Smart Classroom

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CERTIFICATE

Certified that the contents and form of project report entitled **"Smart ClassRoom"** submitted by 1) Zainab Abbas, 2) Ramsha Khan and 3) Iqra Arooj has been found satisfactory for the requirement of the degree.

Supervisor: _____

Dr. Naveed Iqbal Rao

ABSTRACT

Smart classroom facilitates interactive and collaborative learning among students. Real time interactive session is provided for distance learning. This is a comprehensive solution designed to enhance students' academic performance with simple, practical and meaningful use of technology.

We provide an interactive interface for remote students. We have multiple cameras to capture teacher events. Teacher's live video is transmitted to remote students through automatic selection of camera. We also transmit online student's video to classroom. Instructor's slides are available to remote students. Student's attendance is managed through facial recognition. We also develop an android based application for students so that they can attend online class through their android app.

The project has different modules that are integrated to create an interactive environment, modules include website for online classroom having teacher and student end, automatic camera selection module that captures teachers' events, and attendance management system that marks attendance through facial recognition.

Declaration

This declaration is to clarify that this work has been done by our self and all the work that is in the report has not been submitted in provision of any application for any other degree or qualification of this or any other university or institute.

We also declare that all of the submitted contents of this project are original in its content, apart from those, which have been specifically admitted in the references. All the work process containing this document is from our own idea and creativity. All contents of our project have been submitted as a part of partial fulfillment of Bachelor of Engineering in Software Engineering. We declare that this project is the work of our own excluded for the references that have been acknowledged.

Dedication

We dedicate our work to our family and teachers.

Acknowledgement

In the name of Allah, the Most Beneficent and the Most Merciful.

Thanks to Allah SWT for His never-ending blessings which have been granted upon us. His willing gives us the opportunity to complete this Final Year Project. Firstly, we would like to express our deepest thanks to, Dr. NaveedIqbalRao, as our supervisor who had given valuable information, suggestions and guidance in the compilation and preparation of this final year project. He had guided us a lot during the last one year.

We also want to thank the lecturers and staffs of Military College of Signals for their cooperation during the completion of final year project.

Deepest thanks and appreciation to our parents, family, and others for their cooperation, encouragement, constructive suggestion and full of support for the report completion, from the beginning till the end. Also thanks to all of our friends and everyone, who have contributed by supporting our work and help us during the final year project progress till it is fully completed.

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Chapter 1: Introduction

SMART CLASSROOM is an efficient learning system that aims to provide learning opportunity to remote students. Students can attend online class live and interact with the teacher easily using their laptops and android phones, they can download/access lecture contents and other helping materials. Teacher on the other end delivers online lecture, events of teacher are captured by multiple cameras through automatic selection. Attendance of students is maintained through facial recognition.
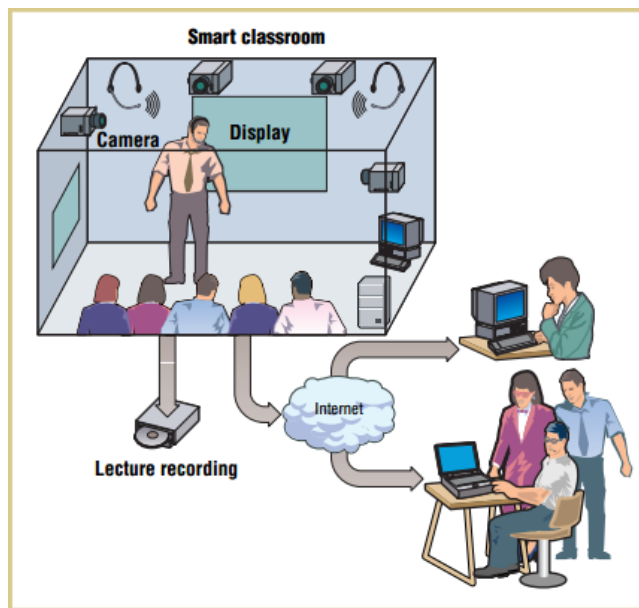
Figure 1: Smart classroom view

1.1 Background:

1.1.1 Need of Smart classroom System:

Students living in remote areas or having limited resources are unable to access knowledge, expertise and resources efficiently because today's virtual classrooms are not providing rich interactivity and efficient knowledge transfer. Students of rural areas do not have access to good universities. This solution will help them to explore more knowledge means efficiently.

1.1.2 Smart classroom in Pakistan:

Smart classroom technology is highly essential in developing countries like Pakistan where every one cannot have access to good education. Pakistan is one of the most densely populated countries in the world, yet students cannot get the desired technology in education. Students in remote areas cannot come to schools and colleges, there is a need to facilitate them and give quality education to them through internet. Keeping in mind the education condition of Pakistan as compared to other developing countries importance of Smart class room technology is clear. To provide quality education we can have different solutions:

 The first is to build schools and colleges at remote areas and provide latest equipments that will help the students get quality education by going to colleges. This is an expensive approach so not possible to implement on large scale.

The second solution is to develop an online class so that students can get access to lectures and attend class online. They will need an internet connection, laptop or an android phone for this.

Figure 2: Smart Classroom in Pakistan

1.2 Problem Statement:

This solution provides live synchronous class to students, where they can easily interact with the teacher by using their android phones or laptops. Instructor and class room is covered with two cameras. There are two types of video streaming in process. First, based on the actions performed by the instructor, select most suitable camera for transmission i.e. one to many - from instructor to students streaming. Second, all students watching the lecture, their images are displayed at one screen i.e. Many to one - from students to the instructor. Attendance of all students will be managed through face recognition.

The aim of this project is to provide a web application where students can access resources and attend lecture by efficiently handling the bandwidth and using suitable internet protocols and technology.

1.3 Goals and Objectives

To provide an interactive learning environment by covering and transmitting Teachers' action through automatic selection between multiple cameras, making instructor slides available to remote students, transmitting remote student's video to classroom when they join online class providing an interactive interface for remote students so they can ask questions from instructor, managing attendance through face recognition and developing of android based application for viewing these lectures.

1.4 Deliverables:

1.4.1 Project deliverables:

Our deliverables include: web application, camera selection module, attendance management system, android phone web application and the reports delivered are project Synopsis, Software requirement specification document (SRS), Progress, reports, Literature review, Architecture and Design document, Project documentation + code, User manual and Quality assurance document.

Chapter 2: Literature Review

2.1 Introduction:

Learning techniques have been improved from the past by introducing new concepts like e-learning, online-learning, multimedia based learning and virtual classrooms etc. Smart classrooms are electronically enhanced lecture rooms that use learning technologies and electronic components to make education more effective.
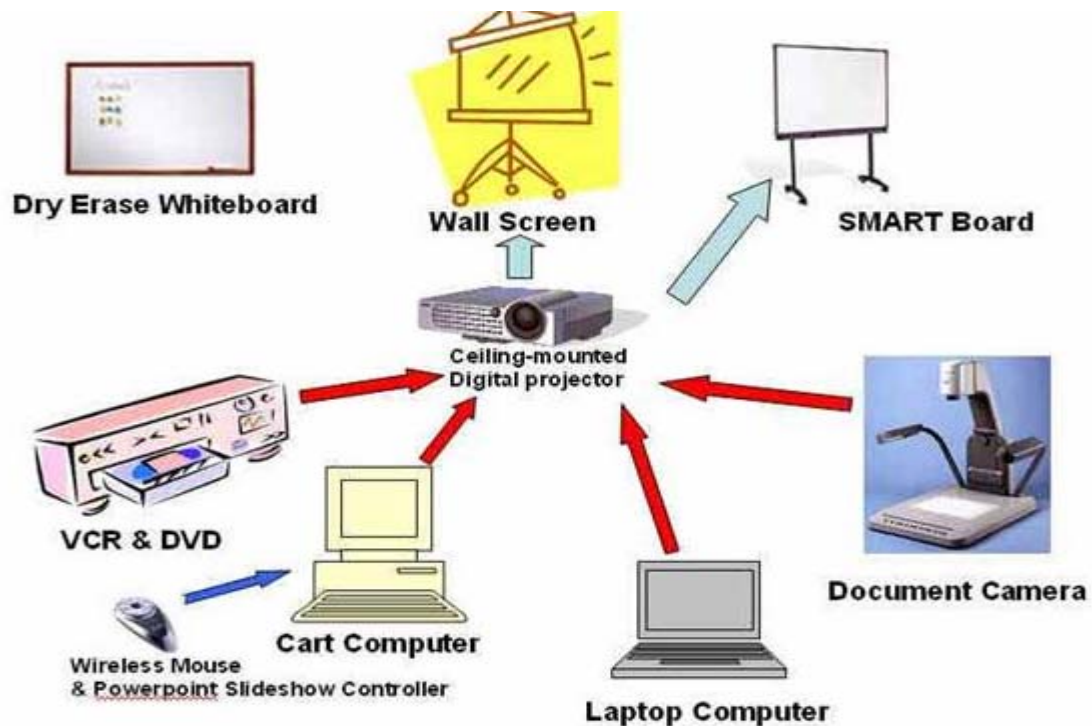
Figure 3: Equipments required for Smart classroom

2.2 Background:

Different organizations and universities have worked on various e-learning techniques.

It started in early 1960; the University of Illinois developed a classroom having computer systems that were connected to each other so that students can access different resources by listening to recorded lectures using audio devices like radio. Now these techniques have been advanced, the latest work in this field includes:

2.2.1 ClassX software Stanford:

The ClassX open source project is an interactive video streaming platform. It is designed for students, researchers and software developers. It has client and server side. Server supports video streaming while clients interface implements streaming.

This project has a module for capturing videos and selecting region of interest for video streaming. Automatic selection of region is to minimize human effort. It also supports automatic matching between lecture video and slides.

 A mobile application is also developed for this but it only supports Apple iOS.
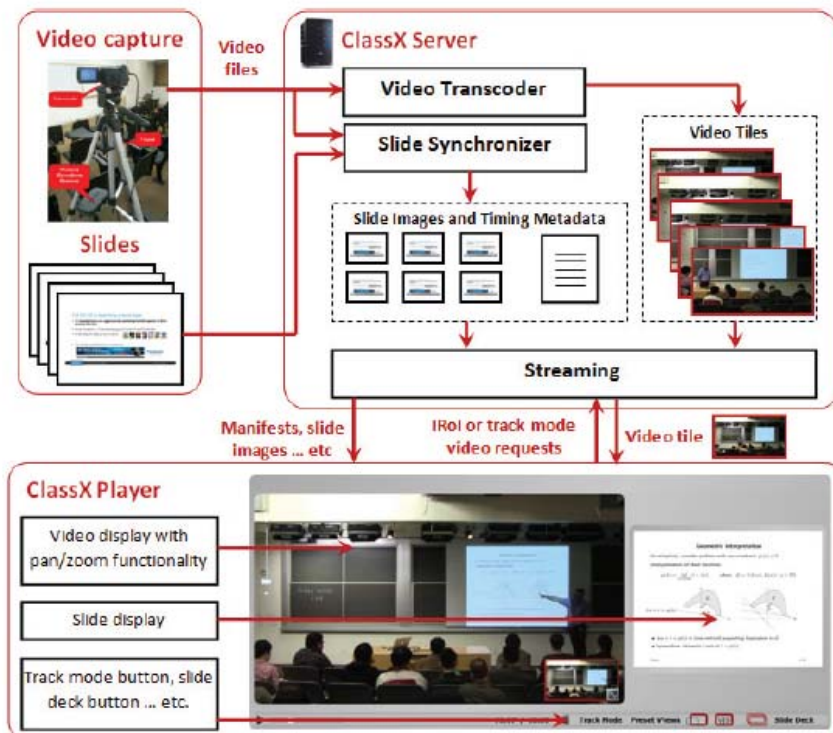
Figure 4: Overview of the ClassX System

Note: Some part of it is open source but developed for LINUX based systems.

Mobile phone application is only developed for Apple iOS.

http://classx.stanford.edu/ClassX/

2.2.2 WizIQ:

WizIQ is an online teaching and learning solutions. This site is designed to help students and teachers to interact each other.

Web browser and adobe flash is required to run this application. An online student can find test, tutorials and recorded classes. Interesting thing is that anybody with knowledge can be a teacher. All they need to do is to upload their profiles with all essential data that what they teach and what they are offering to teach. After running searches for their required field, online students can get benefit from it. Other features like screen sharing and chat are also provided.
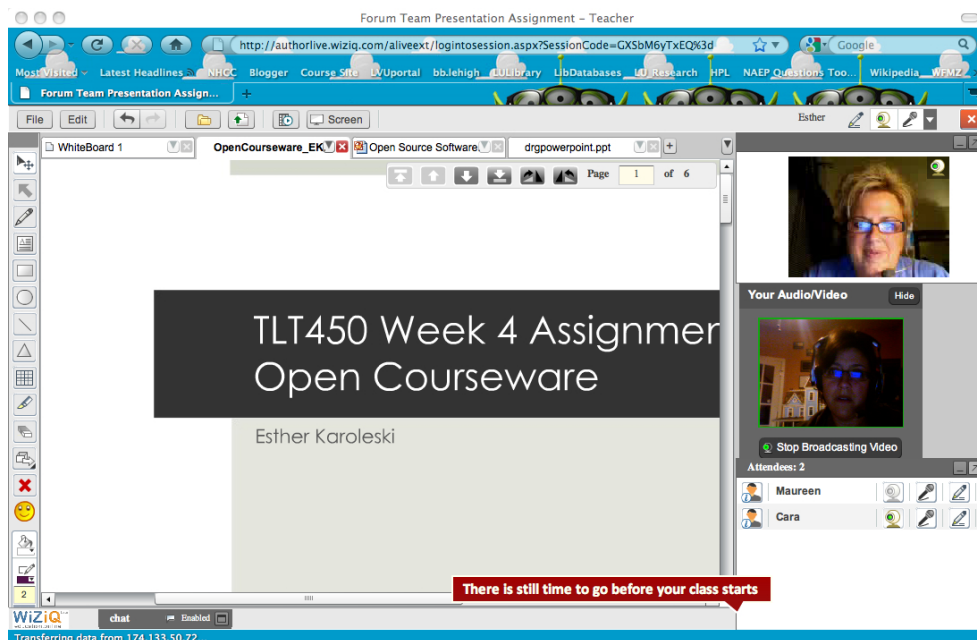
Figure 5: WizIQ Interface

Note: This is not open source, no real time classroom coverage and no mobile phone application exists for this.
http://www.wiziq.com/

2.2.3 Tsinghua University Project:

Researchers at the Tsinghua University developed a prototype system for smart classroom. It consist of a main class room equipped with two projector screens, one for displaying teaching material and the other is Student Board displaying remote students' images.
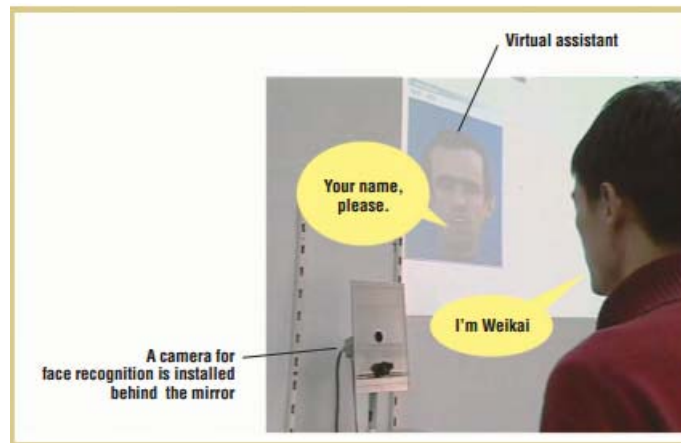
Figure 6: Tsinghua University project Interface

When a remote student logs in, live video and audio of that student is projected to the classroom. The teacher and local students view and interact with remote students through the Student Board. The classroom is equipped with several cameras. They capture the teacher's actions, which are transmitted to remote students, this two way communication makes classroom session more interactive. http://tu139015.ip.tsinghua.edu.cn/paper/2003/2003IEEEPervasiveComputing-SHI%20Yuanchun.pdf

2.3 Shortcomings/issues

2.3.1 Band width

For remote students, bandwidth can be biggest issue to provide such services. Also to stream multiple videos to classroom, quality of video will be compromised to great extent due to bandwidth.

2.3.2 Congestion

In video streaming, congestion can cause packet loss which can reduce video quality to great extent.

2.3.3 Signal latency

Signals can have high latency because of low bandwidth in far off areas. The information transport of digital signals in many steps needs time; an increased latency larger than about 150–300 MS becomes noticeable and is soon observed as unnatural and distracting.

2.4 Issue Resolved

There is no open source video conferencing classroom is available so our project resolve this issue by providing an open source system. The system developed by us is Windows based which makes it more usable.

We replaced manual camera selection which is being done by automatic camera selection to capture teacher events.

