a href="#">Create Thumbnails</a> |           |
| ML-SE4060   | ML Lecture1.mp4    | <a href="#">Create Thumbnails</a> | Try Again |
| ML-SE4060   | ML Lecture2.mp4    | <a href="#">View</a>              |           |

(C) All Rights Reserved Privacy Policy | Terms and Conditions

Figure 6 : Create Thumbnail Chapters from recorded videos

http://www.elearning.lk

Lecture Capturing System

Dashboard  
Live Stream  
Attendance  
All Lectures  
Settings  
Contact  
About Us

## < CDAP Lecture 1

| Time        | Slide | Video | Audio | Text                      |
|-------------|-------|-------|-------|---------------------------|
| 00:00-00:10 |       |       |       | (Audio converted to text) |
| 00:10-00:15 |       |       |       | (Audio converted to text) |
| 00:15-00:25 |       |       |       | (Audio converted to text) |
| 00:25-00:32 |       |       |       | (Audio converted to text) |
| 00:32-00:41 |       |       |       | (Audio converted to text) |

(C) All Rights Reserved Privacy Policy | Terms and Conditions

Figure 7 : View thumbnail chapters of the video



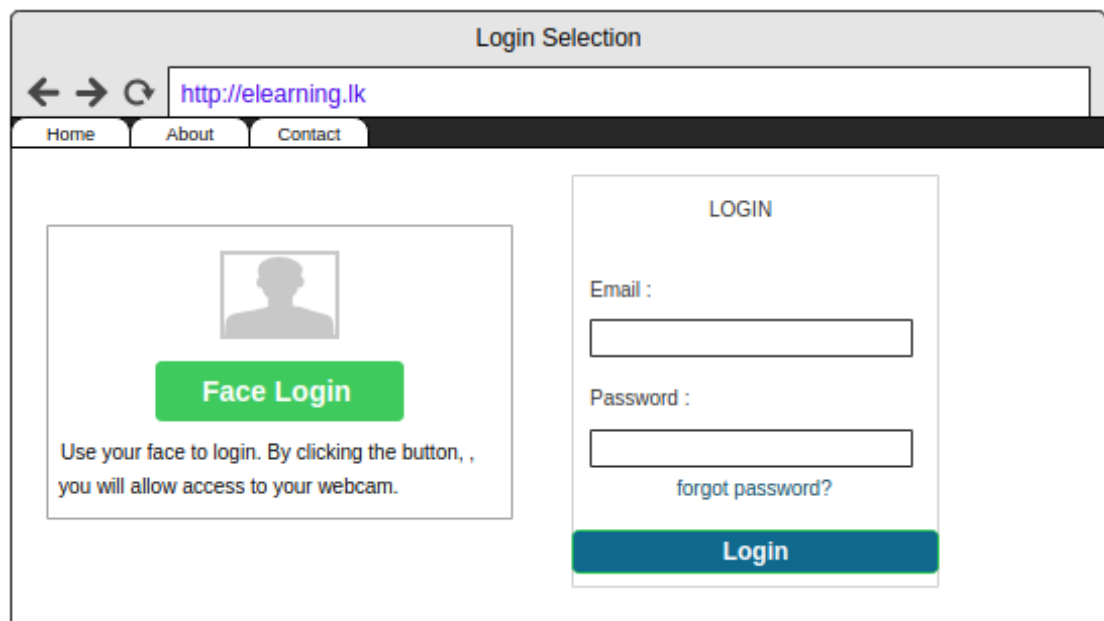


Figure 8 : User login selection

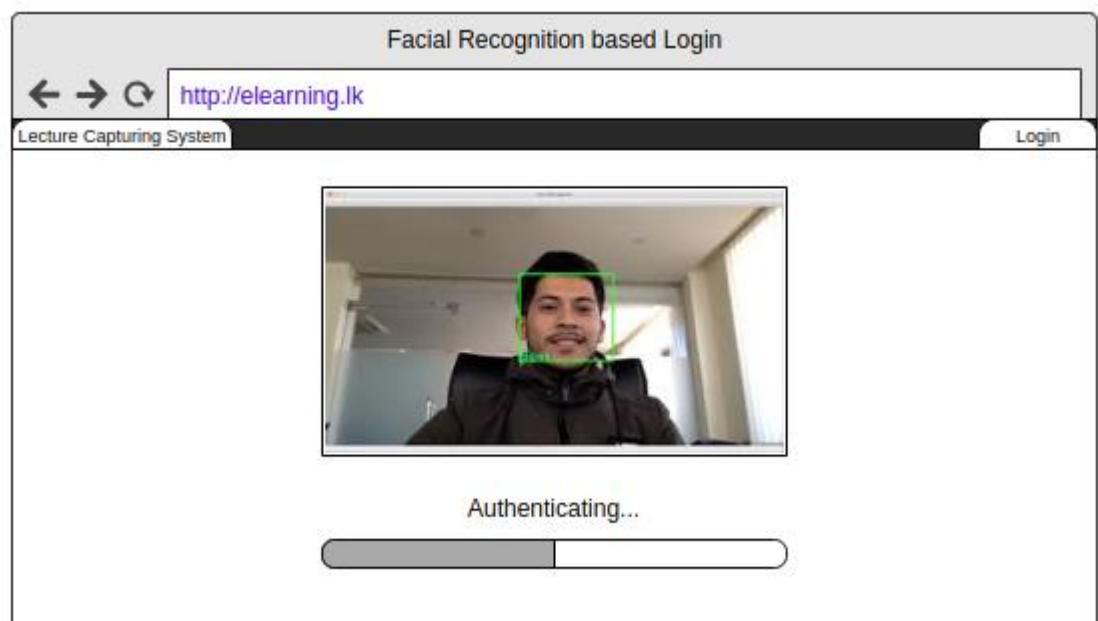


Figure 9 : Facial Recognition based login

http://www.elearning.lk

Lecture Capturing System

Attendance Analysis

Filter by :

| Student ID | 2018-05-04 | 2018-05-06 | 2018-05-07 | 2018-05-08 | 2018-05-09 | 2018-05-10 | 2018-05-11 |
|------------|------------|------------|------------|------------|------------|------------|------------|
| IT25349    | P          | A          | P          | A          | P          | A          | P          |
| IT73232    | P          | P          | P          | A          | P          | P          | P          |
| IT84343    | P          | A          | P          | P          | P          | P          | P          |
| IT73473    | A          | P          | P          | A          | P          | P          | P          |

◀ Prev 5 6 7 8 9 10 11 12 13 14 Next ▶

(C) All Rights Reserved Privacy Policy | Terms and Conditions

Figure 10 : Attendance Analysis

http://www.elearning.lk

Lecture Capturing System

Admin

User Management

Filter by :      [Reset Filter](#)

| User ID | User Type | Username    | Full Name        | Email                | Last Login         | Phone No   | Groups |
|---------|-----------|-------------|------------------|----------------------|--------------------|------------|--------|
| IT25349 | Student   | ashenjay123 | Ashen Jayasinghe | jayasinghe@gmail.com | 28/05/2018 1:50 AM | 0772237273 | User   |
| LT25349 | Lecturer  | ashenjay123 | Ashen Jayasinghe | jayasinghe@gmail.com | 28/05/2018 1:50 AM | 0772237273 | User   |
| IT25349 | Student   | ashenjay123 | Ashen Jayasinghe | jayasinghe@gmail.com | 28/05/2018 1:50 AM | 0772237273 | User   |
| LT25349 | Lecturer  | ashenjay123 | Ashen Jayasinghe | jayasinghe@gmail.com | 28/05/2018 1:50 AM | 0772237273 | User   |
| IT25349 | Student   | ashenjay123 | Ashen Jayasinghe | jayasinghe@gmail.com | 28/05/2018 1:50 AM | 0772237273 | User   |

