



# Digital Board Marker (Storage Efficient System for Class Lectures)



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# **Declaration**

We declare that the work contained in this thesis is our own, except where explicitly stated otherwise. In addition this work has not been submitted to obtain another degree or professional qualification.

Signed: \_\_\_\_\_

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*To our parents and respected members*

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# Abbreviations

**LAH** List Abbreviations Here

# **Abstract**

In a new educational concept, the Lecture Recording system is one of the devices that are widely used to provide educational material to students. Lecture recording plays an important role in online learning and distance education. Most of they are recorded by a cameraman or a static camera. But high resolution recorded video require lot of storage space and also the internet bandwidth. In this work, a storage and bandwidth efficient lecture recording system is proposed to minimize the storage and bandwidth issues. This system is 100 times more efficient than the previously developed lecture recording system. This system is also small in size and portable. This lecture recording system allows students to re-experience the lecture session at anytime and anywhere by downloading it with the minimum bandwidth available or viewing it through the portal. It is made public to promote research and further development in this system. The proposed system is combination of hardware module and software modules. Its first step is position detection at each point of board marker through stereo vision cameras to generate a file that will later be easily played offline as well as online on the web portal. . . .

# **Chapter 1**

## **Introduction**

### **1.1 Overview of the Project**

Digital board marker is a size efficient, bandwidth saving lecture recording system. It can record lecture, providing automated google search of handwritten words. Provides on the spot wiki. Lecture text notes can be generated automatically. Lecture can be named and divided into topics and subtopics automatically. According to a survey, 94% students go for online help of recently attended lectures because they can't fully grab the concepts. Recorded lectures as video format require so much internet bandwidth to play. In most cases, large sized videos are difficult to handle or download. Because students mostly don't have huge amount of extra space available especially for the CSE students, as they already use bulky software and also students don't have large amount of bandwidth of internet available.

### **1.2 Background**

Mostly systems for online video lecture that exist now a days work on the principle of simple video recording and a website for that organization. The systems like edx, coursera, MIT Open Courseware simple records mp4(or any other format) video and then upload it on their website in a particular section related to particular course. Some of them allow to download the videos. These mp4 videos of 1 hour can take upto 900mb to 1gb of storage space and internet data.

Now DBM came up with the solution of this large storage issue and more internet usage. Instead of recording video it stores position of a pen from which teacher is writing on the white-board. Since position of pen/marker is stored in a text/json file which will reduce the size upto 100 times.

## 1.3 Motivation

The motivation and purpose to do this project is to minimize the use of resources that are used in lecture systems now a days working in all over the world i.e. video lecture recording and streaming through internet.

- The first motivation is to deal with the large amount of storage that normally video lectures take. This system is not based on video recording but on recording the writing on the board with marker. It will record the position of the marker as the coordinates of board where marker touches and store it in the text file (which will later be converted and played like a video). This will take minimum amount of database storage to store this kind of data on a website.
- The second motivation to do this project is to use less internet resources for accessing the lectures. Normally the video lectures of different institutes worldwide are very large and to download those on the system through internet requires large amount of resources which are normally difficult for students to get and to download it in high quality even more resources are required. The lectures for recording are very low in memory as compared to normal video recording and will require very minimum resources to download on the system.
- The third motivation is for example a power failure occurred during the lecture and you cannot clearly see the board but teacher is still writing and erases the board after some time, this may result in not getting proper notes or missing the important point of lecture. Moreover students can get benefit by seeing the lecture again and again if they missed any concept or if they were absent minded or not attending lecture. These few are the reasons which motivated us to do this project.

## 1.4 Objectives of the Project

### 1.4.1 Industry Objectives

In industry most of the time it is hard to choose areas for work which have low bandwidth internet and let's suppose you are playing a lagging call of duty run-through and your stream is buffering and stopping because of low bandwidth it's like you are losing because of this or you are presenting something which is

improved work of someone else and It requires high quality fast internet to present it but it's not guaranteed.

In some places people try to reduce the cost of these things as much as possible but not having proper interface is the main reason of failure so we can cop up with this issue by this new system we are introducing.

- To reduce internet bandwidth usage which will lead to progress in industry. Every industry wants to minimum resources and get maximum results so when you want to record some writing on a white-board you can reduce that video size from giga-bytes to few mega-bytes. This smaller size will use less and internet resources.
- To minimize the storage issue which can increase working efficiency of industry. Instead of recording video in mp4 DBM records position of marker writing on the white-board which is just like text file. The text file takes very less storage than a video file. So using minimum storage resources will increase industry's efficiency.

#### **1.4.2 Research Objectives**

In the development of digital board marker, computer vision is used and computer vision is most vital in the field of research. Computer vision plays a great role in research work. So by improving the uses of computer vision in future work its vast area for research work. Research objective of the system is to go through all the recent research work done in system's development fields and then on its basis, developing a system which is storage and bandwidth efficient.

- To reduce storage and internet usage by recording position of marker and storing it in a text/json file.
- To find precise orientation and position of marker on white board with the help of computer vision.
- To use colour detection to find location of marker just by using stereo vision.
- To find correct way to give offset while calibration of marker for translating position of marker from real world to local(computer) world by interconversion Euler angle and Quaternion.

- To reduce the noise in audio hardware due to analogue input in mic. Instead of using mic module is used(built-in noise reduction feature) a mic is used, noise is reduced by using electronic components like capacitor, variable resistor, potential divider resistors and coding(in Embedded C).

### 1.4.3 Academic Objectives

Digital board marker mainly cover academic area the main purpose is to provide each and every student all the lectures with better quality and less bandwidth because in Pakistan we students face this issue the most, as we know it cannot be resolved in near future we have to work something out for this issue and that's where this system will work it will provide an interface to all the students which have all the lectures of their respective subjects from their respective teachers which can be streamed online and downloaded for offline to play later on at very low bandwidth. It will provide all the assignment related material and lectures at same platform to students. It is the new revolution in the academic field.

- To learn major computer science field i.e. computer vision.
- To complete all the work before respective deadlines. So by working in a professional way project will be at its best.
- To be able to risk the change management in their projects, during the projects, developers might face different kinds of situation and their decision making plays an important role in leading them to success.

## 1.5 Problem Statement

To make a storage and bandwidth efficient system with a lecture player and learning management system for the students and the educational institutes.

## 1.6 Scope of the Project

Digital board marker mainly cover academic area the main purpose is to provide each and every student all the lectures with better quality and less bandwidth because in Pakistan we students face this issue the most, as we know it cannot be resolved in near future we have to work something out for this issue and that's where this system will work it will provide an interface to all the students which have all the lectures of their respective subjects from their respective teachers

which can be streamed online and downloaded for offline to play later on at very low bandwidth. It will provide all the assignment related material and lectures at same platform to students. It is the new revolution in the academic field. Although it covers industry and researches as well.

## 1.7 Challenges

### 1.7.1 Technology Selection

The technology used is:

- Angular 8 and C# for web application
- C# windows application for desktop application
- Embedded C for marker hardware

The selection of technology was one of the first major issue at the start of project. The first technology we thought of using was **django** (a python related framework) but we could not get comfortable with that so we switched to C# and angular 8. These were quiet familiar to us and also angular 8 was newly stable released latest technology so we opted these.

### 1.7.2 Marker not Visible to Camera

Teacher's hand might come in front of camera which will cover the marker and it cannot correctly record the position and orientation. Glowing ball of board marker must be at least partially visible by either of the cameras. Precision of marker position decreases from Case 1 to 6. Best Accuracy in Case 1 and no output at all in Case 6

### 1.7.3 Marker

User is supposed to be not touching the Marker tip while recording the lecture. If touched it can make error in input.

### 1.7.4 Ball detection

The ball attached on the top of marker is used to detect the position of marker but sometimes the color of ball can match with dress of user and cameras can confuse with the color, which came up as a challenge.

### **1.7.5 Marker Transmitter Range**

Board Marker Transmitter and Receiver are in range of 2 meters for less noise and preventing latency issues.

### **1.7.6 Pressure Sensor handling**

Pressure threshold of board marker tip is 5Pascals that is equivalent to pressure of lead pencil tip. Above this pressure, marker will write and otherwise not.

### **1.7.7 Defined Boundary of Platform**

User is supposed to be write only in the boundary of the defined platform i.e. whiteboard.

### **1.7.8 Audio Transmitter and Receiver Range**

Audio Transmitter and Audio Receiver must be in range of 5 meters.

### **1.7.9 Microphone Range**

Microphone should be in range of 10cm from the audio source i.e. speaker's mouth.

### **1.7.10 Controller Application**

Application is not closed while recording otherwise all recording will be wasted.

## **1.8 Assumptions and Constraints**

Following are assumptions which were kept in mind during the implementation of the project:

- The position is detected via ball using the computer vision so ball color should not interfere with color of surroundings.
- Teacher should erase complete board and not some words or some parts and also there should be an indication of that so that screen can be removed accordingly.
- Teacher or writer should not block the vision of camera by coming in the way.

- Teacher should start recording using a button on the controller app and similarly stop in the same way.

## 1.9 Possible Applications of Work

Following are the possible applications where DBM can be used:

### 1.9.1 Educational Institutes

There can be different types of users in educational institutes so DBM will be helpful to all these users. Although there are many other online lecture systems but they are not very efficient in terms of storage space and internet bandwidth usage. Already existing systems have mp4 videos which require approx. 1gb of storage space which is a big issue for students.

So DBM will be using much less resources. The video size will reduce from 1gb to few mbs(less than 100mb) which will be helpful for students with limited resources.



FIGURE 1.1: Digital Board Marker Application: Educational Institute

### 1.9.2 Online Tutors

Online tutors can use DBM. There can be different types of users in online tutors as well. Online tutors are also the one with limited storage space so instead of recording normal video of 1 hour which can take too much space they can use DBM which will use very less resources and will also be helpful to people listening to these onlune tutors.



FIGURE 1.2: Digital Board Marker Application: Online Tutors

### 1.9.3 Sketch Artist

Sketch artists can use the system just like online education and showing their sketch skills and help others in improving theirs. The people learning from these sketches need to watch the video again and again which will require a lot of internet data. So DBM will reduce the data usage as it has very small size for video and users can easily buffer the video again and again.



FIGURE 1.3: Digital Board Marker Application: Sketch Artists

### 1.9.4 Industrial Presentations

Digital board marker can be helpful in industrial presentation so that if any person cannot appear at the particular time, that person can watch the recorded (storage efficient) presentation later. So industry will also have less use of its resources.



FIGURE 1.4: Digital Board Marker Application: Industrial Presentations

# **Chapter 2**

## **Literature Review**

### **2.1 Literature Review**

As a student have you ever wanted that if you can take the lecture you missed because of some mishap or the concepts delivered in that lecture was too hard to grasp immediately and you wanted to discuss them later with other people but you could not remember most of it because you cannot jot down each and every thing? One time or another we all have been there. To achieve this goal many techniques were used providing notes or recording lectures and later providing them to all the students but since every thing has its own pros and cons so first we have to make sure that these facilities are either productive or destructive many researches has done to support the idea of use of revolutionized lecture systems different techniques were used to achieve this goal but we will get back to those techniques later. First we have to see the use of these facilities is beneficial or not. The use of video lectures in educational institution is considered as an essential source because students can't pay complete attention in class whole the time. It is important to provide an alternative as good as possible that's why video lectures play a huge role. Web-based lecture technologies are being used increasingly in higher education. One widely-used method is the recording of lectures delivered during face-to-face teaching of on-campus courses. The recordings are subsequently made available to students on-line and have been variously referred to as lecture capture, video podcasts, and Lectopia. We examined the literature on lecture recordings for on-campus courses from the perspective of students, lecturers, and the institution. Institutions receive pressure from a range of sources to implement web-based technologies, including from students and financial imperatives, but the selection of appropriate technologies must reflect the vision the institution holds. Students are positive about the availability of lecture recordings. They make significant use

of the recordings, and the recordings have some demonstrated benefits to student learning outcomes. Lecturers recognize the benefits of lecture recordings for students and themselves, but also perceive several potential disadvantages, such as its negative effect on attendance and engagement, and restricting the style and structure of lectures. It is concluded that the positives of lecture recordings outweigh the negatives and its continued use in higher education is recommended. However, further research is needed to evaluate lecture recordings in different contexts and to develop approaches that enhance its effectiveness.[\[20\]](#)

Then a research team decided to see the impact of flipped classroom on students and their growth. A flipped classroom is an instructional strategy and a type of blended learning that reverses the traditional learning environment by delivering instructional content, often online, outside of the classroom. It moves activities, including those that may have traditionally been considered homework, into the classroom.

The meta-analysis comparing these 29 traditional flipped interventions in relation to student achievement showed an overall significant effect in favor of the flipped classroom over traditional lecturing (Hedges'  $g = 0.289$ , 95% CI [0.165, 0.414],  $p < .001$ ). A moderator analysis showed that the effect of the flipped classroom was further enhanced when instructors offered a brief review at the start of face-to-face classes.

They calculated students learning rate by means of hedges'  $g$  which tells whether the impact of flipped classroom is positive or negative and the impact of flipped classrooms was mostly positive the learning rate of students increased and passing rate of class also increased. That means flipped classroom was much more good than traditional classrooms. They used number of samples to make sure the conclusion and in majority of samples result was same that flipped classroom are an innovation in educational institutions.[\[15\]](#)

Then we have to see the effects of prior knowledge on students because different approaches can be used to increase the growth rate of students so it can be a positive approach. A research was conducted to analyze these results and a research paper was published as a result of data set in 2019. That paper shows how a student behaves in general if lecture related material or videos are provided first. They categorized students in two categories the one with low prior knowledge LK and the one with high prior knowledge HK then they used these samples to examine the behavior of students in each sample to check with prior knowledge how many times students does what actions like start over rewind a video after the lecture so that they can see how much interest students are showing and how these videos are helping them in their studies and students with high prior knowledge had more

potential and passed their exams with more marks than LK.

The purpose of this analysis was to answer the following questions:

1. Does prior knowledge affect students' engagement level of viewing video lectures?
2. Does prior knowledge affect students' strategies used for viewing video lectures?
3. Does prior knowledge affect students' learning performance when learning from video lectures?
4. Does prior knowledge affect learners' attitudes toward video lectures?

Effect was positive for all the students with high prior knowledge they have to do less effort.[\[13\]](#)

Then a system was made to use the video lectures but to make them more effective it was based on the brainwaves of learner. This system was made for the benefit of students so that they can learn everything on the basis of their attention. Video lectures are common but this system records the patches of video based on the attention of students on brain signals that if they missed any part which was important they can watch it later and know that they missed this thing.[\[14\]](#) A study was done in 2019 to see the benefit of recorded lectures that they are decreasing the burden off for both students and teachers and how they are helpful for them. This study was done for the students of pharmacy to see their response and performance if they get recorded lectures or not study shows that students have more storage space like a storage device when we tell them they can have the recorded lectures so they can focus on other things which are more productive and it will increase their performance because now they have a medium for later use so that they can use their brain for other important things study shows how human minds works as a storage space if we tell them that they will not get recorded lectures they will save their storage space to absorb the lecture and fully remind so that later on they don't get any difficulty but in spite of helping them it will stop them from growing.[\[21\]](#)

Sometimes customized things are better in educational system because everyone has their own method of teaching and learning for that purpose video lectures are used but what if we change the way of delivery of those lectures by marking the timeline so that students know which part is important for them for that purpose a research was done and published in 2019. That research shows how a marked timeline of a video lecture affects the behavior of students they took two groups of students as sample and showed one group conventional video of lectures and other group the marked timeline video and the experiment showed how the behavior of students who were shown a marked timeline with topics or keynotes was different they clicked less on timeline and their pattern of clicking the timeline was almost

same and later on they performed well on that test or quiz held from that video because of the interactive timeline the behavior of students changes and the feel more open to learn and explore.[22]

Now if we are using video lectures then we have to see the effects on audience on them. For that purpose a study was conducted on the effects of video lectures on university students and how they spend their time on them. This study shows how online lectures plays a good role in the learning of students they provided online videos to students with lectures and recorded their time spent on lecture and video lectures and study showed students uses online videos as a substitute of lectures and it is a positive thing to learn those who spent time in lecture have same learning to those who spent equal time on video lectures.[18]

Video lectures was invented because student cannot take notes about each and everything in lecture and they miss things. A research was conducted to see how it can be helpful to take effective notes in classroom. This research focuses on the behavior of students while taking notes typically students note everything written on board and a very few of them write on their own to find links between lecture and their learning and this thing is good for the growth of any student but a few does it because a student brain thinks what a teacher is writing on the board is most important and after that what he is saying is important very few thinks what they are learning and that's what's needed in notes taking for a productive notes taking of students.[10]

Online lectures have their own cons but they can be recovered by a number of things a research was conducted in 2018 to study the effect of these facilitation in online courses. This study shows how some strategies work for the students interaction and interest in an online course teacher uses different strategies to engage students in an online course because it is so easy for students to just let it go they can just quit it so all the teachers around the globe uses some strategies to develop the interest of student and in this study they examined 13 strategies to see the behavior of students.

1. Instructor presence
2. Instructor Connectedness
3. Engagement
4. Learning

All 13 strategies constructs around these four factors. and these strategies are:

1. Video based instructor introduction (e.g., Voicethread, Animoto, Camtasia)
2. Video based course orientation (e.g., recording using Camtasia, screencastomatic)
3. Able to contact the instructor in multiple ways (contact the instructor forum,

- email, phone, 4. virtual office hours)
5. Instructors timely response to questions (e.g., within 24 to 48 h) via forums, email
  6. Instructors weekly announcements to the class (e.g. every Monday via announcement forum, email)
  7. Instructor created content in the form of short videos/multimedia (e.g., Camtasia, articulate modules)
  8. Instructor being present in the discussion forums (e.g., refers to students by name, responds to students posts)
  9. Instructor providing timely feedback on assignments/projects (e.g., within 7days)
  10. Instructor providing feedback using various modalities (e.g., text, audio, video, and visuals) on assignments/projects
  11. Instructors personal response to student reflections (e.g., via journals to questions on benefits/challenges)
  12. Instructors use of various features in synchronous sessions to interact with students (e.g., polls, emoticons, whiteboard, text, or audio and video chat)
  13. Interactive visual syllabi of the course (e.g., includes visual of the instructor and other interactive components)[17]

Online learning environments use different approaches to convey their information to their audience but when learning is most important thing in an online environment then we can use learning centered environment it uses number of factors to increase the learning rate. The design of online course materials is rarely informed by learning theories or their pedagogical implications. The goal of this research was to develop, implement and assess a virtual learning environment (VLE), SOFIAA, which was designed using the cognitive apprenticeship model (CAM), a pedagogical model based on learning-centered theory. We present an instructional design case study that reveals the steps taken to improve student performance in a master's level blended learning course on program evaluation. The case study documents four phases of improving on-line instruction in program evaluation, starting with Online Course Materials (OCM) that contained resources and information required to complete team field projects. In phase 1, quantitative analyses revealed that there was improvement of student test scores using the OCM, however, qualitative analyses of think-aloud sessions found that students failed to attain key course objectives. In phase 2, a team of experts reviewed the materials and suggested ways to improve opportunities for student learning. In phase 3, a (VLE) was designed based on the results of phase 2 using a reconceptualization of CAM as a design model. In phase 4, the VLE was validated using

experts' appraisal of content and presentation, and student achievement, which indicated that use of the VLE led to significant improvement in learning over use of OCM. The design process is discussed in terms of a reconceptualization of CAM as a general strategy for instructional design that can be used to improve both the content and quality of online course materials.[7]

A study was conducted on the note taking quality of students in 2018. Many Students are terrible note takers who record just one third of a lecture's important points in their notes. This is not a good practice, because the number of lesson points recorded in notes is directly proportional to student's achievement. Moreover, both recording notes and the continuous review of notes are beneficial. The authors offer instructors a menu of research-based advice for increasing effectively student note taking: provide complete notes, partial notes, note-taking cues, represent the lesson, pauses and revision opportunities, control laptop usage, control "cyber-slacking", use slides effectively, and teach notes-taking skills to students. Authors also suggest ways to help students change their notes during the note-review process and select, organize, associate, and regulate their notes effectively to success. This study shows how notes taking helps student and how student are not good with it but we have to do something to improve it so their are some things or remedies we can do to improve it because notes are basically most essential thing for a student to get through the exams.[11]

Engagement of students increase student's satisfaction, enhances student's motivation to learn, reduces the isolation sense, and improves performance of each student in online course. A survey-based research study was conducted to examine student's perception on different engagement strategies which are used in online courses based on an interaction framework MOOR. 38 item survey was completed by one hundred and fifty-five students which was based on engagement strategies of learner-to-learner, learner-to-instructor and learner-to-content. The most valued engagement strategy was Learner-to-instructor among the three categories .In the learner-to-learner category the engagement strategy rated the most was Icebreaker/introduction discussions and working collaboratively using online communication, whereas in learner to instructor category sending regular announcements or email reminders and providing grading rubrics for all assignments were rated most beneficial. In the learner-content category, students mentioned working on real-world projects and having discussions with structured or guiding questions were the most beneficial. This study also analyzed the effects of age, gender and years of online learning experience differences on student's perception of engagement strategies. The results of the study have involved conclusion for online instructors, instructional designers, and administrators who wish to enhance engagement

in the online courses. Basically, this paper shows how engagement matters in an online course because online courses can be a complete waste if we don't do it properly and study properly in it includes engagement of the student that he can follow the course as the instructor is teaching and what strategies we should use to engage a student in an online course. [16]

A study was conducted to analyze the behavior of students in massive open online courses (MOOCS) like how students show their confusion about things and how to improve that model so that student will have less confusion because more confusion creates less retention so if we can provide things in a way that students would have less confusion then they will focus on much more creativity and new ideas so in MOOCS we have to reduce the reasons of confusion as much as possible.[25]

Discussion forums are also held in MOOCS and the odds of confusion is much more greater than the online courses because different people are giving different views and discussing them which can lead to confusion among the learners. The construction and destruction both are equally possible in discussion forums because confusion can change the discussion entirely and to prove that point a study was conducted in 2015 to examine the effects of confusion in MOOCS.[24]

Then we have to see the patterns on which a student view and understand a video lecture for that cause a study was conducted in 2016 to see if there is any relationship between video lecture pattern and student perception of watching them and results shows that there were certain patterns on which a student watches an online lecture.[8]

We have discussed all the pros and cons of video lectures and how to make them more efficient for the students but what if the quality or source of video becomes a problem video lectures takes a lot of space and a lot of speed is needed to stream them smoothly. If they are not streamed smoothly it is almost impossible to understand a lecture. A human mind loses interest in something after 2 seconds if its buffering and we feel angry and irritated so how can we focus on a video lecture which buffers after every 1 minute or even seconds. For that purpose different techniques were introduced to optimized the video size or quality to stream it smoothly. A good quality video is hard to stream but an average quality video can be streamed easily but what if we cannot compromise on quality. It is a seesaw but we have to balance both quality and space.

Automated video recording system was introduced in 2010 by a researcher in his paper. A PTZ camera was used in this study to capture the video lecture instead of a cameraman this camera acts as a cameraman and tracks the screen and lecturer and starts recording the lecture.[6] The cons of this system was it provides

the simple video and the streaming issue remains the same even if a student downloads every lecture he may need a lot of space to save them because 1 lecture of one hour can take space up to 1 GB.

Another technique to increase the quality and understanding of video lecture was introduced in 2017 by research team in their research paper. This technique captures video from different angles and multi-stream them. The approach was to use multiple cameras to get same scenes from different angles and stream the most suitable. The movements and actions of cameras were synchronized all the cameras captures the video at the same time. It increased the canvas of video lecture at that time later this technique was used in many gaming engines too. [4] The con of this technique was that to capture a scene which is static in case of lecture video use of multiple cameras was expensive and quality wasn't even that much better.

A tracker named Gal Tracker was also introduced in 2013 by a researcher. The use of this tracker was to optimize the lecture recording. It captures the lecture in real time environment also called real time lecture capturing. It captures all the important parts of lecture and creates slides of lecture according which can be later distributed among the users.[9] Again the issue is it can not capture all the important points given that it works on cues it can only capture a certain type of info and if something new comes it might fail in that environment. Its basically optimizing the lecture notes not lecture videos but trying to provide the same feature.

In MOOCS platform it is essential to provide videos but many people are working how to optimize them as much as possible and their type of optimization depends on how user can interact with video lectures. A research was conducted in 2015 to check how user interacts with single and multi streamed videos and their behavior on them. They also tested how it will help if a user can stream two videos at the same time.[23] This statistical data from this research can be used to improve many new video streaming engines.

Since many people are streaming videos worldwide it is a wast field to compress these files but but compression can cause loss of data. To minimize the loss of data as much as possible different techniques of compression are used throughout the years. Wavelet transform is an efficient method to compress videos but in 2011 a research was conducted to achieve video compression algorithm using frame difference approach. This technique was to discard unimportant frames and keep the ones which can be important now the factors which decides whether the frame is important or not can be compression performance or frame change from previous one if its too minor it can be discarded. This technique was tested on

many videos and the results were positive it can optimize the video size upto 3 percent and it's a big thing when we stream a 2 GB HD video with less amount of bandwidth.[1] As we discussed earlier video compression is a wast field so here is another technique to compress a video: in 1992 an algorithm was developed to compress a video by MPEG video compression algorithm. The major focus of this algorithm is based on two techniques: block based motion compensation for the reduction of the temporal redundancy and transform domain based compression for the reduction of spatial redundancy. Motion compensation techniques are used with both interpolative and predictive techniques. The prediction error signal is further compressed with spatial redundancy reduction (DCT). This algorithm changed the video about 1.5Mbit/s.[12]

As we discussed different compression algorithms but they have some cons when we compress a video we compromise its quality a data loss is possible. There are some techniques which focuses on video compression as well as preserving the quality or resolution of video one of them was presented in 2016 which focuses on multi-level optimization of encoding to balance video compression and retention of 8k resolution. A paper was presented for this technique. This Paper is focused on providing better quality videos after compression by using some factors and techniques. This paper presents a technique that aimed to achieve an efficient balance between video compression using H.265 protocol and retention of 8K resolution. The study implements multi-level of optimization in the encoding process using H.265 where we can see JPEG2000 standards play an important role. The study also uses a novel concept of orthogonal projection that manages pixels metadata required in every frame transition by using motion compensation. By using multiple file formats of 30 video datasets, the outcome of the study is found to be achieving approximately 49 percent of increase in data quality and around 59 percent of enhancement in video compression in comparison to the former techniques of HEVC-based video compression which are most commonly used techniques.[19] We saw how video lectures are helpful for learning and growth of students, how different video recording techniques are used to provide video lectures or notes, how compression of videos is important and how quality is important. We discussed different techniques and studies to achieve and justify all the goals. These techniques are not perfect but they are achieving the goal somehow "provide video lectures with ease". Ease can be considered as less space hogging and less bandwidth usage and still stream the lecture as possible. But first we have to see one thing to capture these lectures we have to change the environment of a classroom and we have to see either these changes are good or bad for classroom environment some studies were conducted to see the behavior of students towards these changes

and the studies have shown positive result students were much attentive in lecture because they don't have to jot down the lecture they can focus on the concept because now they can access those lectures later on if wanted.[3][5][2]

After discussing all the pros and cons of video lectures, availability of video lectures and techniques to make it easier. We are going to discuss another technique introduced by us. Compression may cause loss of data and quality may increase the space or bandwidth issue. To overcome this issue we are introducing DBM(digital board marker) this technique uses coordinate information to generate a video later on. DBM erases all the noise from video and chooses to save the information written on board or screen and audio of instructor. It draws a virtual plain on board and saves the coordinate information with respect to time in a customized file which can be later used to generate the video of board on our customized player integrated in web app and desktop application with a speed less than 2.5Kb. Which is much less than all the compression techniques used. So, DBM is solving all the compression problems for lecture videos and providing video lectures which is essential for the growth of student's learning.

## 2.2 Comparison Table

Name	Support Video Lectures	Provide Video Lectures	Main Scope	Video Optimization
Multi-level optimization in encoding to balance video compression and retention of 8k resolution.[19]	Yes.	Yes.	H.265 encoding to balance compression and quality of video.	59 percent better compression and 49 percent increase in quality than ordinary compression.
The use of lecture recording in higher education.[20]	Yes	Yes	Simple video lectures captured by a simple camera.	No
Exploring the relationship between video lecture usage patterns and student attitudes.[8]	Yes	Yes	Sensors to analyze the usage pattern by students.	Usage pattern can help to discard the unimportant information hence can optimize video.
The impact of flipped classroom.[15]	Yes	Yes	Ordinary video lectures captured by a camera.	No, ordinary video lectures.
Anchoring interactive points of interest on web-based instruction video.[22]	Yes	Yes	Mark the important points on a web-based video.	Yes, it can be used to optimize point of interest in video later.