Chapter 3: System Design

3.1 Architecture Diagram

3.1.1 System Block Diagram
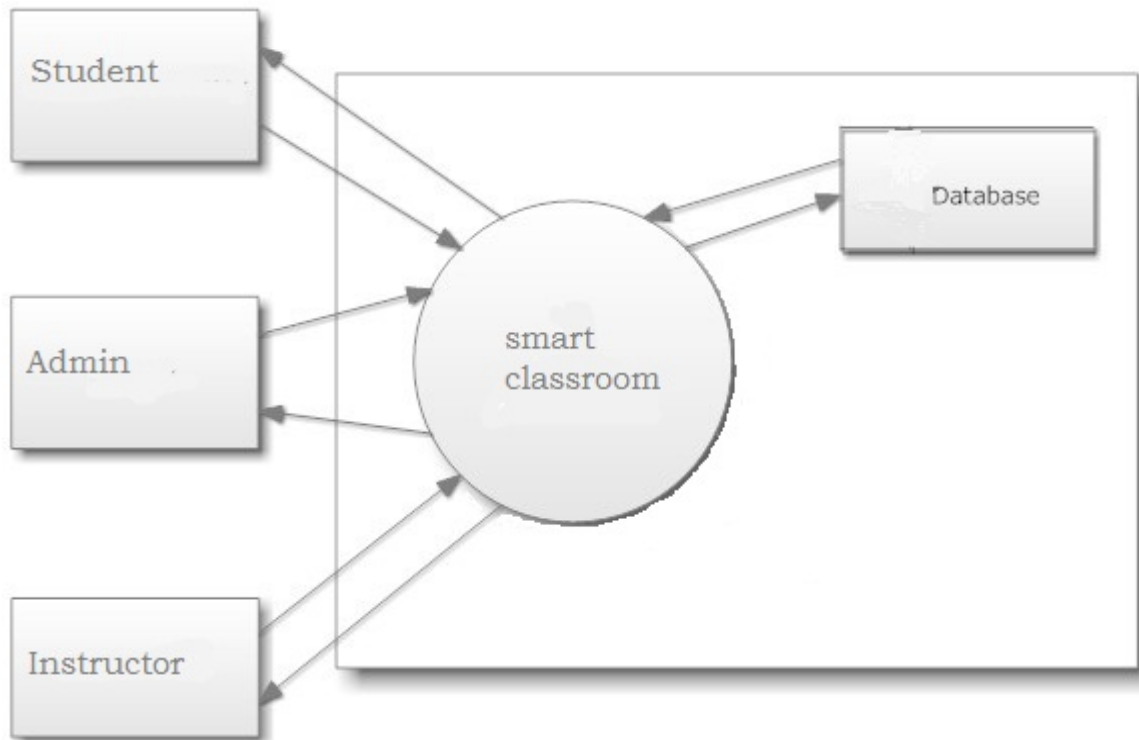
Figure 7: System Block Diagram

3.1.2 System Detailed Architecture Diagram
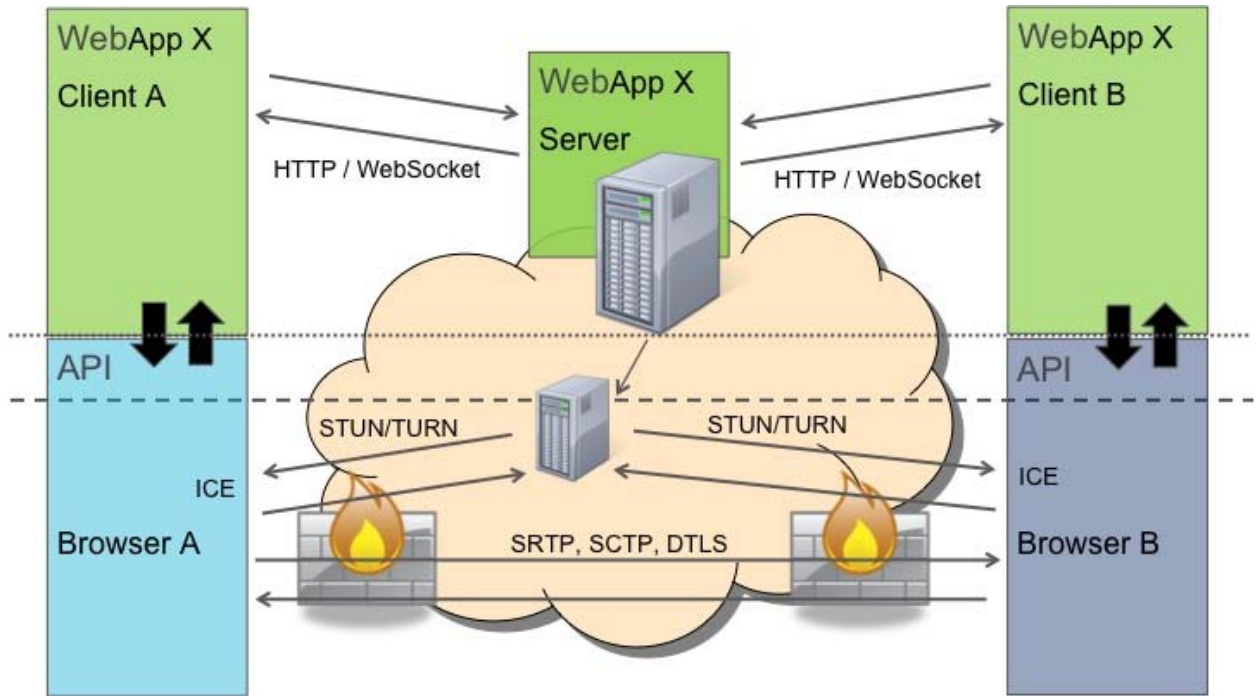
Figure 8: System Diagram

3.1.3 Description of Architecture diagram

In our System Teacher act as client that makes a request for starting a conference to a central server. Client connection is made with ice server that provides audio and video channel transmission. Other clients that act as students also request the server to join the classroom. Their audio and video channels are also provided by ice server. So a central server is responsible for maintaining session between teacher and students.

3.2 Architectural Style:

3.2.1 MVC (Model View Controller Pattern)

Architecture of our system can be modeled using Model-View-Controller. Our System can be divided into three parts Model, View, and Controller.

MODEL: The model handles the state of application. It updates its state like adding or removing record from the database. It contains the main business logic which is going to be implemented on our system. Whatever option the user clicks on the interface, controller notifies the model to perform that function. When the model performs the desired function and change the state of application, the controller notifies the view the model has changed.

VIEW: View contains the user interface. In our application there are different views for different types of users. We implemented our view using html. There are different views like Login page, Register page, lecture page etc.

CONTROLLER: The actions perform by the user are send to the controller. Like in case of our application http request are send to the controller. After receiving the request, controller notifies the model about the particular action. Then after getting models response controller selects the appropriate view.
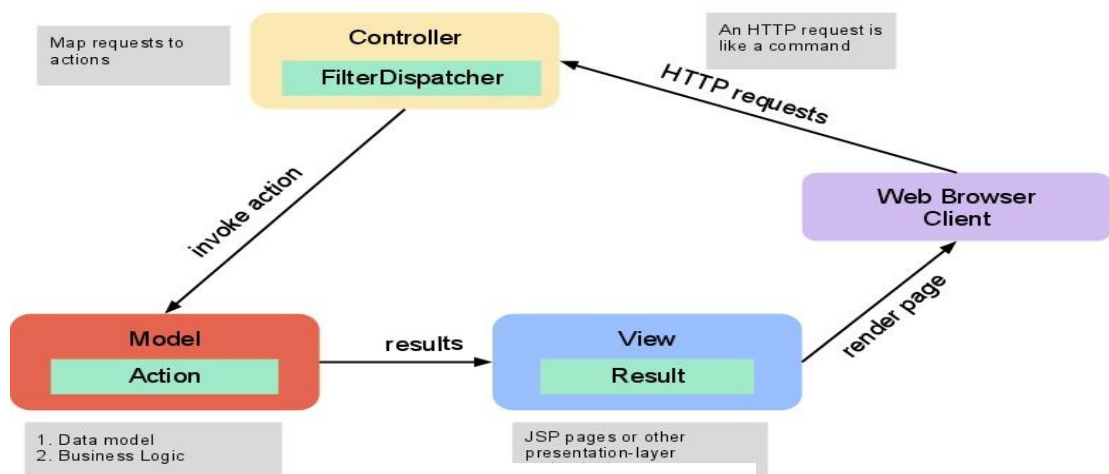
Figure 9: MVC model

3.2.2 System View:
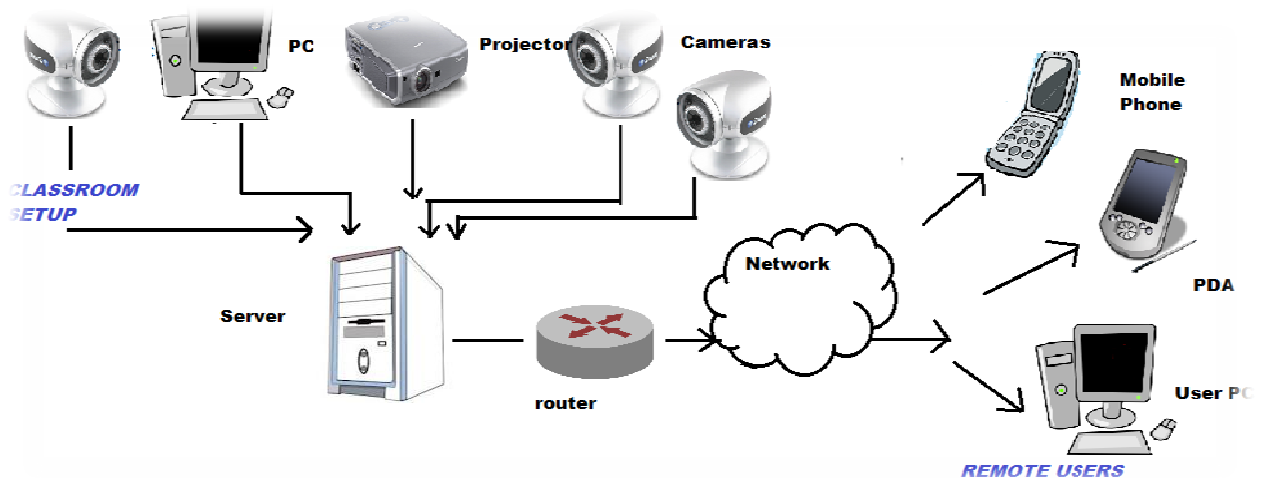
Figure 10: System Diagram
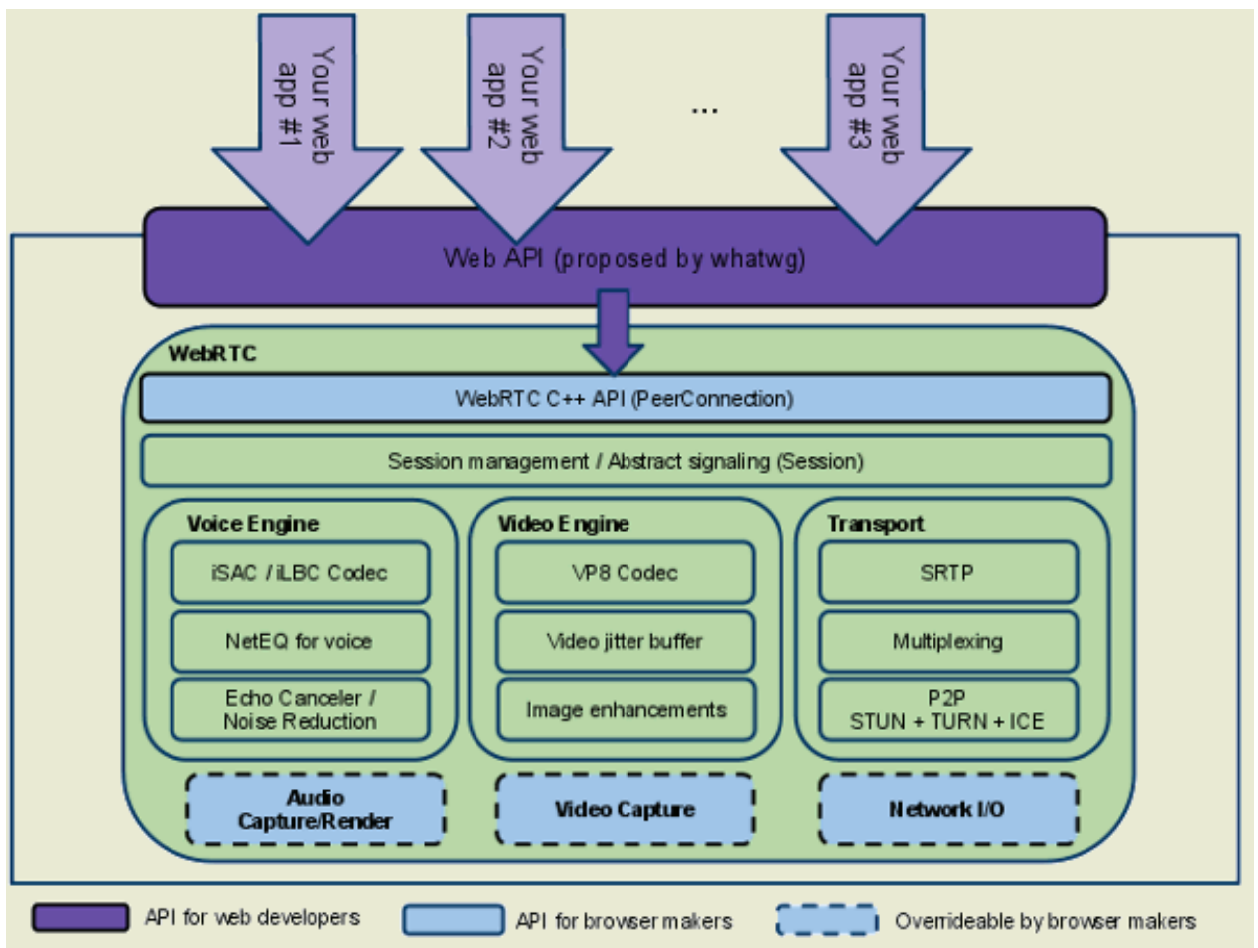
Figure 11: Protocol Stack

3.2.3 Description:

Implementation diagram shows two ends of the system classroom and remote user end.

Protocol stack shows how live session is maintained using the codec like iSAC for audio transmission, VPB for video transmission and Protocol that is the**Secure Real-time Transport Protocol** (SRTP).

3.3 Detailed designs:

3.3.1 Class Diagram

Person

-First Name : string
-Last Name : string

Teacher   1

-First_Name : string
-Last_Name : string
+Deliver_Lecture() : boolean(idl)
+Respond_to_query() : boolean(idl)

Resources And Helping Content   *

-Lec_Name : string = L
-Lec_Type : string
-Instructor : string
-Subject

Lecture   *

-name : wchar_t
-number : int

Smart Classroom   1   1

+Display_Interface() : boolean(idl)
+Connect_To_DB() : boolean(idl)
+Connect_To_Client() : boolean(idl)
+Connect_To_Server() : boolean(idl)
+Manage_Remote_Students() : boolean(idl)
+Provide_Streaming() : boolean(idl)
+Maintain_Connection() : boolean(idl)
+Mark_Attendance() : boolean(idl)
+Select_Desired_Camera() : boolean(idl)

Admin   *   1

-User Name : string
-Password : string
+Manage_Lectures() : void
+Manage_Database() : void
+Manage_Contents() : void
+Assign_User_Name() : void
+Assign_Password() : void

1   *

DataBase   1

-Name : string
+Save() : boolean(idl)
+Handle query() : boolean(idl)
+Edit() : boolean(idl)
+Delete() : boolean(idl)

Remote Student   *

-User Name : string
-Password : string
+Give_ID() : boolean(idl)
+Give_Pw() : boolean(idl)
+Select_Option()
+Ask_Query() : boolean(idl)
+Download_Lectures() : boolean(idl)

Figure 12: Class Diagram

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Description of class diagram:

This class diagram shows classes involved in functional/operational works.
Classes included are:

Person: This class is the generalized class for other users. It contains simple data like first name, last name and id.

Teacher: This class contains simple data of teacher like teacher name, id and functions like deliver lecture() and respond to query().

Remote Student: This class contains simple data elements regarding student information like student username and password. Functions of student are to give id, password for login, then attend online class and download lectures.

Lecture: This class represents the lecture online delivered by the teacher. Its data attributes are lecture number and name.

Smart Classroom: This class is the main class that represents the main Smart Class. It contains functions like displaying interface to user, making connection with database, server and clients, provide streaming, and mark attendance through face recognition using attendance module and capture teacher events through automatic camera selection.

Admin: This class is for representing admin, the data items included here are admin id and password. Function of admin is to manage the content, lectures on the website, assign user id and password and manage the database.

Resources and helping content: This classis contains data about the resources and helping materials placed by the admin. Like the lecture name, type (format), instructor name and subject of the lecture uploaded during the online class.

Database: This class contains data about the databases connected to the system like database name and id. Functions like save, delete, edit records are placed in this class that are operations related to database.