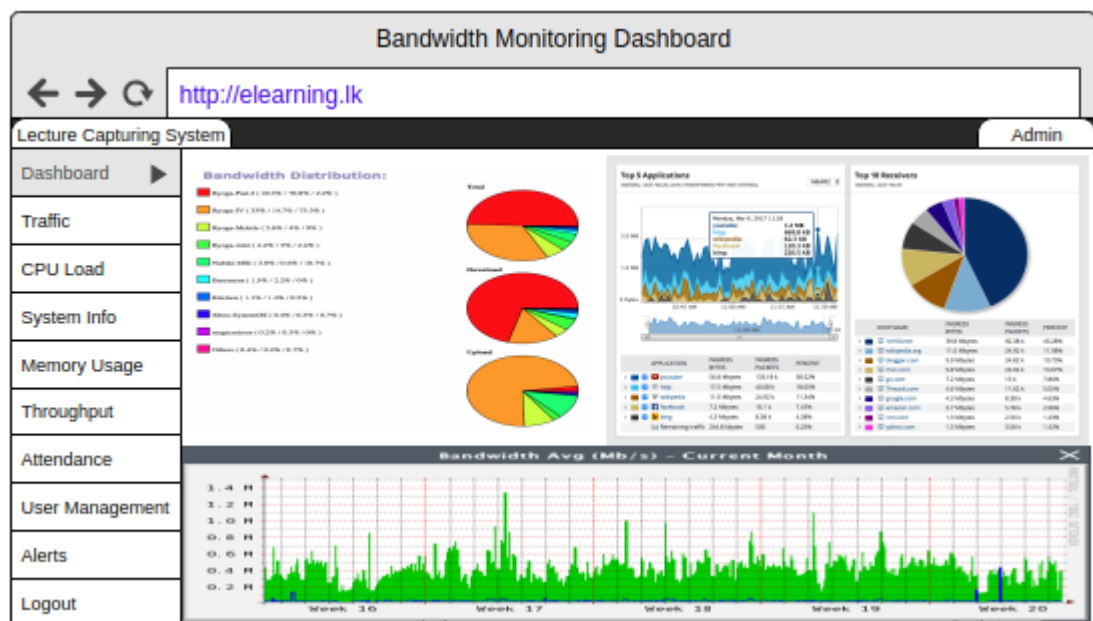
◀ Prev 5 6 7 8 9 10 11 12 13 14 Next ▶

(C) All Rights Reserved Privacy Policy | Terms and Conditions

Figure 11 : View User

The screenshot displays the 'Admin Dashboard' interface. At the top, there is a navigation bar with the title 'Admin Dashboard' and a set of navigation icons (back, forward, refresh). Below this is a search bar containing the URL 'http://elearning.lk'. A dark sidebar on the left contains a menu with the following items: 'Dashboard', 'Bandwidth', 'User' (which is highlighted with a grey background and a right-pointing arrow), 'Reports', and 'Settings'. The main content area has a dark header with the text 'Admin' on the right. Below this header, the section is titled 'Add User :'. It contains four input fields stacked vertically, each with a label to its left: 'Name :', 'Email :', 'Password :', and 'Student No. :'. At the bottom of this section is a large, light-grey rounded rectangle with the text 'Drop Image' in the center, indicating a placeholder for a user profile picture.

Figure 12 : Add User



*Figure 13 : Bandwidth Monitoring Dashboard*

http://www.elearning.lk

Lecture Capturing System

Dashboard

Live Stream

Attendance

All Lectures

Settings

Contact

About Us

## Quota Management

Filter by: User Type: Student Month: May Year: 2018

[Edit Monthly Quota for all students](#)

Students' Data Usage for May 2018

| User ID    | Used Data (GB) | Remaining Data(GB) | Edit Monthly Quota |
|------------|----------------|--------------------|--------------------|
| IT15123456 | 5              | 5                  |                    |
| IT15123457 | 7              | 3                  |                    |
| IT15123458 | 2              | 8                  |                    |