Name	Support Video Lectures	Provide Video Lectures	Main Scope	Video Optimization
Modeling and quantifying the behaviors of students in lecture capture environments. <a href="#">[3]</a>	Yes	Yes	Analyze lecture capturing environment.	No
Student perception of helpfulness of facilitation strategies that enhance instructor presence, connectedness, engagement and learning in online courses. <a href="#">[17]</a>	Yes	Yes	Provide helping material to students to analyze its effect.	No
Guided notes for university mathematics and their impact on students' notes-taking behavior. <a href="#">[10]</a>	No	No	Providing notes so that issue of notes-taking can be resolved.	Better notes-taking can resolve the issue of capturing the complete video lecture.

Name	Support Video Lectures	Provide Video Lectures	Main Scope	Video Optimization
Effects of prior knowledge on attitudes, behavior and learning performance in video lecture viewing.[13]	Yes.	Yes.	providing video lectures after the lecture and analyze its impact.	No.
Exploring the effects of confusion in discussion forums of massive open online courses.[24]	Yes.	Yes.	Identifying the confusion factors in online video lectures.	No.
Effects on learning time spent by university students attending lecture and watching online videos.[18]	Yes.	Yes.	Providing ordinary video lectures and analyze the learning growth of student by time spent on them.	No.

Name	Support Video Lectures	Provide Video Lectures	Main Scope	Video Optimization
Automated lecture recording system.[6]	Yes.	Yes.	Video lecture captured by PZT camera with motion and scene sensors.	Yes, recording the video when it matches certain criterion.
Design of learning-centered online environment.[7]	Yes.	Yes.	Design an environment for video lectures with better learning.	Yes, this design can optimize the video by capturing and providing only points of interest.
Optimized adaptive streaming of multi-video stream bundles.[4]	Yes.	Yes.	Synchronized streaming of multiple videos.	Yes, it uses encoding to optimize the streaming.
GalTracker: Real time lecture tracking for lecture capturing.[9]	Yes.	Yes.	Provides slides by creating them in real time from frames of a video lecture.	Yes, it discards the frames with minor distance and creates slides based on some factors.

Name	Support Video Lectures	Provide Video Lectures	Main Scope	Video Optimization
Lecture capture: student perceptions, expectations and behaviors. <a href="#">[2]</a>	Yes.	Yes.	Provide video lectures to analyze student behavior and expectations.	No.
Improving effectiveness of learners review of video lectures by using an attention based video lecture review mechanism based on brainwave signals. <a href="#">[14]</a>	Yes.	Yes.	Review video lectures based on brainwave signals of learner.	Yes, video lecture can be optimized by the attention points of learner.
Optimizing the video experience in MOOCs(massive open online courses). <a href="#">[23]</a>	Yes.	Yes.	Increase the streaming quality in MOOCs.	Yes, it optimizes the video by providing a timeline with video lecture.

Name	Support Video Lectures	Provide Video Lectures	Main Scope	Video Optimization
Exploring the effects of students confusion in massive open online courses. <a href="#">[25]</a>	Yes.	Yes.	Identify the problems because of confusion in MOOCs.	No.
Engagement Matters: student perception on the importance of engagement strategies in the online learning environment. <a href="#">[16]</a>	No.	No.	Analyzing the student views on engagement with instructor for learning.	No.
Video Compression Algorithm based on Frame Difference Approaches. <a href="#">[1]</a>	Yes.	Yes.	Video compression based on difference in frames by some factors: performance and difference from previous frame.	Yes, it optimizes the video size by 3 percent.

Name	Support Video Lectures	Provide Video Lectures	Main Scope	Video Optimization
The MPEG Video Compression Algorithm.[12]	Yes.	Yes.	Video compression by MPEG algorithm by interpolation and predictive technique.	Yes, it optimizes video by 1.5 Mbits
Recorded lectures as a source of cognitive off loading.[21]	Yes.	Yes.	Record video lectures and provide them to students to increase their learning growth.	No.
How to take good notes.[11]	No.	No.	Increase student learning growth by taking good notes and review them later.	No.

## 2.3 Shortcomings in Existing Systems

Like all the other systems existing systems also have some shortcomings which may or may not be overcome by new systems such as:

- Students can become lazy.
- Attendance rate can decrease because of availability of all the resources.
- Student behavior can change which can change the premise of lecture.
- Using ordinary video capture techniques might not be suitable for all the students.
- Students who don't or cannot have suitable internet connection cannot stream the video lectures.
- Some students cannot have the space to store ordinary lecture videos because of their size.
- Compression might cause loss in data.
- No matter how accurately we can use the factors to compress a video but we are discarding some frames that may cause loss of crucial information.
- Quality of video is also compromised in some systems which is not tolerated in some cases.
- It can be difficult to adapt the new environment for both students and instructor.
- Instructor will be a little conscious in new lecture capturing environment.
- Students can become non-serious about taking lectures in real time environment so we have to make sure the attendance is compulsory.
- A platform has to be introduced for video lectures availability.
- Maintaining those video lectures can be difficult.

# **Chapter 3**

## **Proposed Methodology**

### **3.1 Proposed Solution**

The proposed system focuses on size efficiency of the output video. System acts well in the environment where there is storage issue and bandwidth issue in terms of internet transfer rate. Ultra-durability makes the system more portable to use and more reliable to handle. Re-positionable cameras make the system able to work well in different canvas sizes i.e. size of writing board. System automates the process of video compression technique. Video of the lecture is not recorded as it is in video format rather only the important data is extracted. By utilizing the stereo vision and high-speed cameras and low wireless latency, video animation and sound quality is maintained in noisy environment as well.

### **3.2 General Flow**

The system consists of several modules and deliverables one of which is controller application. This application is quite important because it includes major functionalities and complex image processing algorithms. Furthermore, the instructor is mainly connected to the controller application so that he/she is controlling the recording of lecture i.e. he can start, pause or stop the recording. After the lecture is recorded, he can replay the lecture for any further changes. When the lecture is finally uploaded to central computer, students can play lecture online or save the lecture file in .dbm(file extension) extension to watch later.

Offline player is also one of the major modules of the project. It plays the downloaded lecture file just like video player. Learning management system is the online platform where all uploaded online lecture hierarchy is accessible. It is a comprehensive management system designed by placing the convenience of instructor and

student in focus. Reliability, security and quality are the top priorities. A simple visual of the working of system can be seen below

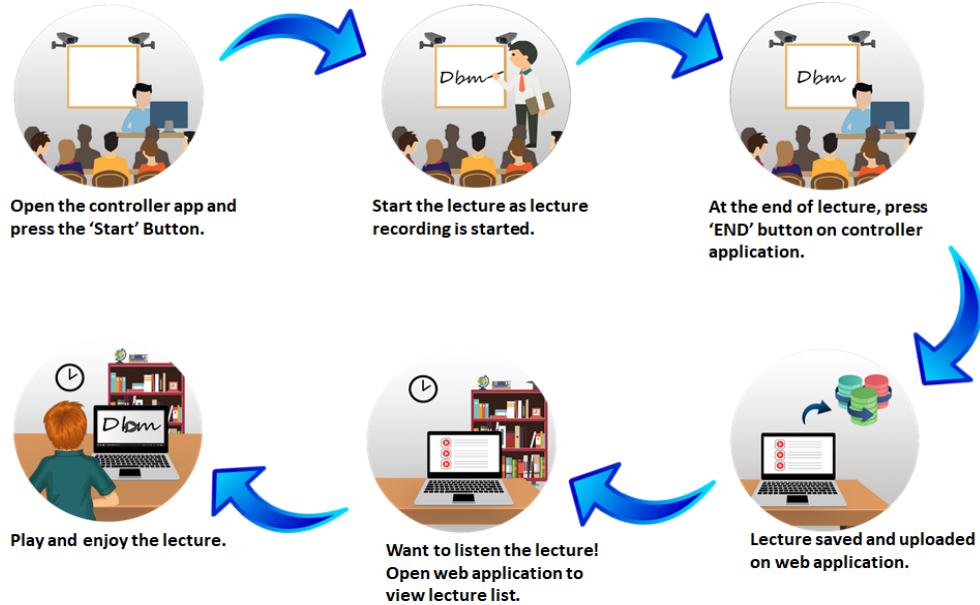


FIGURE 3.1: General Flow of the Project

### 3.3 General Proposed Model

General working model of the system can be seen below

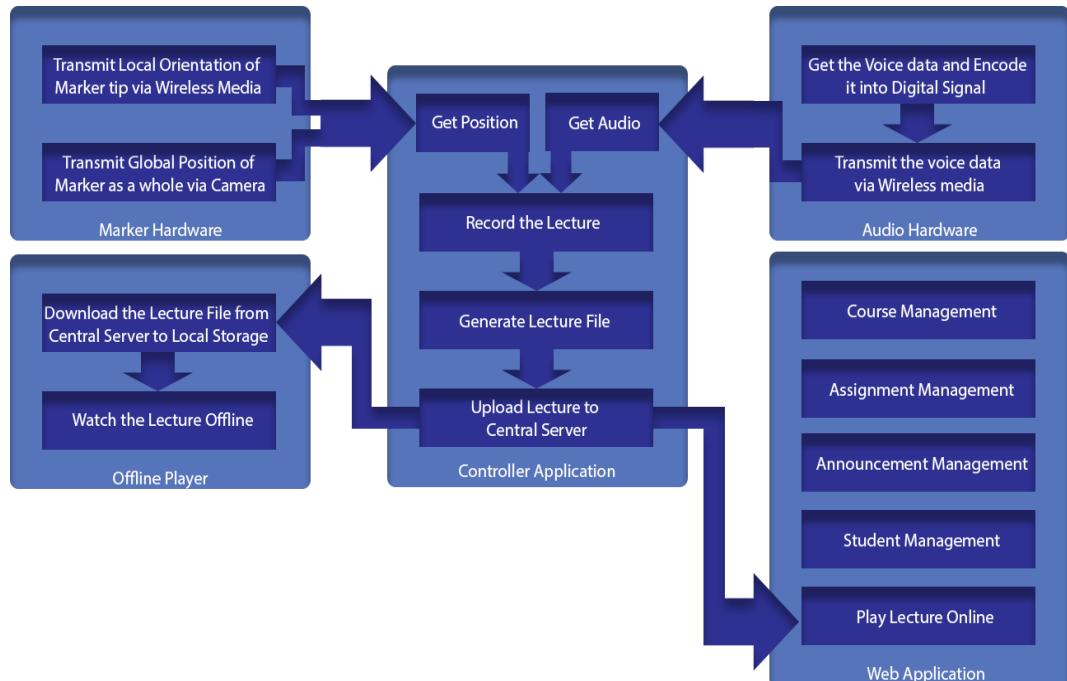


FIGURE 3.2: General Methodology View of the System

### 3.4 Formulas Used

Descriptor	Explanation	Formula
Euler Angles Rotation Matrices	Transpose of the fixed-axis matrix. Used in orientation extraction of Board Marker	$R_x(\theta) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos \theta & -\sin \theta \\ 0 & \sin \theta & \cos \theta \end{bmatrix}$ $R_y(\theta) = \begin{bmatrix} \cos \theta & 0 & \sin \theta \\ 0 & 1 & 0 \\ -\sin \theta & 0 & \cos \theta \end{bmatrix}$ $R_z(\theta) = \begin{bmatrix} \cos \theta & -\sin \theta & 0 \\ \sin \theta & \cos \theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$
Quaternion to Euler conversion	Used in Marker calibration when an offset is given in particular dimension.	$q_{IB} = \begin{bmatrix} \cos(\psi/2) \\ 0 \\ 0 \\ \sin(\psi/2) \end{bmatrix} \begin{bmatrix} \cos(\theta/2) \\ 0 \\ \sin(\theta/2) \\ 0 \end{bmatrix} \begin{bmatrix} \cos(\phi/2) \\ \sin(\phi/2) \\ 0 \\ 0 \end{bmatrix}$
Euclidean distance formula	Used to compute the distance in one-dimension.	$d(x, y) = \sqrt{\sum_{i=1}^n (x_i - y_i)^2}$
Equation of line in slope-intercept form	Used to draw lines and get relative position of Marker with respect to cameras.	$y = mx + c$

TABLE 3.1: Formulae and Equations used

### 3.5 Use-Case Diagrams

To describe the system requirements, use-case diagrams in form of simple user interaction are detailed below

#### 3.5.1 Controller Application

The main end user of controller application is the class instructor or teacher. Teacher use the controller application in

- Calibrating hardware
- Record the Lecture
- Live Stream Lecture
- Generate Lecture File and annotate it
- Send Lecture file to Central Server

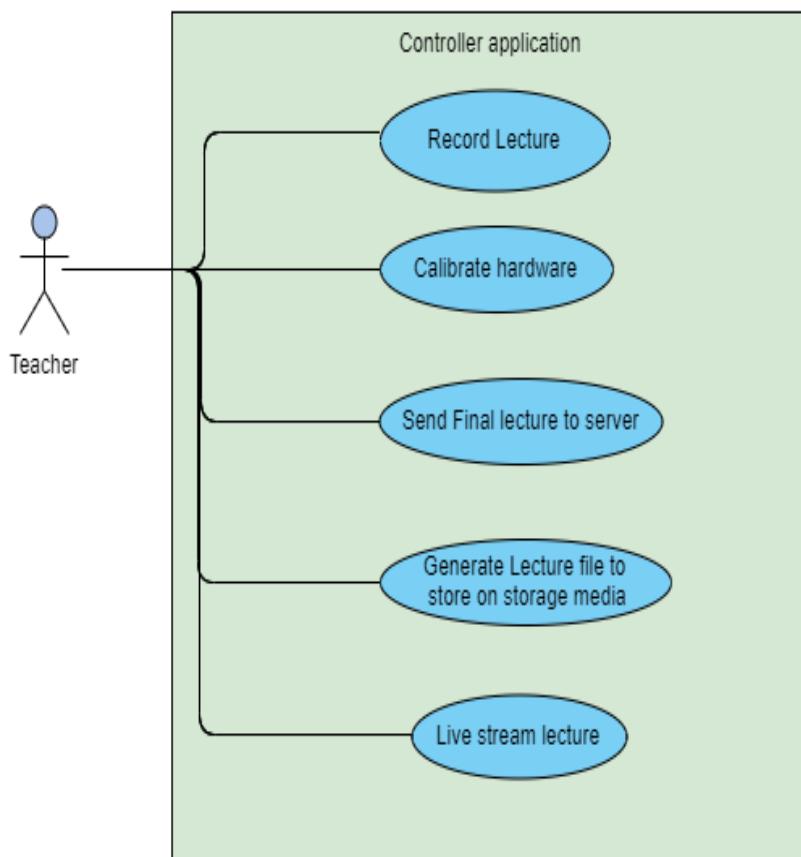


FIGURE 3.3: Use-case Diagram of Controller Application

### 3.5.2 Player Application

Just like media player, the player application plays the lecture. Common end user of Player Application is student. Teacher and Student are end users of controller application. Typical actions of Player application are:

- View Playlist
- Play Lecture
- Live Stream Lecture

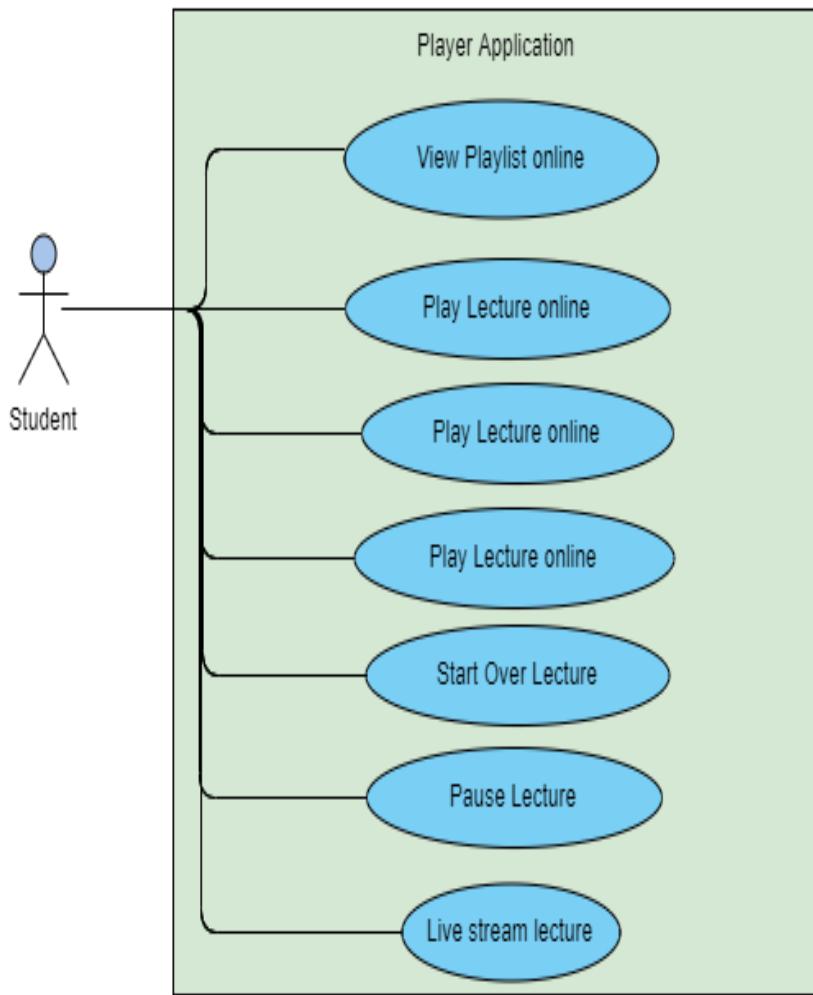


FIGURE 3.4: Use-case Diagram of Player Application

### 3.5.3 LMS Web Application

LMS application is major module in terms of accessibility. Students, Teachers and administration can have access to this module simultaneously. LMS functionality is sub-divided into following different users:

- Admin, who manages the institute.
- Teacher, who manages students
- Users, who are students

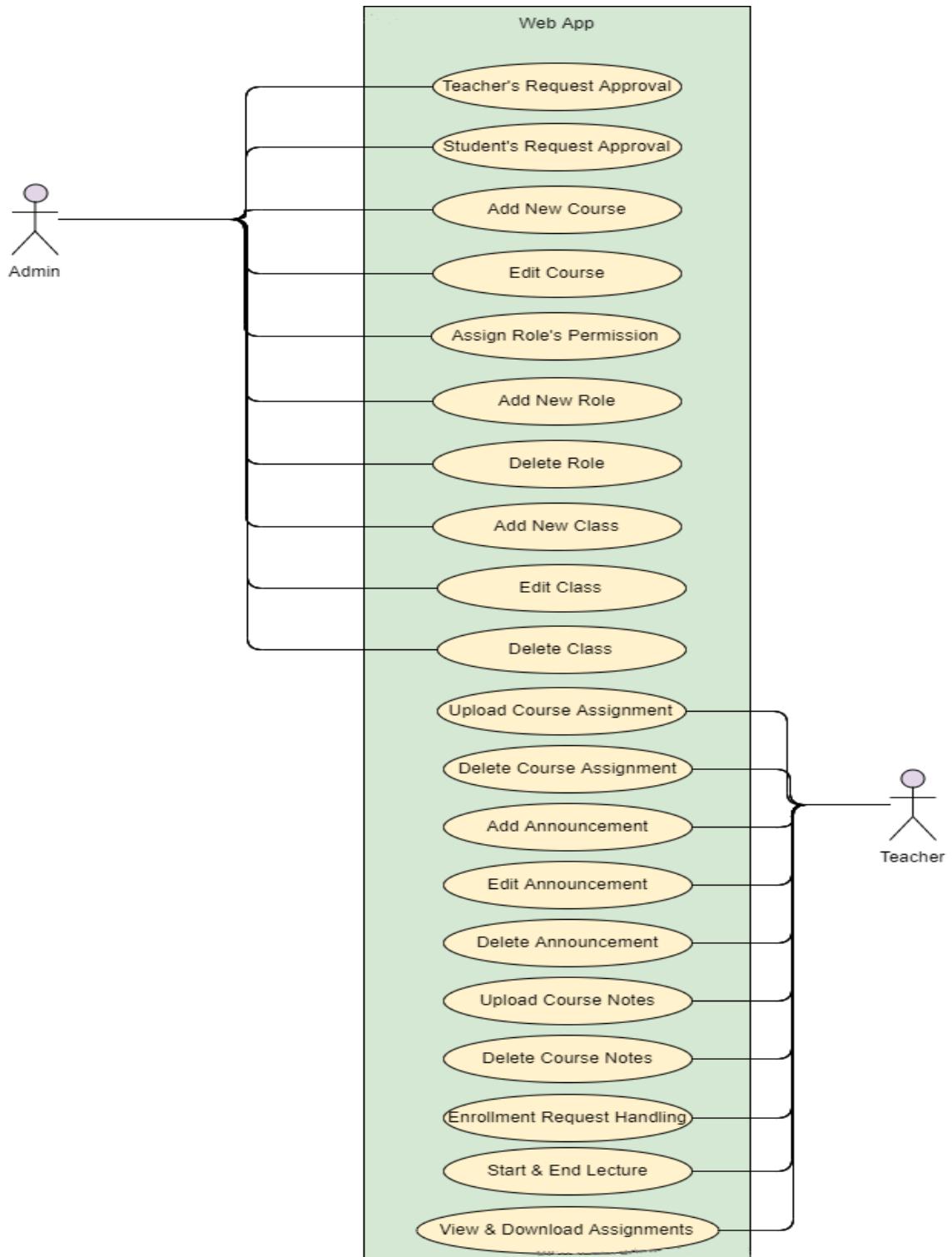


FIGURE 3.5: Use-case Diagram of LMS Web Application Part-I

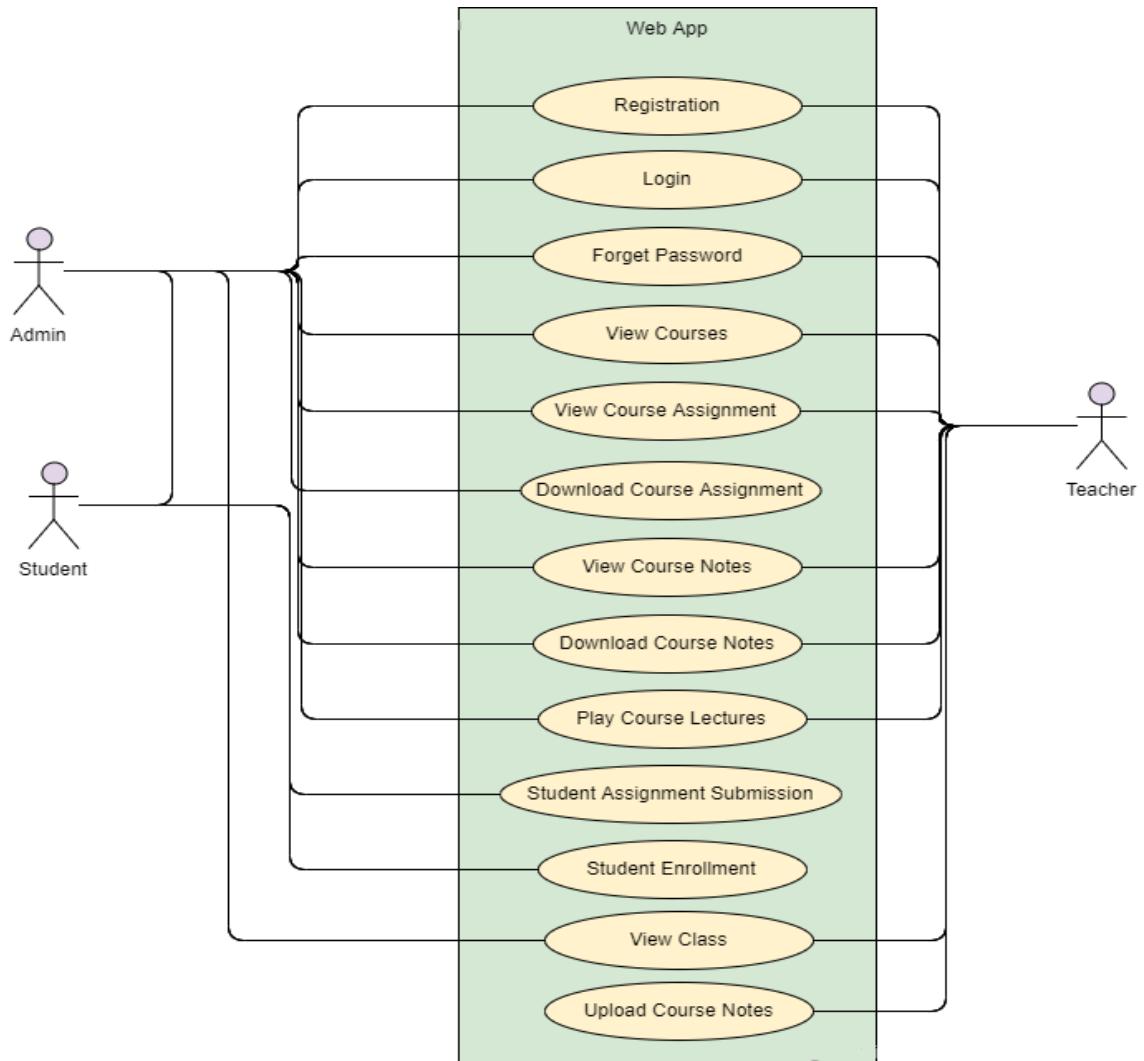


FIGURE 3.6: Use-case Diagram of LMS Web Application Part-II

## 3.6 Use Cases(Web App)

### 3.6.1 Use Case UC-1: User Registration

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Student, Teacher

**Post Condition:**

User data successfully sent to admin request approval page.

**Main Success Scenario:**

1. User wants to register.
2. User clicks on the Register link from the main Page header.
3. Registration page will be open by the system.

4. User will enter First Name, Last Name, Email, CNIC, Password and Date of birth.
5. User will select Institute name from the select list.
6. User select whether he is teacher or a student from the select list.
7. If user is student then system will show a input box for student registration No.
8. Student will enter his registration Number.
9. User clicks the **Sign Up** button.
10. System then send data to the Admin Request Approval page for the student request approval.

#### **Alternative Flow:**

\*a. At any time system fails.

1. User must check the internet connectivity.
  2. Restart the browser and try again.
  3. Try after sometime might be servers are down.
- 3a. Registration page is not opened.
1. Refresh the browser.
  2. Reload the page and try again.
- 4a. User entered the invalid First Name, Last Name.
1. System will show the error message.
  2. System will ask the user to enter the data again.
- 4b. User entered the invalid Email.
1. System will show the error message.
  2. System will ask the user to enter the data again.

4c. User entered the invalid CNIC.

1. System will show the error message.
2. System will ask the user to enter the data again.

4d. User entered the invalid Registration No.

1. System will show the error message.
2. System will ask the user to enter the data again.

4e. User entered the invalid Date of birth.

1. System will show the error message.
2. System will ask the user to enter the data again.

8a. Student entered the registration No. in invalid format.

1. System will show the error message.
2. System will ask the user to enter the data again.

9a. Required fields are empty.

1. System will show the error message.
2. System will ask the user to complete all the required fields.

9b. Sign Up button is not clicked.

1. information will be saved as a draft for later use.

#### **Frequency of Occurrence:**

One time per user.

#### **3.6.2 Use Case UC-2: User Login**

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Student, Teacher, Admin

#### **Preconditions:**

- User is approved by the admin.

- User is identified and authenticated.
- User's record is saved.

**Post Condition:**

- User is logged in into the system.
- User has access to different functionality of the system.

**Main Success Scenario:**

1. User wants to login.
2. User clicked on the login link to access the login page from the header.
3. System open the login page for the user.
4. User enter email address along with the password.
5. User clicked the **Sign In** button.
6. System validates the user email and password.
7. System will redirect the user to next page.

**Alternative Flows:**

\*a. At any time, system fails.

1. User must check the internet connectivity.
  2. Restart the browser and try again.
  3. Try after sometime might be servers are down.
- 3a. Login page is not opened.
1. Refresh the browser.
  2. Reload the page and try again.
- 4a. User entered invalid email and password.
1. System will show the error message.