3.3.2 ER Diagram:

ERD of the system is given below
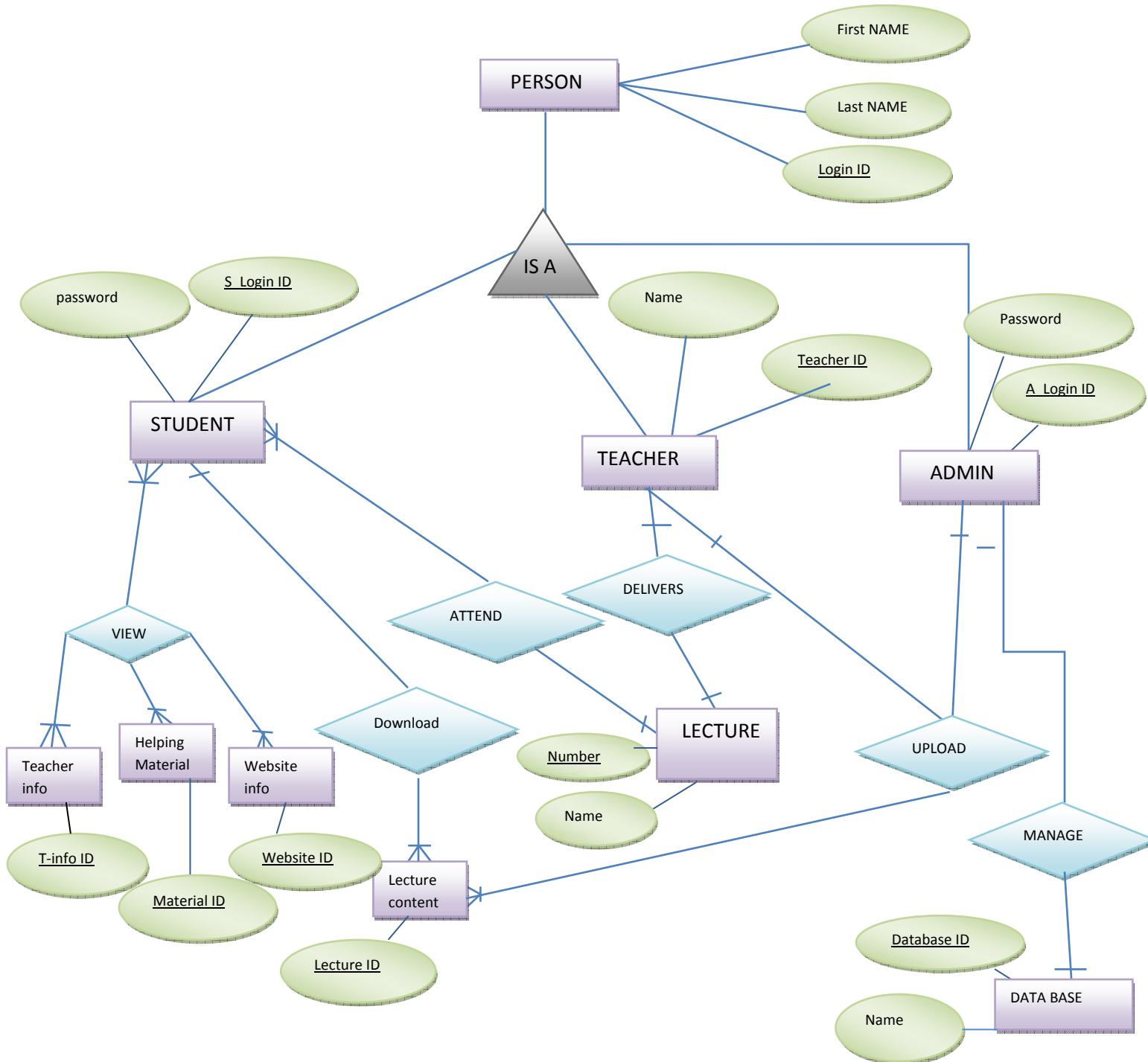
Figure 13: Entity Relationship Diagram

Description of ER diagram:

The entities present in the system are given below:

ENTITY	DESCRIPTION	PRIMARY KEY
User	It is a general entity for other users, its attributes are simple, first name , last name and Login_id.	Login_ID
Student	This entity represents the students with entities s_login_id and password. Students have relation with other entities, they can attend class, view teacher and website info, download lecture content and attend online lecture.	S_login_ID
Teacher	Teacher entity represents teacher with attributes teacher_id and name.Teacher is responsible to start online class.	Teacher_ID
Admin	Admin entity represents the admin entity with attributes A_login_ID and password. Admin can upload content and manage database.	A_login_ID
Lecture	Lecture entity is the online class lecture started by teacher, it has attributed lecture name and number.	Number
Lecture Content	Lecture content is entity for the lecture uploaded the admin(teacher) on the website before starting the lecture. It has attribute Lecture_ID.	Lecture_ID
Database	This entity represents the database connected to the system. It attributes database name and database ID.	Database ID
Teacher information	Teacher information entity is for the information regarding teacher that is uploaded by the admin with attribute T_info_ID.	T_info_ID
Website info	Web information entity is for the content that is placed by the admin with attribute Website_ID.	Website_ID
Helping Material	Helping Materialentity is for the material that is uploaded by the admin to help the students. It has attribute Material_ID.	Material_ID

3.3.3 Use Case Diagram:
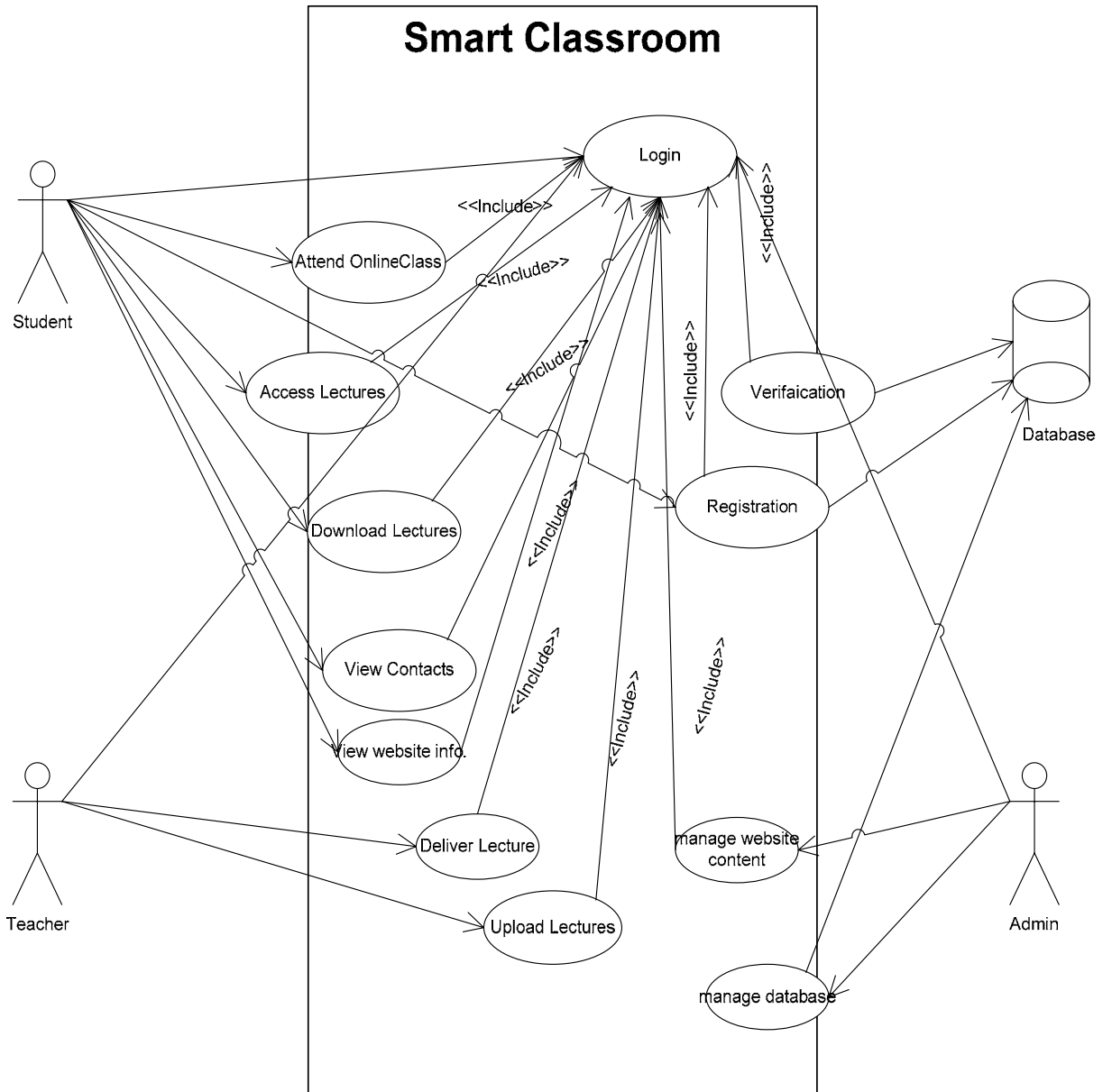
Figure 14: Use Case Diagram

3.3.4 Sequence Diagrams:

a) User Login
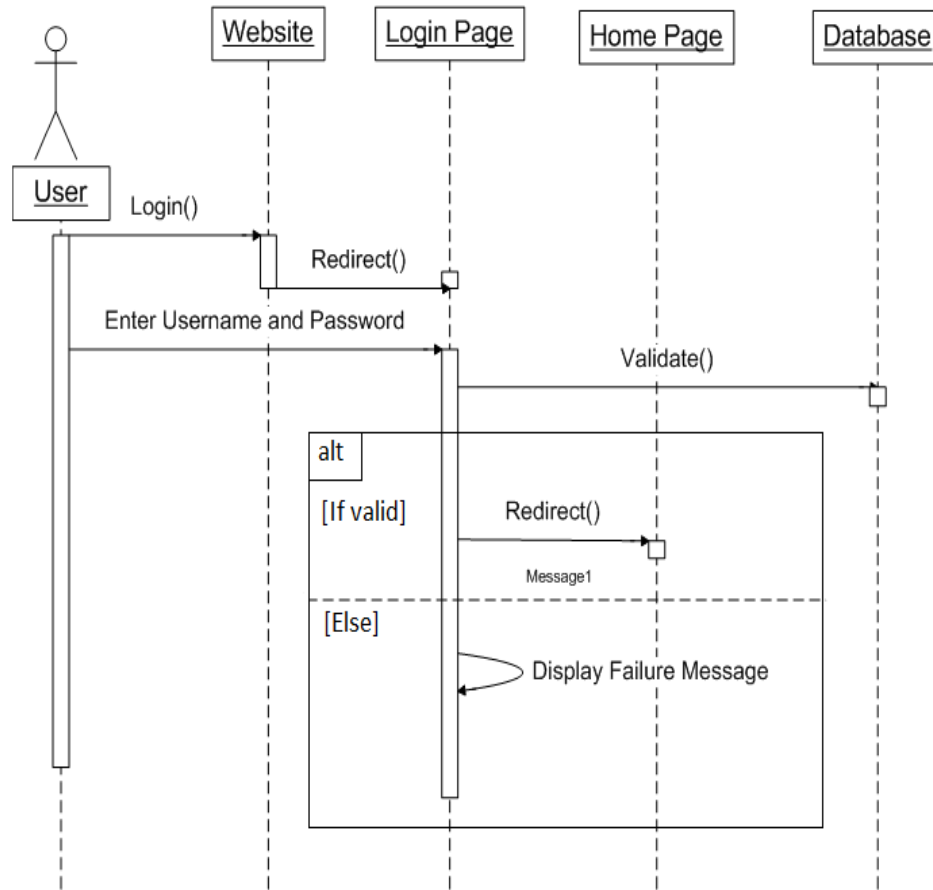
Figure 15: Sequence Diagram of Login

Explanation:

The remote student will first login to the website, the login and password will be verified from the database, if match found then he student will be directed to home page, else he will be prompted to enter password again.

b) Attend online class
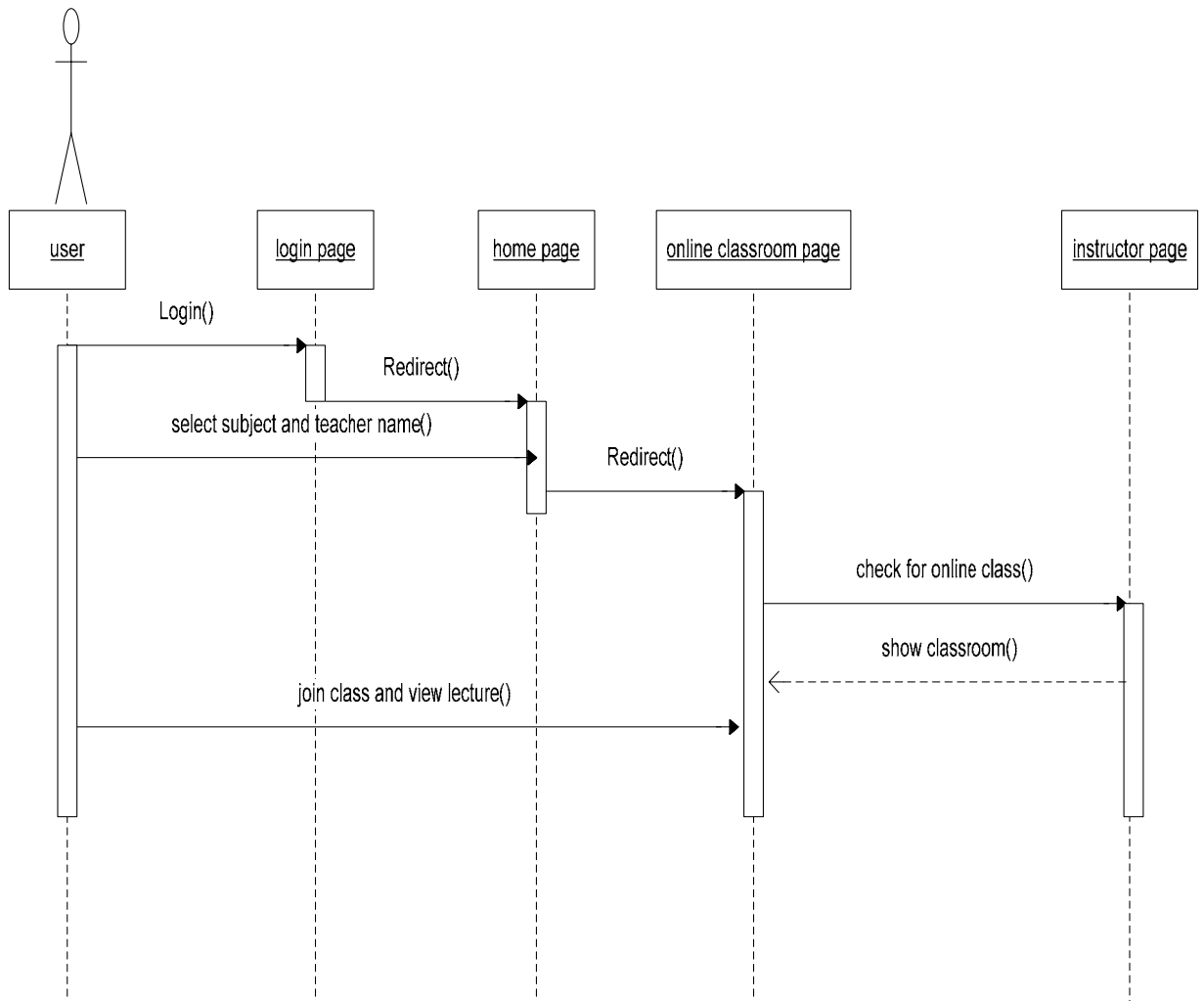
Figure 16: Sequence Diagram to attend online Classroom

Explanation:

After successful login, student is directed to the homepage of website, where he/she has different options, to attend online class user will select subject tab, by which he/she is redirected to online class room page and can attend online classes if available at that time.

c) View and download Helping material

Helping Material
Sequence Diagram
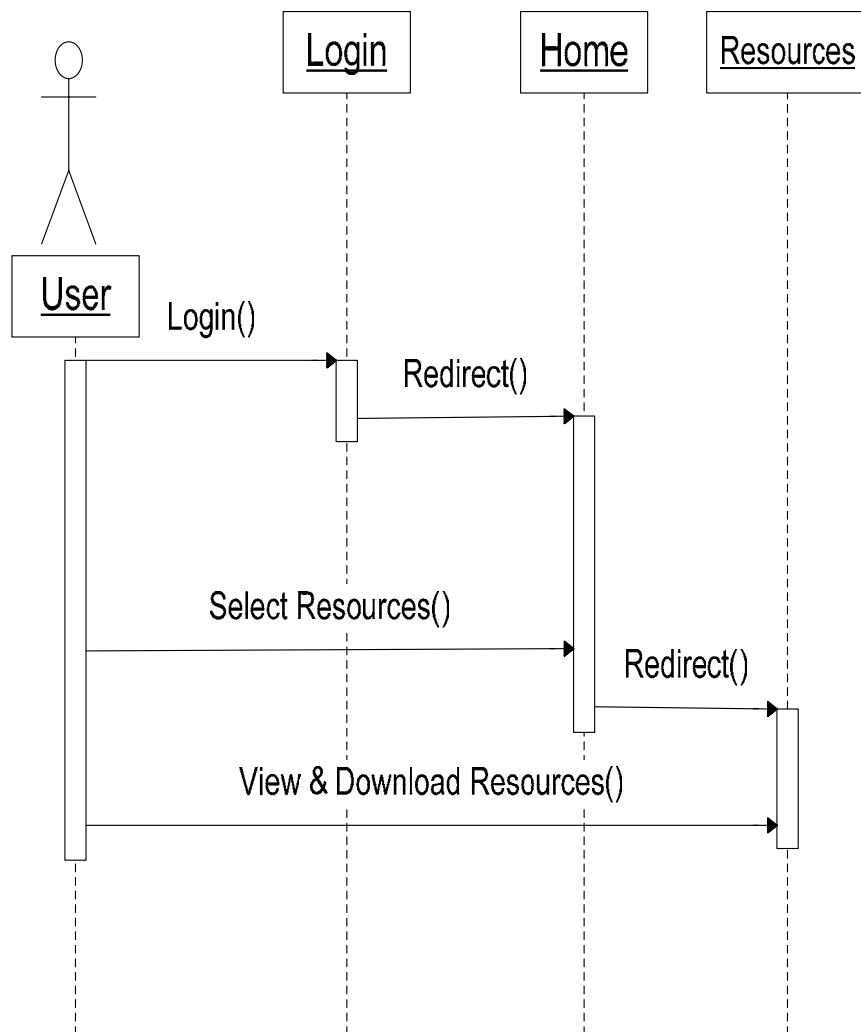
Figure 17: Sequence Diagram to Access Resources

Explanation: After successful login, user can go to resources page and download or view available resources.