(C) All Rights Reserved Privacy Policy | Terms and Conditions

Figure 14 : Quota Management Dashboard

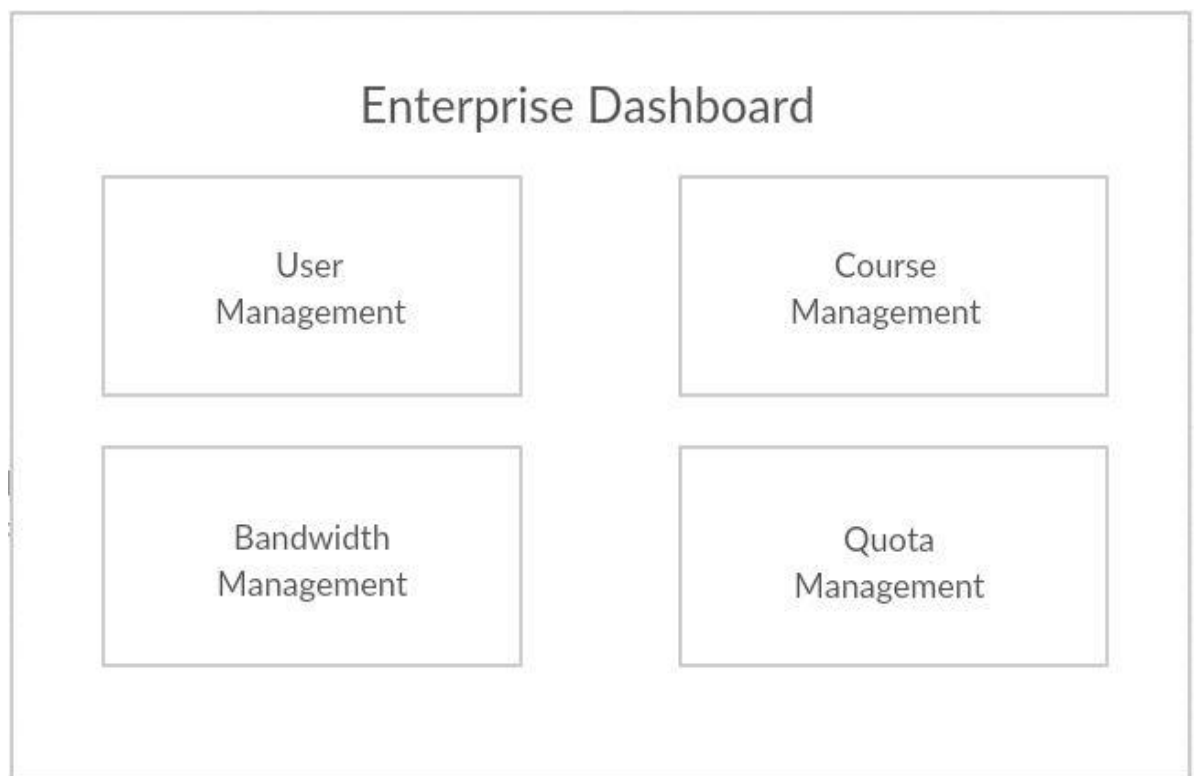
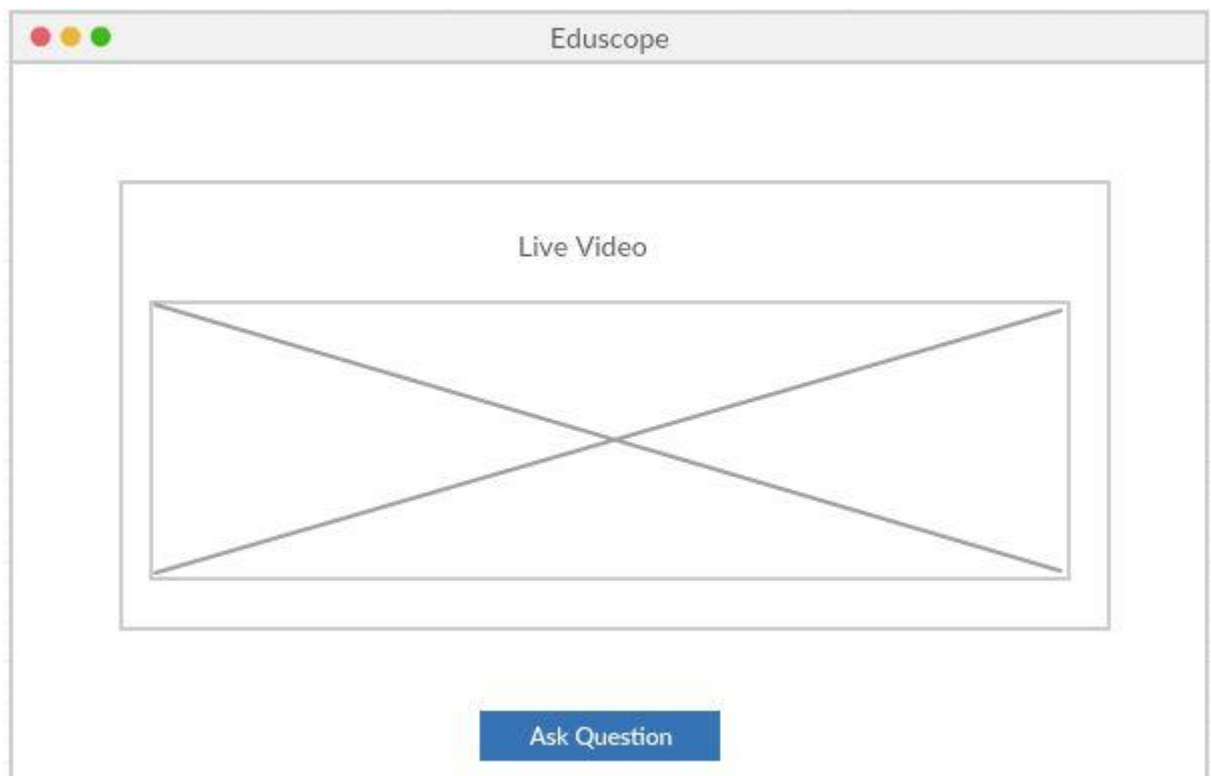
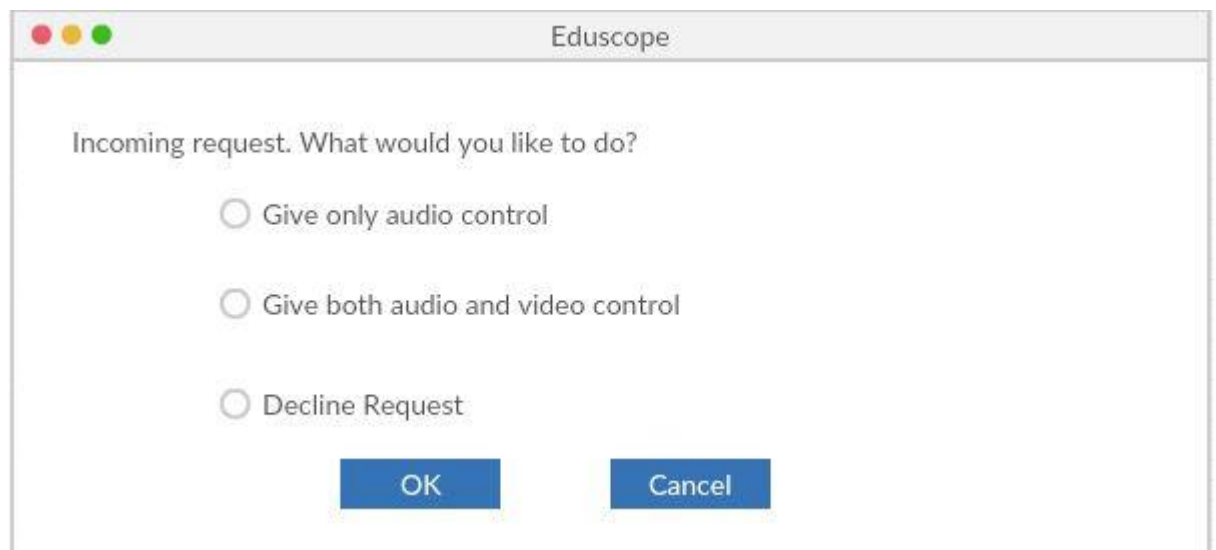


Figure 15 : Enterprise Dashboard



*Figure 16 : Live video streaming Interface with ask question*



*Figure 17 : Give Control Interface*

### 2.1.3 Hardware interfaces

- PTZ Camera



Figure 18 : PTZ Camera

*This PTZ Camera connects to the computer via Ethernet cable either directly or to the same network computer is in. With that we will be able to control the camera with commands and to take the video feed.*

#### **2.1.4 Software interfaces**

The communication between the different parts of the system is important since they depend on each other. Following software, interfaces are required to Lecture Capturing System.

- MongoDB database
- WebStorm IDE
- Open Broadcaster Software
- A latest updated web browser (Mozilla Firefox version 59 or above, Google Chrome etc.)
- Browser WebRTC Extension for Screen Sharing
- Studio3T MongoDB GUI and IDE

#### **2.1.5 Communication interfaces**

Following communication, interfaces are required operate Lecture Capturing System.

- Internet connection with fairly higher bandwidth will be required to run the system efficient since it deals with large about of video files.
- Database connection interface will be needed to connect to the database.

#### **2.1.6 Memory constraints**

Everything is designed to run on a single machine with 8 GB RAM, but this will be variable with respect to the type of operation being needed. RAM heavy operations are all image processing, video recording and controlling tasks which are also CPU intensive.

Only system testing can let us know about the actual usage post design.