2. System will ask the user to enter the data again.
- 5a. Required fields are empty.
  1. System will show the error message.
  2. System will ask the user to complete all the required fields.
- 6a. User is not identified or authenticated.
  1. System will show error message.
  2. System will ask the user to register yourself first.

**Frequency of Occurrence:**

Whenever the user wants to login.

### **3.6.3 Use Case UC-3: Teacher's Requests Approval/Disapproval**

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Admin

**Preconditions:**

- Admin is logged in the system..
- Admin is identified and authenticated.

**Post Conditions:**

- Requests are approved / disapproved.
- On approval / disapproval, Email is sent to the teacher.
- Teachers can login to the system.

**Main Success Scenario:**

1. Admin wants to handle the requests of teachers.
2. Admin clicks on the Teacher requests approval link from the header.
3. System open the **teachers request approval** page for the admin.

4. Admin can see the list of all the requests of teachers.
5. Admin clicks on the **Approve** button for approval of request.
6. System send the approval email to that teacher.
7. System show the success message to admin that email is sent.
8. System saves the record of the teacher.
9. System removes the request from the page.
10. Admin disapprove the request of a teacher by clicking on **Disapprove** button.
11. System delete that temporary record of the user.
12. System send an disapproval email to the teacher.
13. System show the success message to admin that email is sent.
14. System removes the request from the page.

#### **Alternative Flows:**

\*a. At any time, system fails.

1. User must check the internet connectivity.
  2. Restart the browser and try again.
  3. Try after sometime might be servers are down.
- 3a. Page is not opened.
1. Refresh the browser.
  2. Reload the page and try again.
- 5a. Approve button is not working properly.

1. Admin must have to refresh the page.
2. Restart the browser and try again.
3. May be some backend issue, resolve that issue.

6-7a. Email is not sent to the teacher.

1. Admin must again approve the request of teacher.
2. May be some backend issue, resolve that issue.

8-9a. Request is not removed from the page and record is unsaved.

1. Admin must again approve the request of teacher.
2. May be some backend issue, resolve that issue.

10a. Disapprove button is not working properly.

1. Admin must have to refresh the page.
2. Restart the browser and try again.
3. May be some backend issue, resolve that issue.

12-13a. Email is not sent to the teacher.

1. Admin must again approve the request of teacher.
2. May be some backend issue, resolve that issue.

14a. Request is not removed from the page.

1. Admin must again approve the request of teacher.
2. May be some backend issue, resolve that issue.

#### **Frequency of Occurrence:**

Whenever the requests appear on the page.

#### **Open Issues:**

What will happen if admin has mistakenly approve or disapprove the request of teacher?

### 3.6.4 Use Case UC-4: Student's Requests Approval/Disapprovals

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Admin

**Preconditions:**

- Admin is logged in the system..
- Admin is identified and authenticated.

**Post Conditions:**

- Requests are approved / disapproved.
- On approval / disapproval, Email is sent to the student.
- Students can login to the system.

**Main Success Scenario:**

1. Admin wants to handle the requests of students.
2. Admin clicks on the student requests approval link from the header.
3. System open the **Students Request Approval** page for the admin.
4. Admin can see the list of all the request of students.
5. Admin clicks on the **Approve** button for approval of request.
6. System send the approval email to that student.
7. System show the success message to admin that email is sent.
8. System saves the record of the student.
9. System removes the request from the page.
10. Admin disapprove the request of a student by clicking on **disapprove** button.
11. System delete that temporary record of the user.
12. System send an disapproval email to the student.

13. System show the success message to admin that email is sent.

14. System removes the request from the page.

### **Alternative Flows:**

\*a. At any time, system fails.

1. User must check the internet connectivity.

2. Restart the browser and try again.

3. Try after sometime might be servers are down.

3a. Page is not opened.

1. Refresh the browser.

2. Reload the page and try again.

5a. Approve button is not working properly.

1. Admin must have to refresh the page.

2. Restart the browser and try again.

3. May be some backend issue, resolve that issue.

6-7a. Email is not sent to the student.

1. Admin must again approve the request of student.

2. May be some backend issue, resolve that issue.

8-9a. Request is not removed from the page and record is unsaved.

1. Admin must again approve the request of student.

2. May be some backend issue, resolve that issue.

10a. Disapprove button is not working properly.

1. Admin must have to refresh the page.

2. Restart the browser and try again.
3. May be some backend issue, resolve that issue.

12-13a. Email is not sent to the teacher.

1. Admin must again approve the request of student.
2. May be some backend issue, resolve that issue.

14a. Request is not removed from the page.

1. Admin must again approve the request of student.
2. May be some backend issue, resolve that issue.

**Frequency of Occurrence:**

Whenever the admin get requests from students.

**Open Issues:**

What will happen if admin has mistakenly approve or disapprove the request of student?

### **3.6.5 Use Case UC-5: Add New Course**

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Admin

**Preconditions:**

- Admin is logged in the system.
- Admin is identified and authenticated.

**Post Condition:**

Course is added successfully.

**Main Success Scenario:**

1. Admin want to add new course.
2. He clicks on the course link from the header.
3. All courses screen will be open.
4. Admin clicks the **Add Course** button to add new course.

5. System open a new page.
6. Admin add all course related information.
7. Admin clicks the **Submit** button.

**Alternative Flows:**

\*a. At any time, System fails.

1. User must check the internet connectivity.
  2. Restart the browser and try again.
  3. Try after sometime might be servers are down.
- 2a. Courses link is not shown on the header.
1. Admin must have to refresh the page.
  2. Restart the browser and try again.
- 3a. All courses page is not opened.
1. Admin must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 4a. Add button not working.
1. Admin must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
  4. May be some backend issue, try to resolve that issue.
- 5a. New page is not appearing.
1. Admin must check the internet connectivity.
  2. Refresh the browser.

3. Try for sometime, may be servers are down.
- 6a. Admin enter invalid data.
  1. System will prompt an error message.
  2. System will ask the user to enter valid data.
- 7a. Required fields are empty.
  1. System will prompt an error message.
  2. System will ask the user to enter all the required information.
- 7b. Admin don't click on **Add** button.
  1. System will save the record as draft for later use.

**Frequency of Occurrence:**

Whenever the admin wants to add new course.

### **3.6.6 Use Case UC-6: Edit Course**

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Admin

**Preconditions:**

- Admin is logged in the system.
- Admin is identified and authenticated.
- Course must be added.

**Post Condition:**

Course is updated successfully.

**Main Success Scenario:**

1. Admin wants to edit particular course.
2. Admin clicks on the courses link from the header.
3. System open a page of all courses.

4. Admin click on the **Edit** button of course which he wants to update.
5. Course Edit screen will appear.
6. Admin update the required information.
7. Admin clicks the **Update Course** button.
8. System update the course.

#### **Alternative Flows:**

\*a. At any time, System fails.

1. User must check the internet connectivity.
  2. Restart the browser and try again.
  3. Try after sometime might be servers are down.
- 2a. Courses link is not shown on the header.
1. Admin must have to refresh the page.
  2. Restart the browser and try again.
- 3a. All courses page is not opened.
1. Admin must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 4a. Edit button not working.
1. Admin must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
  4. May be some backend issue, try to resolve that issue.
- 5a. Edit Course page is not appearing.

1. Admin must check the internet connectivity.
  2. Refresh the browser.
  3. Try for sometime, may be servers are down.
- 6a. Admin enter invalid data.
1. System will prompt an error message.
  2. System will ask the user to enter valid data.
- 7a. Required fields are empty.
1. System will prompt an error message.
  2. System will ask the user to enter all the required information.
- 7b. Admin don't click on **Update Course** button.
1. System will save the record as draft for later use.

**Frequency of Occurrence:**

Whenever the user wants to update the course information.

### **3.6.7 Use Case UC-7: Delete Course**

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Admin

**Preconditions:**

- Admin is logged in the system.
- Admin is identified and authenticated.
- Course must be added.

**Post Condition:**

Course is deleted successfully.

**Main Success Scenario:**

1. Admin wants to delete particular course.
2. Admin clicks on the courses link from the header.

3. System open a page of all courses.
4. Admin click on the **Delete** button of course which he wants to delete.
5. A pop message show "Are you sure you want to delete the course?" .
6. Admin clicks the sure button.
7. System delete that course from the record.

### **Alternative Flows:**

\*a. At any time, System fails.

1. User must check the internet connectivity.
  2. Restart the browser and try again.
  3. Try after sometime might be servers are down.
- 2a. Courses link is not shown on the header.
1. Admin must have to refresh the page.
  2. Restart the browser and try again.
- 3a. All courses page is not opened.
1. Admin must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 4a. Delete button not working.
1. Admin must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
  4. May be some backend issue, try to resolve that issue.
- 5a. Admin clicks the sure button but course is not deleted.

1. May be servers are down. Try again after sometime.
2. Press again the delete button.

**Frequency of Occurrence:**

Whenever the admin wants to delete a course. **Open Issues:**

What will happen if admin has mistakenly deleted the course?

### 3.6.8 Use Case UC-8: View Courses

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Admin, Teacher, Student

**Preconditions:**

- User is logged in the system.
- User is identified and authenticated.
- Courses must be added.

**Post Condition:**

Courses List is viewed successfully.

**Main Success Scenario:**

1. Admin wants to view all courses.
2. Admin clicks on the courses link from the header.
3. System open a page of all courses.

**Alternative Flows:**

\*a. At any time, System fails.

1. User must check the internet connectivity.
  2. Restart the browser and try again.
  3. Try after sometime might be servers are down.
- 2a. Courses link is not shown on the header.
1. Admin must have to refresh the page.

2. Restart the browser and try again.
- 3a. All courses page is not opened.
  1. Admin must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.

**Frequency of Occurrence:**

Whenever the user wants to view all course.

### **3.6.9 Use Case UC-9: Upload Course Assignment**

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Teacher

**Preconditions:**

- Teacher is logged in the system.
- User is identified and authenticated.
- Course is assigned to the teacher.

**Post Condition:**

Course assignment is uploaded successfully.

**Main Success Scenario:**

1. Teacher wants to upload course assignment.
2. Teacher clicks on the courses link from the header.
3. System opens a page of all courses.
4. Teacher clicks on the **View** button of course of which he wants to upload assignment.
5. System opens a course dashboard page.
6. Teacher clicks on the **Assignments** tab.
7. System opens the assignments page.
8. Teacher click on **Upload Assignment** button.

9. System opens upload assignment page.
10. Teacher enters all the data.
11. System validates the data.
12. Teacher press the **Upload Assignment** button.
13. System saves the assignment record.

#### **Alternative Flows:**

\*a. At any time, System fails.

1. User must check the internet connectivity.
  2. Restart the browser and try again.
  3. Try after sometime might be servers are down.
- 2a. Courses link is not shown on the header.
1. User must have to refresh the page.
  2. Restart the browser and try again.
- 3a. All courses page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 4a. View button not working.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
  4. May be some backend issue, try to resolve that issue.
- 5a. Course dasboard page is not opened.

1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 6a. Assignments tab not working.
1. Reload the page and try again.
  2. May be some backend issue, try to resolve that issue.
- 7a. Assignments page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 8a. Upload assignment button not working.
1. Reload the page and try again.
  2. Check the internet connectivity.
  3. May be some backend issue, try to resolve that issue.
- 9a. Upload assignment page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 10-11a. User enter invalid data.
1. System will show error message.
  2. System will ask the user to enter the data again.
- 12a. Required fields are empty.
1. System will show error message.
  2. System will ask the user to enter the required data.

**Frequency of Occurrence:**

Whenever user wants to upload assignments.

### 3.6.10 Use Case UC-10: View Course Assignments

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Teacher, Student

**Preconditions:**

- User is identified and authenticated.
- User is logged in the system.
- Student is enrolled in that course.
- Course is assigned to teacher.

**Post Condition:**

Course Assignment viewed successfully.

**Main Success Scenario:**

1. User wants to view course assignment.
2. User clicks on the courses link from the header.
3. System opens a page of all courses.
4. User clicks on the **View** button of course of which he wants to view assignment.
5. System opens a course dashboard page.
6. User clicks on the **Assignments** tab.
7. System opens the assignments page.

**Alternative Flows:**

\*a. At any time, System fails.

1. User must check the internet connectivity.
  2. Restart the browser and try again.
  3. Try after sometime might be servers are down.
- 2a. Courses link is not shown on the header.

1. User must have to refresh the page.
  2. Restart the browser and try again.
- 3a. All courses page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 4a. View button not working.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
  4. May be some backend issue, try to resolve that issue.
- 5a. Course dasboard page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 6a. Assignments tab not working.
1. Reload the page and try again.
  2. May be some backend issue, try to resolve that issue.
- 7a. Assignments page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.

**Frequency of Occurrence:**

Whenever user wants to view assignments.

### 3.6.11 Use Case UC-11: Download Course Assignment

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Teacher, Student

**Preconditions:**

- User is logged in the system.
- User is identified and authenticated.
- Course is assigned to the teacher.
- Student is enrolled in that course.

**Post Condition:**

Course assignment is downloaded successfully.

**Main Success Scenario:**

1. User wants to download course assignment.
2. User clicks on the courses link from the header.
3. System opens a page of all courses.
4. User clicks on the **View** button of course of which he wants to download assignment.
5. System opens a course dashboard page.
6. User clicks on the **Assignments** tab.
7. System opens the assignments page.
8. User click on **Download Assignment** button.
9. System downloads the assignment file for the user.

**Alternative Flows:**

\*a. At any time, System fails.

1. User must check the internet connectivity.
2. Restart the browser and try again.

3. Try after sometime might be servers are down.
- 2a. Courses link is not shown on the header.
  1. User must have to refresh the page.
  2. Restart the browser and try again.
- 3a. All courses page is not opened.
  1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 4a. View button not working.
  1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
  4. May be some backend issue, try to resolve that issue.
- 5a. Course dasboard page is not opened.
  1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 6a. Assignments tab not working.
  1. Reload the page and try again.
  2. May be some backend issue, try to resolve that issue.
- 7a. Assignments page is not opened.
  1. User must check the internet connectivity.
  2. Refresh the browser.

3. Reload the page and try again.
- 8a. Download assignment button not working.
1. Reload the page and try again.
  2. Check the internet connectivity.
  3. May be some backend issue, try to resolve that issue.

**Frequency of Occurrence:**

Whenever user wants to download assignments.

### **3.6.12 Use Case UC-12: Delete Course Assignment**

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Teacher

**Preconditions:**

- Teacher is logged in the system.
- User is identified and authenticated.
- Course is assigned to the teacher.

**Post Condition:**

Course assignment is deleted successfully.

**Main Success Scenario:**

1. Teacher wants to delete course assignment.
2. Teacher clicks on the courses link from the header.
3. System opens a page of all courses.
4. Teacher clicks on the **View** button of course of which he wants to upload assignment.
5. System opens a course dashboard page.
6. Teacher clicks on the **Assignments** tab.
7. System opens the assignments page.
8. Teacher click on **Delete Assignment** button.

9. A pop message show "Are you sure you want to delete the assignment?".
10. Teacher clicks the sure button.
11. System delete that assignment from the record.

**Alternative Flows:**

\*a. At any time, System fails.

1. User must check the internet connectivity.
  2. Restart the browser and try again.
  3. Try after sometime might be servers are down.
- 2a. Courses link is not shown on the header.
1. User must have to refresh the page.
  2. Restart the browser and try again.
- 3a. All courses page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 4a. View button not working.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
  4. May be some backend issue, try to resolve that issue.

5a. Course dasboard page is not opened.

1. User must check the internet connectivity.
2. Refresh the browser.

3. Reload the page and try again.
- 6a. Assignments tab not working.
  1. Reload the page and try again.
  2. May be some backend issue, try to resolve that issue.
- 7a. Assignments page is not opened.
  1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 8a. Delete assignment button not working.
  1. Reload the page and try again.
  2. May be some backend issue, try to resolve that issue.
- 10-11a. Teacher clicks the sure button but assignment is not deleted.
  1. May be servers are down. Try again after sometime.
  2. Press again the delete button.

**Frequency of Occurrence:**

Whenever user wants to delete assignment.

### **3.6.13 Use Case UC-13: Add Course Announcement**

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Teacher

**Preconditions:**

- Teacher is logged in the system.
- Teacher is identified and authenticated.
- Course is assigned to the teacher.

**Post Condition:**

Course Announcement is added successfully.

**Main Success Scenario:**

1. Teacher wants to add course related announcement.
2. Teacher clicks on the courses link from the header.
3. System opens a page of all courses.
4. Teacher clicks on the **View** button of course of which he wants to add announcement.
5. System opens a course dashboard page.
6. Teacher clicks on the **Announcement** tab.
7. System opens the announcement page.
8. Teacher click on **Add Announcement** button.
9. System opens add announcement page.
10. Teacher enters all the data.
11. System validates the data.
12. Teacher press the **Add Announcement** button.
13. System saves the announcement record.

**Alternative Flows:**

\*a. At any time, System fails.

1. User must check the internet connectivity.
  2. Restart the browser and try again.
  3. Try after sometime might be servers are down.
- 2a. Courses link is not shown on the header.
1. User must have to refresh the page.

2. Restart the browser and try again.
- 3a. All courses page is not opened.
  1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 4a. View button not working.
  1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
  4. May be some backend issue, try to resolve that issue.
- 5a. Course dasboard page is not opened.
  1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 6a. Announcement tab not working.
  1. Reload the page and try again.
  2. May be some backend issue, try to resolve that issue.
- 7a. Announcement page is not opened.
  1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 8a. Add announcement button not working.
  1. Reload the page and try again.

2. May be some backend issue, try to resolve that issue.
- 9a. Add announcement page is not opened.
  1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.

**Frequency of Occurrence:**

Whenever user wants to add announcement.

### **3.6.14 Use Case UC-14 :Edit Course Announcement**

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Teacher

**Preconditions:**

- Teacher is identified and authenticated.
- Teacher is logged in the system.
- Course is assigned to the teacher.

**Post Condition:**

Course Announcement is updated successfully.

**Main Success Scenario:**

1. Teacher wants to edit course related announcement.
2. Teacher clicks on the courses link from the header.
3. System opens a page of all courses.
4. Teacher clicks on the **View** button of course of which he wants to edit announcement.
5. System opens a course dashboard page.
6. Teacher clicks on the **Announcement** tab.
7. System opens the announcement page.

8. Teacher click on **Edit Announcement** button of the announcement.
9. System opens edit announcement page.
10. Teacher edit the required data.
11. System validates the data.
12. Teacher press the **Update Announcement** button.
13. System updates the announcement record.

#### **Alternative Flows:**

\*a. At any time, System fails.

1. User must check the internet connectivity.
  2. Restart the browser and try again.
  3. Try after sometime might be servers are down.
- 2a. Courses link is not shown on the header.
1. User must have to refresh the page.
  2. Restart the browser and try again.
- 3a. All courses page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 4a. View button not working.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
  4. May be some backend issue, try to resolve that issue.

5a. Course dashboard page is not opened.

1. User must check the internet connectivity.
2. Refresh the browser.
3. Reload the page and try again.

6a. Announcement tab not working.

1. Reload the page and try again.
2. May be some backend issue, try to resolve that issue.

7a. Announcement page is not opened.

1. User must check the internet connectivity.
2. Refresh the browser.
3. Reload the page and try again.

8a. Edit announcement button not working.

1. Reload the page and try again.
2. May be some backend issue, try to resolve that issue.

9a. Update announcement page is not opened.

1. User must check the internet connectivity.
2. Refresh the browser.
3. Reload the page and try again.

10a. Teacher enters the invalid data.

1. System prompts the error message.
2. System will ask the user to enter the data again.

12a. Required fields are empty.

1. System prompts the error message.
2. System will ask the user to enter the data in the empty fields.

#### **Frequency of Occurrence:**

Whenever user wants to update announcement.

### 3.6.15 Use Case UC-15: Delete Course Announcement

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Teacher

**Preconditions:**

- User is identified and authenticated.
- User is logged in the system.
- Course is assigned to the teacher.

**Post Condition:**

Course announcement is deleted successfully.

**Main Success Scenario:**

1. Teacher wants to delete course announcement.
2. Teacher clicks on the courses link from the header.
3. System opens a page of all courses.
4. Teacher clicks on the **View** button of course of which he wants to delete announcement.
5. System opens a course dashboard page.
6. Teacher clicks on the **Announcements** tab.
7. System opens the announcements page.
8. Teacher click on **Delete Announcement** button.
9. A pop message show "Are you sure you want to delete the announcement?" .
10. Teacher clicks the sure button.
11. System delete that announcement from the record.

**Alternative Flows:**

\*a. At any time, System fails.

1. User must check the internet connectivity.

2. Restart the browser and try again.
  3. Try after sometime might be servers are down.
- 2a. Courses link is not shown on the header.
1. User must have to refresh the page.
  2. Restart the browser and try again.
- 3a. All courses page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 4a. View button not working.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
  4. May be some backend issue, try to resolve that issue.
- 5a. Course dasboard page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 6a. Annoucement tab not working.
1. Reload the page and try again.
  2. May be some backend issue, try to resolve that issue.
- 7a. Annoucement page is not opened.
1. User must check the internet connectivity.

2. Refresh the browser.
  3. Reload the page and try again.
- 8a. Delete announcement button not working.
1. Reload the page and try again.
  2. May be some backend issue, try to resolve that issue.
- 10-11a. Teacher clicks the sure button but announcement is not deleted.
1. May be servers are down. Try again after sometime.
  2. Press again the delete button.

**Frequency of Occurrence:**

Whenever user wants to delete announcement.

**Open Issues:**

What will happen if teacher have mistakenly delete the announcement?

### **3.6.16 Use Case UC-16: Student Assignment Submission**

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Student

**Preconditions:**

- User is identified and authenticated.
- User is logged in the system.
- Student is enrolled in that course.

**Post Condition:**

Assignment is submitted successfully.

**Main Success Scenario:**

1. Student wants to submit course assignment.
2. Student clicks on the courses link from the header.
3. System opens a page of all courses.

4. Student clicks on the **View** button of course of which he wants to submit assignment.
5. System opens a course dashboard page.
6. Student clicks on the **Assignment** tab.
7. System opens the assignment page.
8. Student click on **Submit Assignment** button.
9. System open a new page.
10. Student upload assignment file which he/she wants to submit.
11. Student clicks on the **Submit** button.
12. System save the assignment of student in the record.

**Alternative Flows:**

\*a. At any time, System fails.

1. User must check the internet connectivity.
  2. Restart the browser and try again.
  3. Try after sometime might be servers are down.
- 2a. Courses link is not shown on the header.
1. User must have to refresh the page.
  2. Restart the browser and try again.
- 3a. All courses page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 4a. View button not working.
1. User must check the internet connectivity.

2. Refresh the browser.
  3. Reload the page and try again.
  4. May be some backend issue, try to resolve that issue.
- 5a. Course dasboard page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 6a. Assignment tab not working.
1. Reload the page and try again.
  2. May be some backend issue, try to resolve that issue.
- 7a. Assignment page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 8a. Submit assignment button not working.
1. Reload the page and try again.
  2. May be some backend issue, try to resolve that issue.
- 9a. Submit assignment page is not opened.
1. User must check the internet connectivity.
  2. Reload the page and try again.
  3. May be some backend issue, try to resolve that issue.
- 11a. Assignment file is not attached.
1. System will show error message.
  2. System will ask the user to attach the file first.

**Frequency of Occurrence:**

Whenever user wants to submit assignment.

### 3.6.17 Use Case UC-17: Upload Course Notes

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Teacher

#### Preconditions:

- Teacher is logged in the system.
- User is identified and authenticated.
- Course is assigned to the teacher.

#### Post Condition:

Course notes uploaded successfully.

#### Main Success Scenario:

1. Teacher wants to upload course notes.
2. Teacher clicks on the courses link from the header.
3. System opens a page of all courses.
4. Teacher clicks on the **View** button of course of which he wants to upload assignment.
5. System opens a course dashboard page.
6. Teacher clicks on the **Notes** tab.
7. System opens the Notes page.
8. Teacher click on **Add Notes** button.
9. System opens upload notes page.
10. Teacher enters all the data.
11. System validates the data.
12. Teacher press the **Submit** button.
13. System saves the notes.

#### Alternative Flows:

- \*a. At any time, System fails.

1. User must check the internet connectivity.
  2. Restart the browser and try again.
  3. Try after sometime might be servers are down.
- 2a. Courses link is not shown on the header.
1. User must have to refresh the page.
  2. Restart the browser and try again.
- 3a. All courses page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 4a. View button not working.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
  4. May be some backend issue, try to resolve that issue.
- 5a. Course dasboard page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 6a. Notes tab not working.
1. Reload the page and try again.
  2. May be some backend issue, try to resolve that issue.
- 7a. Notes page is not opened.

1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 8a. Upload notes button not working.
1. Reload the page and try again.
  2. Check the internet connectivity.
  3. May be some backend issue, try to resolve that issue.
- 9a. Upload notes page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 12a. Required fields are empty.
1. System will show error message.
  2. System will ask the user to enter the required data.
- Frequency of Occurrence:**  
Whenever user wants to upload course notes.
- 3.6.18 Use Case UC-18: View Course Notes**
- Stakeholders:** University, Educational Institutes
- Primary Actors:** Teacher, Student
- Preconditions:**
- User is identified and authenticated.
  - User is logged in the system.
  - Student is enrolled in that course.
  - Course is assigned to teacher.

- Course Notes are added.

**Post Condition:**

Course notes viewed successfully.

**Main Success Scenario:**

1. User wants to view course notes.
2. User clicks on the courses link from the header.
3. System opens a page of all courses.
4. User clicks on the **View** button of course of which he wants to view notes.
5. System opens a course dashboard page.
6. User clicks on the **Notes** tab.
7. System opens the notes page.

**Alternative Flows:**

\*a. At any time, System fails.

1. User must check the internet connectivity.
  2. Restart the browser and try again.
  3. Try after sometime might be servers are down.
- 2a. Courses link is not shown on the header.
1. User must have to refresh the page.
  2. Restart the browser and try again.
- 3a. All courses page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 4a. View button not working.

1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
  4. May be some backend issue, try to resolve that issue.
- 5a. Course dashboard page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 6a. Notes tab not working.
1. Reload the page and try again.
  2. May be some backend issue, try to resolve that issue.
- 7a. Notes page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.

**Frequency of Occurrence:**

Whenever user wants to view course notes.

### **3.6.19 Use Case UC-19: Download Course notes**

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Teacher, Student

**Preconditions:**

- User is logged in the system.
- User is identified and authenticated.
- Course is assigned to the teacher.

- Student is enrolled in that course.
- Course notes are added.

**Post Condition:**

Course notes downloaded successfully.

**Main Success Scenario:**

1. User wants to download course notes.
2. User clicks on the courses link from the header.
3. System opens a page of all courses.
4. User clicks on the **View** button of course of which he wants to download notes.
5. System opens a course dashboard page.
6. User clicks on the **Notes** tab.
7. System opens the notes page.
8. User click on **Download Notes** button.
9. System downloads the notes file for the user.

**Alternative Flows:**

\*a. At any time, System fails.

1. User must check the internet connectivity.
  2. Restart the browser and try again.
  3. Try after sometime might be servers are down.
- 2a. Courses link is not shown on the header.
1. User must have to refresh the page.
  2. Restart the browser and try again.
- 3a. All courses page is not opened.

1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 4a. View button not working.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
  4. May be some backend issue, try to resolve that issue.
- 5a. Course dashboard page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 6a. Notes tab not working.
1. Reload the page and try again.
  2. May be some backend issue, try to resolve that issue.
- 7a. Notes page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 8a. Download notes button not working.
1. Reload the page and try again.
  2. Check the internet connectivity.
  3. May be some backend issue, try to resolve that issue.

**Frequency of Occurrence:**

Whenever user wants to download notes.

### 3.6.20 Use Case UC-20: Delete Course Notes

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Teacher

**Preconditions:**

- Teacher is logged in the system.
- User is identified and authenticated.
- Course is assigned to the teacher.
- Course notes are added.

**Post Condition:**

Course notes deleted successfully.

**Main Success Scenario:**

1. Teacher wants to delete course notes.
2. Teacher clicks on the courses link from the header.
3. System opens a page of all courses.
4. Teacher clicks on the **View** button of course of which he wants to delete notes.
5. System opens a course dashboard page.
6. Teacher clicks on the **Notes** tab.
7. System opens the notes page.
8. Teacher click on **Delete Notes** button.
9. A pop message show "Are you sure you want to delete the notes?" .
10. Teacher clicks the sure button.
11. System delete that notes from the record.