d) Teacher Actions Sequence Diagram

Teacher Actions Sequence Diagram
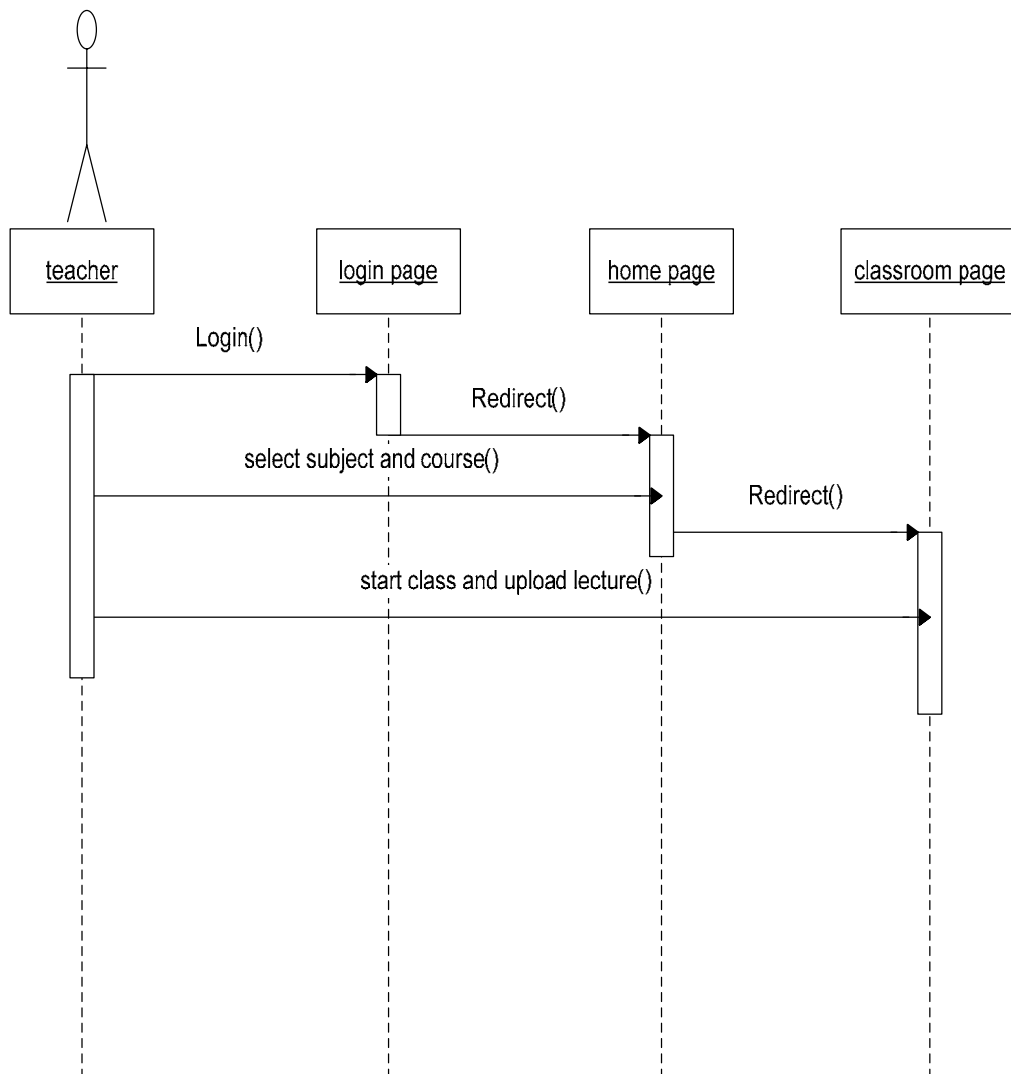
Figure 18: Sequence Diagram of Teacher Action

Explanation: After successful login, teacher goes to classroom page from the subject tab and there he/she can upload lectures and start online class.

e) Admin Actions Sequence Diagram

Admin Actions Sequence Diagram
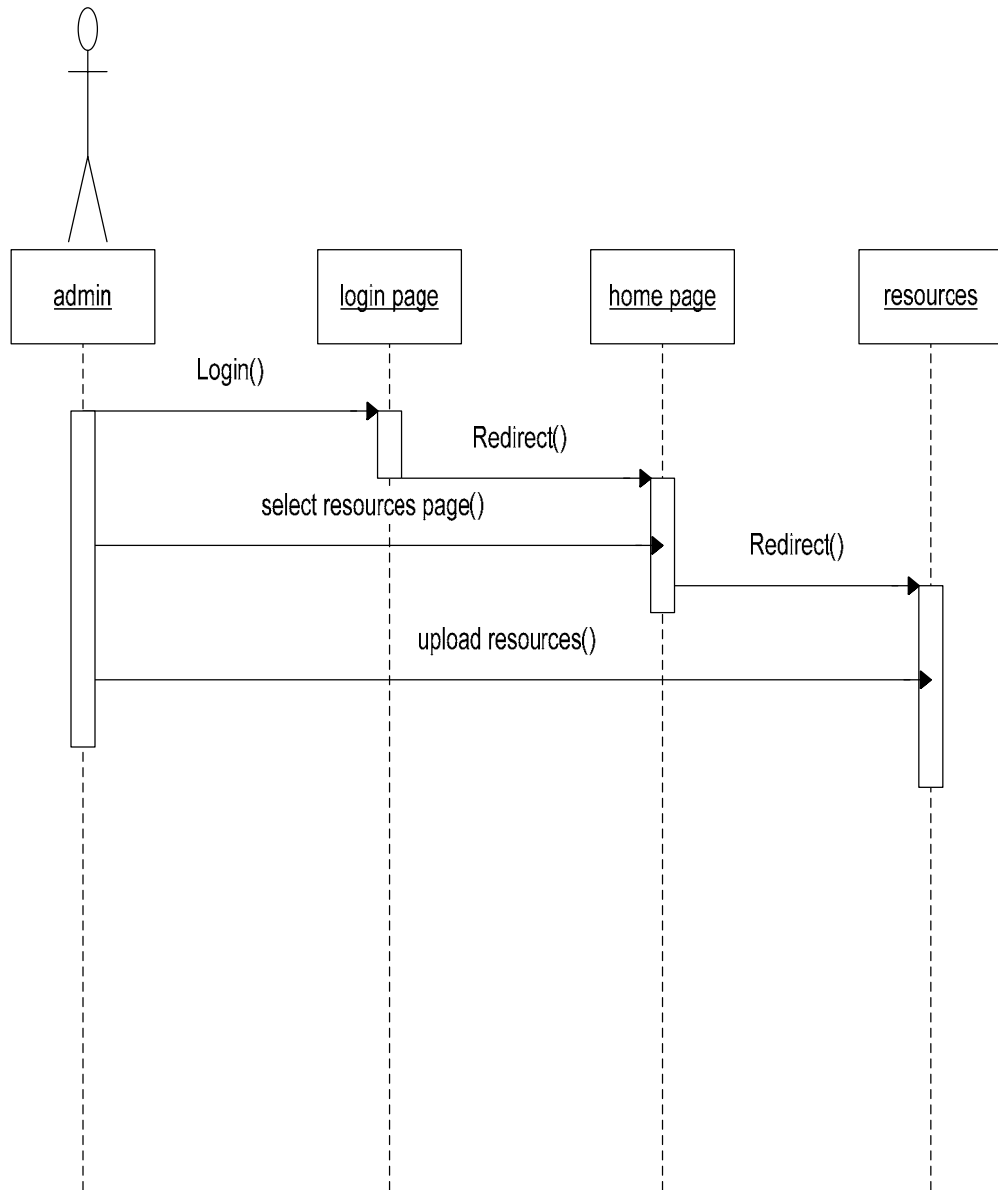
Figure 19:Sequence Diagram of Admin Action to manage Resources

Explanation: After successful login, admin goes to resources page from the resources tab and there he/she can upload new resources or edit previous.

3.4 Web Modeling:

3.4.1 Presentation model
a) **Main page:**

```
┌─────────────────────────────────────────────┐
│               <<page>>                       │
│               Main Page                      │
│  ┌──────────────────────────┬────────────┐   │
│  │  <<presentation unit>>    │ <<button>> │   │
│  │  Smart Classroom          │ Login      │   │
│  │                           │            │   │
│  ├───────────────────────────┴────────────┤   │
│  │            <<text>>                     │   │
│  │   Please login to smart classroom       │   │
│  ├─────────────────────────────────────────┤   │
│  │         <<picture gallery>>             │   │
│  │       smart classroom pictures          │   │
│  │                                         │   │
│  │                                         │   │
│  │                                         │   │
│  │                                         │   │
│  │                                         │   │
│  ├─────────────────────────────────────────┤   │
│  │            <<text>>                     │   │
│  │   Please login to smart classroom       │   │
│  └─────────────────────────────────────────┘   │
└─────────────────────────────────────────────┘
```
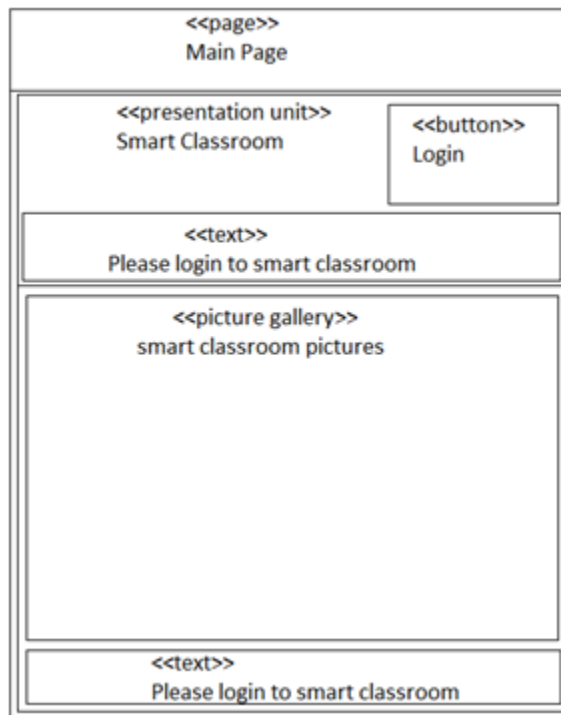
Figure 20: Presentation model for main page

Explanation:

In the presentation model of our main page we have images related to our website resources and a login button, to proceed further user first have to login, otherwise he/she will not be able to access the resources given on the website.

b) Login page:
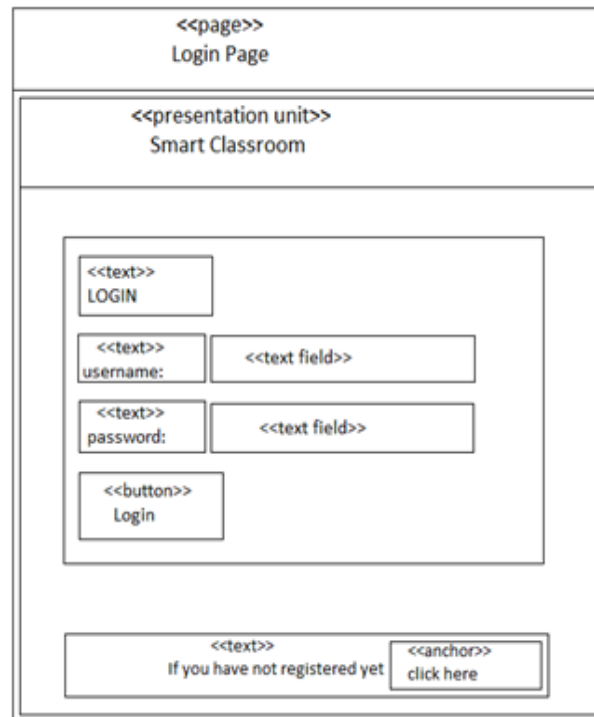
Figure 21: Presentation model for login page

Explanation:

In the presentation model of our login page we have text fields for user name and password, along with their text labels. User can enter login information in the given text fields and press the login button. Registration option is also there which allows the user to register if he/she is not registered yet.

c) Welcome page:
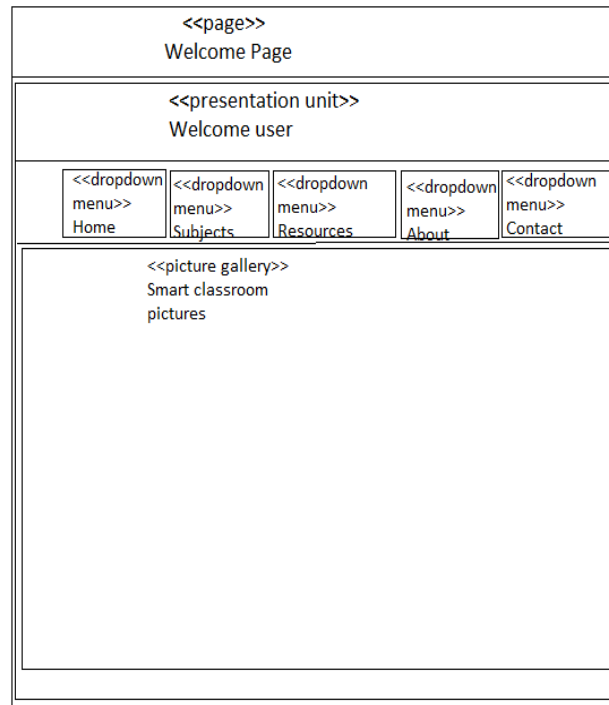
Figure 22: Presentation model for website welcome page

Explanation:

In the presentation model of our welcome page we have text fields for the Website title and text field to welcome the user by displaying welcome (then user name). After that different tabs are available for user to provide access to other pages of website. In the end different classroom pictures are displayed.

d) Classroom page:
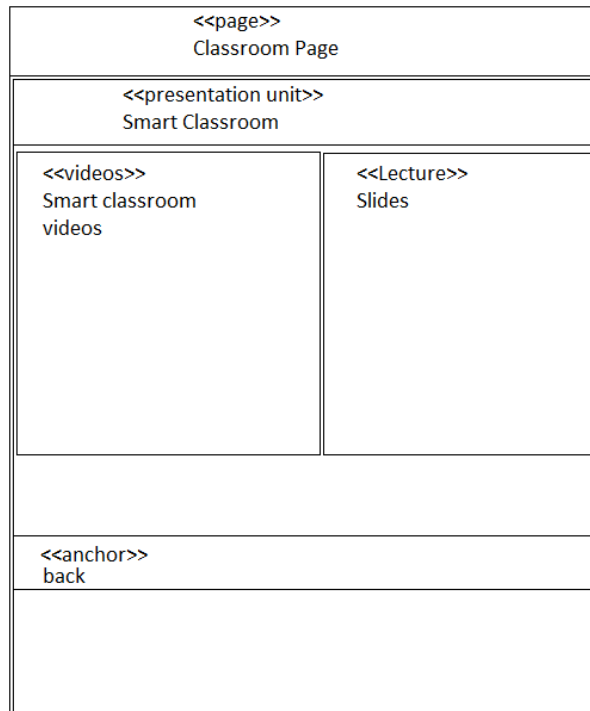
Figure 23: Presentation model for website Classroom page.

Explanation:

In the presentation model of our classroom page we have field displaying video of teacher on the left and a field displaying lectures uploaded by teacher on the right side.

3.4.2 Access Model:
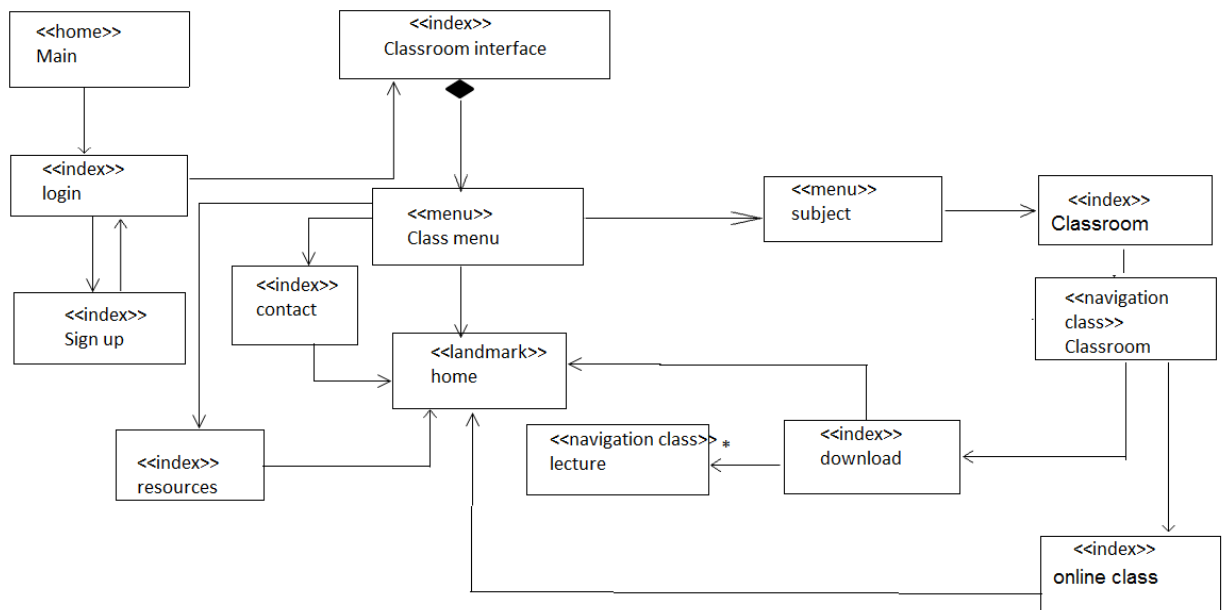
Figure 24: Access Model

Explanation:

The access model shows how a user can navigate using different links available on the website, where the user starts from main page, goes to login page and after successful login he/she is redirected to main welcome page having different tabs to visit. After visiting subject, about, contact and resources pages user is again redirected to welcome page which is the home page of the website.