## 2.2 Product functions

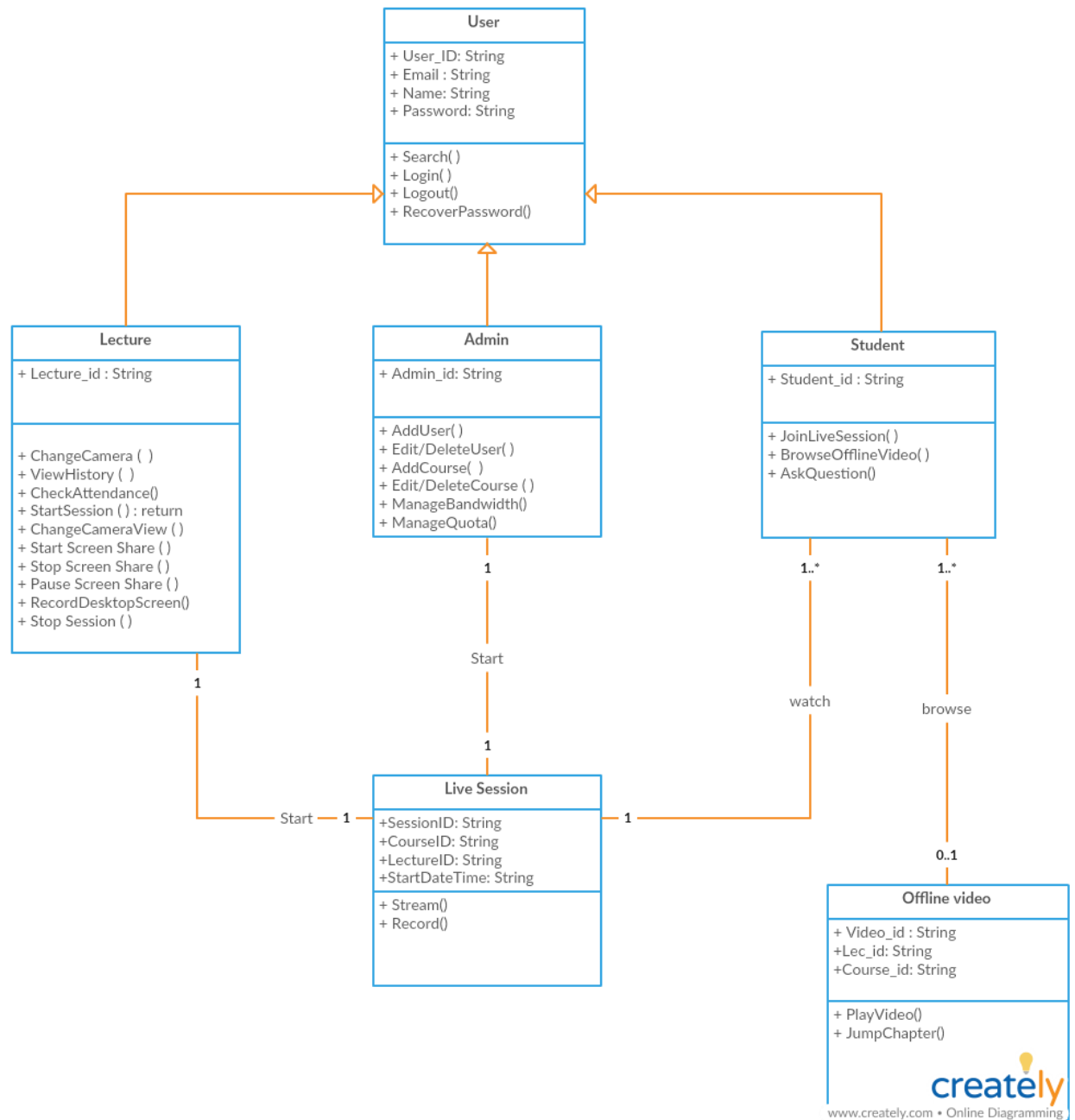


Figure 19 : Class Diagram



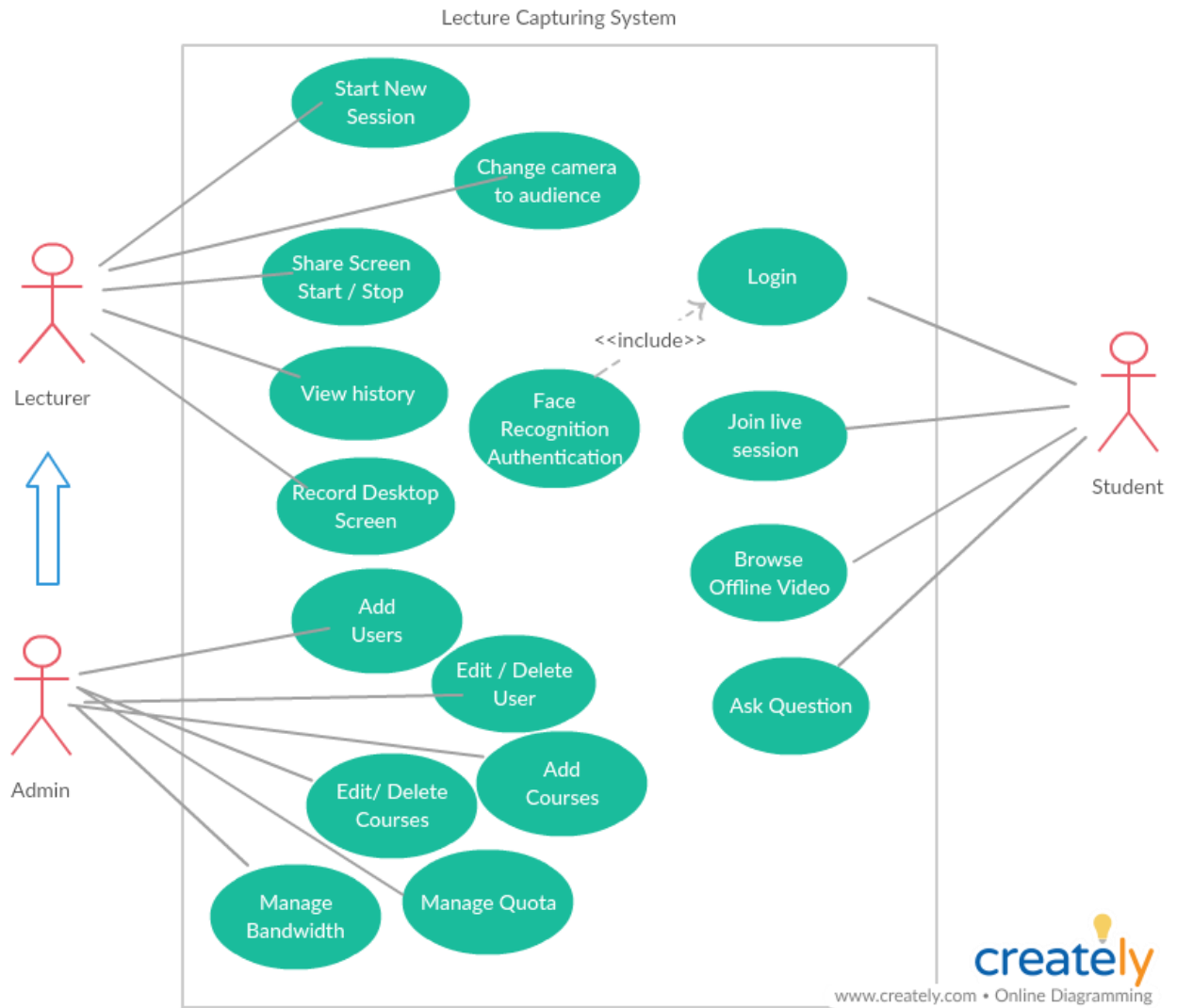


Figure 20 : Use Case Diagram

*Table 3 : Use Case Scenario 01 – Lecture Movement Capture*

|                       |                                                                                                                                                                                                                                                               |
|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Use Case No           | 01                                                                                                                                                                                                                                                            |
| Use Case Name         | Capturing the Lecture Movement                                                                                                                                                                                                                                |
| Actors                | Lecturer / Guest Speaker                                                                                                                                                                                                                                      |
| Pre-Condition         | The lecturer should be on the stage and system should be running.                                                                                                                                                                                             |
| Main Success Scenario | <ol style="list-style-type: none"> <li>1. The Lecturer has to log into the system with correct credentials.</li> <li>2. After login to the system the Lecturer has to start a new session.</li> </ol>                                                         |
| Post Conditions       | <ol style="list-style-type: none"> <li>1. Prompt a popup box for confirmation of ending session.</li> <li>2. Successfully streamed session.</li> </ol>                                                                                                        |
| Extensions            | <ol style="list-style-type: none"> <li>1.1 If the user name or password is incorrect lecturer has to enter again and log into the system.</li> <li>1.2 If the password or username has forgotten lecturer have to click forgot your password link.</li> </ol> |

*Table 4 : Use Case Scenario 02 – Lecture Sharing Laptop/PC Screen*

|               |                            |
|---------------|----------------------------|
| Use Case No   | 02                         |
| Use Case Name | Sharing Laptop / PC Screen |
| Actors        | Lecturer / Guest Speaker   |

|                 |                                                                                                                                                              |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pre-Condition   | The lecturer should have logged in and started a new session.                                                                                                |
| Main Scenario   | Success<br>1. After starting a new session lecturer has to click on share screen feature.<br>2. Lecturer should share whole screen or custom crop a section. |
| Post Conditions | 1. Prompt a popup box for confirmation of ending screen sharing.<br>2. Successfully streamed screen sharing.                                                 |
| Extensions      | 1.1 New session has to be initialized first.                                                                                                                 |