**Alternative Flows:**

- \*a. At any time, System fails.

1. User must check the internet connectivity.
  2. Restart the browser and try again.
  3. Try after sometime might be servers are down.
- 2a. Courses link is not shown on the header.
1. User must have to refresh the page.
  2. Restart the browser and try again.
- 3a. All courses page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 4a. View button not working.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
  4. May be some backend issue, try to resolve that issue.
- 5a. Course dasboard page is not opened.
1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 6a. Notes tab not working.
1. Reload the page and try again.
  2. May be some backend issue, try to resolve that issue.
- 7a. Notes page is not opened.

1. User must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 8a. Delete notes button not working.
1. Reload the page and try again.
  2. May be some backend issue, try to resolve that issue.
- 10-11a. Teacher clicks the sure button but notes not deleted.
1. May be servers are down. Try again after sometime.
  2. Press again the delete button.

**Frequency of Occurrence:**

Whenever user wants to delete notes.

**Open Issues:**

What will happen if teacher has mistakenly deleted the course notes?

### **3.6.21 Use Case UC-21: Student's Course Enrolment**

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Student

**Preconditions:**

- User is identified and authenticated.
- User is logged in the system.
- Course must be added.

**Post Condition:**

Course enrollment request sent to the teacher successfully.

**Main Success Scenario:**

1. Student wants to enroll in a course.
2. Student clicks on the courses link from the header.
3. System open a page of all courses.

4. Students clicks on the **Enroll** button of the course.
5. System change the status of enrollment from Not Enrolled to pending.
6. System send the enrollment request to the course teacher.

**Alternative Flows:**

\*a. At any time, System fails.

1. User must check the internet connectivity.
  2. Restart the browser and try again.
  3. Try after sometime might be servers are down.
- 2a. Courses link is not shown on the header.
1. Student must have to refresh the page.
  2. Restart the browser and try again.
- 3a. All courses page is not opened.
1. Student must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.
- 4a. Enrollment link is not working.
1. Student must check the internet connectivity.
  2. Refresh the browser.
  3. Reload the page and try again.

5a. Enrollment status is not changed.

1. Refresh the browser.
2. Reload the page and try again.

**Frequency of Occurrence:**

Whenever the user wants to enroll in a course.

### 3.6.22 Use Case UC-22: Course Enrolment Requests Handling

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Teacher

**Preconditions:**

- Teacher is identified and authenticated.
- Teacher is logged in the system.
- Course is added.
- Teacher is assigned a course.

**Post Conditions:**

- Course enrollment requests are approved / disapproved.
- On approval / disapproval, Email is sent to the student.
- Students can view course details.

**Main Success Scenario:**

1. Teacher wants to handle the requests of student's course enrollment.
2. Teacher clicks on courses link from the header.
3. System opens a page of course assigned to teacher.
4. Teacher clicks on the enrollment requests button of the course of which he wants to approve/disapprove requests.
5. System open the **Course Enrollment Requests** page for the teacher.
6. Teacher can see the list of all the request of students.
7. Teacher clicks on the **Approve** button for approval of request.
8. System send the approval email to that student.
9. System show the success message to admin that email is sent.
10. System now allow the student to view all course details.

11. System removes the request from the page.
12. Teacher disapprove the request of a student by clicking on **disapprove** button.
13. System delete that temporary record of the user.
14. System send an disapproval email to the student.
15. System show the success message to admin that email is sent.
16. System removes the request from the page.

**Alternative Flows:**

\*a. At any time, system fails.

1. User must check the internet connectivity.
  2. Restart the browser and try again.
  3. Try after sometime might be servers are down.
- 3a. Assigned Course page is not opened.
1. Refresh the browser.
  2. Reload the page and try again.
- 4a. Enrollment request link is not working.
1. Teacher must have to refresh the page.
  2. Restart the browser and try again.
  3. May be some backend issue, resolve that issue.
- 5a. Course Enrollment Requests page is not opened.
1. Refresh the browser.
  2. Reload the page and try again.
- 7a. Approve button is not working properly.

1. User must have to refresh the page.
  2. Restart the browser and try again.
  3. May be some backend issue, resolve that issue.
- 8-9a. Email is not sent to the student.
1. User must again approve the request of student.
  2. May be some backend issue, resolve that issue.
- 11a. Request is not removed from the page.
1. User must again approve the request of student.
  2. May be some backend issue, resolve that issue.
- 12a. Disapprove button is not working properly.
1. User must have to refresh the page.
  2. Restart the browser and try again.
  3. May be some backend issue, resolve that issue.
- 14a. Email is not sent to the teacher.
1. User must again approve the request of student.
  2. May be some backend issue, resolve that issue.
- 16a. Request is not removed from the page.
1. Admin must again approve the request of student.
  2. May be some backend issue, resolve that issue.

**Frequency of Occurrence:**

Whenever the teacher get course enrollment requests from students.

**Open Issues:**

What will happen if teacher has mistakenly approve or disapprove the course enrollment request of student?

### 3.6.23 Use Case UC-23: Assign Courses

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Admin

**Preconditions:**

- User is logged in the system.
- User is identified and authenticated.
- Courses must be added.

**Post Condition:**

Course is assigned successfully.

**Main Success Scenario:**

1. Admin wants to assign courses to teacher.
2. Admin clicks on the courses link from the header.
3. System open a page of all courses.
4. Admin clicks the **View** button.
5. System open the course dashboard.
6. Admin clicks on the **Assign Course** button.
7. System open the assign course page for the user.
8. Admin select the teacher to which he wants to assign course.
9. Admin clicks the **Submit** button.
10. System saves the record i.e assign course to the teacher.

**Alternative Flows:**

\*a. At any time, System fails.

1. User must check the internet connectivity.
2. Restart the browser and try again.
3. Try after sometime might be servers are down.

2a. Courses link is not shown on the header.

1. Admin must have to refresh the page.
2. Restart the browser and try again.

3a. All courses page is not opened.

1. Admin must check the internet connectivity.
2. Refresh the browser.
3. Reload the page and try again.

4a. View button is not working.

1. Reload the page and try again.
2. May be some backend issue. Admin must resolve it.

5a. Course dashboard page is not opened.

1. Admin must check the internet connectivity.
2. Refresh the browser.
3. Reload the page and try again.

6a. Assign course button is not working.

1. Reload the page and try again.
2. May be some backend issue. Admin must resolve it.

7a. Assign Course page is not opened.

1. Admin must check the internet connectivity.
2. Refresh the browser.
3. Reload the page and try again.

9a. User didn't select any teacher.

1. System show error message.
2. System will ask the user to select atleast one teacher.

#### **Frequency of Occurrence:**

Whenever the user wants to assign course.

### 3.6.24 Use Case UC-24: View Students Assignments

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Teacher

**Preconditions:**

- Teacher is identified and authenticated.
- Teacher is logged in the system.
- Course is added.
- Teacher is assigned a course.
- Course assignments uploaded.

**Post Conditions:**

Students assignments viewed successfully.

**Main Success Scenario:**

1. Teacher wants to view students assignments.
2. Teacher clicks on courses link from the header.
3. System opens a page of all courses.
4. Teacher clicks on the course which he is assigned and click on the button of submitted assignments.
5. System open the **Students Assignments** page for the teacher.
6. Teacher can see the list of all the assignments of students.

**Alternative Flows:**

\*a. At any time, system fails.

1. User must check the internet connectivity.
  2. Restart the browser and try again.
  3. Try after sometime might be servers are down.
- 3a. Assigned Course page is not opened.

1. Refresh the browser.
  2. Reload the page and try again.
- 4a. Students Assignments button is not working.
1. Teacher must have to refresh the page.
  2. Restart the browser and try again.
  3. May be some backend issue, resolve that issue.
- 5a. Students Assignments page is not opened.
1. Refresh the browser.
  2. Reload the page and try again.

**Frequency of Occurrence:**

Whenever the teacher wants to view the students assignment.

**3.6.25 Use Case UC-25: Download Student's Assignments**

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Teacher

**Preconditions:**

- Teacher is identified and authenticated.
- Teacher is logged in the system.
- Course is added.
- Teacher is assigned a course.
- Students have submitted the assignments.

**Post Conditions:**

Teacher downloaded the assignments successfully. **Main Success Scenario:**

1. Teacher wants to download the students assignments.
2. Teacher clicks on assigned courses link from the header.
3. System opens a page of all courses assigned to teacher.

4. Teacher clicks on the **Students Assignments** link.
5. System open the **Students Assignments** page for the teacher.
6. Teacher can see the list of all the students assignments.
7. Teacher clicks on the **Download** button.
8. System download the Assignments files for the user.

**Alternative Flows:**

\*a. At any time, system fails.

1. User must check the internet connectivity.
  2. Restart the browser and try again.
  3. Try after sometime might be servers are down.
- 3a. Assigned Course page is not opened.
1. Refresh the browser.
  2. Reload the page and try again.
- 4a. Students Assignments link is not working.
1. Teacher must have to refresh the page.
  2. Restart the browser and try again.
  3. May be some backend issue, resolve that issue.
- 5a. Students Assignments page is not opened.
1. Refresh the browser.
  2. Reload the page and try again.
- 7a. Download button is not working properly.
1. User must have to refresh the page.
  2. Restart the browser and try again.

3. May be some backend issue, resolve that issue.
- 8a. Assignments files not downloaded.
1. User must have to refresh the page.
  2. Restart the browser and try again.
  3. May be some backend issue, resolve that issue.

**Frequency of Occurrence:**

Whenever the teacher wants to download the Students Assignments.

## 3.7 Use Cases (Offline Player)

### 3.7.1 Use Case UC1: User Authentication

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Student, Teacher

**Post Condition:**

User data successfully sent to server and token successfully saved in local database.

**Main Success Scenario:**

1. User has to authenticate to use other features.
2. User clicks on the authenticate button on dashboard.
3. Authentication page will be opened.
4. User will enter username and password.
5. User clicks the **Login** button.
6. System then send data to the web api to authenticate user and show proper message based on data.

**Alternative Flow:**

a\*. At any time system fails.

1. User must check the internet connectivity.
  2. Try after sometime might be servers are down.
- 3a. Authentication page is not opened.

1. Make sure the internet connectivity.
  2. try again.
- 4a. User entered the invalid username.
1. System will show the error message.
  2. System will ask the user to enter the data again.
- 4b. User entered the invalid password.
1. System will show the error message.
  2. System will ask the user to enter the data again.

### **3.7.2 Use Case UC2: View Lecture Playlist(Online)**

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Student, Teacher

**Post Condition:**

All the downloaded and recently fetched lectures from website are shown in lecture playlist.

**Main Success Scenario:**

1. User must have the authentication token in local database which is not expired.
2. User must have the stable internet connection.
3. If token is expired then fresh token can be fetched from website.
4. User will open lecture playlist page from navbar.
5. User clicks the **Fetch Lectures** button on lecture playlist page.
6. System then send request to website with token.
7. All the downloaded lectures will be same and newly fetched lectures will be shown on page.

**Alternative Flow:**

- a\*. At any time system fails.

1. Start the application again.
  2. User must check the internet connectivity.
  3. Try after sometime might be servers are down.
- 3a. Lecture playlist is not opened.
1. Make sure the internet connectivity and token is present in local database which is not expired.
  2. try again.

### **3.7.3 Use Case UC3: View Lecture Playlist(Offline)**

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Student, Teacher

**Post Condition:**

All the downloaded and previously fetched lectures from website are shown in lecture playlist.

**Main Success Scenario:**

1. User must have the authentication token in local database which is not expired.
2. If token is expired then fresh token can be fetched from website but it requires internet connectivity.
3. User will open lecture playlist page from navbar.
4. All the downloaded and previously fetched lectures will be shown on page.

**Alternative Flow:**

a\*. At any time system fails.

1. Start the application again.
- 3a. Lecture playlist is not opened.
1. Make sure the token is present in local database which is not expired.
  2. try again.

### 3.7.4 Use Case UC4: Play Lecture(Online)

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Student, Teacher

**Post Condition:**

All the downloaded lectures can be played in lecture player and recently fetched lectures can be downloaded.

**Main Success Scenario:**

1. User must have the stable internet connection.
2. User must have the authentication token in local database which is not expired.
3. If token is expired then fresh token can be fetched from website.
4. User will open lecture playlist page from navbar.
5. All the downloaded and newly fetched lectures will be shown on page.
6. Then user can download any lecture by clicking on checkbox of that lecture.
7. When checkbox is ticked it means lecture is downloaded user can play that lecture by clicking on **Play** button.
8. It will open the lecture player where user can play, pause and start over that lecture.

**Alternative Flow:**

a\*. At any time system fails.

1. check the internet connectivity.
  2. Start the application again.
- 3a. Lecture player is not opened.
1. Make sure the lecture is downloaded and checkbox is ticked.
  2. Make sure the token is present in local database which is not expired.
  3. try again.

### 3.7.5 Use Case UC5: Play Lecture(Offline)

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Student, Teacher

**Post Condition:**

All the downloaded lectures can be played in lecture player.

**Main Success Scenario:**

1. User must have the authentication token in local database which is not expired.
2. If token is expired then fresh token can be fetched from website but it requires internet connectivity.
3. User will open lecture playlist page from navbar.
4. All the downloaded and previously fetched lectures will be shown on page.
5. Then user can play any lecture which is downloaded whose checkbox is ticked.
6. When checkbox is ticked it means lecture is downloaded user can play that lecture by clicking on **Play** button.
7. It will open the lecture player where user can play, pause and start over that lecture.

**Alternative Flow:**

a\*. At any time system fails.

1. Start the application again.
- 3a. Lecture player is not opened.
1. Make sure the lecture you are trying to play is downloaded.
  2. Make sure the token is present in local database which is not expired.
  3. try again.

### 3.7.6 Use Case UC6: View About page

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Student, Teacher

**Post Condition:**

About page of dbm offline player is shown successfully.

**Main Success Scenario:**

1. User will open the About page from navbar.
2. User will click **About** button on navbar.
3. About page will be opened.
4. Now user can read about our terms and condition and how to use Offline player.

**Alternative Flow:**

a\*. At any time system fails.

1. Start the application again.
- 3a. About page is not opened.
  1. try again.

### 3.7.7 Use Case UC7: View Contact us page

**Stakeholders:** University, Educational Institutes

**Primary Actors:** Student, Teacher

**Post Condition:**

Contact us page of dbm offline player is shown successfully.

**Main Success Scenario:**

1. User will open the Contact us page from navbar.
2. User will click **Contact us** button on navbar.
3. Contact us page will be opened.
4. Now user can read contact info in case of any problem user can contact us by that information.

**Alternative Flow:**

a\*. At any time system fails.

1. Start the application again.
- 3a. Contact us page is not opened.
  1. try again.

## 3.8 Architecture Diagram

Interaction among different modules of the system is not simple but can be simplified and easy to understand. The set of rules and concepts concerned by the overall project are visually explained by the Architecture Diagram shown below. It consists of follow modules:

- Stereo Vision Cameras
- Marker Hardware
- Audio Hardware
- Controller Application
- Player Application
- Learning Management System

## 3.9 Modules Methodology Description

System consists of five major modules. General work flow of each module is detailed using visuals and diagrams.

### 3.9.1 Board Marker

Board marker transfer the position data of currently written word on the platform i.e. Whiteboard. It is subdivided in two sub-modules

### 3.9.2 Audio Hardware

Wireless voice transmission is done by this module. Voice data is accepted at transmitter module. This data is converted into digital audio. Digital audio is then transmitted to receiver at another end. Receiver module decode the digital

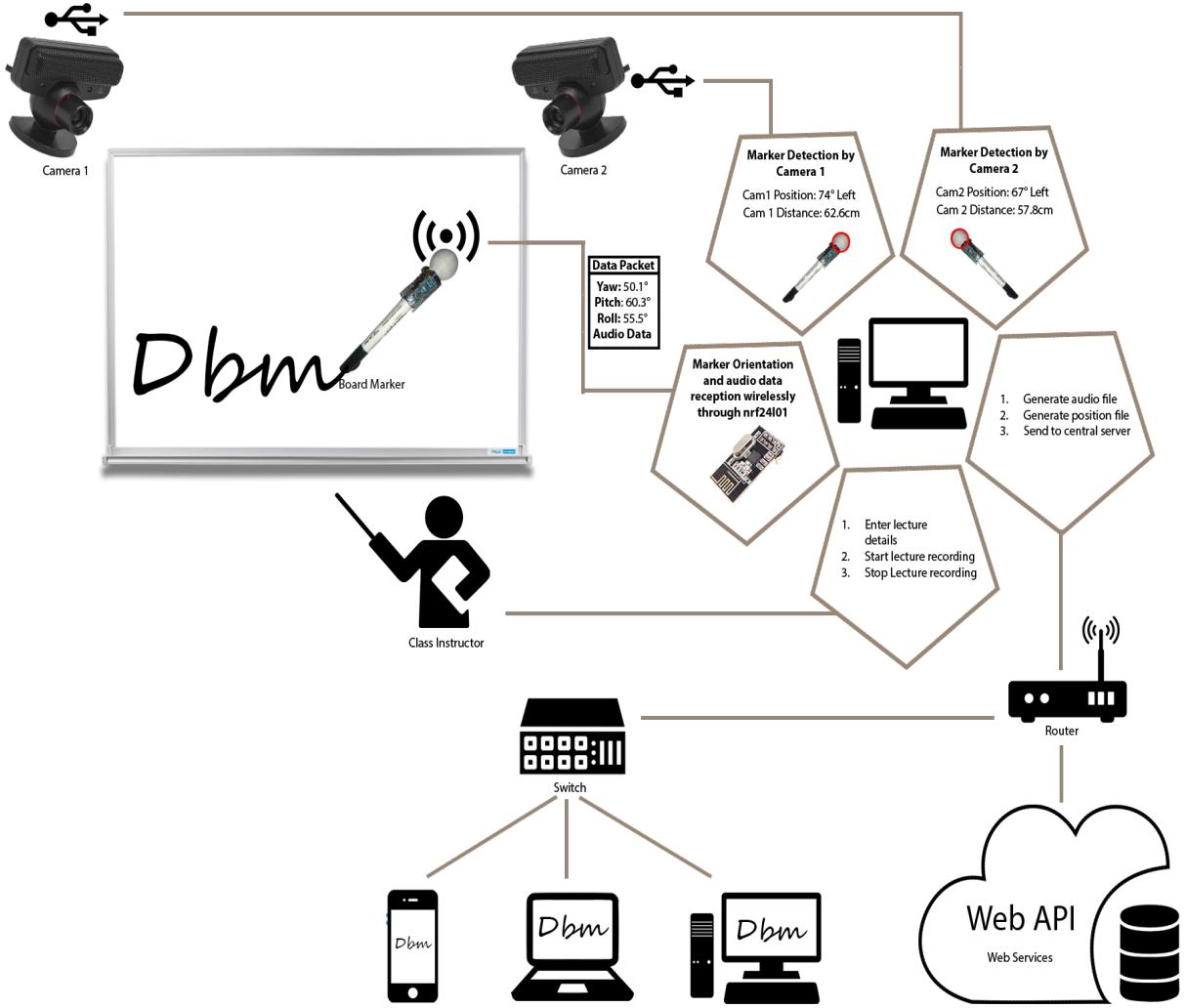


FIGURE 3.7: Architecture Diagram of Digital Board Marker

audio into analogue audio. Receiver module is attached to computer through Line-in[2] on which controller application is being executed. Controller application encode the analogue audio into lightweight ogg(file extension) file format. After the audio file generation is successful, audio file is then embedded into lecture file and uploaded to central server.

### 3.9.2.1 Stereo Vision Cameras

At least two high framerate cameras get the video of back ball and send it to controller application. Stereo vision is important for accurately extracting marker position by placing these cameras at such position so that different angles make same alignment to the writing platform irrespective to size. Square and rectangular boards can be mapped to same parent algorithm with simple to calibrate camera placement guide.

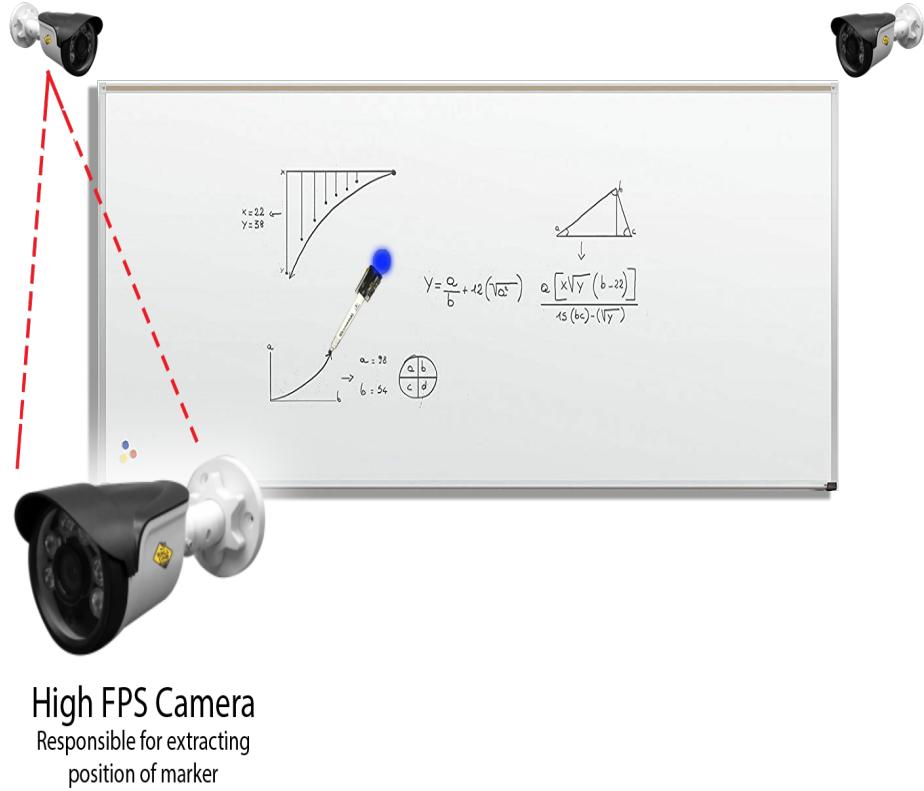


FIGURE 3.8: High frame rate camera placement

### 3.9.3 Controller Application

Controller application plays several roles in the project. First of all, it is responsible for application of computer vision algorithms to detect marker and extract the position data. At least two camera perspectives are considered for position extraction. Manual calibration system aids in the setup and view port positioning of multiple cameras. Marker position data and audio data have to be synchronously written in the final output file.

Second, it is also responsible for decoding the orientation data. Orientation data is sent using encoded packet by Marker Hardware and received by the controller application. Orientation is extracted using quaternions. Euler angles then extracted using converted quaternion to avoid gimble lock. Position of the marker is extracted.

Third, it can play the lecture file before uploading the lecture. Lecture can be paused, resumed and replayed. also, the lecture can be annotated by the instructor i.e. topic and sub-topic markings. Audio and video quality can be controlled over performance of lecture play media.

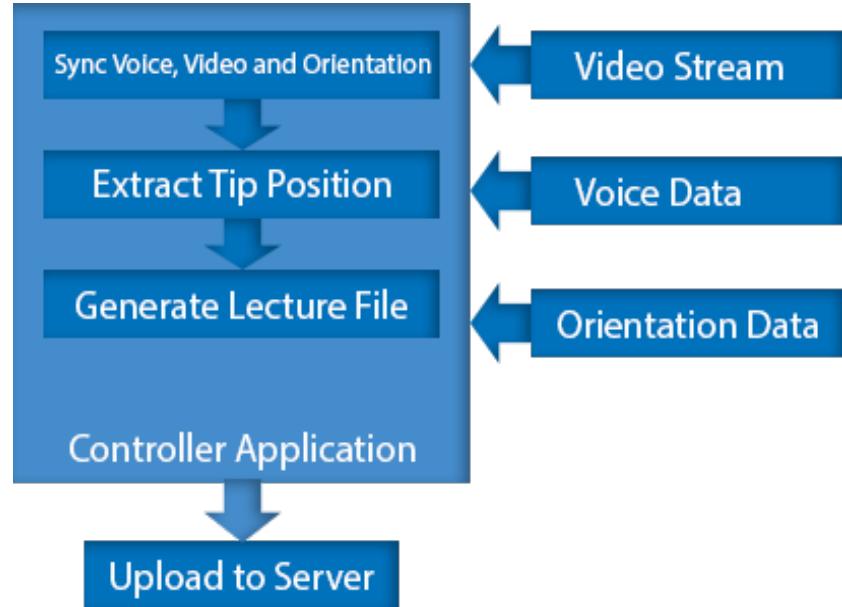


FIGURE 3.9: Controller Application General Methodology

### 3.9.3.1 Marker Hardware

To extract marker orientation, Marker Hardware is connected to controller application.

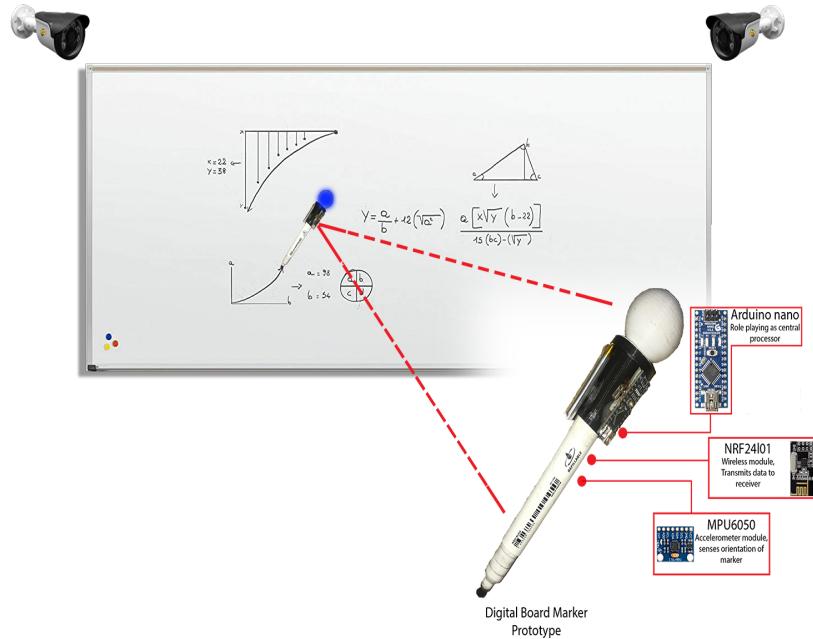


FIGURE 3.10: Marker Hardware working methodology

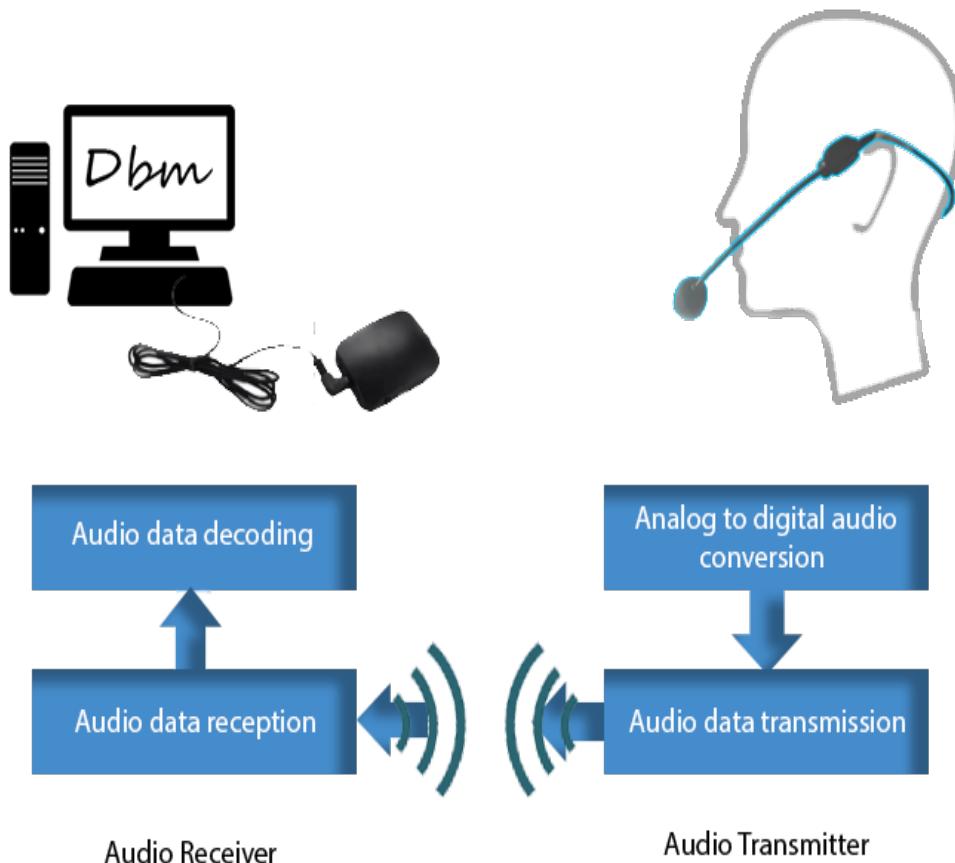


FIGURE 3.11: Audio Hardware General Methodology

### 3.9.4 Player Application

Just like media player, the player application plays the lecture. Common end user of Player Application is student. Player application has two version based on data availability.