Subject tab leads to classroom page where user can attend the class and view/download lectures

3.5 Activity Diagrams

3.5.1 Attending Lectures
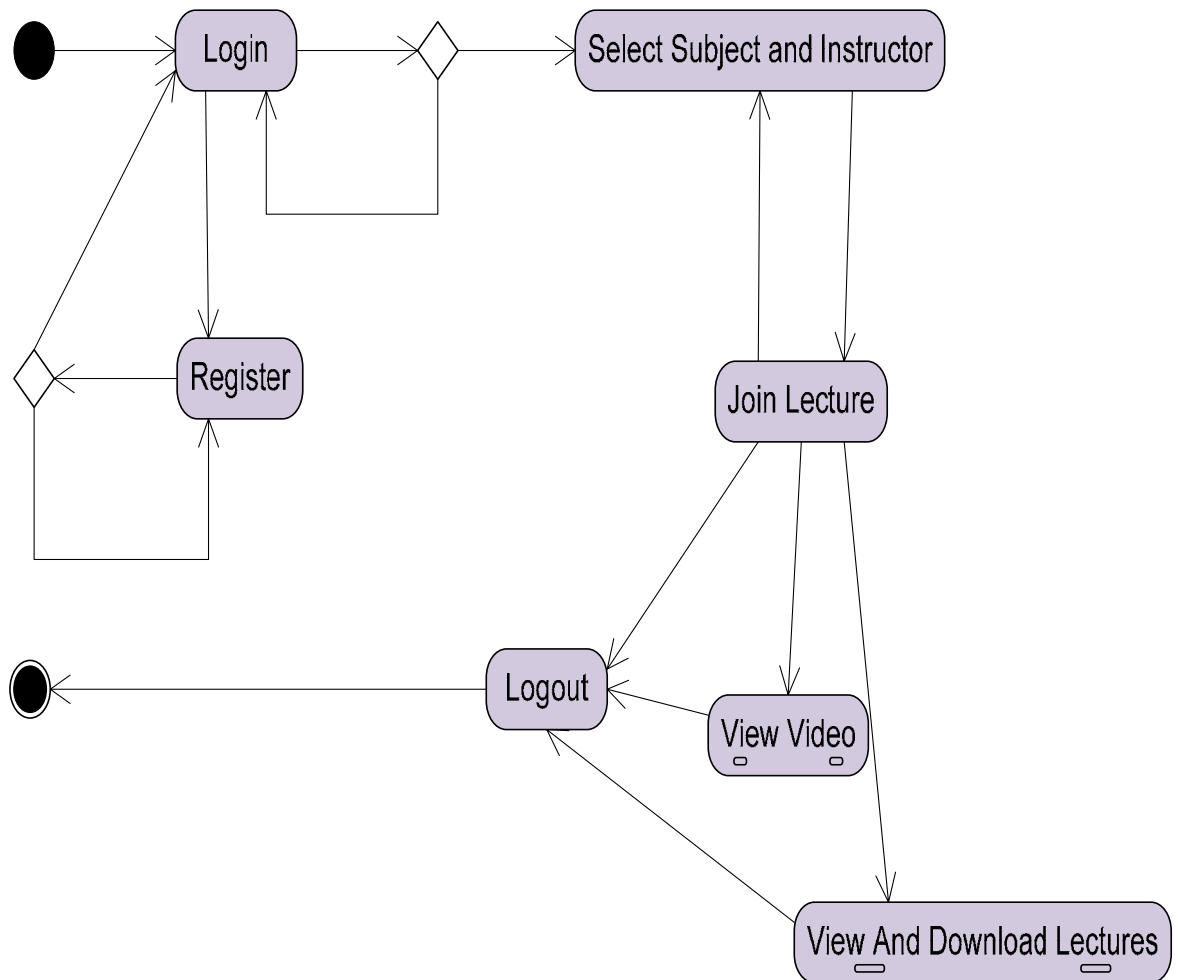
Figure 25: Activity Diagram to attend online Classroom

Explanation:

Student first goes to activity **login**, if not login then **register**. After successful login user **selects subject** and goes to activity **join lecture** which lead to **view video** and access **(view /download) lectures** uploaded by teacher.

3.5.2 Managing Lectures and conferences
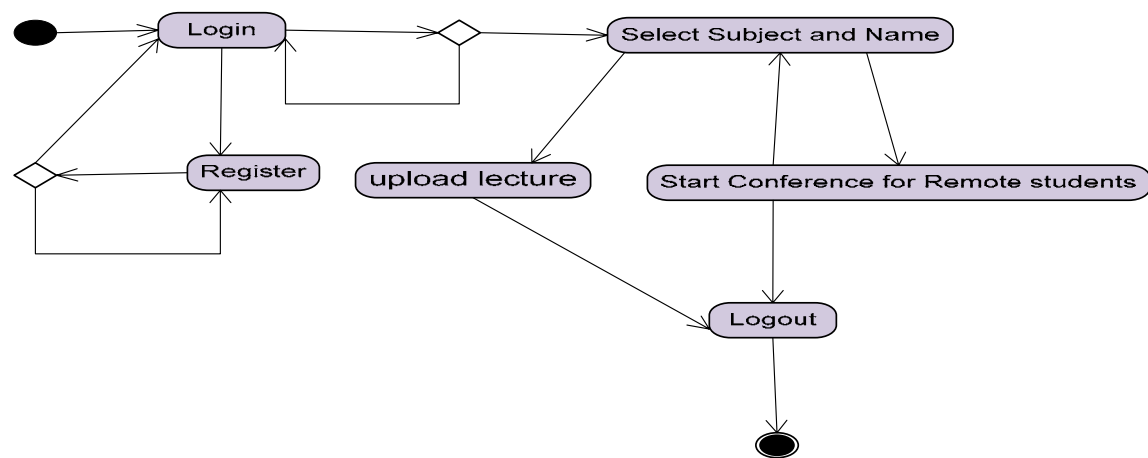
Figure 26: Activity Diagram to Start conference and upload lecture for remote students

Explanation:

Teacher first goes to activity **login**, if not login then **register.** After successful login user **selects subject** and goes to activity **upload lecture** by teacher can upload the lecture, or the teacher can also go to activity **start conference for remote students** by which he/she can start an online class after providing the class name.

3.5.3 Admin managing Database
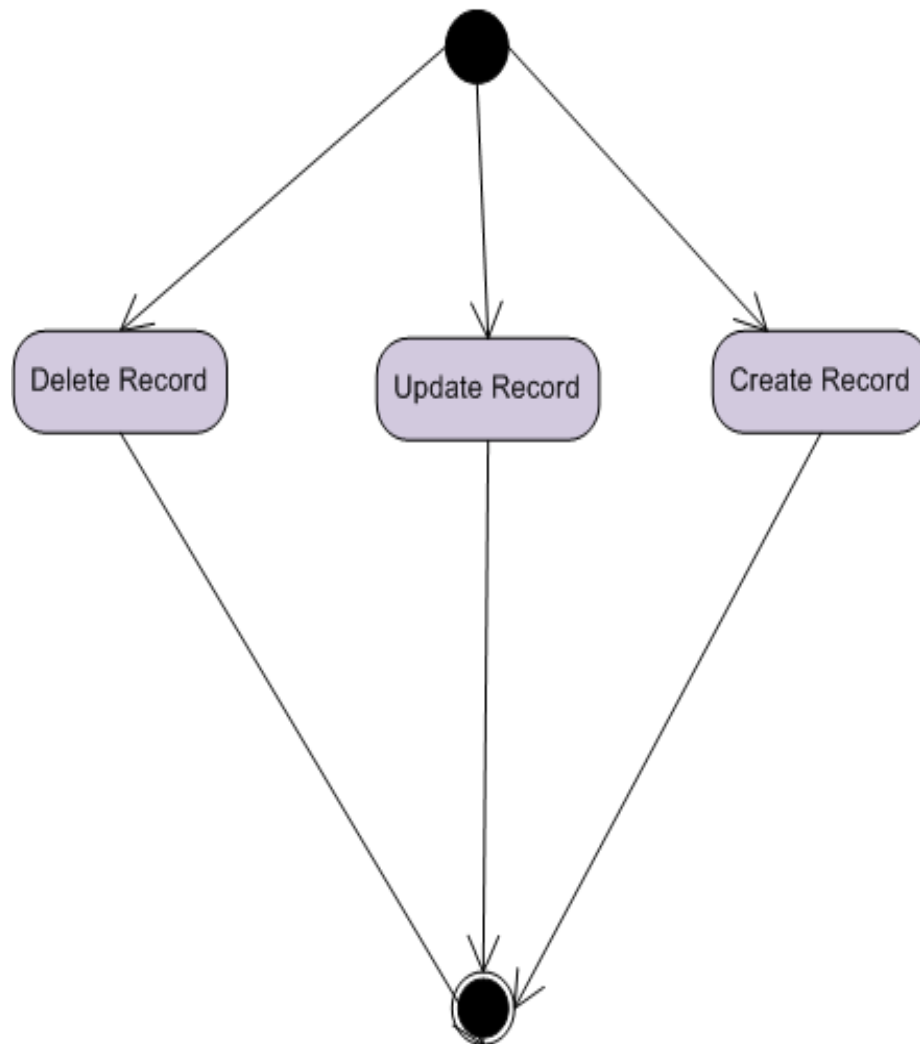
Figure 27: Activity Diagram of Admin actions to manage Database

Explanation:

Admin activities are backend database operations like **delete record, update record** and **create record.**

Chapter 4: System Implementation

4.1 Website module

Implementation diagram:
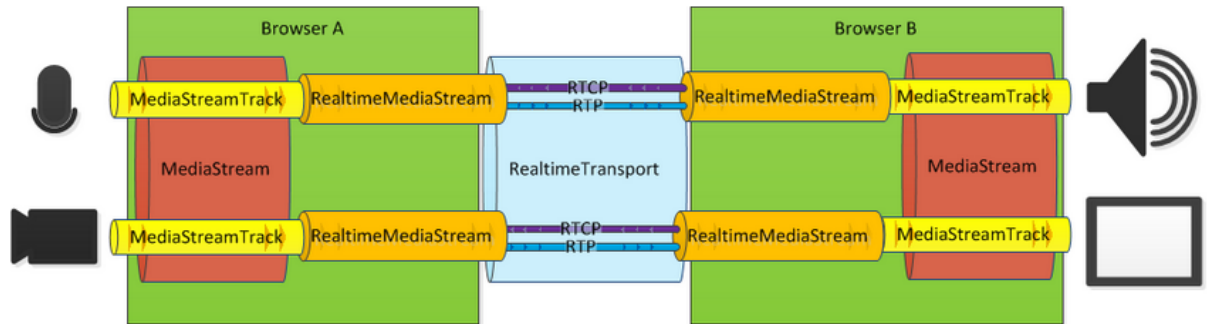
Figure 28: Implementation Diagram

At browser A side, input sources for video and audio are there. They are captured by getUserMedia.

HTML5 is used to get user media (the video and audio channels).

GET USER MEDIA:

Here is the code to get user media in chrome:

```
var streamToAttach;
navigator.webkitGetUserMedia({ audio: true, video: true }, function (stream)
{
    video.src = webkitURL.createObjectURL(stream);
    streamToAttach = stream;
});
```

These audio and video medias are encoded using codecs and transmitted as packets to the other end.At Browser B end these packets are received and they are decoded.

These streams are sent to output devices at Browser B end.

Total 4 streams are sent:
1. Two audio streams one for A and other for B.
2. Two video streams one for A and other for B.

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ICE server:

A peer connection to be opened to get connected to the ICE(STUN or TRUN) servers.

ICE sever connects the peers directly over UDP.

A user here can act either as an *offerer* or an *answerer*:

Offerer:

He is the one who creates the conference and share resources like our teacher here is the offerer.Offerer creates sdp and sent it to the other users.For this a peer connection need to open to get connected to the ICE(STUN or TRUN) servers.ICE sever connects the peers directly over UDP.After that event handlers are set for peer connection object here audio and video streams of local user are attached for other peers.

Creating Offerer Session description:

Sdp of offerer is created by using a function:

peerConnection.createOffer(function (sessionDescription){…………}

Figure 29: Online Classroom Interface

In this diagram, teacher is the offerer and the students are the answerers.

ANSWERER:

Once offerersdp is received at the answerer then, answerer sdp is sent to the offerer.Sdp of answerer is created by using a function:

peerConnection.createAnswer(function (sessionDescription) {……………..}

In this way session is established between the peers and their audio and video streams are attached and sent using ICE candidate.

Languages used:

HTML 5, JavaScript.

4.2 IP Camera Motion Detector Module

This module contains server side code and client side code.

Server Side Code:

Server side code capture images from stream, through URL provided by camera manufacturer i.e. http://user:pwd@IP_ADDRESS:80/mjpeg.cgi, and then perform motion detection algorithm on received images using AForge.Net library
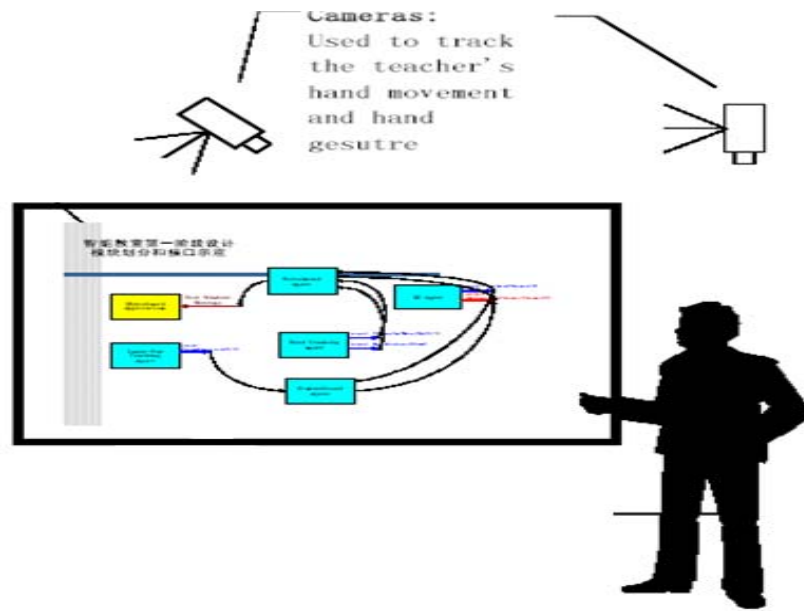
Figure 30: Motion detection of teacher actions.

After detecting motion on a camera a global static variable named "public static string motionCam" gets updated with camera number.

Indext.php :

functionstartClassroom() :

This method is called when start classroom button is pressed.

functioninitFrame() :

Initialize the iframe which will contain the audio video of cameras. This method will be executed once after 4000 milliseconds.

Other functions are

Initializing motion detector object used to detect motion between image frames:**detector1   =   new   MotionDetector(new TwoFramesDifferenceDetector(), new MotionAreaHighlighting());**

detector2 = new MotionDetector(new TwoFramesDifferenceDetector(), new MotionAreaHighlighting());

Connecting to camera stream which will capture images from stream continuously:**MJPEGStream source1 = new MJPEGStream(cam1 + "/mjpeg.cgi");**

MJPEGStream source2 = new MJPEGStream(cam2 + "/mjpeg.cgi");
source2_NewFrame(object sender, NewFrameEventArgseventArgs) :
When image is recieved from second camera this method is called
checkStatus() :
teacherStatus.txt file is used to check whether teacher is streaming or not when teacher starts streaming php code starts updating this file after few seconds. In this code i will check the difference of current time and the file last write time, if that is greater than 20 seconds code assume that teacher is not streaming.

Client Side Code

Client side code contains 4 html elements:
<input type="hidden" id="hid" onclick="callServer()" />
Above element calls a java script method on click. Click method of this hidden element is called through java script.
<asp:Imagerunat="server"   OnInit="video1_Init"   id="video1"
AlternateText="Stream   not   available"   style="position:absolute;
top:0;left:0;z-index:0;" />
<asp:Imagerunat="server"   OnInit="video2_Init"   id="video2"
AlternateText="Stream   not   available"   style="position:absolute;
top:0;left:0;z-index:0;" />
Above two elements are asp alternatives of html <img> element one at a time is visible to user according to a number received from server. That number is used to decide which camera has motion.
<my:MyDiv ID="MyDiv1" runat="server"></my:MyDiv>

This element is executed on server after page loading it is replaced with Java applet. I got this applet from main page of camera URL because DLink has not provided any URL for sound that's why I used this applet which is not visible to client.
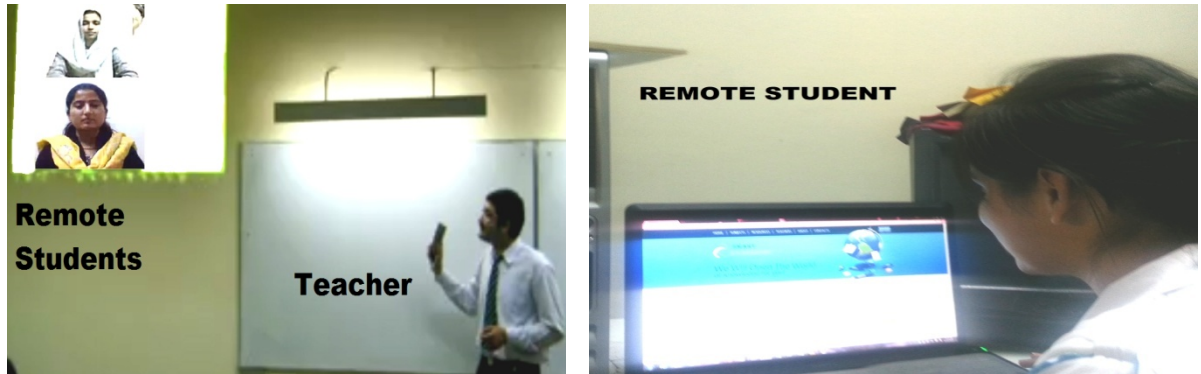
Figure 31: Student end and Teacher end

Client side code contains two scripts

Server Script

This script is executed on server containing two methods "video1_init" and "video2_init" both these methods are executed onInit of the image tags. These methods set the source of image tags from server. Source is supposed to be the URL of IP cameras which server receives from campip.txt file.

Client Script

This is a java script executed on client side it has a statement

varintervalId = setInterval(poll_func, 3000);

Above statement calls the poll_func method continuously after 3000 milliseconds this method returns an id which is stored in a variable named as intervalId this variable is later used to stop the interval.

Poll_func

> This method is executed continuously after 3000 milliseconds because of setInterval method. This method calls the hidden element's click method present in html (if you check the hidden element present in html you will notice that on click it will call CallServer Method).

callServer

> This method further call another method callServerMethod(1,'') you will not find this method in the file but this method will be present in html source when you view the page source of page after loading it in web browser because server side code adds the javascript of this method.

> This method will call a server method "RaiseCallBackEvent" when this method is called server call its own method "GetCallBackResult" after receiving result server call client side method "GetOutputFromServer(rValue)"

GetOutputFromServer

> As I have described in previous method this method is called by server with an rValue which is result value rValuecontains 1, 2 or 3

> If rValue contains 1 it means camera 1 has motion similar for 2

> If rValue contains 3 it means that client should stop streaming now. This could happen when teacher stopped streaming or due to some other factors.