*Table 5 : Use Case Scenario 03 – Course Management – Adding a new course*

|               |                                                                           |
|---------------|---------------------------------------------------------------------------|
| Use Case No   | 03                                                                        |
| Use Case Name | Adding a new Course to the system                                         |
| Actors        | Lecturer / Guest Speaker                                                  |
| Pre-Condition | The lecturer should have logged in to the system with correct credentials |

|                 |         |                                                                                                                                                                                                                                          |
|-----------------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Main Scenario   | Success | <ol style="list-style-type: none"> <li>1. Lecturer should navigate to course management tab.</li> <li>2. Lecturer should click on add new course option.</li> <li>3. Lecturer should type necessary details and click on add.</li> </ol> |
| Post Conditions |         | <ol style="list-style-type: none"> <li>1. Prompt a popup box for confirmation of adding a new course.</li> <li>2. Successfully added new course message.</li> </ol>                                                                      |

*Table 6 : Use Case Scenario 04 – Offline screen capturing and uploading*

|                       |                                                                                                                                                                                                                                                                                                           |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Use Case No           | 04                                                                                                                                                                                                                                                                                                        |
| Use Case Name         | Offline screen capturing and uploading                                                                                                                                                                                                                                                                    |
| Actors                | Lecturer                                                                                                                                                                                                                                                                                                  |
| Pre-Conditions        | OBS Studio (including the developed plugin) is installed in the lecturer's computer.                                                                                                                                                                                                                      |
| Main Success Scenario | <ol style="list-style-type: none"> <li>1. The lecturer records the lecturer's desktop screen offline using OBS Studio.</li> <li>2. The lecturer logs into the server with the OBS Studio plugin using a valid username and password.</li> <li>3. The recorded video is uploaded to the server.</li> </ol> |
| Post Conditions       | The recorded video is successfully uploaded to the remote server.                                                                                                                                                                                                                                         |
| Extensions            | <p>2a. The lecturer enters an invalid username/password to connect to the remote server.</p> <p>2a1. The plugin displays an error saying "Invalid username/password. Try again."</p>                                                                                                                      |

|  |                                                                                                                                                                                                                                         |
|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>3a. The internet connection is interrupted during the video transfer.</p> <p>3a1. The plugin displays an error “Internet connection disrupted. Please upload the video again”.</p> <p>3a2. The lecturer uploads the video again.</p> |
|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

*Table 7 : Use Case Scenario 05 – Video thumbnails creation*

|                       |                                                                                                                                                                                                                                                                                        |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Use Case No           | 05                                                                                                                                                                                                                                                                                     |
| Use Case Name         | Video thumbnails creation                                                                                                                                                                                                                                                              |
| Actors                | Lecturer                                                                                                                                                                                                                                                                               |
| Pre-Conditions        | Lecturer is logged into the web application.                                                                                                                                                                                                                                           |
| Main Success Scenario | <ol style="list-style-type: none"> <li>1. The lecturer views the list of the recorded lectures.</li> <li>2. The lecturer selects one video and clicks on the “Create Video Thumbnails” button.</li> <li>3. A series of video thumbnail chapters is created from that video.</li> </ol> |
| Post Conditions       | The recorded video is split into a series of thumbnail chapters, and a success message is displayed to the user.                                                                                                                                                                       |
| Extensions            | <p>2a. The video is corrupted so the system is unable to process the file.</p> <p>2a1. The system displays an error saying “Corrupted video file. Please try again.”</p>                                                                                                               |

*Table 8 : Use Case Scenario 06 – Edit the data quota of a user/users*

|                       |                                                                                                                                                                              |
|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Use Case No           | 06                                                                                                                                                                           |
| Use Case Name         | Edit the data quota of a user/users                                                                                                                                          |
| Actors                | Administrator                                                                                                                                                                |
| Pre-Conditions        | The administrator is logged into the system.                                                                                                                                 |
| Main Success Scenario | <ol style="list-style-type: none"> <li>1. The administrator selects the “Quota Management” tab.</li> <li>2. The list of users is displayed filtered by user type,</li> </ol> |

|                 |                                                                                                                                                                                                                                                                                              |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                 | <p>month, and year.</p> <ol style="list-style-type: none"> <li>3. The administrator clicks on the “Edit monthly quota for all” link.</li> <li>4. A new value is entered for the monthly data quota value.</li> </ol>                                                                         |
| Post Conditions | A message saying “Monthly quota successfully updated” is displayed.                                                                                                                                                                                                                          |
| Extensions      | <ol style="list-style-type: none"> <li>4a. The administrator enters an invalid value (e.g. letters) in the monthly quota field.               <ol style="list-style-type: none"> <li>4a1. The system displays an error saying “Invalid value. Please enter a number.”</li> </ol> </li> </ol> |

*Table 9 : Use Case Scenario 07 – Gesture Based audience capturing*

|               |                                                                   |
|---------------|-------------------------------------------------------------------|
| Use Case No   | 07                                                                |
| Use Case Name | Gesture Based Audience Capturing                                  |
| Actors        | Lecturer, Members of Audience                                     |
| Pre-Condition | The lecturer should be on the stage and system should be running. |

|                 |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Main Scenario   | Success | <ol style="list-style-type: none"> <li>1. The Lecturer has to log into the system with correct credentials.</li> <li>2. After login to the system the Lecturer has to start a new session.</li> <li>3. A member of the audience has a question to ask.</li> <li>4. The lecturer will perform a predefined gesture at the PTZ camera.</li> <li>5. The camera will process and identify the gesture and turn towards the audience.</li> <li>6. The student who has to ask the question will perform a predefined gesture at the camera.</li> <li>7. The camera will successfully identify the gesture and zoom in at the student.</li> <li>8. The student will ask the question from the lecturer.</li> <li>9. Once the student finishes asking the question and performs the gesture again, the camera will again turn and focus on the lecturer.</li> </ol> |
| Post Conditions |         | <ol style="list-style-type: none"> <li>1. Camera will successfully focus on the lecturer again.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Extensions      |         | <ol style="list-style-type: none"> <li>1.1 If the user name or password is incorrect lecturer has to enter again and log into the system.</li> <li>1.2 If the password or username has forgotten lecturer have to click forgot your password link.</li> <li>5.1. The camera will not identify the gesture, and the lecturer will have to perform it again.</li> <li>7.1 The camera will not identify the gesture, and the student will have to perform it again.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                 |

*Table 10 : Use Case Scenario 08 – Giving over video, audio control to a user*

|                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Use Case No           | 08                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Use Case Name         | Giving over video and/or audio control to a remotely logged in user                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Actors                | Lecturer, Remote user.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Pre-Condition         | <ol style="list-style-type: none"> <li>1. The lecturer should be on the stage and system should be running.</li> <li>2. The remote user should be logged in to the system.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Main Success Scenario | <ol style="list-style-type: none"> <li>1. The Lecturer and the remote user have to log into the system with correct credentials.</li> <li>2. After login to the system the Lecturer has to start a new session.</li> <li>3. Remote user will need some clarification from the lecturer and send a signal using a button on the interface.</li> <li>4. The lecturer will receive a notification saying that a remote user needs some clarification.</li> <li>5. The lecturer accepts the notification.</li> <li>6. The lecturer selects whether to give video and/or audio control over to the remote user.</li> <li>7. The remote user asks the question and the control goes back to the lecturer.</li> </ol> |
| Post Conditions       | <ol style="list-style-type: none"> <li>1. Control will get back to the lecturer again.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |



|            |                                                                                                                                                                                                                                                                                                                           |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Extensions | <p>1.1 If the user name or password is incorrect the lecturer or remote user has to enter again and log into the system.</p> <p>1.2 If the password or username has forgotten lecturer or remote user has to click forgot your password link.</p> <p>5.1 The lecturer declines the request and continues the session.</p> |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