### 3.9.5 Offline Player

Lecture file can be played on the computer via Offline Player with no interaction with internet at all. Typical end user is student. A student can rewind, play, pause, stop and resume while watching the lecture. As the lecture is being played by generated lecture file So, there is no compromise on quality.

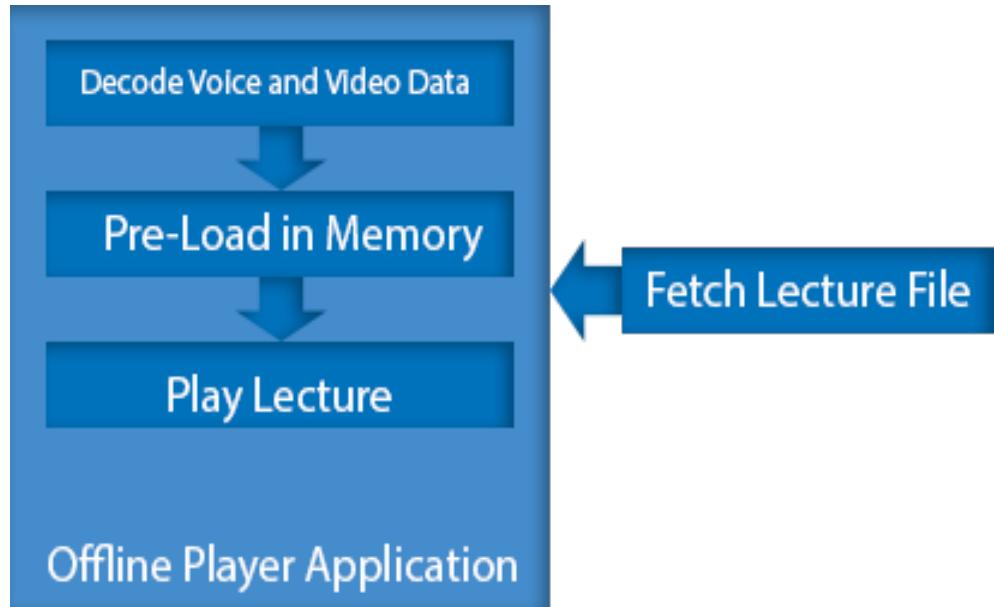


FIGURE 3.12: Offline Player Application General Methodology

### 3.9.6 WebGL Player

It is an online in-browser player that streams the lecture right in the webpage. Similar to video media player, flow of video can be controlled by user. This online player first loads its necessary packages and plugins before it could be fully functional. While browsing the lecture hierarchy, any lecture can be played by user and annotated by an instructor.

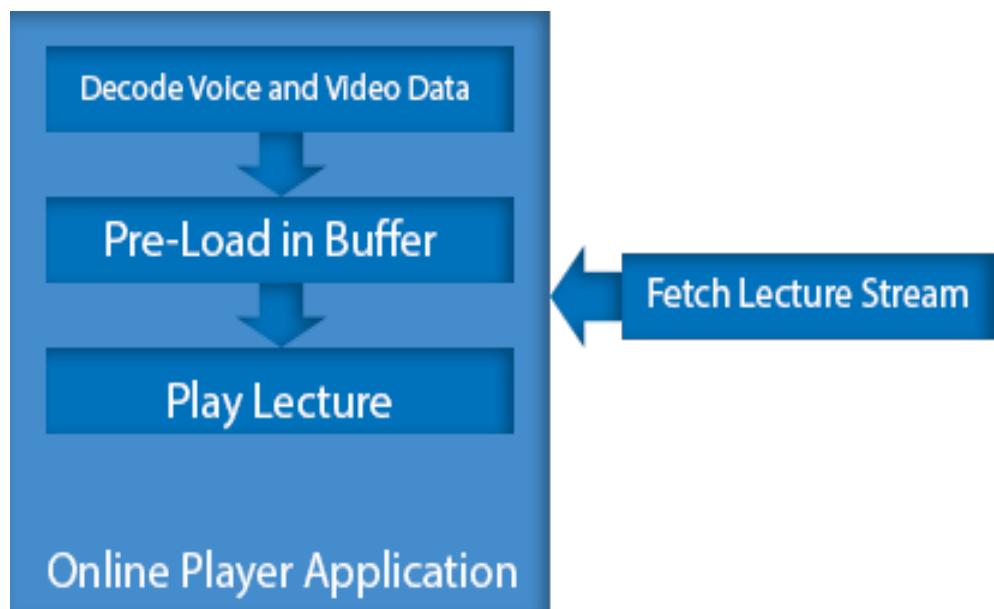


FIGURE 3.13: Online Player Application General Methodology

### 3.9.7 Learning Management System

LMS System that provides platform for playing online lectures, assignment submission and course content management. This module will act as a final deliverable when integrated with Online Lecture Player. This module consists of many sub-modules and functionalities. It also acts as an online portal for students and play important role in maintaining their profile. Below is further detailed discussion about this module. LMS developed for this project has other features including Administration, Access to high quality study material and learning data, email updates for students as well as teachers, fast delivery of learning material guided by the instructor and organized by existing institute, updates of emerging technologies to make students up-to-date and excel in their career in future. Report generation is another major advantage of the developed module. Using this functionality, instructor of the class can generate reports daily, weekly, monthly and so on. Also, reports are not only about the students. They can be about course material and Lecture data as well. Attendance of students and instructors as well can be maintained and reported easily. Concerned party can view the generated report at any time. Students can view timetable. Concerned instructor can suggest the adjustments to the timetable that administration can see and adjust accordingly. The application is web based so that accessibility of the system could be increased. Reliability and security are major concerns to the system. Administration can suspend the user by analysing the suspicious activity performed by the corresponding person.

#### 3.9.7.1 Entity Relationship Diagram

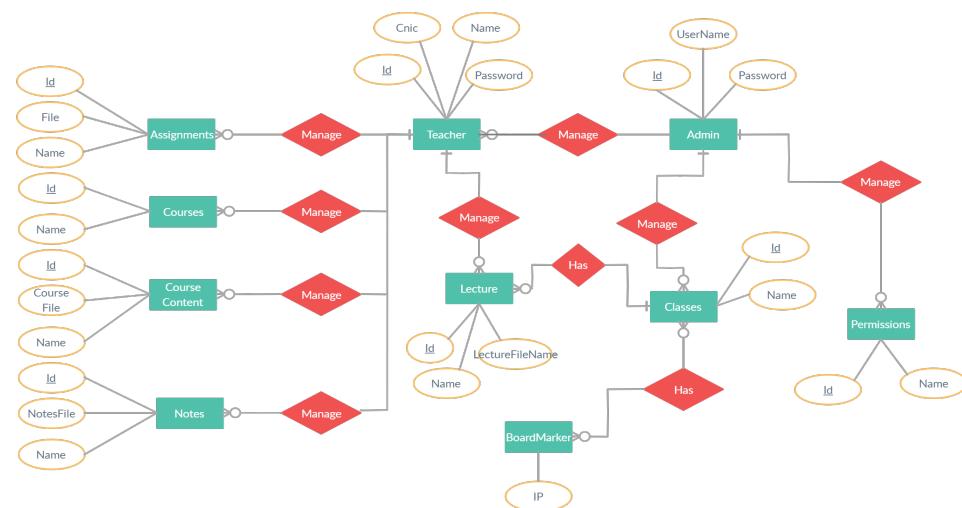


FIGURE 3.14: ER Diagram of LMS

### 3.9.7.2 Database Diagram

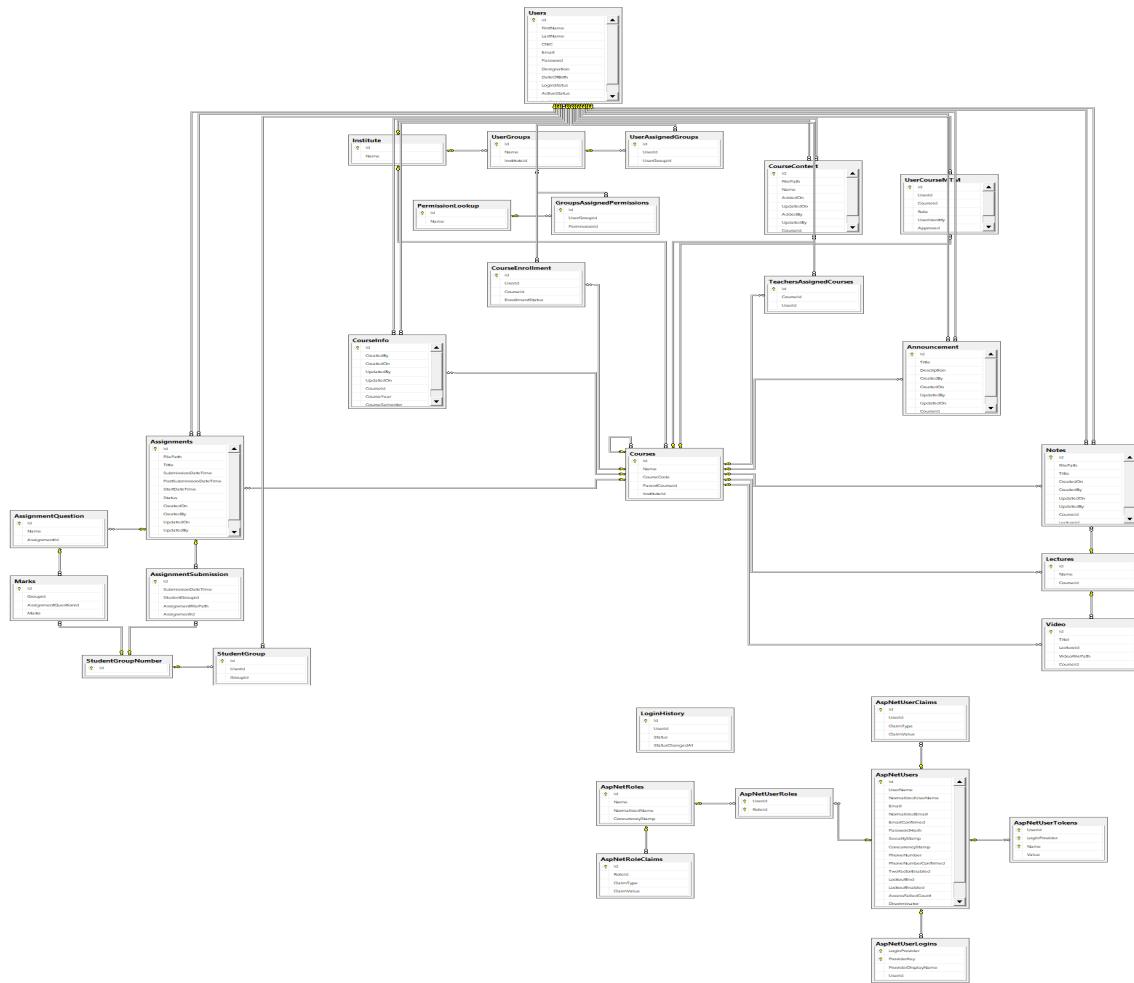


FIGURE 3.15: DB Diagram of LMS

# Chapter 4

## Implementation Details

### 4.1 Implementation

The system consists of five major modules i.e. Marker Hardware, Audio Hardware, Controller Application, Player Application and LMS Web Application. Implementation detail of each module is discussed below.

### 4.2 Overall Project Structure

This diagram shows how the modules are connected and how the effort is implemented to develop modules and connect them to form a Digital Board Marker system.

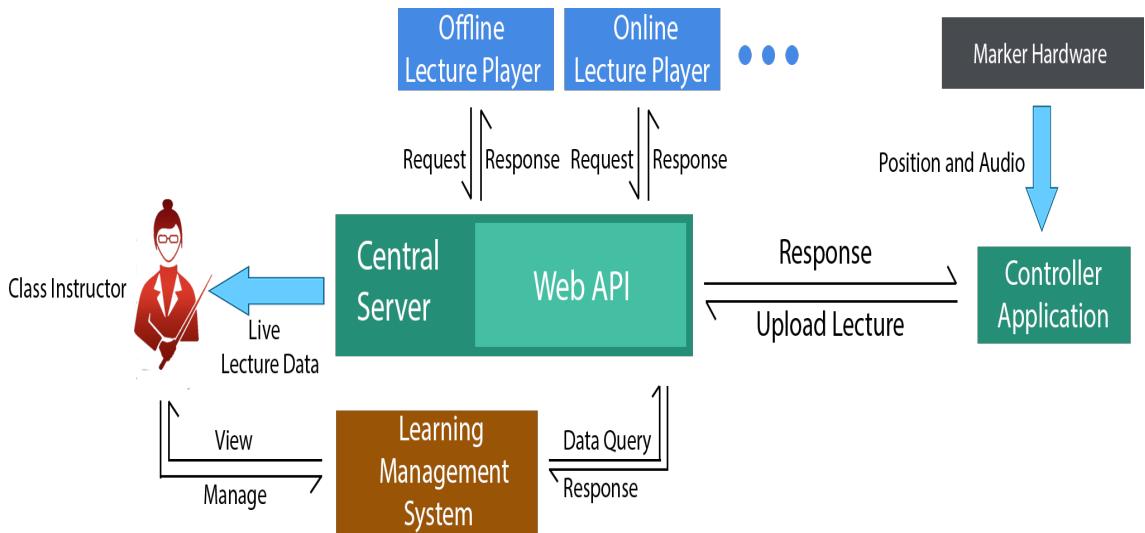


FIGURE 4.1: Overall Project Structure

## 4.3 Marker Hardware

The role of this module is to give orientation and tip pressure of the marker. The module sends data packet that contain encoded orientation of marker in 3d space in form of Euler angles.

### 4.3.1 Requirements Addressed

#	Requirements	Priority
1	Determine orientation of board marker and calculate respective Euler angles	HIGH
2	Transmit the calculated Euler angles to desktop app via nrf24l01 module	HIGH
3	Transmit the calculated Euler angles to desktop app via RS232 serial connection	LOW
4	Turn on using 3.6 volts Li-po battery with Boost converter circuit	MEDIUM
5	Build battery charging circuit within board marker	LOW
6	Implement RGB Led for positioning purpose (Input for camera module)	HIGH

TABLE 4.1: Board Marker Hardware Requirements

### 4.3.2 General Flow

- Board Marker try to establish wireless connection with the receiver. RGB Led fades meanwhile.
- RGB Led turns to constant red after successful connection.
- Accelerometer unit in the Board Marker determines the orientation data.
- NRF24l01 wireless module in the Board Marker transmits the orientation data to Receiver wirelessly.
- Receiver Transfers orientation data to desktop app via serial connection.

### 4.3.3 Detailed Design

Marker hardware has two major sub-modules named as **Transmitter** (marker itself) and **Receiver**. Below is the detail of components:

#### 4.3.3.1 Tact Tactile Switch

Toggle switch that turns on/off the system when runs on Battery. It does not have any effect when system is running via USB cable.



FIGURE 4.2: Tact Tactile Switch

#### 4.3.3.2 USB DC-DC Boost Converter

Converts the 3.7V to 5V to turn on and constantly run the Arduino nano prototype board. This sub-module has built-in charging circuit that charges the battery through USB connection.



FIGURE 4.3: DC-DC Boost Converter

#### 4.3.3.3 Glowing Ball

Round shaped glowing ball can glow in any combination of RGB colors. It is not for just looks but acts as an input to Stereo cameras for position tracking.

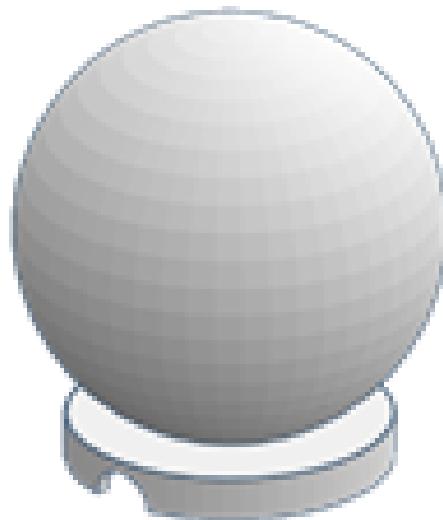


FIGURE 4.4: Glowing Ball

#### 4.3.3.4 Arduino nano

Arduino nano acts as main processing board to which all modules and sensors are attached. It acts just like a motherboard with central processor chip soldered on mainboard.

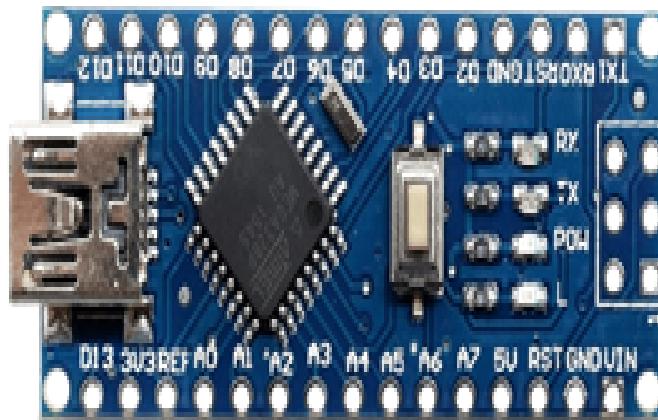


FIGURE 4.5: Arduino nano

#### 4.3.3.5 Li-po battery

600mAh 3.7V Li-po battery used to run system while there is no USB connection. Voltage may be up to 4.2 volts when fully charged.

DC-DC Boost Converter is hooked up with the battery that charges the battery as well as raises its voltage to 5V to make the Board Marker Transmitter working properly.

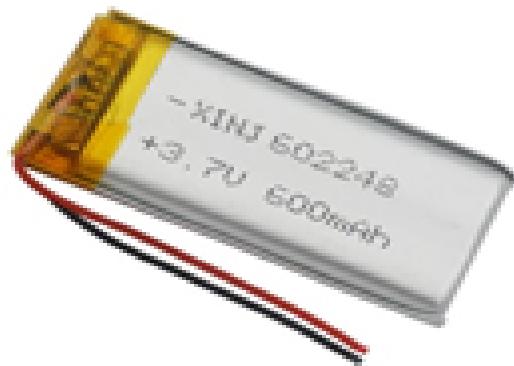


FIGURE 4.6: Li-po Battery

#### 4.3.3.6 dc-le14112 RGB Led

3W RGB Led used to create custom color of choice, the corresponding color that is required for position sensing can glow in Glowing ball. It may be given external power source but, in our case, it is directly connected to Arduino nano.



FIGURE 4.7: RGB Led

#### 4.3.3.7 MPU-6050

MPU-6050 or GY-521 board contains accelerometer and gyroscope packed in a single chip. It senses the orientation of the object. It is connected to Arduino nano via I2C bus.

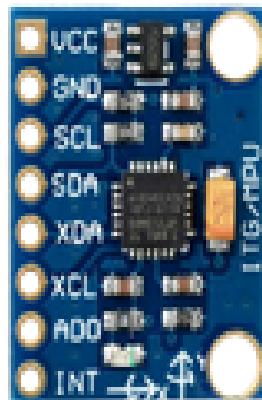


FIGURE 4.8: MPU-6050

#### 4.3.3.8 nRF24L01

nRF24L01 is a single chip radio transceiver. It is responsible for transmitting orientation data from transmitter module to receiver.

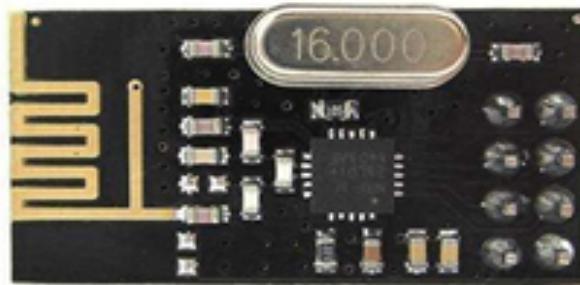


FIGURE 4.9: nRF24L01

#### 4.3.4 Marker Transmitter

The objective of the transmitter module is to extract orientation of the board marker. The challenge is the marker is changing its orientation while writing on the board. Transmitter module is designed as a back cap of board marker. It is attached to the board marker to record orientation of marker. The role of this sub-module is to transmit the tip pressure and orientation of marker in space. Further details of each part constituting the transmitter are given below.

##### 4.3.4.1 Components Used

Detailed description of electronic components excluding discrete consumer parts, e.g. wires, is given below and described above.

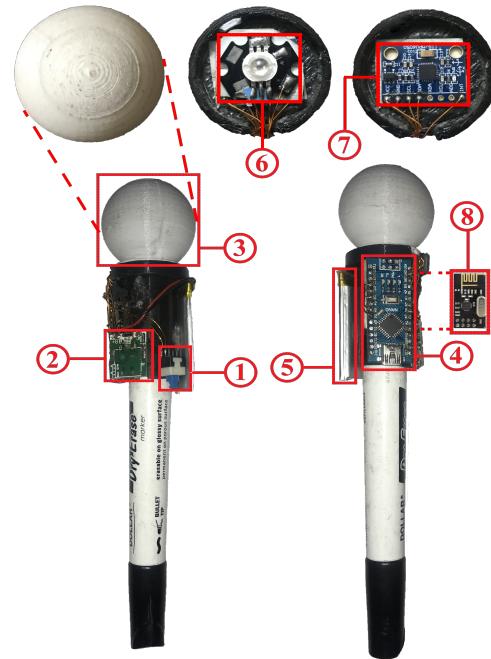


FIGURE 4.10: Board Marker with Transmitter Components

#### 4.3.4.2 Component Connection Diagram

This diagram represents how sub-modules or components are connected in Transmitter module.

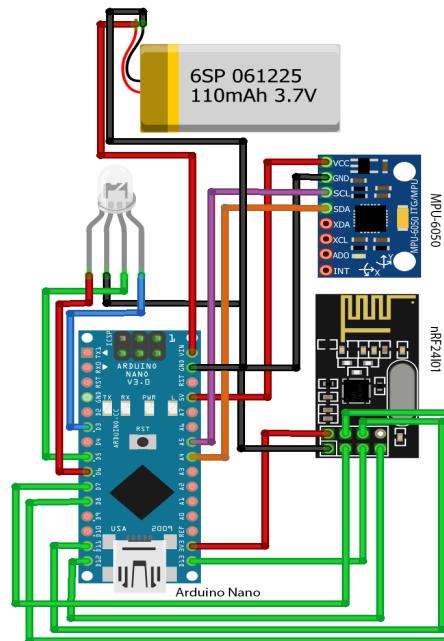


FIGURE 4.11: Component connection diagram of Board Marker Transmitter

#### 4.3.4.3 Schematic Diagram

Schematic diagram of Board Marker Transmitter can be seen as below

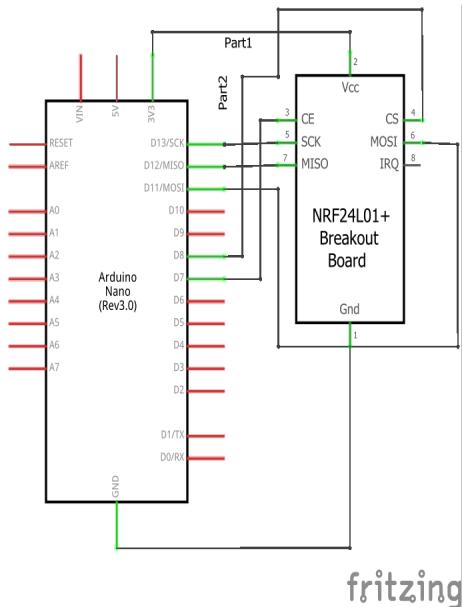


FIGURE 4.12: Schematic diagram of Board Marker Transmitter

#### 4.3.4.4 General Flow

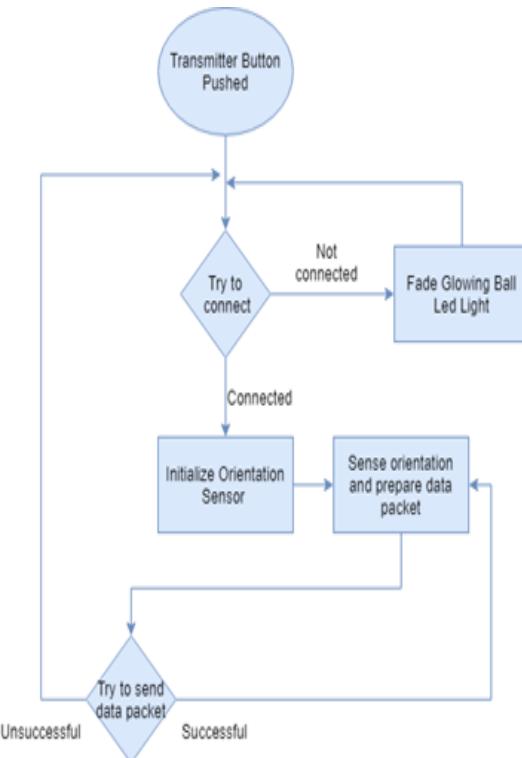


FIGURE 4.13: General Flow of Board Marker Transmitter

### 4.3.5 Marker Receiver

Receiver module receives orientation data as Euler angles and transfer it to the desktop application via USB connection. As it is connected via USB so it does not need any external power source.

#### 4.3.5.1 Component Connection Diagram

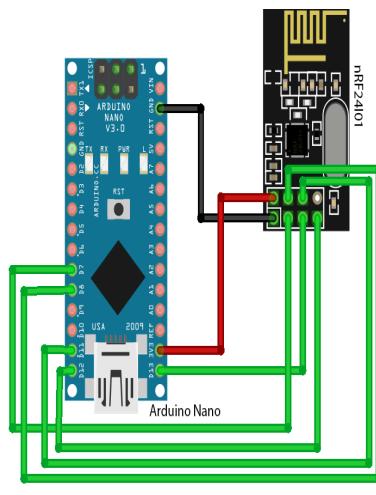


FIGURE 4.14: Component connection diagram of Board Marker Receiver

#### 4.3.5.2 Schematic Diagram

Schematic diagram that shows abstract component view of Receiver module is given below

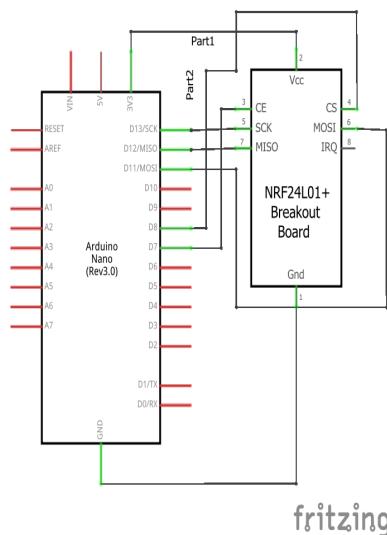


FIGURE 4.15: Schematic diagram of Board Marker Receiver

#### 4.3.5.3 General Flow

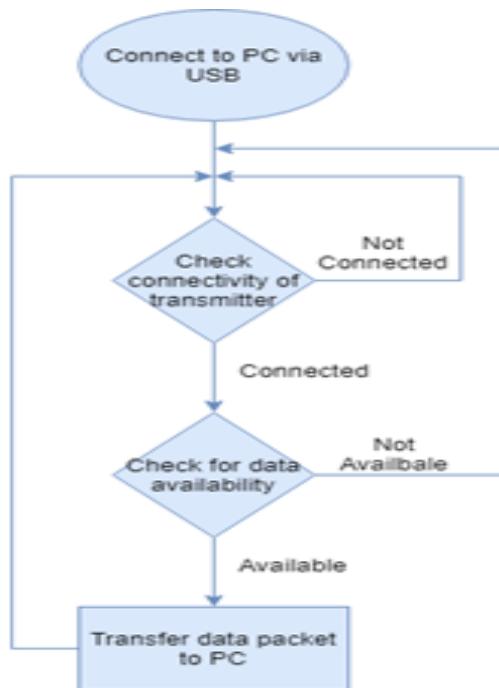


FIGURE 4.16: General Flow of Board Marker Receiver

#### 4.3.6 Rules and Assumptions

Following are rules and cases of assumptions that are assumed to be true while normal working

- Board Marker Transmitter and Receiver are in range of 2 meters for less noise and preventing latency issues.
- Pressure threshold of board marker tip is 5Pascals that is equivalent to pressure of lead pencil tip. Above this pressure, marker will write and otherwise not.
- Glowing ball of board marker must be at least partially visible by either of the cameras. Precision of marker position decreases from Case 1 to 6. Best Accuracy in Case 1 and no output at all in Case 6.
- User is supposed to be not touching the Marker tip while recording the lecture.
- User is supposed to be write only in the boundary of the defined platform i.e. whiteboard.