Technology used:

Asp.net, php, JavaScript, HTML5, IIS (Internet Information Services) server.

4.3 Facial Recognition Module:

Images of students are captured and stored in a file as training data.

Names of students are stored in another file; these files will be used for classification.

Facial recognition:

In Our facial recognition module EMGU wrapper is used for facial recognition.

The EigenObjectRecognizer class is used it applies Principle Component Analysis (PCA)on each student picture; this will make an array of Eigen values for which we can train a Neural Network.

The way in which PCA is used will affect the results of the system, it can be used to give accurate results and remove noise and lightening effect.

Figure 32: Attendance system interface.

For PCA the steps are:

Mean Subtraction

In this step we the calculation of our covariance matrix by subtracting the mean of each row from each element in that row.

44

Covariance Matrix

The Covariance equation for two dimensional matrix is:

$$cov(x, y) = \frac{\sum_{i-1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{(n - 1)}$$

Here x represents the pixel value and x is the average (mean) of all pixel values, total values are represented by n. The covariance matrix of image pixel data represents the difference of dimensions and mean..

The covariance matrix:

$$C^{n*n} = (C_{i,j}, C_{i,j} = cov(Dim_i, Dim_j))$$

For more explanation consider a large 3x3 matrix:

$$C_{mat} = \begin{pmatrix} cov(x,x) & cov(x,y) & cov(x,z) \\ cov(y,x) & cov(y,y) & cov(y,z) \\ cov(z,x) & cov(z,y) & cov(z,z) \end{pmatrix}$$

$$I1 = \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix} \qquad C(I1) = \begin{pmatrix} cov(1,1) & cov(2,5) & cov(3,9) \\ cov(4,1) & cov(5,5) & cov(6,9) \\ cov(7,1) & cov(8,5) & cov(9,9) \end{pmatrix}$$

Eigenvectors and Eigen values

Eigen values are found by following the steps give below in the example:

$$Covarience\ Matrix = \begin{bmatrix} 2 & 3 \\ 2 & 1 \end{bmatrix}$$

$$Eigenvector = \begin{bmatrix} 6 \\ 4 \end{bmatrix}$$

Multipied:

$$\begin{bmatrix} 2 & 3 \\ 2 & 1 \end{bmatrix} * \begin{bmatrix} 6 \\ 4 \end{bmatrix} = \begin{bmatrix} 24 \\ 16 \end{bmatrix} = 4 \begin{bmatrix} 6 \\ 4 \end{bmatrix}$$

Scaling vector to ½:

$$\begin{bmatrix} 2 & 3 \\ 2 & 1 \end{bmatrix} * \begin{bmatrix} 3 \\ 2 \end{bmatrix} = \begin{bmatrix} 12 \\ 8 \end{bmatrix} = 4 \begin{bmatrix} 3 \\ 2 \end{bmatrix}$$

Eigenvectors are scaled in a way that they have length 1:

$$\begin{bmatrix} A \\ B \end{bmatrix} \quad becomes \quad \begin{bmatrix} A/(\sqrt{A^1 + B^2)} \\ B/(\sqrt{A^1 + B^2)} \end{bmatrix}$$

Then we finf Eigen value it is the value of which the original vector was scaled.

Feature Vectors

Next we order the Eigen vectors by Eigenvalue, highest to lowest. Then we get data in order of preference and might remove the lowest data.

$$Resultant\ Eigenvalues = \begin{bmatrix} 0.6392 \\ 0.7691 \end{bmatrix}$$

Transposition:

At last step of PCA we take transpose of the feature vector matrix and multiply it to the left of the transposed the adjusted data set in from Stage 1 in which we subtracted mean from data values.

In the end the transposed data is fed into the Neural Network as training data. While matching an image, PCA is performed the test data Eigenvalues and Eigenvectors are compared to theEigen values and Eigenvectors of training set data the Neural Network tells if match is found or not

When a student enters the class his/her picture is taken and compared to already stored values in form of Eigen vectors. If results are matched then attendance Is marked for that student.

Language used:

C#

Chapter 5: Testing and Results Analysis

5.1 Test Case no.1

Name: User Interface Test

Description: It shall test the ease of use regarding the interfaces provided to users.

Precondition: System is correctly installed and working properly.

Input Values: User shall click on the desired feature button to check if it is accessible or not.

Steps:

- It shall be checked that the Graphical User Interface is understandable or not.
- User accesses all the features available and decides whether the output is the expected one or not.

Expected Output: Output should be according to the one expected by the user! User shall understand the output of system.

Result: User interface was working accordingly.

5.2 Test Case no.2

Name: Starting classroom test

Description: It shall test the functionality weather a teacher can start classroom online or not.

Precondition: System is correctly installed and working properly.

Input Values: After logging in, teacher goes to main page and enter subject name.

Steps:

- Teacher selects the start classroom button by clicking it.
- Browser prompts for audio and video device permission.
- Teacher provides access by allowing the required audio and video devices.
- Cameras start capturing teachers' events and transmit them to the students.

Expected Output: System shall be able to create online class and transmit live video of teacher to multiple students.

Result: Teacher was able to create online class successfully.

5.3 Test case no.3

Name: Attend Classroom test.

Description: It shall test the attend class room option.

Precondition: System is correctly installed and working properly and Teacher has started on line class.

Input Values: After logging in the student goes to subjects page to check which classroom is available to attend.

Steps:

- User selects the attend classroom button.
- Browser prompts for audio and video device permission.
- Student provides access by allowing the required audio and video devices.
- Teachers' video is visible to student.
- The system captures students' video and transmits it to the classroom.

Expected Output: Student shall be able to view teachers' video, and in return students' video shall be transmitted to the class.

Result: Students were able to attend the online class and their video was successfully transmitted to the classroom.

5.4 Test case no.4

Name: Maximum number of online students test.

Description: It shall test the maximum number of students that can attend the online class.

Precondition: System is correctly installed and working properly.

Input Values: Different students are logged from different places to attend the class; they go to subject's page for attending class.

Steps:

- Student select attend class button.

- Browser prompts for audio and video device permission.

- Students provide access by allowing the required audio and video devices.

- Teachers' video is visible to all students.

- The system captures all the online students' video and transmits it to the classroom.

Expected Output: System shall be able to stream teachers' video students. The maximum number of students that can attend class without having transmission problem shall be recoded.

Result: 5-10 students can attend the class depending on the internet connection.

5.5 Test case no.5

Name: Upload and download material test.

Description: It shall test the upload and download material functionality.

Precondition: System is correctly installed and working properly.

Input Values: Teacher and student are both logged in .

Steps at teacher end:

- Teacher selects the browse button.

- System allows teacher to select the required document of any format.

- Teacher selects add file button.

- The system prompts that file has been added.

Steps at student end:

- Student selects the download button for desired file.

- The specified file shall be downloaded on the students system.

Expected Output: System shall allow the teacher to upload files and student shall be able to download them.

Result: Teacher successfully uploaded file and students downloaded them.

5.6 Test case no.6

Name: Attendance through facial recognition system test.

Description: It shall test that attendance of students is maintained through facial recognition.

Precondition: System is correctly installed and working properly.

Input Values: User provides images of students.

Steps:

- Students come in front of the camera facing towards their face.
- System takes snapshot and compares it with previously stored images.
- System displays the name of student when picture is matched.
- The system creates an attendance file and puts names of students who are present by matching their picture.

Expected Output: System should be able to mark attendance in attendance file.

Result: System correctly marked attendance through facial recognition, 90% result were correct, some were incorrect due to light effects.

5.7 Test case no.7

Name: Automatic camera selection test.

Description: It shall test that camera is automatically selection through motion detection.

Precondition: System is correctly installed and working properly.

Input Values: Teacher configured the cameras and selected them as input sources.

Steps:

- Teacher selects start conference option.
- System shall be able to capture teacher events by automatic camera selection.
- If teacher moves in front of camera-1 it shall transmit the video, similarly if teacher is in front of camera-2 it shall transmit video.

Expected Output: System shall transmit teachers' video through automatic camera selection.

Result: System successfully transmitted teachers' video through automatic camera selection.

5.8 Test case no.8

Name: Testing system on android phone.

Description: It shall test the complete functionality of students' end on android phone.

Precondition: Website is opened on android browser.

Input Values: Students log in.

Steps:

- Students visit each page and links to check the functionality of links.
- System provides the desired functionality.

Expected Output: Website shall work on android phone with all functionalities.

Result: Students successfully used android phone to attend the class and download material from the website

Chapter 6: Conclusion and Future Work

6.1 Conclusion:

Smart class room provides an interactive learning environment by integrating various learning technologies to facilitate the students and teachers.

It has two ends: The teacher end and the student end.

- Teacher can start online class and upload lectures, helping material &Informational details. Teacher's actions are captured by multiple cameras through motion detection. This stream is then transmitted to many students across the network. Attendance of students is maintained through facial recognition and is uploaded by the teacher.

- At the student end Remote students can attend online class (using laptops & android phones) where they can see teacher's live video and in return their video is transmitted to the teacher end.

Student can download lectures, helping content and the details uploaded by the teacher.

6.2 FUTURE WORK:

Our team is currently planning to improve the motion detection and face recognition algorithms & streaming techniques for better results.

Smart class room is a vast technology. It can be expanded by adding various features e.g. Auto-synchronization of slides and lecture videos, chat application and addition of smart board etc. Control over response time can be made using increased bandwidth, better codex & control over frame rate.

References:

- For GUI, the webpage: http://bazman.tripod.com/checklist.html is referred.
- For Heuristics Evaluation of Interfaces:http://www.stcsig.org/usability/topics/articles/he-checklist.html is referred.
- Tsinghua university project link:
  http://tu139015.ip.tsinghua.edu.cn/paper/2003/2003IEEEPervasiveComputing-SHI%20Yuanchun.pdf
- Research paper:
  http://www.cs.cmu.edu/~jiangch/pub/smartroom.pdf
- History of E-learning:
  http://en.wikipedia.org/wiki/E-learning
- WizIQ:
  http://www.wiziq.com/
- Stanford university ClassX:
  http://classx.stanford.edu/ClassX/

Appendix B: User Manual

User Guide
GENERAL INFORMATION

System Overview

Smart classroom facilitates interactive and collaborative learning among students. Real time interactive session is provided for distance learning. This is a comprehensive solution designed to enhance students' academic performance with simple, practical and meaningful use of technology.

We provide an interactive interface for remote students. We have multiple cameras to capture teacher events. Teacher's live video is transmitted to remote students through automatic selection of camera. We also transmit online student's video to classroom. Instructor's slides are available to remote students. Student's attendance is managed through facial recognition. Remote students can also attend online class through their android app.

Authorized Use Permission

Usage of this software is limited to its owner via the terms of its development. Smart classroom system is wholly owned by MCS (NUST), and may not be used or referenced without their express consent.

Points of Contact

Information

For additional information, Contact

Project Supervisor

Dr. NaveedIqbalRao

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Application Installation

GETTING STARTED Administrator Tasks

Extracting from the .ZIP archive

In addition to user documentation, the Smart Classroom.ZIP file contains all of the code which user needs to run on his/her system.

Install Internet Information Services (IIS) Server

Steps:

- Go to Control panel of Windows.
- Select programs and features
- Select turn window features on or off on left side
- Select internet information service/server and mark this option then
- Further select world wide web Services
- Select Application development features and mark all the check boxes.
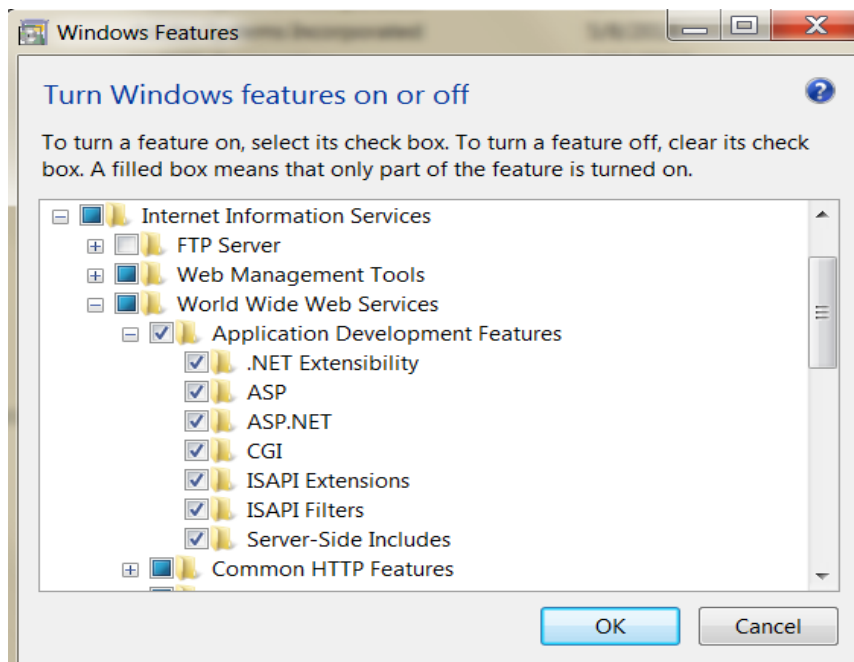
Installation Figure

Enable or start IIS manager

Steps:
- Go to Control panel of Windows
- Select Administrative Tools
- Go to Internet Information Services (IIS) Manager
- Start Manager Server on the right side.

Install PHP

Installs PHP using following link

http://php.iis.net/

Extract the IpCameraMotionDetector.zip file

After installation place the code and extract it in the following directory

C:\inetpub\wwwroot

Configuration of IP Cameras

1. Configure both IP cameras on computer. All configuration steps are given in the user manual of IP cameras.
2. After configuration replace the IP's of both cameras in the following file

   C:\inetpub\wwwroot\IpCameraMotionDetector\files\camip.txt

Launching the Website
Launch the website after performing the above steps.

Starting Application

Task at Teacher side

OpenBrowser (Google Chrome/Firefox (recommended)) and write
http://*Ip-Address of your
server*/IpCameraMotionDetector/student/main.html

Main Page

Press LOGIN to proceed further.

Login Steps:

After coming to login page enter the required information.

Login Page

Example:

- Enter username: admin
- Password: 123
- Press login

After login you will see this screen
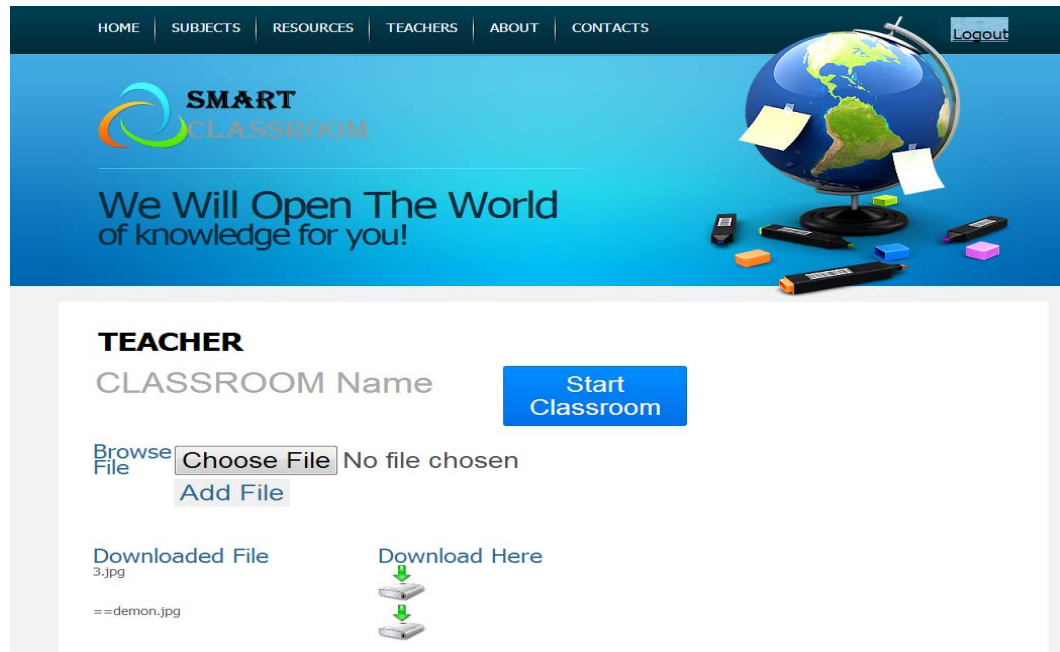
Teacher Interface

Start classroom

Once the teacher has logged in he can start classroom, upload lecture slides and visit other tabs. For starting the classroom

- Enter Classroom name in the text box
- Press Start Classroom button.
- Teacher can upload file by clicking Choose File button.

Task at student side

Open Smart Classroom Website

For attending online class:

Open Browser (Google Chrome/Firefox(recommended)) and write

http://*Ip-Address of your*

*serve*r/IpCameraMotionDetector/student/main.html

Main Page

Press LOGIN

Login Steps:

Login Page

Enter the required information:

Example:

- Enter username: dd
- Password: dd
- Press login

You will see this screen

Welcome Page

This is the welcome page for the user who logs in, it has different tabs like
HOME, SUBJECTS, RESOURCES, TEACHERS, ABOUT and
CONTACTS.