*Table 11 : Use Case Scenario 09 – Facial Recognition based login*

|                       |                                                                                                                                                                                                                                                                                                                                       |
|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Use Case No           | 09                                                                                                                                                                                                                                                                                                                                    |
| Use Case Name         | Facial Recognition based login                                                                                                                                                                                                                                                                                                        |
| Actor                 | Student, lecturer                                                                                                                                                                                                                                                                                                                     |
| Pre-Conditions        | The student or lecturer is logged into the system.                                                                                                                                                                                                                                                                                    |
| Main Success Scenario | <ol style="list-style-type: none"> <li>1. The student or lecturer should select the facial recognition-based login option from the two login options.</li> <li>2. The system runs the facial recognition process to authenticate the student's face through the webcam.</li> <li>3. The student logs into the system.</li> </ol>      |
| Post Conditions       | The student or lecturer logs into the system after successfully authenticating student's face.                                                                                                                                                                                                                                        |
| Extensions            | <p>2a. The student or lecturer clicks the face login button.</p> <p>2a1. The system grants access to the webcam.</p> <p>2b. The internet connection is interrupted during the face authentication process.</p> <p>2b1. The system displays an error "Authentication failed. Please try again or try the credential login option."</p> |

*Table 12 : Use Case Scenario 10 – Edit Profile*

|                       |                                                                                                                                                                                                                                                                           |
|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Use Case No           | 10                                                                                                                                                                                                                                                                        |
| Use Case Name         | Edit Profile                                                                                                                                                                                                                                                              |
| Actor                 | Student                                                                                                                                                                                                                                                                   |
| Pre-Conditions        | The student is logged into the system.                                                                                                                                                                                                                                    |
| Main Success Scenario | <ol style="list-style-type: none"> <li>1. The student selects the 'Edit Profile' tab.</li> <li>2. The student can edit input values such as Student Name, address, phone number and add a profile picture.</li> <li>3. The student clicks the 'Update' button.</li> </ol> |
| Post Conditions       | Updated student profile information will be stored in the database.                                                                                                                                                                                                       |
| Extensions            | <p>2a. The student enters an invalid phone number.</p> <p>2a1. The system displays an error "Invalid phone number"</p>                                                                                                                                                    |

*Table 13 : Use Case Scenario 11 – Modify Student Attendance*

|                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Use Case No           | 11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Use Case Name         | Modify Student Attendance                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Actors                | Admin, Lecturer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Pre-Conditions        | Admin, lecturer is logged into the system.                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Main Success Scenario | <ol style="list-style-type: none"> <li>1. The admin, lecturer selects the 'Student Attendance' tab.</li> <li>2. The admin, lecturer provides filter details such as student id, month, date, year, and semester and subject to retrieve the attendance of a student.</li> <li>3. The system displays the attendance details according to the provided filtering details.</li> <li>4. The admin or lecturer can edit the attendance of a student by entering either 'Present' or 'absent'.</li> </ol> |
| Post Conditions       | Updated attendance information will be stored in the database.                                                                                                                                                                                                                                                                                                                                                                                                                                       |

|            |                                                                                                                                                                                                                                                                                                                                     |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Extensions | <p>2a. The admin or lecturer provide a incorrect student id number to the search bar.</p> <p>2a1. The system displays an error “Student ID not found”</p> <p>4. a. The admin or lecturer provides a word other than ‘Present’ or ‘Absent’.</p> <p>4a1. The system displays an error “Invalid Input! Expected Absent or Present”</p> |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

*Table 14 : Use Case Scenario 12 – View Student Attendance*

|                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Use Case No           | 12                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Use Case Name         | View Student Attendance                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Actors                | Student                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Pre-Conditions        | Student is logged into the system.                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Main Success Scenario | <ol style="list-style-type: none"> <li>1. The student selects the ‘Attendance’ tab.</li> <li>2. The system displays all the attendance details of the logged in student throughout the degree program duration.</li> <li>3. The student provides filtering details such as month, date, year, and semester and subject to filter the attendance details from the database.</li> <li>4. The system displays the filtered attendance details to the student.</li> </ol> |
| Post Conditions       | The system displays the filtered attendance details to the student.                                                                                                                                                                                                                                                                                                                                                                                                   |
| Extensions            | <p>4a. The system doesn’t find attendance data according to the given filter details.</p> <p>4a1. The system displays an error “No records found”</p>                                                                                                                                                                                                                                                                                                                 |

*Table 15 : Use Case Scenario 13 – Activate Attendance Marking Camera*

|                       |                                                                                                                                                                                                                                                |
|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Use Case No           | 13                                                                                                                                                                                                                                             |
| Use Case Name         | Activate Attendance Marking Camera                                                                                                                                                                                                             |
| Actors                | Timer                                                                                                                                                                                                                                          |
| Pre-Conditions        | Set up lecture time schedule information                                                                                                                                                                                                       |
| Triggering events     | The camera will recognize and detect students' faces                                                                                                                                                                                           |
| Main Success Scenario | <ol style="list-style-type: none"> <li>1. Timer turns the camera on.</li> <li>2. Camera will detect and recognize faces.</li> <li>3. Camera sends the captured image to the server for image processing.</li> </ol>                            |
| Post Conditions       | Captured image is sent to the server.                                                                                                                                                                                                          |
| Extensions            | <ol style="list-style-type: none"> <li>1a. The timer turns the camera on <ol style="list-style-type: none"> <li>1a1. If the faces (objects) are not identified for a longer period, the timer will turn the camera off.</li> </ol> </li> </ol> |

*Table 16 : Use Case Scenario 14 – Bandwidth Monitoring Dashboard*

|                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Use Case No           | 14                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Use Case Name         | Bandwidth Monitoring Dashboard                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Actors                | Admin                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Pre-Conditions        | <ol style="list-style-type: none"> <li>1. The Admin is logged into the system.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                    |
| Main Success Scenario | <ol style="list-style-type: none"> <li>1. The administrator selects the “Bandwidth Management” tab.</li> <li>2. All the bandwidth details such as traffic, memory and system usage details etc. are displayed in the dashboard using graphs and tables.</li> <li>3. The administrator selects the ‘alerts’ tab.</li> <li>4. In the alert page, the system will display alerts when traffic usage and bandwidth utilization exceed pre-defined threshold settings.</li> </ol> |

### **2.3 User characteristics**

There are three types of users that interact with the system: Student, lecturer and administrator. Each of these users has different use of the system therefore each of them has their own requirements.

- The student can log in to the web application using facial recognition process and follow the live streaming lecture. The student also can view the attendance updated to the web application by the automated attendance monitoring process in the system or manually by the lecturer and administrator. The student also can access the lecture recordings uploaded by the lecturer.
- The lecturer can log in to the web application and open a new lecture session to live stream the lecture and share the PC screen to other remote students logged in to the web application. The lecturer also can update the attendance of the students manually if the automated attendance process has done a mistake and also, the lecturer can record the presentations offline and upload to the server. Finally, the lecturer can manage courses and manage the lecture time schedule to automatically activate the camera to mark the attendance of the students.
- The administrator logs in to the web application and register users with the image data for facial recognition-based login. The admin is responsible for monitoring bandwidth and managing quota for the students. The admin can also update attendance of the students. This person is also responsible for user management.

### **2.4 Constraints**

- Time is the major constraint of this system. Team members that have more speed than the others can finish their tasks quickly within a short period

of time. So, when allocating tasks better team members come to the top and those who have a less speed going to the bottom of the list. Those who are finishing early can imagine their feedback also in a good state. Maintaining a peer reviewing like this can save the time of the supervisor. Because he can analyze all the good and bad reviews of the team members and can update his team member's list to allocate tasks automatically.