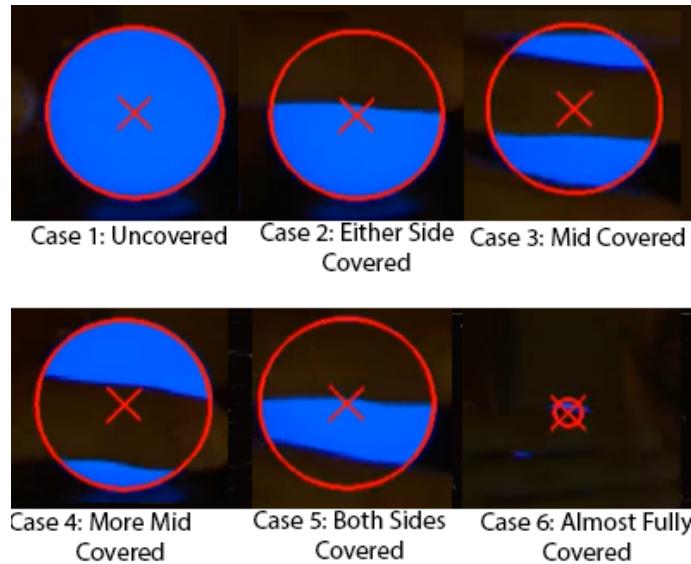


FIGURE 4.17: Glowing Ball Detection While Covered

### 4.3.7 Tools and Technologies used

List all software that are used to develop and needed to operate the developed module are detailed below.

#### 4.3.7.1 Arduino IDE v1.8.9

Code environment in which all code for Board Marker Transmitter and Receiver is written. This IDE is numerously used as a debugging tool as well.

#### 4.3.7.2 Processing v3.5.3

This tool is used for debugging and visualization of Board Marker Transmitter as a teapot object. In order to view Board Marker Transmitter and verify the placement of MPU-6050 orientation sensor and latency, we visualized the teapot object moving in the window of Processing software. Following parameters and properties are visualized and debugged.

- Correct orientation data packet format of Board Marker Transmitter.
- Generation of noise with respect to obstacles and distance involved while data transmission.
- Latency in data transmission with respect to obstacles and distance involved while data transmission.

Sample image of object is given below

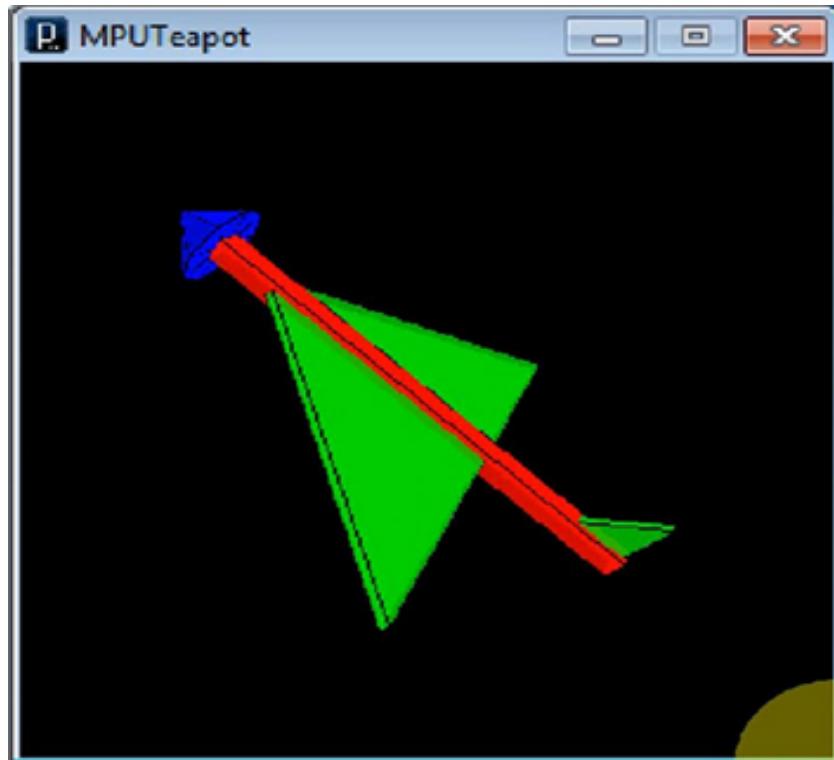


FIGURE 4.18: Marker Orientation Image in Processing Software

## 4.4 Audio Hardware

Role of Audio Hardware is to establish a wireless voice communication between Teacher and Controller Application. The module wirelessly transmits the voice of Teacher to controller app. The module works on 2.4G frequency band approved and approved by RoHS.

### 4.4.1 Requirements Addressed

#	Requirements	Priority
1	Transfer Voice data from one point to another.	HIGH
2	Transfer Voice data from transmitter to receiver wirelessly.	HIGH
3	Transmitter should be standalone in terms of power.	HIGH
4	Receiver should output voice data as analogue audio wave.	MEDIUM
5	Implement noise control knob in transmitter.	MEDIUM

TABLE 4.2: Audio Hardware Requirements

#### 4.4.2 General Flow

- Transmitter try to connect to the Receiver
- After a successful connection, Transmitter reads analogue signal and converts it into digital PWM wave.
- Transmitter then starts transmitting the voice data through nRF24L01 module.
- Voice data arrives at nRF24L01 of Receiver.
- Receiver converts the incoming signal into audio wave.

#### 4.4.3 Detailed Design

Audio hardware has two major sub-modules named as Transmitter and Receiver

##### 4.4.3.1 Electret Microphone

9767 Condenser Electret Microphone used to capture voice.



FIGURE 4.19: Electret Microphone

##### 4.4.3.2 100K Resistor

Used to adjust input gain of microphone. It is connected with the [Microphone Circuit](#).



FIGURE 4.20: 100K Resistor

#### 4.4.3.3 Microphone Circuit

An electric circuit implemented on a dotted Veroboard. It transfers the voltage change due to microphone to the Arduino nano mainboard

#### 4.4.3.4 Input Audio Socket

3.5mm Audio Socket that is used to input the audio wave. It acts as mono input audio channel.

#### 4.4.3.5 Output Audio Socket

3.5mm Audio Socket that is used to output the audio wave. It acts as mono output audio channel.



FIGURE 4.21: Audio Jack

#### 4.4.3.6 Arduino nano

Arduino nano acts as main processing board to which all modules and sensors are attached. It acts just like a motherboard with central processor chip soldered on mainboard.

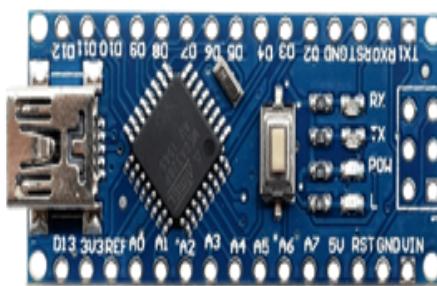


FIGURE 4.22: Arduino nano

#### 4.4.3.7 nRF24L01 Adapter

5V to 3.3V nRF24L01 adapter gives constant 3.3V from input 5V. It prevents nRF24L01 module not to drain power from Arduino nano mainboard.

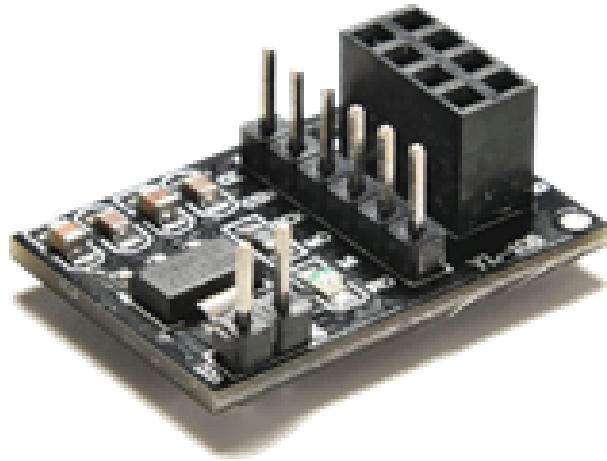


FIGURE 4.23: nRF24L01 Adapter

#### 4.4.3.8 Noise Reduction Circuit

The circuit is used to reduce random noise with the help of gradual grounding the input audio wave.

#### 4.4.3.9 nRF24L01

nRF24L01 is a single chip radio transceiver. It is responsible for transmitting voice data from transmitter module to receiver.



FIGURE 4.24: nRF24L01 Antenna Version

#### 4.4.4 Audio Transmitter

The objective of the Audio Transmitter is to get voice data from microphone and transmit it to the Audio Receiver. After getting the data from microphone, it

converts analogue audio data into a digital Pulse Width Modulation or PWM wave.

#### 4.4.5 Components Used

Detailed description of electronic components excluding discrete consumer parts, e.g. wires, is given below and described above.

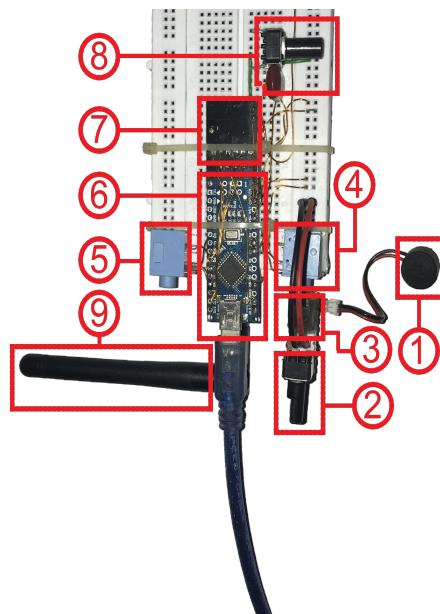


FIGURE 4.25: nRF24L01 Audio Transceiver Component Detail

#### 4.4.6 Component Connection Diagram

This diagram represents how sub-modules or components are connected in Transceiver module.

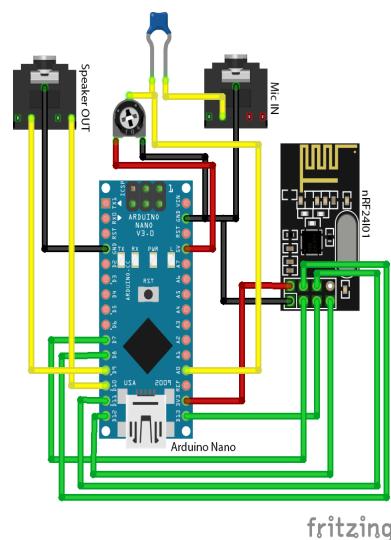
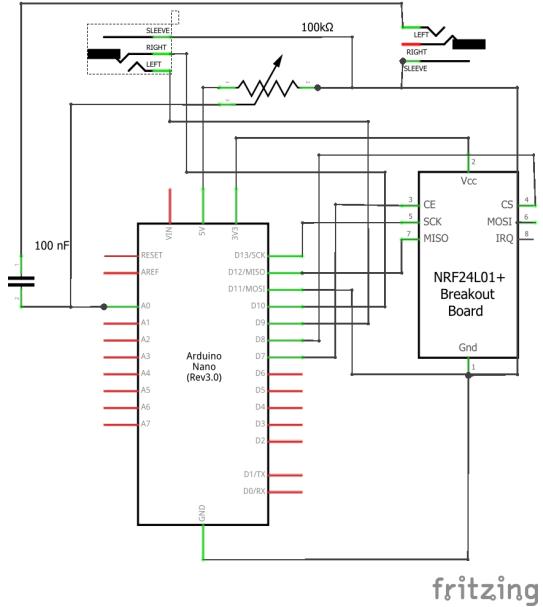


FIGURE 4.26: Audio Transceiver Component Connection Diagram

#### 4.4.7 Schematic Diagram



fritzing

FIGURE 4.27: Audio Transceiver Schematic Diagram

#### 4.4.8 General Flow

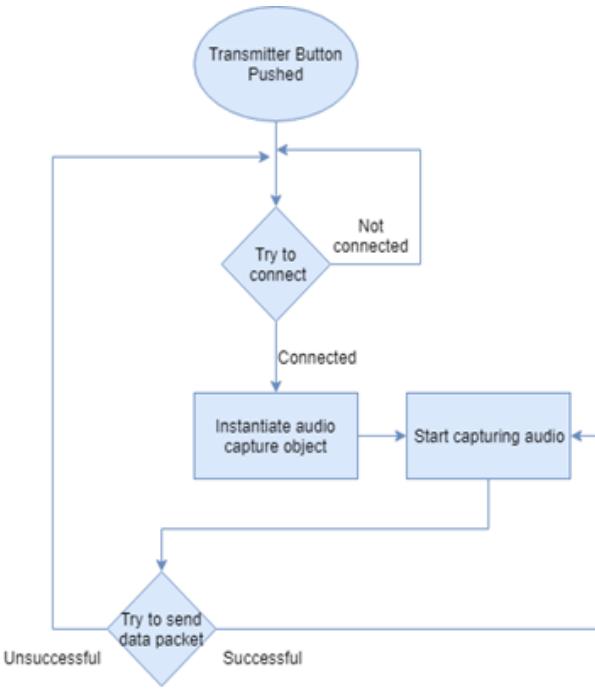


FIGURE 4.28: General Flow of Audio Transmitter

#### 4.4.9 Audio Receiver

Receiver module receives audio data from transmitter. Although the Arduino nano mainboard is programmed differently but the circuit and composition of receiver module is identical to transmitter module.

#### 4.4.10 Components Used

Detailed description of electronic components excluding discrete consumer parts, e.g. wires, is given below and described above.

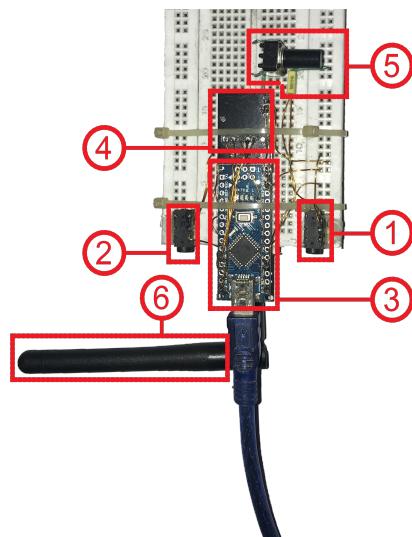


FIGURE 4.29: Component Diagram of Audio Receiver

#### 4.4.11 General Flow

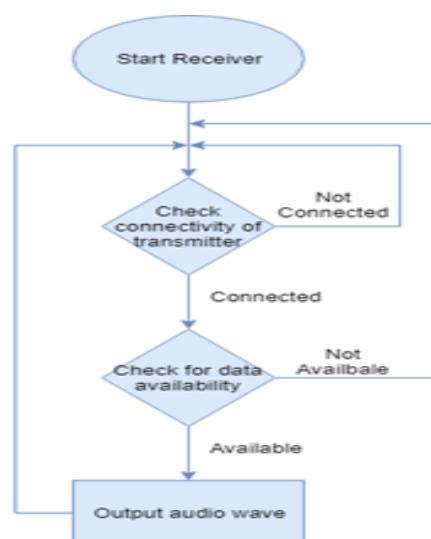


FIGURE 4.30: General Flow of Audio Receiver

#### 4.4.12 Rules and Assumptions

Following are rules and cases of assumptions that are assumed to be true while normal working:

- Audio Transmitter and Audio Receiver must be in range of 5 meters.
- Microphone should be in range of 10cm from the audio source i.e. speaker's mouth.

#### 4.4.13 Tools and Technologies used

List all software that are used to develop and needed to operate the developed module are detailed below:

##### 4.4.13.1 Arduino IDE v1.8.9

Code environment in which all code for Audio Transmitter and Audio Receiver is written. This IDE is numerously used as a debugging tool as well.

### 4.5 Controller Application

This module controls the recording of lecture. It acts as a receiver end from the Marker and Audio Hardware point of view. It generates a lecture file with .dbm extension. That file is then uploaded to central server. Lecture file now can be played on the website using WebGL player or Offline player application.

Complete description along with UI screens of controller application are given below:

#### 4.5.1 Home Screen

Controller application has navigation bar on left side that control panel and sub-panels that contain buttons. Buttons navigate to the corresponding form. A hierarchy that describe the categorization of forms is given below.

1. Home Panel
  - Player
  - Home Screen
2. Settings Panel
  - a. Hardware Input Sub-Panel

- Position
- Camera
- Orientation
- Filter

**Home Screen:** Home Screen button is clicked; home screen of Controller Application is shown. It acts just as splash indicating that application is running fine. Application show home screen by default on launch.

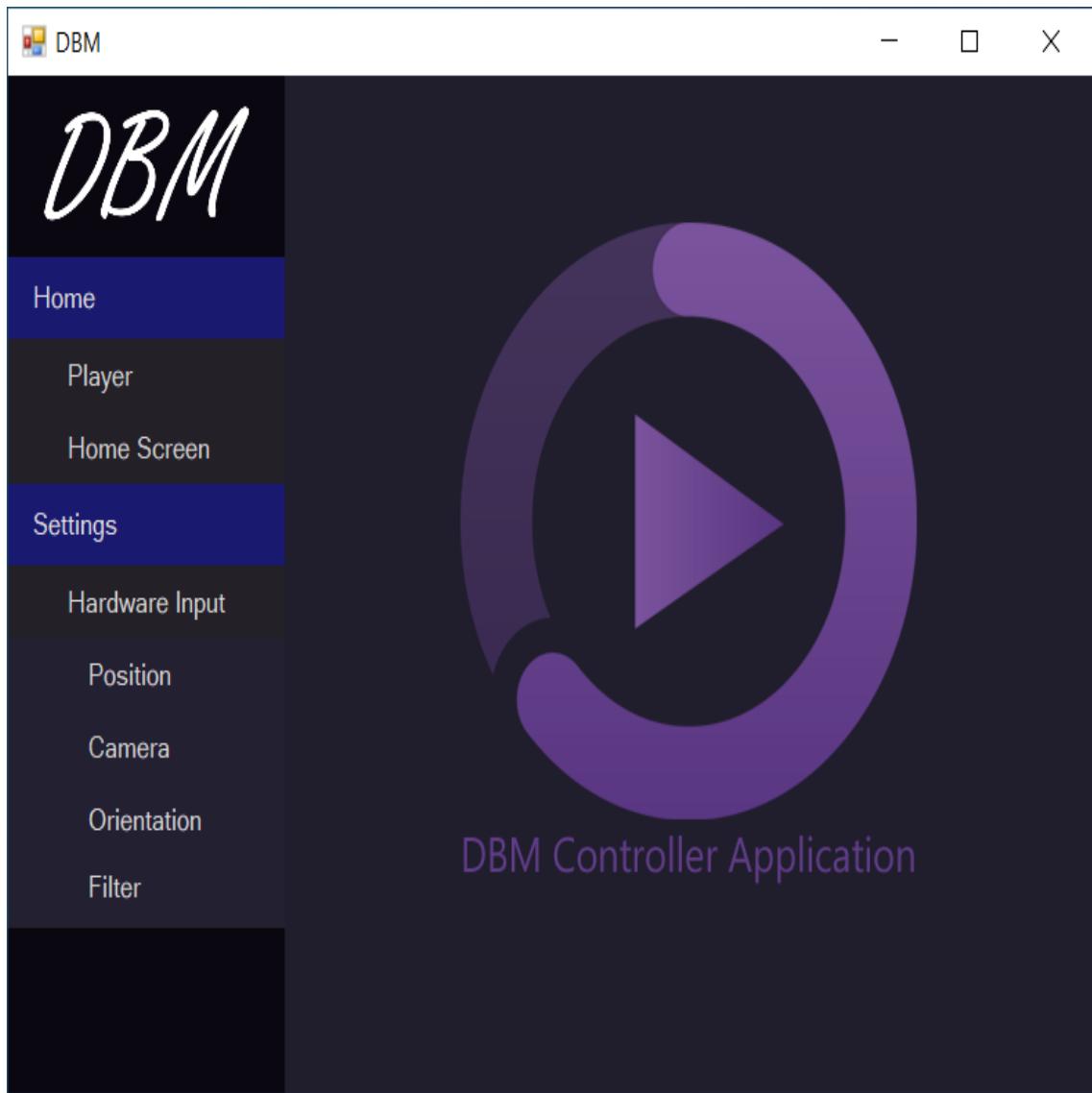


FIGURE 4.31: Home Screen Controller Application

#### 4.5.2 Record Panel Screen

When player button is clicked, application opens the lecture recording control panel. This panel contain the following controls:

1. Seek bar: Indicates the current playing time of the lecture video. It also indicates how much video has passed and how much is remaining.
2. Start Recording button: Lecture recording is started after pressing this button.
3. Stop Recording button: Lecture recording is stopped after pressing this button.
4. Start Playing button: Plays the recorded lecture.
5. Duster button: Press it when you want to erase a little.
6. Clear button: Press it when whole board is to be erased.
7. Enable Device Input button: Press it to enable Marker hardware and Audio hardware input to controller application for lecture recording. When disabled, mouse input is considered i.e. you will be using mouse to write on canvas.
8. Save File button: To save the recorded lecture file. It will generate a file with .dbm extension.
9. Load File button: To load the recorded lecture file. It will open a file browser from which a file with .dbm extension is selected.
10. Thickness Trackbar: Controls the line thickness of writing being written and also duster size.
11. Tick Resolution numeric up down: Controls the refresh rate of Canvas. Lower the value, higher the resolution and hence better quality but more storage required.
12. Color picker: Change the color of writing. In case you are using multiple board markers with different colors.
13. Position textbox: Indicates the current position of pointer on the Canvas.
14. Load Saved button: Load the saved settings on local storage.
15. Save Settings button: Save the settings from local storage.
16. Canvas: Black window on which words are being written i.e. Board.

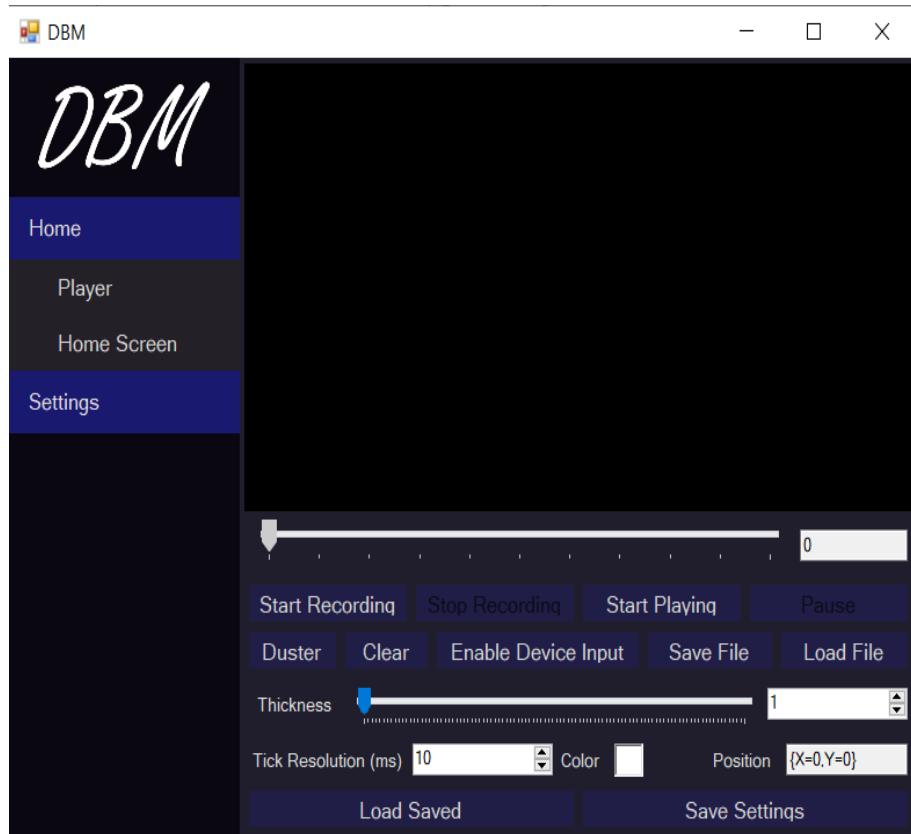


FIGURE 4.32: Controller Application Record Panel

#### 4.5.3 Position Calibration Screen

When Settings->Hardware Input->Position from navigation bar is clicked, Position Calibration form is displayed. It contains the following controls

1. Canvas: A container that holds visual elements of either side of board. It contains the lines of sight of each camera and red circle indicates the glowing ball position of the marker. The blue dot indicates the tip position of the marker.
2. Invert Left button: Inverts the control of left-side camera.
3. Invert Right button: Inverts the control of right-side camera.
4. Position textbox: Indicates the current tip position of the Marker Hardware.
5. Load button: Load the saved settings from local storage.
6. Save button: Save settings on local storage.

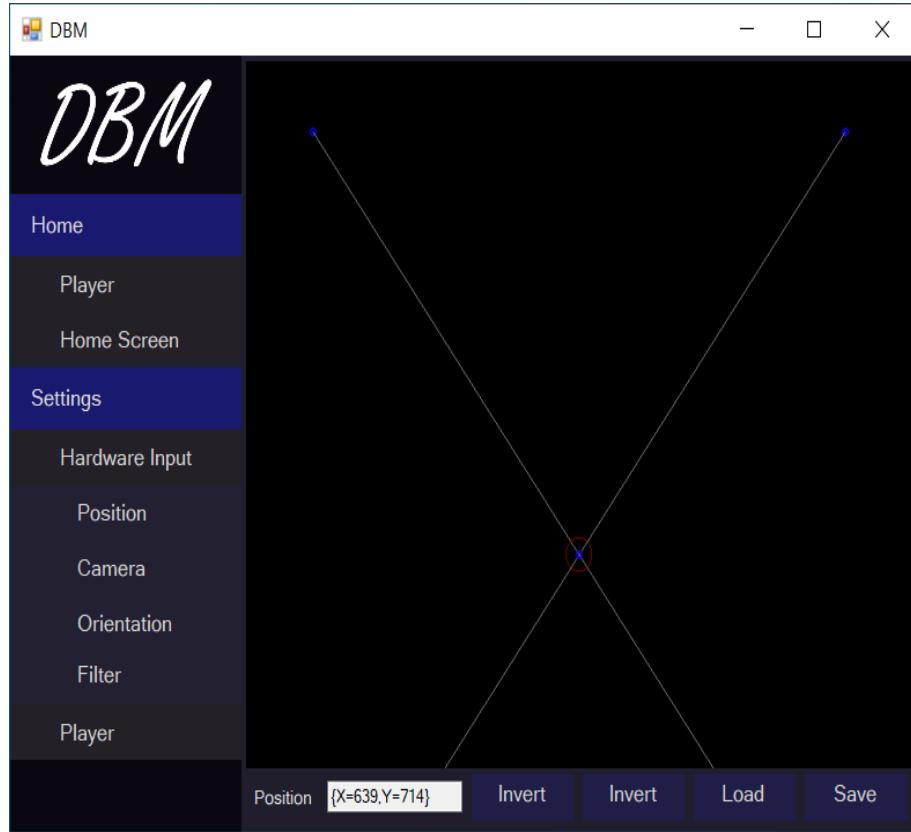


FIGURE 4.33: Controller App Position Settings

#### 4.5.4 Camera Control Panel Screen

When Settings->Hardware Input->Camera from navigation bar is clicked, Camera Control Panel form is displayed. Role of this form is to start camera stream and preview in the form window from connected cameras. It contains at least two sub-forms that contain settings of each camera. Each camera form contains the following controls:

1. Select Camera dropdown: Contains list of all connected cameras from which any of the cameras can be selected. Choose carefully i.e. what camera is placed on Left or Right on the board.
2. FPS textbox: The framerate of camera. Higher the framerate, better the performance. Framerate should not exceed from the mentioned framerate on camera.
3. Capture button: Start the camera capture.
4. Preview button: Camera preview is displayed on the preview box below.
5. Load Saved button: Load saved settings from the local storage.