Attend class

- Click on Subject tab

  User will see this screen
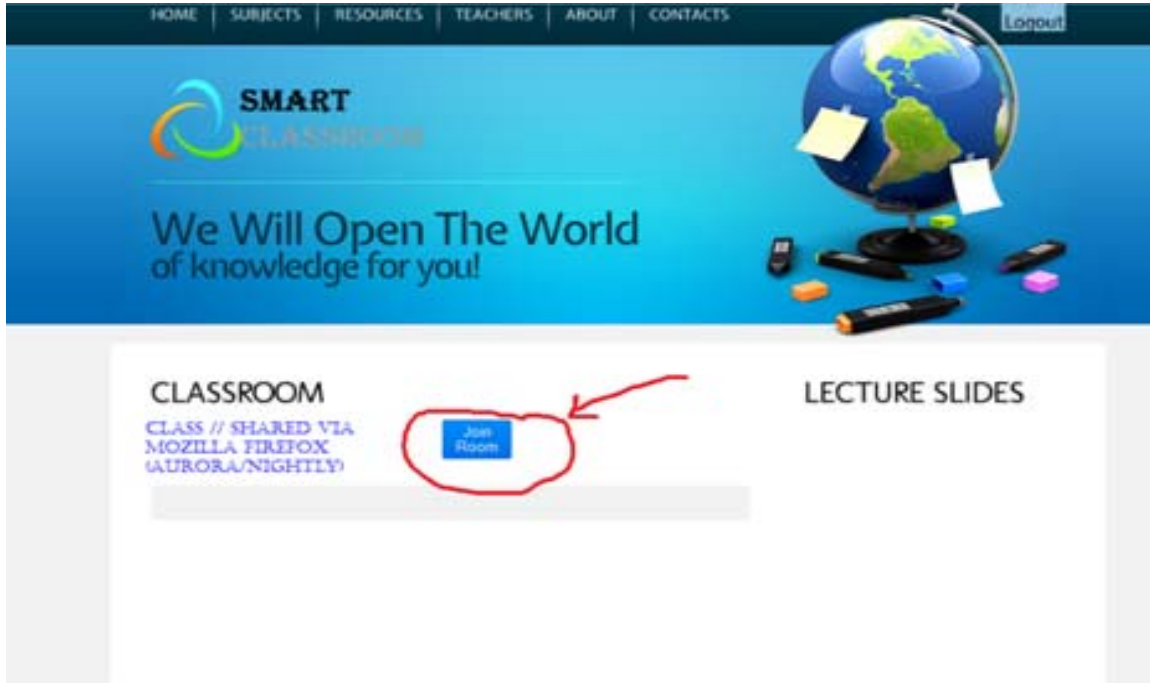
Attend Class Page

- Click on Join Room button to attend the online lecture.
- Click on download option to download the lecture uploaded by teacher.
- Move through the slides uploaded by teacher to view the lecture.
- Students can also visit other tabs for more information

Appendix A: System Requirement Specification

Software Requirements Specification

For

SMART CLASSROOMS

Group Members

- *Zainab Abbas*
- *Ramsha Khan*
- *IqraArooj*

Supervisor

Lt. Col. Dr. NaveedIqbalRao

Introduction

Purpose

The proposed system is meant to facilitate the students and instructors. Smart Classroom is an interactive classroom which provides a learning environment by integrating various functionalities of existing systems including the newly suggested modules.

The SRS explains the working, features and requirements of our system. Current smart class rooms have certain functionalities that we want to integrate and form a new improved smart classroom. This document also explains certain new proposed features, modules and the constraints over them.

Our class room shall be able to provide the various functionalities that are listed below:

- It shall facilitate the remote students to attend the class.
- It shall provide two way communication between instructors and students.
- It shall provide lecture contents and helping material.
- Attendance shall be done automatically via face recognition.
- Mobile phone application for the classroom shall be available.
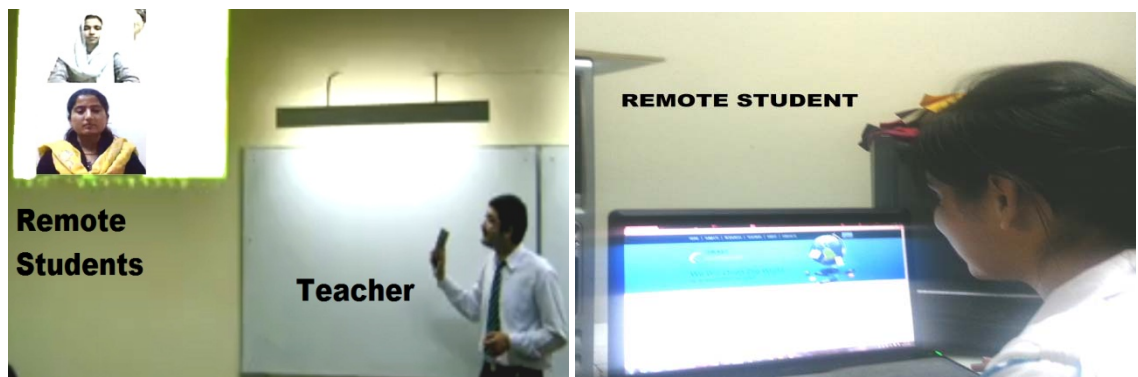
Teacher and remote student end.

Document Conventions

Conventions:

a) Font Size=12

b) Font Style=Times New Roman

c) Main Heading(1,2,3,4,5,6)=Bold(18 Font)

d) Sub Heading(1.1,2.1,3.1,4.1,5.1,6.1)=Bold(14 Font)

e) Heading(3.1.1,4.1.1,5.1.1)=Bold(12 Font)

f) Reference Links=Italic(12 Font)

Requirements:

All of the requirements have their own priority which is required by the users.

Our major system requirements are:

- Online video transmission.
- Two way communication.
- Automatic camera selection.
- Availability of lectures.
- Attendance management.
- Mobile phone application.

Intended Audience and Reading Suggestions

The Software Requirements Specification (SRS) document is meant for all the stakeholders.

1. **Client (Student and Teacher):**

    It will help to gain the client's agreement. The client will be able to get better understanding of the software and hardware requirements.

2. **Developer:**

    It will help the developer to develop the product and to trace back the functional requirements.

3. **Testing Team:**

    It will help the testers to understand the constraints.

4. **Employees:**

    It will help the employers (training staff) to know about the system features in detail.

5. **Product Manager:**

    It will help the product manager to manage development tasks according to the complexity and features of the system.

6. **Marketing Manager:**

    It will help the marketing manager to get better idea about the system, its scope and vision.

    The document is arranged in several sections;

    1. This Section 1 is introduction to the proposed system in which the purpose, scope, vision and references are highlighted.
    2. Section 2 thoroughly describes the system perspective, features, user class and characteristics, operating system, design and implementation constraints, user documents and assumptions and dependencies.
    3. Section 3 contains a detailed description of all the system features.
    4. In Section 4 the external interface requirements are mentioned.
    5. While the Section 5 gives an insight of the non-functional requirements.
    6. In the later sections, other requirements and glossary are given.

    It is suggested that one should go through the document with the following Section sequence; Section 1 (Introduction) -> Section 3 (System Features) -> Section 5 (Non-Functional Requirements) -> Section 6 (Other Requirements) -> Section 2 (Overall Description) -> Section 4 (Hardware and Software Interfaces). In this way, the reader will get the idea about the

system overall description and features and afterwards the insight of the product.

Product Scope

This system will provide an interactive class room environment to the remote students.

Smart classroom will have multiple cameras to capture teacher events, automatic selection of cameras will be done. Video along with the slides of teacher will be transmitted to remote students. A screen having videos of all the remote students who are logged in is placed in the classroom on projector screen.

Attendance of students will be managed through face recognition.

Mobile phone application will allow the students to attend the class sitting anywhere, without having the burden of PC.

References

- For GUI, the webpage: http://bazman.tripod.com/checklist.html is referred.
- For Heuristics Evaluation of Interfaces, http://www.stcsig.org/usability/topics/articles/he-checklist.html is referred.
- For project purpose, scope, objectives and recent work completed in this area, the documents named "FYP Synopsis" and "Project Proposal" which were submitted are referred.
- Use case diagrams and class diagram are given in Chapter 4 of thesis.

Overall Description

Product Perspective

The project is a replacement of existing smart classroom system; it integrates different features and certain new modules to provide a better interactive learning environment.

Certain existing modules like attendance via face recognition and learning management system will be integrated along with new proposed system having two way real time communication, and a mobile phone application. A detailed account on the software and hardware interfaces is mentioned later in this report.
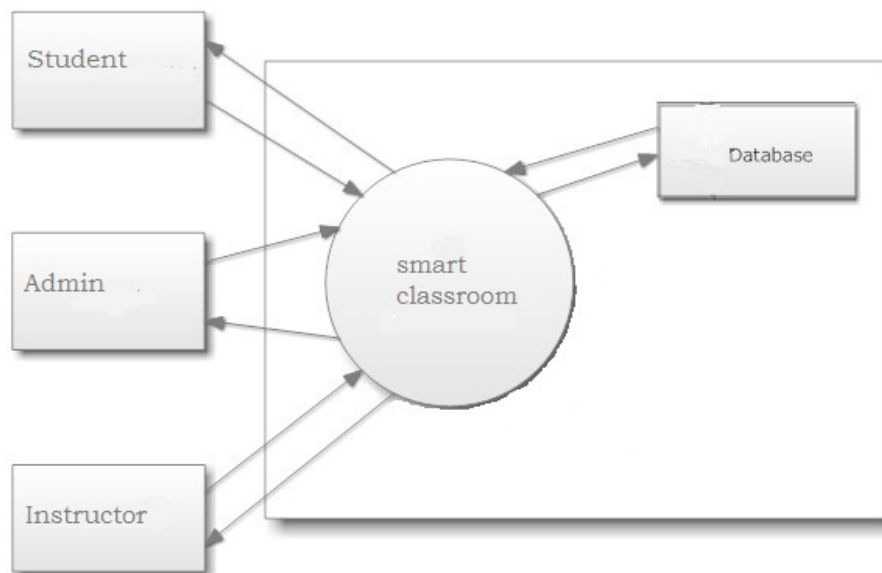
Context view of smart classroom.

Product Functions

The proposed system provides the following features:

- Live Coverage and transmission of Teachers' action through multiples cameras and providing automatic selection of cameras.
- Making instructor slides available to remote students.
- Managing attendance through face recognition.
- Transmission of remote student's video to classroom when they login and making instructor's live video available to students for two way communication.
- Providing an interactive interface for remote students.

- Development of android based application for viewing these lectures.

The remote student must first login to access lectures and watch teachers' live video and can also communicate remotely with the teacher.

User Classes and Characteristics

- **Customer(Student or teacher):**

  Customer is the one uses the system, like remote student will first login and then will be able to access the lectures and make communication with teacher.
  Customer can also be the instructor who is using the system and making his live video available to students.

- **Administrator:**

  Administrator is responsible for monitoring and maintaining the content and lectures available to students and managing database for students' login record. He/she shall be an expert using the system and accessing the database.

- **Training Person:**

  Training person will demonstrate a way to use the interface of system for the new students. They shall be having complete knowledge about the interfaces and its use.

- **Installation Technician:**

  The initial installation shall be done by a Technician. He/she shall make the system work as expected in that environment. Moreover, the tasks related to the maintenance and repairing hardware or software shall also be the job of the technician. He/she shall be having the complete domain knowledge of the system.

Operating Environment

- **Software Platform:**

    Operating System: Windows and Android.

- **Hardware Platform:**

    Hardware required:

    - 2 to 3 IP cameras.

    - PCs and laptops.

    - Android mobile.

    - Projector screens.

    - Network connection.

Design and Implementation Constraints

Constraints	Rationale
- SQL will be used for database management.	- SQL provides an efficient way of accessing the database through different interfaces using queries.
- Skilled employees will be hired along with a training team to guide the users.	- The customers might feel difficulty in using the proposed system. So the skilled team will be there to help the users.
- Android operating system will be used for mobile application.	- Android is open source and a lot of help is available.
- Real time protocol for communication will be used.	- Live transmission of video required real time streaming protocol.
- Internet connection is required during transmission.	- Video streaming and client to server connection requires internet.

• Required Band width shall be available.	• For real time video conferencing we need band width of 256MB.
• Video shall be transferred in a compressed format.	• Compression techniques and standards for specific video type and then video type capability with the browsers

User Documentation

- User manuals in hard copy shall be provided with the product on deployment.
- User manual shall also be available online.
- A CD containing all the information about the system shall also be delivered along with the product.

Assumptions and Dependencies

Our System shall be assuming and depending upon the following facts:

- It is assumed that our system is provided with constant power supply and internet connection at operational time and it has an unbroken connection with the Database.
- User authentication procedure shall be used to protect data base from unauthorised access.
- Also, network connection with the Database is assumed to be protected.
- A backup of lectures and helping content is maintained regularly.

External Interface Requirements

User Interfaces

Described below is a brief account of the User Interfaces involved in the learning system. The interfaces shall be fulfilling the ergonomic requirements. Detailed account is mentioned in a separate user interface specification.

Remote Student interface

The User Interface shall follow the graphical user interface (GUI) standards, keeping forth the heuristics principles, such as:

- Help icon shall be provided on GUI screen to let the user access the user help manual.
- Cancel/Exit button shall also be present on screen which will enable the user to terminate the process.
- Error messages shall be displayed in case of any network problem or on wrong login information.
- Every control shall be having a meaningful text accordingly to its function.
- Video of remote student is captured and transmitted to the classroom board.
- Live video of instructor is provided to remote student.
- Instructors' slides are also available to remote student.
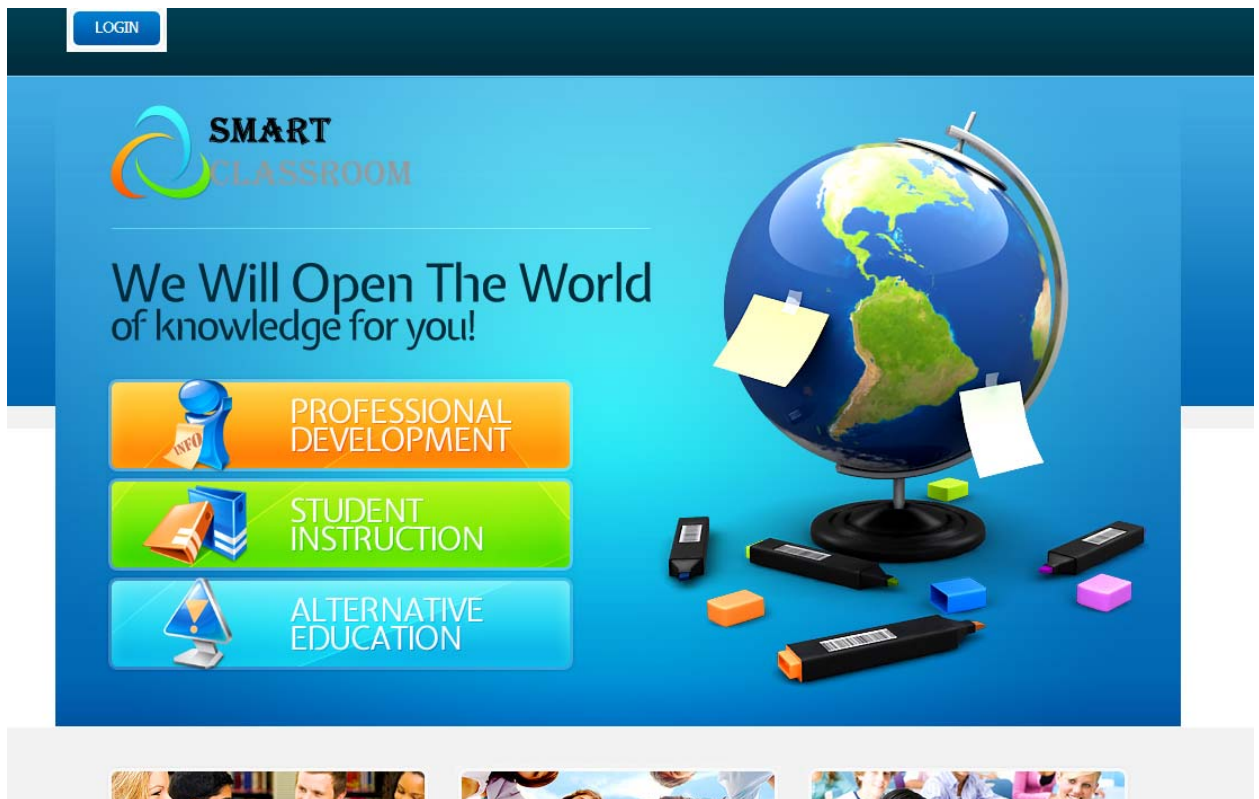
Main Page of Smart classroom website

Login Page for student:

In Login page user (Student) has to enter username and password to login.

If they are correct then Welcome page for user will appear.

Login page

Welcome page:

Welcome page

After login student can perform various task i.e. checking resources, checking teachers information, contact university administration and can attend live classroom on the main classroom page by clicking subject tab.

Classroom page:

Main Classroom interface

For attending lecture student have to go to subject tab, a classroom page will appear where he can download lecture and attend classroom by clicking join class button. In this page at upper right corner there is a logout button so if student wants to logout he/she simply clicks on it.

Teacher page:
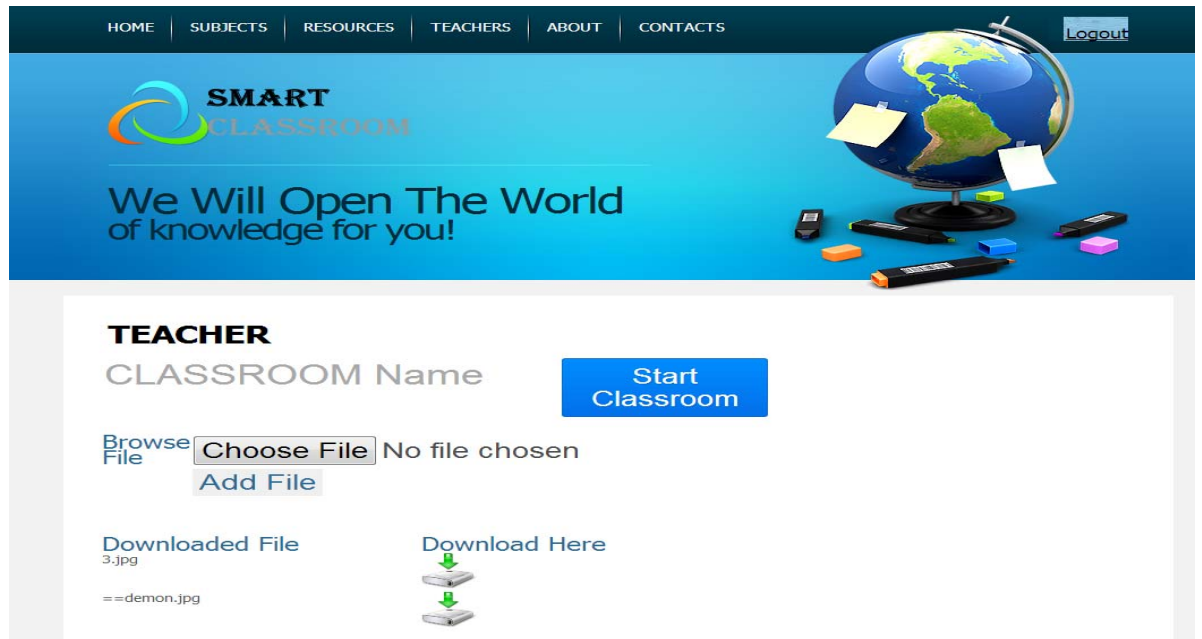
Main Teacher interface

After login teacher can perform various task i.e. checking resources, checking teachers information, upload lectures, visit other tabs and can start live classroom.