- Quality is also a good constraint when giving the feedback to a team member. If a team member finished his work early, but the work is not in a good quality that is not good. If it is like that others are not giving a compliment about him. Therefore, team members must concern about his or her quality too.
- The internet connection should have a higher bandwidth as it needs to transfer a large set of data.
- There is the secondary memory, which is where your files are stored, and a computer can use a Hard Disk to store memory, or a Solid-State Drive (As well as other kinds of Flash Memory). Modern Hard Disks (HDs) can store from around 500 GB to 2TB of data. Hard Drive writing and reading speed is also a factor since have to deal with high amount of data when encoding and writing video files to both cache of the local computer and to the main server storage.
- There is also primary memory, which is the memory that stores information that you are manipulating with immediately, when the computer is ON. To maintain an efficient smooth usage of the system there should be adequate amount of RAM in the local computer.

## **2.5 Assumptions and dependencies**

- Web Server is up and running 24x7.
- If the computer does not have enough hardware resources available for the application, there may be scenarios where the application does not work as intended or even at all.
- Computer is connected to the same network as of the necessary cameras to run the system.
- Computer is connected to a reliable internet connection with a high-speed bandwidth connection.

## **2.6 Apportioning of requirements**

Requirements are described in the above chapter as primary specifications. In chapter 3 are referred to as requirements or functional specifications in detailed.

### **3. Specific requirements**

#### **3.1 External interface requirements**

##### **3.1.1 User interfaces**

- Starting a new Session

From this window, a lecturer can start a new live stream of a lecture. Lecturer has to enter details like physical location of the lecture and course information and can also edit the start time and date if needed.

- Sharing Laptop/PC Screen

After a live session has started lecturer has the ability to share the computer screen with the audience, either full screen or a selected area and he can set a time to end the sharing automatically or to end it manually later on.

- Live Camera View

Lecturer can view all the camera views from this window enabling him to monitor the class.

- Course Management Window

From this administrator can add new courses to the system, edit or delete existing courses.

- Add User

Initially the Administrator of the Lecture Capturing application should login using credentials and create the users (student, lecturer) with the face images for the facial recognition login and other details such as email, username, password, student, lecturer id, etc. for the credential-based login. See Figure 5.

- View User

In Figure 4, the administrator should be able to view all the users created by using the user filtering options available.



- User Login Selection

After the administrator register the user and provide the access and login credentials to the user, the user should be able to select the login type and log in to the the system, see Figure 6.

- Facial Recognition login

If the user selects the facial recognition-based login option, the user will allow access to the webcam device and will be directed to the user authentication page as shown in Figure 7.

- Attendance Analysis

After the automated facial recognition-based attendance marking process, the lecturer should be able to see the attendance details of students in his/her account and filter the attendance details of each student using the filtering options available, as shown in Figure 8.

- Bandwidth Monitoring Dashboard

In Figure 9, the administrator should be able to monitor traffic usage, CPU usage, system information etc. using the bandwidth dashboard which consist of graphs and tables. In addition, the administrator will get alerts to notify exceeded predefined threshold settings and attacks etc.

- Enterprise Dashboard

This is where the system administrator finds all the management related functions. The functions are aggregated as user management, course management, bandwidth management, and quota management. When the administrator clicks on each, they will lead to their respective functional pages.

- Live video streaming Interface with ask question option

When a remote user is watching a live session, there will always be an option for him/her to ask a question from the lecturer. This can be done using the Ask Question button placed at the bottom of the video.

- Give Control Interface

When a remote user requests to ask a question from the lecturer, this is the notification interface shown to the lecturer. There are three options, from which only one option can be selected. That is, the lecturer can either give only audio control, or give audio and video control, or decline the user's request.

- Video Uploading Plugin

OBS Studio will be used to capture a recording of the lecturer's desktop screen. A plugin for OBS Studio which contains predefined settings will be used to connect to the remote server and upload the video.

- Interface for splitting video into thumbnails

When a lecturer selects a video and clicks on the "Create Thumbnails" button, the system will split the video into a series of thumbnail chapters containing the relevant presentation slide, video, audio, and text.

- Quota Management Dashboard

The administrator should be able to view the quota allocation for different types of users filtered by user type, month and year. The administrator should also be able to edit this data quota. The system should display the list of users along with their quota usage statistics and make any changes to the quota initiated by the administrator.

### **3.1.2 Hardware interfaces**

- Personal Computer or Laptop with Minimum configuration 500GB Hard Drive and a 8 GB of RAM.
- 4G Router/ADSL connection to facilitate internet connection.
- PTZ Camera for lecture movement and audience speaker capture.
- In build Web Camera on laptops to authenticate remote users.
- IP Camera for capture live audience to mark attendance.

### **3.1.3 Software interfaces**

- MongoDB

MongoDB is used as the database management system. It will be used regularly for major operations of the system.

- WebStorm IDE

WebStorm will be used as the main IDE for designing and implementing the web-application solution.

- OBS

Open Broadcaster Software is a free and open-source streaming and recording program maintained by the OBS Project. This will be used to record all the laptop, desktop pc interactions [4].

- Kurento

Kurento is a WebRTC media server and a set of client APIs making simple the development of advanced video applications for WWW and smartphone platforms. Kurento Media Server features include group communications, transcoding, recording, mixing, broadcasting and routing of audio-visual flows [5].

- Web Browser

Latest version of Google Chrome or Mozilla Firefox to access the web-application.

### **3.1.4 Communication interfaces**

- Internet Connection

All the camera footage is live streamed along with lecture's screen if required. So in order to stream live content it needs a stable internet connection.

- Database Connection

To authenticate users, mark attendance and keep track of recorded videos database connectivity must be there.

### **3.2 Classes/Objects**

This section includes the requirements that specify all the fundamental actions of the software system.

#### **3.2.1 User class 1 - The Administrator**

**ID: FR1**

**TITLE: Admin Login**

**DESC:** The administrator should be able to login with his username and password.

**IN:** Username and Password

**OUT:** Navigate to admin dashboard and display information available on the system.

**PR:** The application verifies the authenticity of the username and password provided and allows admin to view the information if the username and password is valid.

**DEP:** None

**ID: FR2**

**TITLE: User registration**

**DESC:** The administrator should be able to register students, lecturers and other users by filling a form with the necessary details.

**IN:** Admin will have to provide all the necessary details in the user registration form including quality face images for face recognition-based login process.

**OUT:** All the details entered in the user registration page will be verified and accepted by the system into the database.

**PR:** Store all the details in the user registration form into the database.

**DEP:** FR1

**ID: FR3**

**TITLE: Filter attendance of a student**

DESC: The administrator should be able to filter attendance of a student by Student ID, month, date etc.

IN: Student ID, month, date, year, course, semester

OUT: The filtered attendance details will be displayed to the admin.

PR: Filter attendance details of a student from the database and display them to the administrator.

DEP: FR1

**ID: FR4**

**TITLE: Modify student attendance**

DESC: The administrator should be able to modify the attendance of a student.

IN: 'Present' or 'Absent'

OUT: The details entered in the attendance table will be accepted by the system into the database.

PR: Store the details of attendance into the database.

DEP: FR1

**ID: FR5**

**TITLE: Monitor bandwidth Information**

DESC: The administrator should be able to monitor bandwidth information of the system.

PR: The system should calculate and output bandwidth details such as traffic, memory and system usage etc. to the bandwidth monitoring dashboard. In addition, the system should produce bandwidth warning and alerts and display them in the alert section of the dashboard.

DEP: FR1

**ID: FR15**

**TITLE: Quota management**

DESC: The administrator should be able to view the quota allocation for different types of users filtered by user type, month and year. The administrator should also be able to edit this data quota.