6. Save Settings button: Save the settings on local storage.

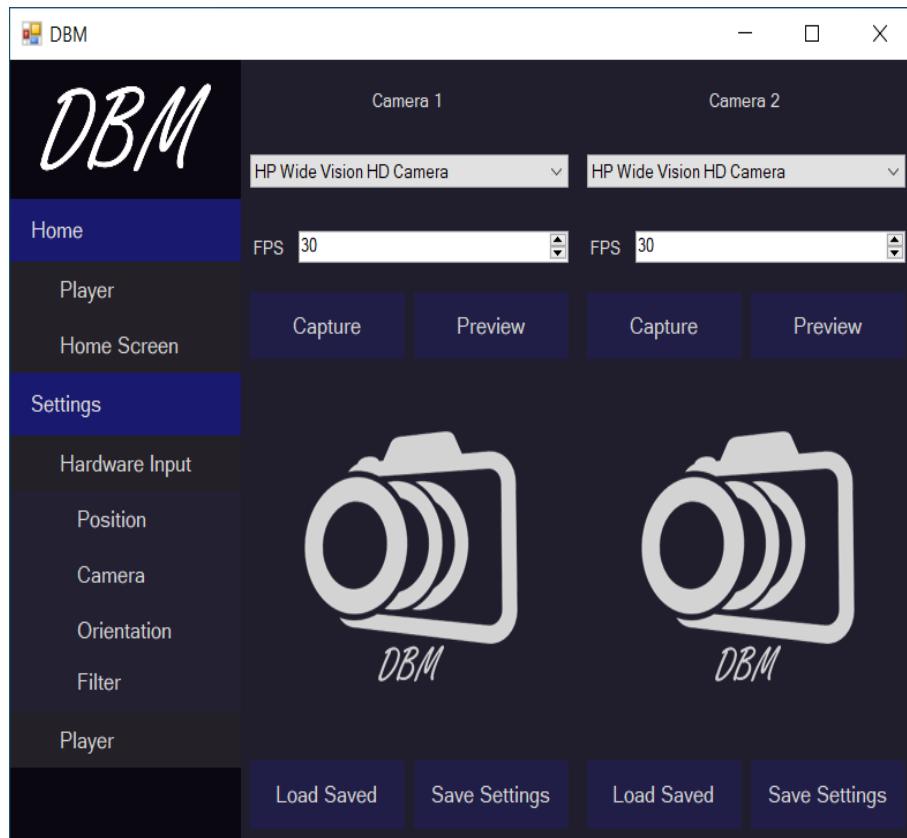


FIGURE 4.34: Controller App Camera Settings

#### 4.5.5 Orientation Calibration Screen

When Settings->Hardware Input->Orientation from navigation bar is clicked, Orientation Control Panel form is displayed. Role of this form is to calibrate and visualize the orientation of the board marker. It contains the following controls:

1. Start button: Starts the orientation input from Marker Hardware. Refresh button: Refreshes the list of available communication serial ports.
2. Serial Port dropdown: Dropdown list of available serial ports.
3. Choose the one with which Marker Hardware is connected.
4. Current Orientation group-box: Shows X-axis, Y-axis and Z-axis rotation of Marker Hardware along its pivot point.
5. Current Pressure textbox: Shows the amount of pressure applied on the tip of Marker.

6. Tip Offset textbox: Shows the calculated tip offset from the origin point as compared to when Marker was kept at 90 degree with the Board.
7. Apply Offset group-box: Trackbars that give offset to calculated angles alone X-axis, Y-axis and Z-axis respectively to calibrate the orientation.
8. Load Saved button: Load saved settings from the local storage.
9. Save Settings button: Save the settings on local storage.
10. Show 3d Orientation button: Opens another form that show orientation of Marker in 3d space.
11. Show 2d Orientation button: Opens another form that show orientation of Marker in 2d plane.

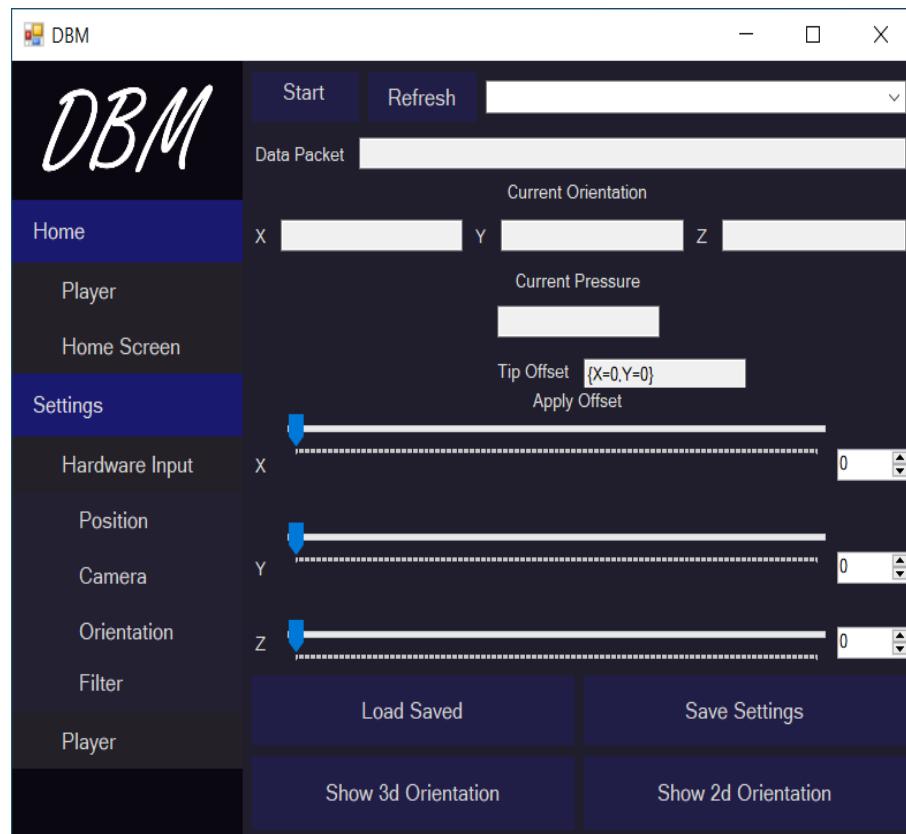


FIGURE 4.35: Controller App Orientation Calibration

#### 4.5.6 3d Orientation Screen

When ‘Show 3d Orientation’ button from Orientation Calibration Form is clicked, 3d Orientation form is displayed. It shows orientation of marker in three-dimensional space. Box of 3d model show tail of the marker and conical head show tip of marker.



FIGURE 4.36: Controller App Orientation Visualization in 3d Space

#### 4.5.7 2d Orientation Screen

When ‘Show 2d Orientation’ button from Orientation Calibration Form is clicked, 3d Orientation form is displayed. It shows orientation of marker in three-dimensional space. Box of 3d model show tail of the marker and conical head show tip of marker.

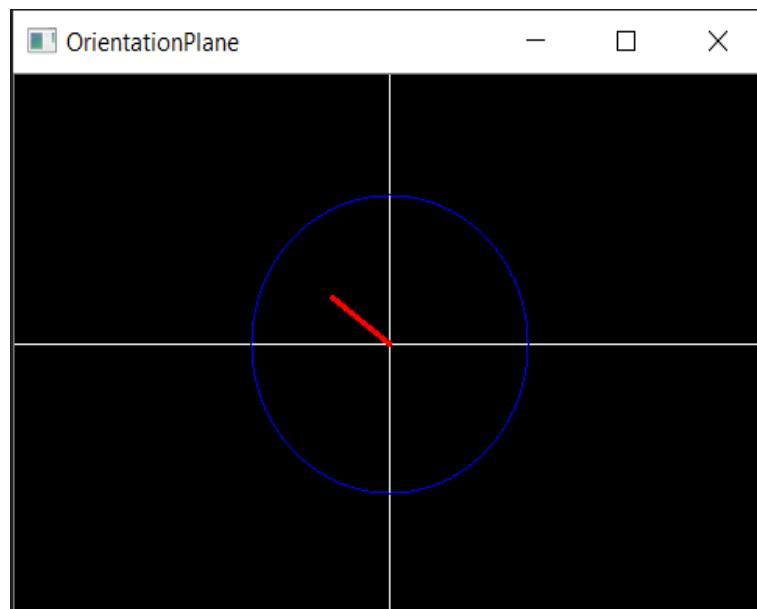


FIGURE 4.37: Controller App Orientation Visualization in 2d Space

#### 4.5.8 Filter Control Panel Screen

When Settings->Hardware Input->Filter from navigation bar is clicked, Filter Control Panel form is displayed. Role of this form is to perform computer vision algorithms and filters to get the position of the glowing ball of the board marker. It contains at least two sub-forms that contain settings of each camera filter. Each filter form contains the following controls:

1. Upper Limit group-box: Contains three trackbars that is used to adjust the upper limit of color filter in HSV color space.
2. Lower Limit group-box: Contains three trackbars that is used to adjust the lower limit of color filter in HSV color space.
3. Preview button: Launches the filter preview form.
4. Load Saved button: Load saved settings from the local storage.
5. Save Settings button: Save the settings on local storage.

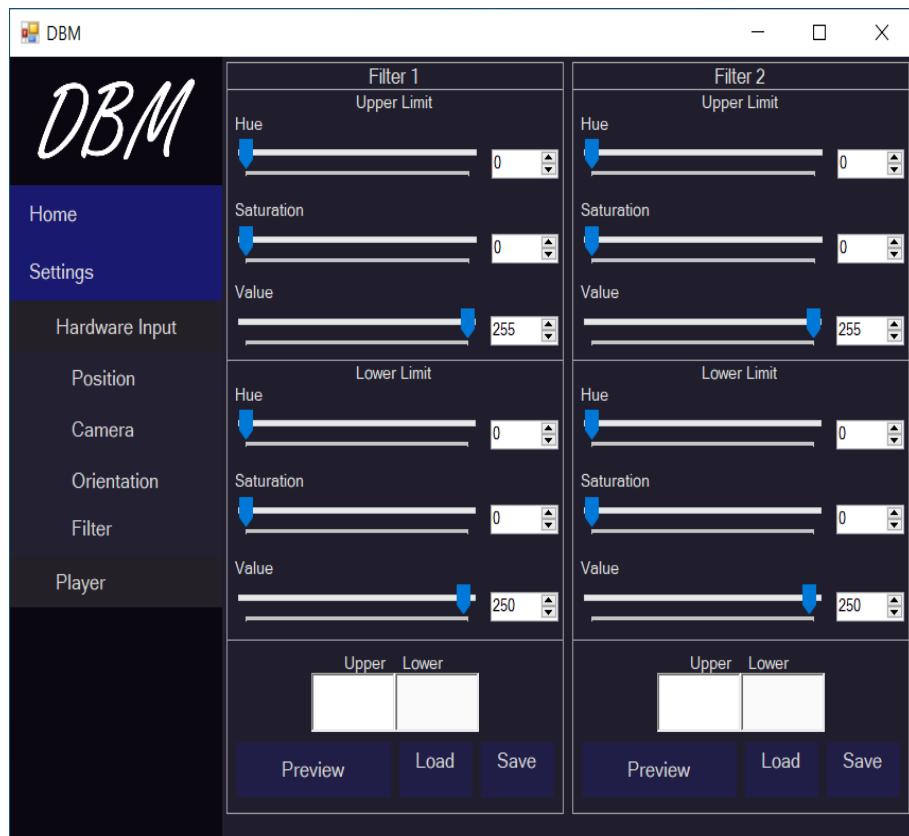


FIGURE 4.38: Controller App Camera Filter Control Panel

#### 4.5.9 Filter Preview Screen

When ‘Preview’ button from Filter Control Panel Form is clicked, 3d Orientation form is displayed. Role of this form is to display the mask applied to camera to extract the position of glowing ball. It contains the following controls:

1. Offset textbox: Displays the relative position of glowing ball with respect to mid. It displays the value in percentage.
2. Show Mask: Toggle show filter and normal preview.
3. Undo button: undo last placed dot on this preview screen.
4. Preview Screen: Dots i.e. particularly three, can be placed. First two dots display a line that is aligned with the surface of Board. Third dot display the corner of the board just ahead of the camera.
5. Load Saved button: Load saved settings from the local storage.
6. Save Settings button: Save the settings on local storage.

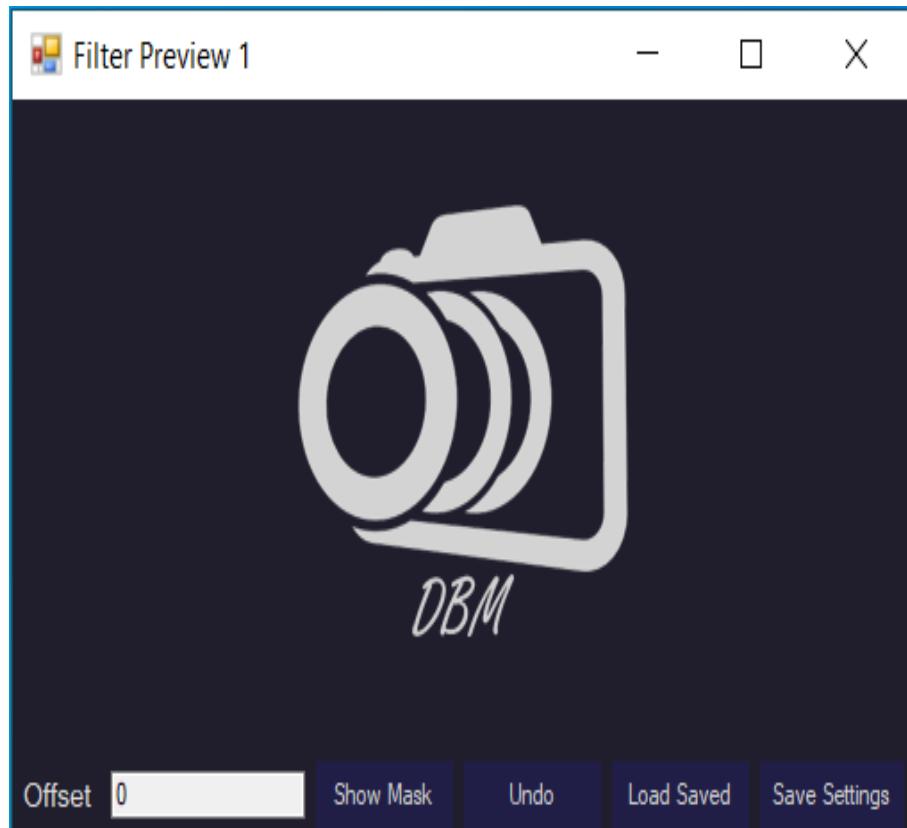


FIGURE 4.39: Controller App Camera Filter Preview

#### 4.5.10 Flow Diagram

The general flow diagram of controller application is given below:

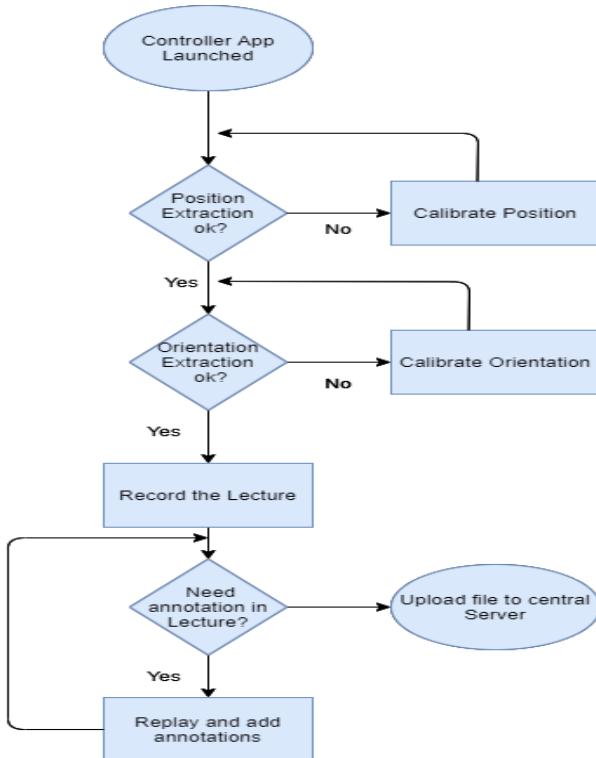


FIGURE 4.40: Controller App Flow Diagram

#### 4.5.11 Rules and Assumptions

Following are rules and cases of assumptions that are assumed to be true while normal working:

- Application is not closed while recording otherwise all recording will be wasted.

#### 4.5.12 Tools and Technologies used

List all software that are used to develop and needed to operate the developed module are detailed below:

#### 4.5.13 Visual Studio 2019

Code environment in which all code for Controller application is written. This IDE is numerously used as a debugging tool as well.

#### Libraries Used

Following external libraries are used while development of controller application:

- Newtonsoft.Json v12.0.3: To serialize and deserialize data into and from Json objects.
- ColorMine v1.1.3: For Inter-conversion of color spaces i.e. RGB and HSV
- EMGU.CV v4.1.1.3497: OpenCV image processing library used in capturing and filter formation.
- DirectShowLib v1.0.0: Used to get list of all connected cameras.
- OpenTK v3.1.0: Used to render 3d model of marker for orientation calibration.

## 4.6 Player Application

This module acts just like regular media player that play video file. The difference is that it plays a lecture file only, generated by controller application. File if of .dbm extension.

Player application has navigation bar on left side that control panel and sub-panels that contain buttons. Buttons navigate to the corresponding form. A hierarchy that describe the categorization of forms is given below:

1. Home Panel
  - a. Player
  - b. Home Screen
2. Settings Panel
  - a. Player Settings

Complete description along with UI screens of controller application are given below

### 4.6.1 Player Screen

When ‘Player’ button from navigation bar is clicked, Player screen is displayed. It contains the following controls

1. Seek bar: Indicates the current playing time of the lecture video. It also indicates how much video as passed and how much is remaining.
2. Start Playing button: Plays the recorded lecture.

3. Load File button: To load the recorded lecture file. It will open a file browser from which a file with .dbm extension is selected.
4. Thickness Trackbar: Controls the line thickness of writing being written and also duster size.
5. Load Saved button: Load the saved settings on local storage.
6. Save Settings button: Save the settings from local storage.
7. Canvas: Black window on which words are being written i.e. Board.

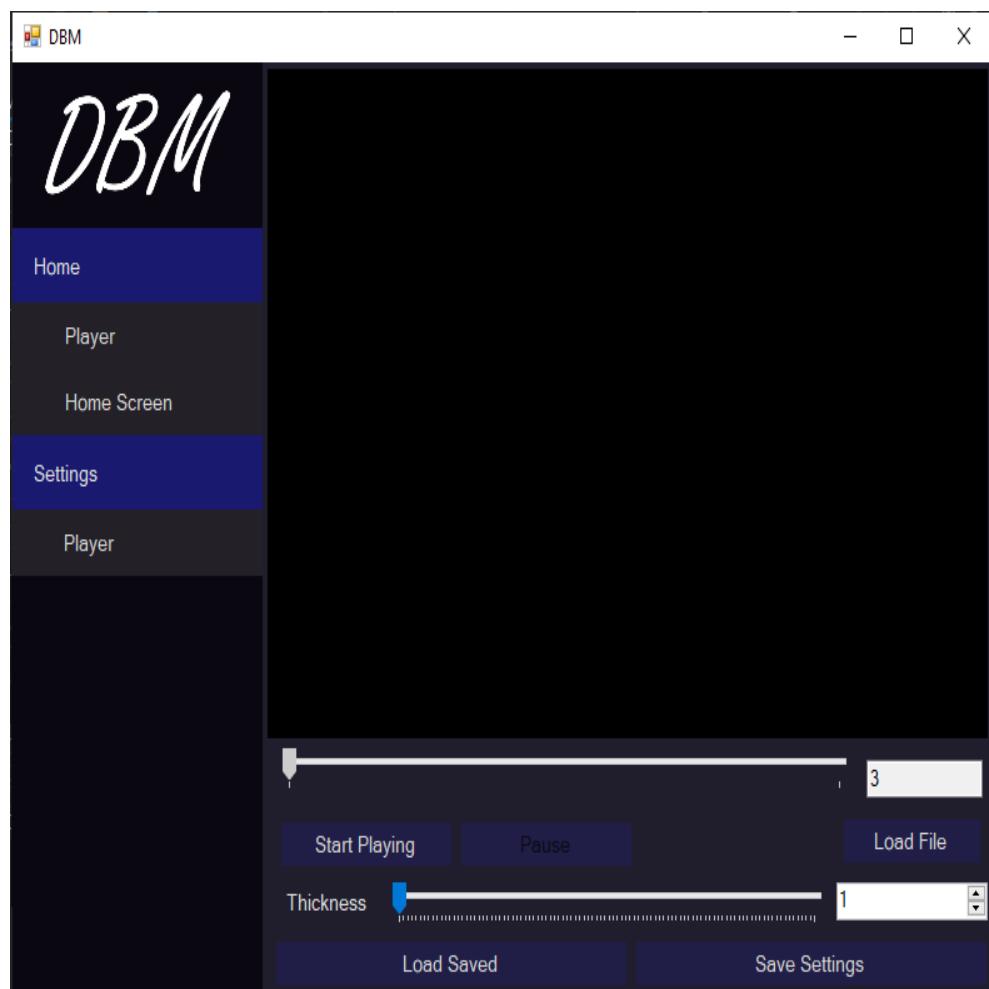


FIGURE 4.41: Player Application Main Screen

#### 4.6.2 Flow Diagram

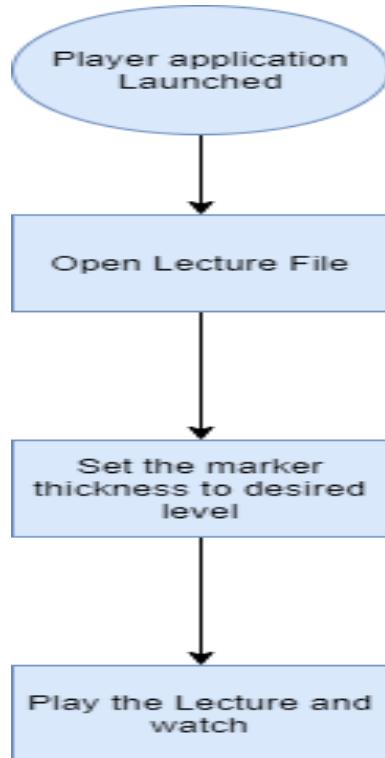


FIGURE 4.42: Player App Flow Diagram

#### 4.6.3 Tools and Technologies used

List all software that are used to develop and needed to operate the developed module are detailed below.

##### 4.6.3.1 Visual Studio 2019

Code environment in which all code for Controller application is written. This IDE is numerously used as a debugging tool as well.

##### Libraries Used

Following external libraries are used while development of controller application:

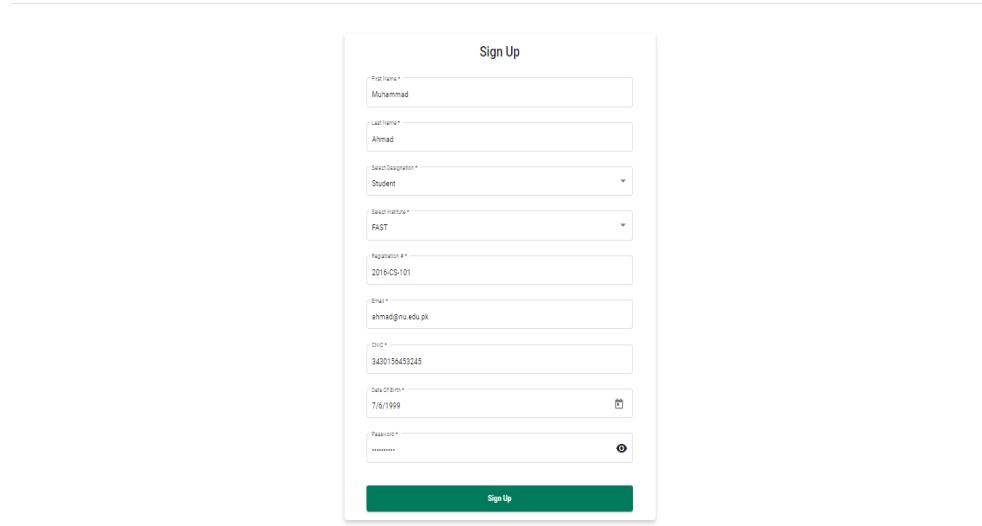
- Newtonsoft.Json v12.0.3: To serialize and deserialize data into and from Json objects.
- ColorMine v1.1.3: For Inter-conversion of color spaces i.e. RGB and HSV
- EMGU.CV v4.1.1.3497: OpenCV image processing library used in capturing and filter formation.

## 4.7 Web Application

This is a website which is a platform where all the lectures are available with respect to particular course.

#### 4.7.1 Sign Up Page

User will enter all the required information to access all the functionalities of the system. After entering the information, user will click the sign up button. After sign up, user can not login until receive approval email from the system.



The image shows a 'Sign Up' form with the following fields:

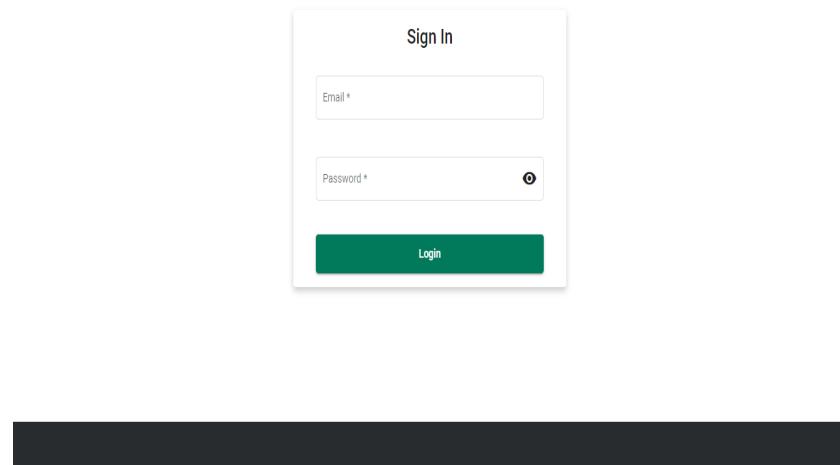
- First name\*: Muhammad
- Last name\*: Ahmad
- Sex designation\*: Student
- Sex status\*: FAST
- Registration #: 2016-CS-101
- Email\*: ahmad@mu.edu.pk
- Phone\*: 9439156459245
- Date of birth\*: 7/6/1999
- Password\*: [redacted]

A green 'Sign Up' button is at the bottom.

FIGURE 4.43: Web Application: Sign Up

#### 4.7.2 Login Page

After signup request approval, User can access the login page by clicking on login button from main page. User will enter login information i.e. Email and password to login to the system.



The image shows a 'Sign In' form with the following fields:

- Email\*
- Password\* [with eye icon]

A green 'Login' button is at the bottom.

FIGURE 4.44: Web Application: Login

### 4.7.3 All Courses Page

After login, teacher can view the courses. Teacher will be able to view only those courses that are assigned by the admin. Student can also view the course once he/she will get logged into the system. Both users can view the course details by clicking on the "View" button which will appear as user will move cursor over the course.

The screenshot shows a web application interface for a teacher. At the top, there is a header with the logo 'DBM' (Digital Board Marker), the text 'Digital Board Marker', a 'Logout' link, and the email 'teacher1@gmail.com'. Below the header, the title 'All Courses' is centered. The main content area displays four course cards, each featuring a thumbnail image of books on a shelf, the course name, and its code. The courses listed are PF(Updated) 201, OOP OOP202, Software Engineering SE-201, and DBMS DB-201. Each card has a green 'Enroll' button at the bottom.

Course Name	Course Code
PF(Updated)	201
OOP	OOP202
Software Engineering	SE-201
DBMS	DB-201

FIGURE 4.45: Web Application: All Courses

### 4.7.4 Course Enrolment Page

Student can also view all the courses once they are logged into the system by clicking on the courses button in the header of main page. They can make the enrolment request for particular course by clicking on the "Enroll" button and can view the details by clicking on the view button, once they are enrolled in that course.