For starting lecture teacher have to go to subject tab for main teacher page, where he can upload lecture and start classroom. Teacher can also see videos of remote online students so that they can easily interact with each other. In this page at upper right corner there is a logout button so if teacher want to logout he/she simply clicks on it.

Hardware Interfaces

IP Cameras

Classroom is covered with 2-3 IP cameras. They capture the actions performed by the instructor, selection of most suitable camera shall be done for streaming instructors video to students i.e. one to many - from instructor to students.

Ip cameras capturing teacher events.

Projector Screen

One large projector screen displaying the online remote students will be placed in the classroom.
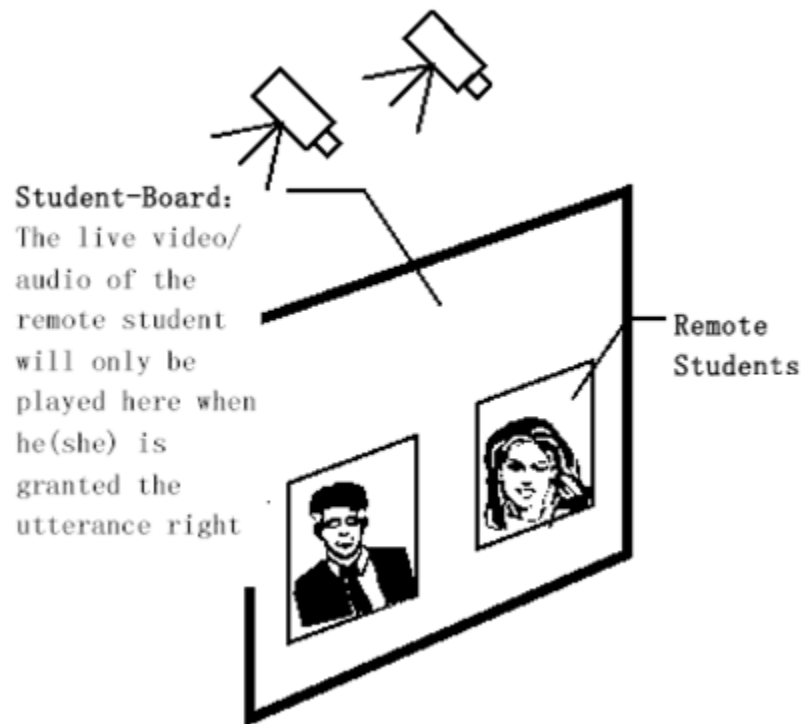
Student board displaying live video of remote students.

Lecture board

Lecture board is required by the instructor to deliver the lectures to students.

Mobile phone

An android phone is required by the students to attend the classroom remotely using the android application of this software.

Laptops or PCs

Remote students will require laptop or PCs to use the smart classroom software that will help them to attend the classroom remotely, to access the lectures and to online communicate with instructor.

Camera for attendance management

A camera is required to capture the image of students and mark the attendance of students via face recognition.

Software Interfaces

Following are the software specifications of the product:

- Operating System: Windows operating system, Android operating system.
- Database: SQL Database Management System.
- Video Streaming libraries shall be used.

Other services required are:

- Internet will be required to connect clients to server for live two way communication.
- Specific bandwidth for efficient video transmission is required.
- Real time streaming protocol is required for communication.
- Video compression techniques shall be used to make it compatible with different browsers.

The student will first login, and then he/she can view instructors' slides and communicate live with the instructor. Instructor and class room is covered with two to three cameras. There are two types of video streaming in process.

a) First from instructor to students i.e. one to many by automatic camera selection.
b) Second from students to instructor i.e. many to one.

An android based mobile phone application will be developed for students to view this data. The classroom will also have an attendance management system via face recognition.

All these components are part of our classroom, they will work together to provide a Smart learning environment.

Communications Interfaces

For live video streaming, RTP/ SRTP (real time streaming protocol) are used. RTP connection will be first made with the server to stream real time video, different clients can access this video from server by making their connection with it .In the similar way clients' video in return is sent to the other end for two way communication.

a) RTP

Real-time Transfer Protocol (RTP) provides end-to-end delivery services for data (such as interactive audio and video) with real-time characteristics.

Real-time multimedia streaming applications require timely delivery of information and can tolerate some packet loss to achieve this goal. RTP combines its data transport with a control protocol (RTCP), which makes the user possible to monitor data delivery for large multicast networks. Monitoring allows the receiver to detect if there is any packet loss and to compensate for any delay jitter. Both protocols work independently of the underlying Transport layer and Network layer protocols. Information in the RTP header tells the receiver how to reconstruct the data and describes how the codec bit streams are packetized.

b) SRTP

Secure Real-time Transport Protocol (SRTP) describes a summary of Real-time Transport Protocol (RTP). The main functions of SRTP are:

a) To provide encryption

b) Message authentication

c) To provide integrity

d) To replay protection to the RTP traffic.

Since RTP is very much related to Real Time Control Protocol (RTCP). RTCP is used to control the RTP session. SRTP has a sister protocol, called Secure RTCP (SRTCP). SRTCP provides the same security-related features to RTCP, as the SRTP provides to RTP.

System Features

- ✓ A Class Diagram is given in Chapter 4: System Design.
- ✓ A Use Case Diagram is given in Chapter 4: System Design.

Request for user (Student) Registration:

Description:

This feature shall facilitate the user to register by providing the required information.

Stimulus and Response Sequence:

The feature subtasks will follow the following sequence:

Normal course:

(Student has selected the login option.)

1. Student selects 'Register' option.
2. System asks for required information for registration.
3. After student provides the information he/she selects submit option.
4. System checks whether all fields are filled or not.
5. If all fields are correct then system allows the student to proceed further.

Alternate Course:

4.a   System finds some missing fields.

4.a.1 System prompts an error message and asks the user to fill the form.

Functional Requirements (FR):

FR #1: The system shall display the option for registration.

FR #2: The system shall acquire the information from the user.

FR #3: The system shall be able to check if user entered all the desired information or not.

FR #4: The system shall be able to save user record in the database.

FR #5: The system shall be able to generate error messages in case of missing or wrongly entered field.

FR #6: The system shall ask the user to enter desired information again.

Request for user (Student) login:

Description:

This feature shall facilitate the user to request the login by providing the required information.

Stimulus and Response Sequence:

The feature subtasks will follow the following sequence:

Normal course:

(Student has given the required information to login and using the system.)
1. Student selects 'Sign In' option.
2. System asks for required information including user name and password.
3. After student provides the information the system verifies the information from database.
4. Now student can further attend the classroom or access resources.

Alternate Course:

3.aStudent entered invalid user name or invalid password.

3.a.1System shows an error message and asks the student to login and password.

4.bSystem cannot match the record from the data base due to connection problem.

4.b.1System prompts an error message.

Functional Requirements (FR):

FR #1: The system shall display the option for login and password.

FR #2: The system shall acquire the information from the user.

FR #3: The system shall be able to match the user information from the database.

FR #4: The system shall be able to identify valid user.

FR #5: The system shall be able to check if the input data is correct or not.

FR #6: The system shall prompt a message for wrong inputs and errors.

FR #7: The system shall ask the user to enter password and login id again.

Request for attending the classroom:

Description:

This feature shall facilitate the student to attend the classroom by selecting the attend class button.

Stimulus and Response Sequence:

The feature subtasks will follow the following sequence:

Normal course:

(Student has selected the attend class button and attending the class.)

1. After login, students selects the attend class button.
2. Student's video is now showing at the projector screen in the classroom and instructors' video and instructors' video is available to student on laptop, PC or on mobile.
3. Student asks the query from the instructor.
4. Instructor responds to the students' query.

Alternate Course:

1.aStudent can't connect to the class due to internet problem.

1.a.1System shows an error message due to low band width.

2.aStudent can watch instructors' video.

2.a.1System shows a connection problem.

Functional Requirements (FR):

FR #1: The system shall display the all possible classes student can attend at that time.

FR #2: The system shall display option for attending classroom.

FR #3: The system shall be able to provide desired video of instructor, live to student.

FR #4: The system shall be able send student video to the classroom.

FR #5: The system shall be able stream video at desired frame rate without too much loss that can affect the quality.

FR #6: The system shall prompt a message in case of low connectivity when video is not clearly delivered.

Accessing resources:

Description:

This feature shall facilitate the student to access the resources by selecting the access resource button.

Stimulus and Response Sequence:

The feature subtasks will follow the following sequence:

Normal course:

(Student has selected the access resource button and viewing the folder.)

1. After login, student selects the access resource button.
2. System shows all previous lectures and all the help material given by teacher, to the student.

3. Student view or download the desired lecture or take the help from given material.

Alternate Course:

3.a   Student can't view, download lecture.

3.a.1   System shows an error message regarding internet problem.

Functional Requirements (FR):

FR #1: The system shall display all the content available to the student.

FR #2: The system shall display option for downloading or viewing the content.

FR #3: The system shall be able to provide some information regarding available content type to the user.

FR #4: The system shall be able to display the update content.

FR #5: The system shall be able to display error messages in case user is having problem in downloading.

Manage Content:

Description:

Administrator is responsible for managing the overall system and managing student's information in database.

Stimulus and Response Sequence:

The feature subtasks will follow the following sequence:

Normal course:

1. Administrator selects 'Sign In' option.
2. System asks for required information including user name and password.
3. After administrator provides the information the system verifies information from database.

4. System allows the administrator to manage the lectures, contents and records of students.

Alternate Course:

3.a   Administrator entered invalid user name or invalid password.

3.a.1 System shows an error message and asks the administrator to reenter the password and login.

3.b   System cannot match the record from the database.

3.b.1   System shows an error message regarding connection problem.

4.a   Admin is not able to upload or edit desired content.

4.a.1   System should show the error message in case of internet or database connection problem.

Functional Requirements (FR):

FR #1: The system shall display the option for login and password.

FR #2: The system shall acquire the information from the administrator.

FR #3: The system shall be able to match the user information from the database.

FR #4: The system shall be able to identify valid administrator.

FR #5: The system shall be able to check if the input data is correct or not.

FR #6: The system shall prompt a message for wrong inputs and errors.

FR #7: The system shall ask the user to enter password and login id again.

FR #8: The system shall provide access to admin to manage database content and content available to student.

Video Capturing and Streaming:

Description

We have two types of streaming:

First is from instructor to remote students, one to many transmissions.

Instructor events are captured by multiple cameras through automatic selection; this will involve video capturing, compression and delivering of video content to the streaming server from the cameras.

By using this feature the student can watch live video stream from the classroom on their android phone or PC.

Suitable compression techniques shall be used for delivering the video. Required bandwidth should also be available for better response. In order to fulfill our very low bandwidth requirement of mobile internet, we will also set other options e.g. reducing file size, low resolution or less frame size, reducing frame rate.

Second streaming is from student to instructor, many to one.

Remote student video is captured live and transmitted to the classroom; this is then displayed in the projector screen along with other remote student's videos.

If the video is captured through the android phone, the cost decreases as no expensive cameras are required for the video streaming feature as the android phone provides its own good quality camera mounted in the phone.

<u>Stimulus and Response Sequence:</u>

The feature subtasks will follow the following sequence:

<u>Normal course:</u>

(Student has selected start video streaming option and connection establishes with the streaming server.)

1. After login student selects attend class option.
2. Connection with streaming server establishes via internet connection.
3. After connection, video streaming starts via cameras to the streaming server.

4. Video streaming starts from the classroom to the remote student via automatic selection of IP cameras and in return video of student is transmitted to class.
5. Connection is closed by selecting "close video stream" option.
6. By closing connection, streaming will stop.

Alternate Course:

1.a   Student can't connect to the class due to internet problem.

1.a.1   System shows an error message due to low band width.

2.a   Video streaming can't start due to low band width.

2.a.1   System shows an error message regarding internet problem.

Functional Requirements (FR):

FR #1: The system shall be able to stream the video from client and server end.

FR #2: The system shall be able to select appropriate camera automatically to capture   instructors' events.

FR #3: The system shall be able to handle the frame rate for transmission.

FR #4: The system shall be able to handle problems like low internet connectivity.

FR #5: The system shall be able to display error messages in case of connection problems.

FR #6: The system shall be able to manage connection between the streaming server and clients.

Attendance via face recognition:

Description:

This feature shall facilitate the users by automatic attendance of students via face recognition.

Stimulus and Response Sequence:

The feature subtasks will follow the following sequence:

Normal course:

1. First the student selects attendance option.
2. Camera captures the face of student and matches it with the saved pictures.
3. Camera recognizes the picture and marks his/her attendance.

Alternate Course:

2.a   Camera doesn't start due to some problem

2.a.1 System shows an error message that "camera is not working".

3.a   Camera doesn't recognizes the picture.

3.a.1 System shows an error message "not matches with saved pictures".

Functional Requirements (FR):

FR #1: The system shall be able to provide attendance option.

FR #2: The system shall be to capture picture from the camera.

FR #3: The system shall be able to recognize the picture of student by matching it from the picture already present in database.

FR #4: The system shall be able to display error messages in case camera is not working or there is a problem in connection to the database.

Other Nonfunctional Requirements

Performance Requirements

Response time

Response time is very important for live video stream module because if there will be less response time then the end user can view the live video stream without long delay. Response time should be less, so the students

can communicate easily with the instructor. If the response time is large then students will not be able to view the video on time as the video stream would have delay factor in that scenario.

Jitter & frame rate:

For the video streaming software, jitter would be minimized while maintaining 30fps as frame rate.

Safety Requirements

Lag/Delay in video stream can cause possible loss or harm. This delay may occur due to slow internet connection. Due to this delay the students may not be able to see the video in a convenient manner and might not be able to communicate remotely with the instructor, this will affect their learning process. To solve this issue we are going to use an efficient video streaming server, which will reduce this delay issue.

Security Requirements

a) Users will get login only by their own username & password.
b) Only authenticated students will be able to access the lecture contents and watch the video.
c) Limited amount of remote students will be allowed to join the room so that there might not be any load.
d) Secure internet connection shall be used.

Software Quality Attributes

Adaptability:

Our system will be adaptable; it shall be able to work on different hardware environments.

Availability:

System shall be available and properly functioning whenever needed. During lecture hours live streaming shall be done till the lecture ends, if no lecture is taking place then previously uploaded contents shall be available to students.

Correctness:

System shall perform correctly involving proper delivery of content to the student and student session handling by streaming servers, providing quality live streaming.

Flexibility:

System shall be flexible enough to cater with problems like low and varying bandwidth. It shall use proper compression and streaming techniques to handle such hurdles.

The system must also be flexible enough to incorporate any changes or addition in functionality.

Interoperability:

All the system modules shall be able to communicate with each other. Connection between them should be there throughout communication.

Maintainability:

System shall be maintainable; it must be able to incorporate changes in future for adding new features and should also be able to manage changes.

Reliability:

System shall be able to generate same response on long run. Video quality should not differ much in case of any bandwidth issue. System must be able to resolve such issues, like by limiting the number of remote students that are attending the classroom.

Reusability:

The system components can further be used by developers to incorporate more features in them for improvement or to use them in their own product.

Robustness:

System shall be able to work in extreme conditions like heavy load on internet or in case of slow internet connection.

In case of heavy load it must only allow limited number of remote students to attend the classroom for efficient communication.

Live up to date video stream shall be provided to the student even if the internet connection is slow. To incorporate these, depending on connection speed at student end video quality may increase or decrease.

Testability:

We must test whether the system works according to mentioned requirements or not.

Streaming should be done properly without jitter and delay, attendance should be marked properly, selection of camera, and mobile application should also work properly.

Usability:

The interface shall be user friendly and easy to learn. User must be able to understand the functionalities of different options resent in the interface without any stress or training.

Business Rules:

According to the given scenario, only limited amount of remote students can join the class, so that there is not much burden on available bandwidth and server.

A student can only attend one class at a time.

Other Requirements

Backup:

The system shall produce a backup file containing the copy of all the data in database as well as of the content available to students. That file shall be used to restore records on data deletion, data corruption or system failure.

Appendix A: Glossary

- <u>SRS:</u> Software Requirement Specification.

- <u>GUI:</u> Graphical User Interface.

- <u>FYP:</u> Final Year Project.

- <u>SQL:</u> Structured Query Language.

- <u>MB:</u>   Mega Bytes

- <u>FPS:</u> Frame per Second.

- <u>CD:</u>   Compact Disk.

- <u>IP:</u>Internet protocol.

- <u>PC:</u>   Personal Computer.

- <u>RTP:</u> Real Time Protocol.

- <u>RTSP:</u> Real Time Streaming Protocol.

- <u>RTCP:</u> Real Time Control Protocol.

- <u>SRTP:</u> Secure Real Time Protocol.

- <u>SRTCP:</u> Secure Real Time Control Protocol.