IN: Monthly quota usage.

OUT: Statistics showing the remaining quota and used quota for a month.

PR: The system should display the list of users along with their quota usage statistics and make any changes to the quota initiated by the administrator.

**ID: FR16**

**TITLE: Course Management**

DESC: The administrator should be able to add new course information to the system. The administrator should also be able to edit and delete course information.

IN: Course ID, Course Name, Duration, Fee and Details.

OUT: Operation Success Message.

PR: The system should display the list of courses along with their details and make any changes to the courses initiated by the administrator.

### **3.2.2 User class 2 - The Lecturer**

**ID: FR6**

**TITLE: Lecturer face recognition login**

DESC: The lecturer should be able to login using face recognition.

IN: The lecturer has to select the face recognition option from the login selection page.

OUT: Navigates to the lecturer dashboard and display the information available on the system.

PR: The application allows access to the webcam and authenticates the face of the lecturer. If the face is recognized, the application automatically logs the lecturer to the application and display available information.

DEP: FR2

**ID: FR7**

**TITLE: Filter attendance of a student**

DESC: The lecturer should be able to filter attendance of a student by Student ID, month, date etc.

IN: Student ID, month, date, year, course, semester

OUT: The filtered attendance details will be displayed to the lecturer.

PR: Filter attendance details of a student from the database and display them to the lecturer.

DEP: FR6

**ID: FR8**

**TITLE: Modify student attendance**

DESC: The lecturer should be able to modify the attendance of a student.

IN: 'Present' or 'Absent'

OUT: The details entered in the attendance table will be accepted by the system into the database.

PR: Store the details of attendance into the database.

DEP: FR6

**ID: FR11**

**TITLE: Upload a video to server from OBS Studio**

DESC: A lecturer should be able to directly upload a video to the server using the OBS Studio plugin.

IN: A video should be selected.

OUT: A message is displayed to the user saying that the video was successfully uploaded to the remote server.

PR: The plugin connects to the remote server based on the saved settings. After the connection is established, the video is uploaded to the server.

**ID: FR12****TITLE: Split a lecture video into thumbnails**

DESC: A lecturer should be able to split a lecture video recording into a series of thumbnail chapters each containing the relevant lecture slide, audio, video, and text (converted from the audio).

IN: A video should be selected from the list of recorded lectures.

OUT: A message is displayed which says that the video was successfully split into a series of thumbnail chapters, and a button is displayed to view the created thumbnails.

PR: The application converts the video recording into a series of thumbnail chapters after comparing it with the PowerPoint presentation slides, resulting in a series of chapters containing the lecture slide, audio, video and text.

**ID: FR13****TITLE: Start a new live session**

DESC: A lecturer should be able to start a new session from the web application.

IN: Session Location, Start Time, Date and Course Name

OUT: A message is displayed to the user saying that the streaming successfully started.

PR: The server need to stream live footage from the local setup.

**ID: FR14****TITLE: Sharing Computer Screen**

DESC: A lecturer should be able to share the computer screen either complete screen or a cropped area from the web application.

IN: Start Time, End Time, Date and Sharing Area

OUT: A message is displayed to the user saying that the screen sharing successfully started.

PR: The web application starts a screen share with the help of a browser extension.



### **3.2.3 User class 3 - The Student**

#### **ID: FR9**

**TITLE: Student face recognition login**

**DESC:** The student should be able to login using face recognition.

**IN:** The student has to select the face recognition option from the login selection page.

**OUT:** Navigates to the student dashboard and display the information available on the system.

**PR:** The application allows access to the webcam and authenticates the face of the student. If the face is recognized, the application automatically logs the student to the application and display available information.

**DEP:** FR2

#### **ID: FR10**

**TITLE: Filter and View attendance**

**DESC:** The student should be able to filter his/her attendance by month, date, year, semester, subject etc and view his/her attendance.

**IN:** Month, date, year, course, subject, semester

**OUT:** The filtered attendance details will be displayed to the student.

**PR:** Filter attendance details from the database according to the filter details provided and display them to the student.

**DEP:** FR9

### **3.3 Performance requirements**

The proposed system should perform all the functions as specified in the functional requirements section without any delay in order to satisfy the performance requirements mentioned below.

- As it is an e-learning web application, it should be capable of handling huge workloads during peak times such as supporting at least 200 concurrent users during a live-streaming lecture session.
- During the live-streaming lecture period, the response time from the application should be less than 2 seconds.

- The database should be able to store various types of data including support for images, audio, and video.

### **3.4 Design constraints**

No specific restrictions on the design of the system were identified. A suitable acceptable design will be used as long as it satisfies the requirements and does not hinder or compromise the functionality of the system.

### **3.5 Software system attributes**

#### **3.5.1 Reliability**

The system should be reliable in its operations which it provides for all users. Information present in the system should be consistent created in the system will be retained for a number of years without the data being changed by the system.

#### **3.5.2 Availability**

- The system functionalities should be available at any given time to users (24/7 accessibility).
- There should be no downtime or lag in the system when there are many concurrent users accessing the system.

#### **3.5.3 Security**

User access to the system has to be controlled so that only authorized users can gain access to the university's content and resources.

- Users have to be authenticated by their valid username and password to access the web application.<sup>1</sup>
- Passwords must be hashed before storing them in the database instead of plain text so that no unauthorized persons can access another user's account [1].
- User authorization verifies that users have access to information depending on their access roles/rights (e.g. Students cannot access resource materials of lecturers).

- Biometric authentication in the form of facial recognition would be used to identify remotely logged in students to the system. This further ensures that the university's resources are not exposed to unauthorized persons.

#### **3.5.4 Maintainability**

The system may need regular corrective and preventive maintenance to make certain that any hindrances and limitations are removed at the earliest time of detection [2]. This is importance to ensure a smoothly functioning system.

#### **3.6 Other requirements**

Additional requirements in order to maintain consistency and global standards are mentioned below.

- Usage of IEEE standards for imagery and typography to maintain consistency [3].
- Usage of open-source software tools and technologies.
- Convenient navigation through the system.
- Positioning of buttons, tabs, labels, and other components.

## References

- [1] P. Brown, “Why do you need to Salt and Hash passwords?,” *Culttt*, 21-Jan-2013. [Online]. Available: <https://www.culttt.com/2013/01/21/why-do-you-need-to-salt-and-hash-passwords/>. [Accessed: 05-May-2018].
- [2] “7 Non-functional requirements you should always keep into account - StartX,” *StartX*, 20-May-2015. [Online]. Available: <https://www.startxconsulting.com/en/articles/7-non-functional-requirements-you-should-always-keep-into-account/>. [Accessed: 05-May-2018].
- [3] “Branding and Visual Elements - IEEE Brand Experience,” *IEEE Brand Experience*. [Online]. Available: <https://brand-experience.ieee.org/guidelines/digital/style-guide/branding-visual-elements/>. [Accessed: 05-May-2018].
- [4] “Open Broadcaster Software | Help.” [Online]. Available: <https://obsproject.com/help>. [Accessed: 06-May-2018].
- [5] “Kurento.” [Online]. Available: <http://www.kurento.org/>. [Accessed: 06-May-2018].
- [6] “Home - BigBlueButton.” [Online]. Available: <https://bigbluebutton.org/>. [Accessed: 12-May-2018].
- [7] “Lecture Capture & Recording Software For Education | Panopto.” [Online]. Available: <https://www.panopto.com/panopto-for-education/lecture-capture/>. [Accessed: 12-May-2018].
- [8] “Echo360 - The Smarter Video Platform for Higher Ed and Continuing Ed.” [Online]. Available: <https://echo360.com/>. [Accessed: 12-May-2018].
- [9] “Video Platform | Kaltura.” [Online]. Available: <https://corp.kaltura.com/>. [Accessed: 12-May-2018].