The screenshot shows a web application interface for a student. At the top, there is a header with the logo 'DBM' (Digital Board Marker), the text 'Digital Board Marker', a 'Logout' link, and the email 'student1@gmail.com'. Below the header, the title 'All Courses' is centered. The main content area displays four course cards, similar to Figure 4.45, but with a purple 'View' button instead of an 'Enroll' button. The courses listed are PF(Updated) 201, OOP OOP202, PRV PRV301, and Software Engineering SE-201. Each card has a green 'Enroll' button at the bottom.

Course Name	Course Code
PF(Updated)	201
OOP	OOP202
PRV	PRV301
Software Engineering	SE-201

FIGURE 4.46: Web Application: Course Enrolment

#### 4.7.5 Enrolment Requests Page

Teacher can approve/disapprove the student's enrolment requests by accessing this page as shown below. For approving the enrolment request, teacher will click the "Approve" button and an approval email will be sent to that user by the system automatically. For disapproving the enrolment request, teacher will click the "Disapprove" button and an disapproval email will be sent to that user by the system automatically.

**Software Engineering Enrollment Requests**

Name	Email	Approve	DisApprove
aa aa	student1@gmail.com	✓	✗
Sumaira Atif	Ayeshaatif7925@gmail.com	✓	✗
haris khan	harriskhaan41@gmail.com	✓	✗
aa aa	student1@gmail.com	✓	✗

FIGURE 4.47: Web Application: Course Enrolment Requests

#### 4.7.6 Course Assignments Page

By clicking on view button, system will redirect the user to course dashboard where he/she can see the course assignments in the assignments tab along with description and submission date and time for that assignment. Teacher or student can download assignments. "Add assignments" , "Edit" and "Delete" button will only visible to the teacher from where teacher will upload assignments, can edit the uploaded the assignments and can also delete that assignments. Students will be able to download and submit the assignment by clicking on the "Download" and "Submit" button respectively.

Software Engineering					
Announcement		Lectures		Assignments	
<a href="#">Add Assignment</a>					
Title	Submission Date and Time	Edit	Delete	Download	Submit
Agile Model scenario	4/30/20, 11:59 PM	✓	✗	Download	Submit
Function and Non Function Requirements of Project	5/8/20, 11:59 PM	✓	✗	Download	Submit
Use cases scenarios	5/12/20, 11:59 PM	✓	✗	Download	Submit

FIGURE 4.48: Web Application: Course Assignments

#### 4.7.7 Assignments Submission Page

After clicking on the submit button in the assignment tab of the course dashboard, system will redirect the user to new page. Where student will add the assignment file and will enter group member's registration numbers in case of group assignments. Student will click the "Submit" button and assignment will be submitted.

The screenshot shows a web form titled "Assignment Submission". It includes fields for "Submission Date and Time" (set to 4/23/2020, 2:13 PM), "Assignment File" (with a browse icon), and "Registration #". There is also a green "Add Group Member" button and a large green "Add" button at the bottom.

FIGURE 4.49: Web Application: Course Assignments Submission

#### 4.7.8 Add Course Assignment Page

For uploading the course assignment, teacher will go to the course dashboard and click on the assignment tab. Teacher can upload assignment by clicking on the "Add Assignment" button and upload the assignment file along with title of the assignment and submission time.

The screenshot shows a web form titled "Add Assignment". It includes fields for "Title" (SQL Sub-Queries), "Submission Date and Time" (set to 4/26/2020, 2:37 PM), "Start Date and Time" (set to 4/23/2020, 11:59 PM), and "Assignment File" (Lab Manual 1.pdf). There is a green "Add" button at the bottom.

FIGURE 4.50: Web Application: Add Course Assignments

#### 4.7.9 View Course Lectures Page

User can view course lecture by clicking on the lectures tab in the course dashboard. Where he/she can play the videos of the lectures and can view notes. Teacher will only be able to upload the lecture and see enrolment requests of the course.

Name	Notes	Play Video	Delete
Lecture 1 (SDLC Models)	<a href="#">Notes</a>	Videos	
Lecture 2(Waterfall Model)	<a href="#">Notes</a>	Videos	
Lecture 3(Spiral Model)	<a href="#">Notes</a>	Videos	
Lecture 4(Agile Model)	<a href="#">Notes</a>	Videos	
Lecture 5(Sprint planning)	<a href="#">Notes</a>	Videos	
Lecture 6(Iterative Model)	<a href="#">Notes</a>	Videos	
Lecture 7(Software Testing)	<a href="#">Notes</a>	Videos	

FIGURE 4.51: Web Application: Course Lectures

#### 4.7.10 Lectures Notes Page

User can view lecture notes and also download the lectures by navigating to the lecture notes page. Teacher can add notes as well as delete the lecture notes.

Name	Download	Delete
Notes1		
SDLC Model Details		
SDLC ppt Files		
Suitable Model Selection ppt		
Agile Model ppt		

FIGURE 4.52: Web Application: Lecture Notes

#### 4.7.11 Add Lectures Notes Page

Teacher can upload the notes by clicking the “Add Notes” button un all lectures page. After clicking this button system will redirect the user to the Upload notes page where he/she can upload notes file along with notes description. After adding notes files, teacher will click the add button and notes will get uploaded.

The screenshot shows a web form titled "Add Lecture Notes". It contains two input fields: "Name \*" and "Notes File \*". The "Notes File \*" field includes a small icon of a folder with a document. Below the fields is a large green "Add" button.

FIGURE 4.53: Web Application: Add Lecture Notes

#### 4.7.12 Add Lecture Video Page

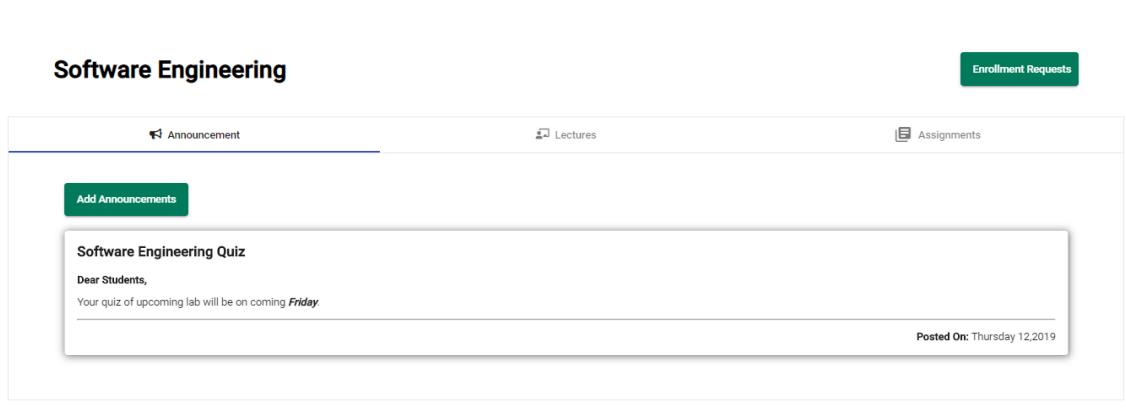
Teacher can upload the lecture video by clicking on video link in the lectures page. Teacher will enter lecture video description along with the video file.

The screenshot shows a web form titled "Add Video Lecture". It contains two input fields: "Name \*" and "Video File \*". The "Video File \*" field includes a small icon of a video camera. Below the fields is a large green "Add" button.

FIGURE 4.54: Web Application: Add Lecture Video

#### 4.7.13 View Course Announcements Page

Users i.e. can view all the course related announcements by clicking on the announcements tab in the course dashboard along with the announcements posted date. Teacher can also add the announcement by clicking on the "Add Announcements" button.

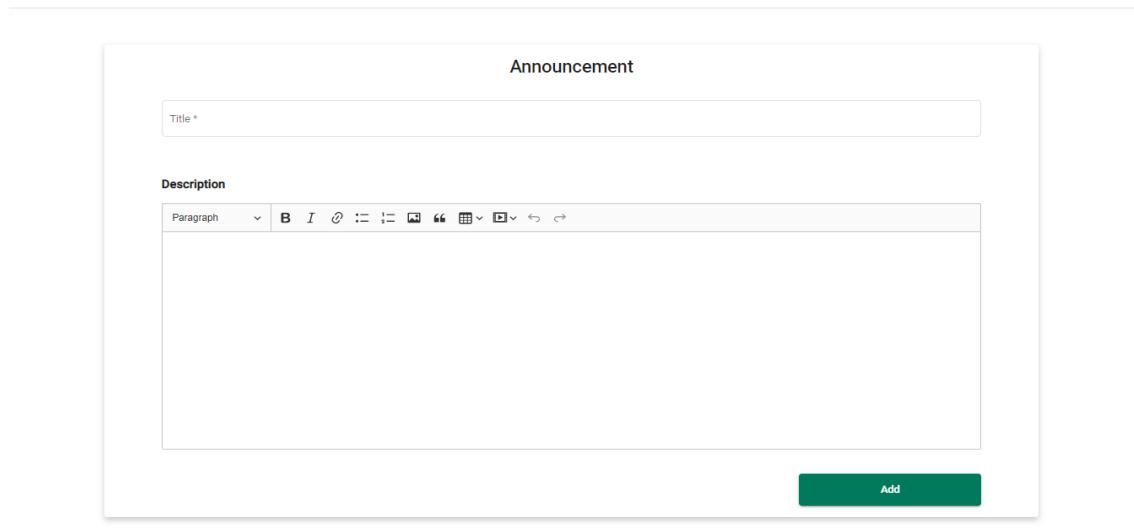


The screenshot shows the course dashboard for "Software Engineering". At the top, there are tabs for "Announcement", "Lectures", and "Assignments". Below the tabs, there is a green button labeled "Add Announcements". A specific announcement is highlighted with a box, titled "Software Engineering Quiz". The message reads: "Dear Students, Your quiz of upcoming lab will be on coming **Friday**". At the bottom right of the announcement box, it says "Posted On: Thursday 12,2019".

FIGURE 4.55: Web Application: See All Announcements

#### 4.7.14 Add Course Announcements Page

Teacher can add announcement of any course by providing the announcement title along with further description of announcement. Teacher will click the "Add" button and announcement will be uploaded.



The screenshot shows the "Add Announcement" form. It has a title field labeled "Title \*". Below it is a rich text editor toolbar labeled "Description". The main area is a large text input field. At the bottom right is a green "Add" button.

FIGURE 4.56: Web Application: Add Announcements

#### 4.7.15 Assign Course to Teacher Page

Admin can assign different courses to different teacher so can teacher can add course content and can access the course details. Admin will click on the assign courses button in the header of main page and system will redirect the user to the course assigned page. Admin will select the course and teacher and click on the "Assign" button. That course will be assigned to teacher. Now teacher will be able to access that course information and can upload course content.

The screenshot shows a web-based application titled 'Assign Course'. It has two dropdown menus: 'Courses \*' containing 'Software Engineering' and 'Teachers \*' containing 'zuhhaazhar989@gmail.com'. A large green 'Save' button is at the bottom.

Courses *	Teachers *
Software Engineering	zuhhaazhar989@gmail.com

Save

FIGURE 4.57: Web Application: Assign Course to Teacher

# Chapter 5

## Evaluation Criteria

Here are the test cases for evaluation of the project:

### 5.1 Web Application

#### 5.1.1 Test Scenario TS-1: User Registration Functionality

**Post-Conditions:** User data successfully sent to admin request approval page.

##### 5.1.1.1 Test Case TC-1: Enter all valid credentials

**Test Steps:**

- Enter valid First Name, Last Name, Email, Password and Registration Number.
- Select a designation & date of birth.
- Click on register button.
- Registration Number: 2016-CS-123

**Test Data:**

- First Name: abc
- Last Name: xyz
- Email: someone@example.com (Email should be already registered on any service.)
- Password: abcd (At least four characters).
- Registration Number: 2016-CS-123

### **5.1.1.2 Test Case TC-2: Enter Invalid First Name**

**Test Steps:**

- Enter invalid First Name
- Enter valid Last Name, Email, Password and Registration Number.
- Select a designation & date of birth.
- Click on register button.

**Test Data:**

- First Name: abc12
- Last Name: xyz
- Email: someone@example.com (Email should be already registered on any service.)
- Password: abcd (At least four characters).
- Registration Number: 2016-CS-123

### **5.1.1.3 Test Case TC-3: Enter Invalid Last Name**

**Test Steps:**

- Enter invalid Last Name
- Enter valid First Name, Email, Password and Registration Number.
- Select a designation & date of birth.
- Click on register button.
- Registration Number: 2016-CS-123

**Test Data:**

- First Name: abc
- Last Name: xyz12
- Email: someone@example.com (Email should be already registered on any service.)
- Password: abcd (At least four characters).
- Registration Number: 2016-CS-123

#### **5.1.1.4 Test Case TC-4: Enter Invalid Email**

**Test Steps:**

- Enter invalid Email
- Enter valid First Name, Password and Registration Number.
- Select a designation & date of birth.
- Click on register button.
- Registration Number: 2016-CS-123

**Test Data:**

- First Name: abc
- Last Name: xyz
- Email: someone.com (Email should be already registered on any service.)
- Password: abcd (At least four characters).
- Registration Number: 2016-CS-123

#### **5.1.1.5 Test Case TC-5: Enter Invalid Password**

**Test Steps:**

- Enter invalid Password.
- Enter valid First Name, Password and Registration Number.
- Select a designation & date of birth.
- Click on register button.
- Registration Number: 2016-CS-123

**Test Data:**

- First Name: abc
- Last Name: xyz

- Email: someone@example.com (Email should be already registered on any service.)
- Password: abc (At least four characters).
- Registration Number: 2016-CS-123

#### **5.1.1.6 Test Case TC-6: Enter Invalid Registration Number**

##### **Test Steps:**

- Enter invalid Registration Number.
- Enter valid First Name, Password and Registration Number.
- Select a designation & date of birth.
- Click on register button.
- Registration Number: 2016-CS-123

##### **Test Data:**

- First Name: abc
- Last Name: xyz
- Email: someone@example.com (Email should be already registered on any service.)
- Password: abcd (At least four characters).
- Registration Number: 2016-CS-1, 2016-CS-A, 2008-123-A, 2016-!A-1, 2016-!A-A, 2019-!A-£, 20!1-AB-1

#### **5.1.2 Test Scenario TS-2: User Login Functionality**

##### **Pre-Conditions:**

- User is approved by the admin.
- User identified and authenticated.
- User's record is saved.

**Post-Conditions:** User is successfully log in to the system.

### **5.1.2.1 Test Case TC-1: Enter all valid credentials**

**Test Steps:**

- Enter valid Email and Password.
- Click on login button.

**Test Data:**

- Email: someone@example.com (Email should be already registered in that system.)
- Password: abcd (password should already registered into the system).

### **5.1.2.2 Test Case TC-2: Enter Invalid Email**

**Test Steps:**

- Enter invalid Email
- Click on login button.

**Test Data:**

- Email: someone.example.com (Email should be already registered in that system)
- Password: abcd (password should already registered into the system).

### **5.1.2.3 Test Case TC-3: Enter Invalid Password**

**Test Steps:**

- Enter invalid Password.
- Enter valid First Name, Password and Registration Number.
- Select a designation & date of birth.
- Click on register button.
- Registration Number: 2016-CS-123

**Test Data:**

- Email: someone@example.com (Email should be already registered in that system)
- Password: c\*d (password should already registered into the system).

### 5.1.3 Test Scenario TS-3: Teacher's Request Approval Functionality

#### Pre-Conditions:

- Admin is logged into the system.
- Admin is identified and authenticated.
- Registration request is sent by the teacher.

**Post-Conditions:** Request is approved by system and approval email is sent to the teacher.

#### Test Steps:

- Click on the approve button.
- Approval email is sent to the user.

### 5.1.4 Test Scenario TS-4: Teacher's Request Disapproval Functionality

#### Pre-Conditions:

- Admin is logged into the system.
- Admin is identified and authenticated.
- Registration request is sent by the teacher.

**Post-Conditions:** Request is disapproved by system and disapproval email is sent to the teacher.

#### Test Steps:

- Click on the disapprove button.
- Disapproval email is sent to the user.

### 5.1.5 Test Scenario TS-5: Students' Request Approval Functionality

#### Pre-Conditions:

- Admin is logged into the system.
- Admin is identified and authenticated.
- Registration request is sent by the student.

**Post-Conditions:** Request is approved by system and approval email is sent to the student.

#### Test Steps:

- Click on the approve button.
- Approval email is sent to the user.

### 5.1.6 Test Scenario TS-6: Students' Request Disapproval Functionality

#### Pre-Conditions:

- Admin is logged into the system.
- Admin is identified and authenticated.
- Registration request is sent by the student.

**Post-Conditions:** Request is approved by system and approval email is sent to the teacher.

#### Test Steps:

- Click on the disapprove button.
- Disapproval email is sent to the user.

### 5.1.7 Test Scenario TS-7: Add Course Functionality

#### Pre-Conditions:

- Admin is logged into the system.
- Admin is identified and authenticated.

#### Post-Conditions:

- Course is successfully added into system.

#### 5.1.7.1 Test Case TC-1: Enter all valid data

##### Test Steps:

- Enter valid Course Name and Course Code.
- Click on Add Course button.

##### Test Data:

- Course name: ABC (course name should contain only alphabets)
- Course Code: 201 (Course code should be unique and not already registered in the system)

#### 5.1.7.2 Test Case TC-2: Enter Invalid Course Name

##### Test Steps:

- Enter invalid Course Name.
- Click on Add Course button.

##### Test Data:

- Course name: ABC12 (course name should contain only alphabets)
- Course Code: 201 (Course code should be unique and not already registered in the system)

### 5.1.7.3 Test Case TC-3: Enter Invalid Course Code

**Test Steps:**

- Enter invalid Course Code.
- Enter valid Course Name.

**Test Data:**

- Course name: ABC (course name should contain only alphabets)
- Course Code: 2B1 (Course code should be unique and contains only numbers)

### 5.1.8 Test Scenario TS-8: Update Course Functionality

**Pre-Conditions:**

- Admin is logged into the system.
- Admin is identified and authenticated.

**Post-Conditions:**

- Course is successfully updated.

#### 5.1.8.1 Test Case TC-1: Enter all valid data

**Test Steps:**

- Enter valid Course Name and Course Code.
- Click on Add Course button.

**Test Data:**

- Course name: ABC (course name should contain only alphabets)
- Course Code: 201 (Course code should be unique and contains only digits.)

### 5.1.8.2 Test Case TC-2: Enter Invalid Course Name

**Test Steps:**

- Enter invalid Course Name.
- Click on Add Course button.

**Test Data:**

- Course name: ABC12 (course name should contain only alphabets)
- Course Code: 201 (Course code should be unique)

### 5.1.8.3 Test Case TC-3: Enter Invalid Course Code

**Test Steps:**

- Enter invalid Course Code.
- Enter valid Course Name.
- Click on the Add Course Button.

**Test Data:**

- Course name: ABC (course name should contain only alphabets)
- Course Code: 2B1 (Course code should be unique and contains only numbers)

## 5.1.9 Test Scenario TS-9: Course Deletion Functionality

**Pre-Conditions:**

- Admin is logged into the system.
- Admin is identified and authenticated.
- Course must be added successfully.

**Post-Conditions:**

- Course details are successfully deleted from the system.

**Test Steps:**

- Click on the delete button.

### 5.1.10 Test Scenario TS-10: View Course Functionality

**Pre-Conditions:**

- User is logged into the system.
- User is identified and authenticated.
- Course must be added successfully.

**Post-Conditions:**

- Course details are viewed.

**Test Steps:**

- Click on the View button.

### 5.1.11 Test Scenario TS-11: Upload Course Assignment Functionality

**Pre-Conditions:**

- Teacher is logged into the system.
- Admin is identified and authenticated.
- Course is added in the system.
- Course is assigned to that teacher.

**Post-Conditions:**

- Course assignment is uploaded successfully updated.

**Test Steps:**

- Upload assignment file.
- Click on Upload Assignment button.

### 5.1.12 Test Scenario TS-12: Downloading Assignment Functionality

#### Pre-Conditions:

- User is logged into the system.
- User is identified and authenticated.
- Assignment must be uploaded successfully.

#### Post-Conditions:

- Assignment is downloaded successfully.

#### Test Steps:

- Click on the download button.

### 5.1.13 Test Scenario TS-13: View Assignment Functionality

#### Preconditions:

- User is identified and authenticated.
- User is logged in the system.
- Student is enrolled in that course.
- Course is assigned to teacher.

#### Post Condition:

- Course Assignment viewed successfully.

#### Test Steps:

- Click on the download button.

### 5.1.14 Test Scenario TS-14: Assignment Deletion Functionality

#### Pre-Conditions:

- Teacher is logged into the system.
- Teacher is identified and authenticated.
- Assignment must be uploaded successfully.

#### Post-Conditions:

- Assignment is deleted successfully.

#### Test Steps:

- Click on the delete button.

### 5.1.15 Test Scenario TS-15: Add Course Announcement Functionality

#### Pre-Conditions:

- Teacher is logged in the system.
- Teacher is identified and authenticated.
- Course is assigned to the teacher.

#### Post-Conditions:

- Course Announcement is added successfully.

#### Test Steps:

- Go to particular course.
- Go to announcements tab.
- Click on Add Announcement button.
- Enter text for announcement.
- Click on add button.

### 5.1.16 Test Scenario TS-16: Edit Course Announcement Functionality

#### Pre-Conditions:

- Teacher is identified and authenticated.
- Teacher is logged in the system.
- Course is assigned to the teacher.

#### Post-Conditions:

- Course Announcement is updated successfully.

#### Test Steps:

- Go to particular course.
- Go to announcements tab.
- Click on edit button.
- Update the announcement.
- Click on save button.

### 5.1.17 Test Scenario TS-17: Delete Course Announcement Functionality

#### Pre-Conditions:

- User is identified and authenticated.
- User is logged in the system.
- Course is assigned to the teacher.

#### Post-Conditions:

- Course announcement is deleted successfully.

#### Test Steps:

- Go to particular course.
- Go to announcements tab.
- Click on delete button.

### 5.1.18 Test Scenario TS-18: Students Assignment Submission Functionality

#### Pre-Conditions:

- User is identified and authenticated.
- User is logged in the system.
- Student is enrolled in that course.

#### Post-Conditions:

- Assignment is submitted successfully.

#### Test Steps:

- Go to particular course.
- Click on submit link in front of particular assignment.
- Select assignment file from device.
- Click on submit button.

### 5.1.19 Test Scenario TS-19: Upload Course Notes Functionality

#### Pre-Conditions:

- Teacher is logged in the system.
- User is identified and authenticated.
- Course is assigned to the teacher.

#### Post-Conditions:

- Course notes uploaded successfully.

#### Test Steps:

- Go to particular course.
- Click on upload notes button.
- Select notes file from device.
- Click on upload button.

### 5.1.20 Test Scenario TS-20: View Course Notes Functionality

#### Pre-Conditions:

- User is identified and authenticated.
- User is logged in the system.
- Student is enrolled in that course.
- Course is assigned to teacher.
- Course Notes are added.

#### Post-Conditions:

- Course notes viewed successfully.

#### Test Steps:

- Go to particular course.
- Go to notes tab to all notes in a list.

### 5.1.21 Test Scenario TS-21: Download Course Notes Functionality

#### Pre-Conditions:

- User is logged in the system.
- User is identified and authenticated.
- Course is assigned to the teacher.
- Student is enrolled in that course.
- Course notes are added.

#### Post-Conditions:

- Course notes downloaded successfully.

**Test Steps:**

- Go to particular course.
- Go to notes tab.
- Click on download button in front of the notes in table.

**5.1.22 Test Scenario TS-22: Delete Course Notes Functionality****Pre-Conditions:**

- Teacher is logged in the system.
- User is identified and authenticated.
- Course is assigned to the teacher.
- Course lectures are added.

**Post-Conditions:**

- Course lectures deleted successfully.

**Test Steps:**

- Go to particular course.
- Go to notes tab.
- Click on delete button in front of the notes in table.

**5.1.23 Test Scenario TS-23: Student Enrolment in Course Functionality****Pre-Conditions:**

- User is identified and authenticated.
- User is logged in the system.
- Course must be added.

**Post-Conditions:**

- Course enrolment request sent to the teacher successfully.

**Test Steps:**

- Go to all courses page.
- Click on enrol button.

**5.1.24 Test Scenario TS-24: Course Enrolment Requests Disapproval Functionality****Pre-Conditions:**

- Teacher is identified and authenticated.
- Teacher is logged in the system.
- Course is added.
- Teacher is assigned a course.

**Post-Conditions:**

- Course enrolment requests are approved.
- On disapproval email is sent to the student.

**Test Steps:**

- Go to the particular course.
- Click on see enrolment requests button.
- Click on disapprove button to disapprove each student.

**5.1.25 Test Scenario TS-25: Course Enrolment Requests Approval Functionality****Pre-Conditions:**

- Teacher is identified and authenticated.

- Teacher is logged in the system.
- Course is added.
- Teacher is assigned a course.

**Post-Conditions:**

- Course enrolment requests are approved.
- On approval email is sent to the student.
- Students can view course details.

**Test Steps:**

- Go to the particular course.
- Click on see enrolment requests button.
- Click on approve button to approve each student.

**5.1.26 Test Scenario TS-26: Assign Courses Functionality****Pre-Conditions:**

- User is logged in the system.
- User is identified and authenticated.
- Courses must be added.

**Post-Conditions:**

- Course is assigned successfully.

**Test Steps:**

- Go to the assigned courses link.
- Select teacher from the dropdown.
- Select course from dropdown.
- Click on assign course button.

### 5.1.27 Test Scenario TS-27: View Students' Assignments Functionality

#### Pre-Conditions:

- Teacher is identified and authenticated.
- Teacher is logged in the system.
- Course is added.
- Teacher is assigned a course.
- Course assignments uploaded.

#### Post-Conditions:

- Students assignments viewed successfully.

#### Test Steps:

- Go to the particular course assigned to teacher.
- Click on all submitted assignments link to see all students assignments.

### 5.1.28 Test Scenario TS-28: Download Students' Assignments Functionality

#### Pre-Conditions:

- Teacher is identified and authenticated.
- Teacher is logged in the system.
- Course is added.
- Teacher is assigned a course.
- Students have submitted the assignments.

#### Post-Conditions:

- Teacher downloaded the assignments successfully.

#### Test Steps:

- Click on download link in front of students' registration number.

## 5.2 Offline Player Application

### 5.2.1 Test Scenario TS-1: User Authentication Functionality

**Post-Conditions:**

- User data successfully sent to server and token successfully saved in local database.

#### 5.2.1.1 Test Case TC-1: Enter Valid Credentials

**Test Steps:**

- Enter valid email.
- Enter valid password.
- Click on login button.

**Test Data:**

- Email: abc@gmail.com
- Password: abcd

#### 5.2.1.2 Test Case TC-2: Enter Invalid Email

**Test Steps:**

- Enter invalid email.
- Enter valid password.
- Click on login button.

**Test Data:**

- Email: abc.com
- Password: abcd

### **5.2.1.3 Test Case TC-3: Enter Invalid Password**

**Test Steps:**

- Enter valid email.
- Enter invalid password.
- Click on login button.

**Test Data:**

- Email: abc@gmail.com
- Password: abc

### **5.2.1.4 Test Case TC-4: Enter All Invalid Credentials**

**Test Steps:**

- Enter invalid email.
- Enter invalid password.
- Click on login button.

**Test Data:**

- Email: abc.com
- Password: abc

## **5.2.2 Test Scenario TS-2: View Lecture Functionality**

**Pre-Conditions:**

- User must be authenticated.

**Post-Conditions:**

- All the downloaded and recently fetched lectures from website are shown in lecture play list.

**Test Steps:**

- Go to play list page.
- Click fetch lectures button.

### 5.2.3 Test Scenario TS-3: Play Lecture Functionality

**Pre-Conditions:**

- User must be authenticated.

**Post-Conditions:**

- All the downloaded and recently fetched lectures from website are shown in lecture play list.

**Test Steps:**

- Go to play list page.
- Click on play button and player screen will open.

### 5.2.4 Test Scenario TS-4: Download Lecture Functionality

**Pre-Conditions:**

- User must be authenticated.

**Post-Conditions:**

- Lecture is downloaded

**Test Steps:**

- Go to play list page.
- Click on download button.

### 5.2.5 Test Scenario TS-5: View About Page Functionality

**Pre-Conditions:**

- User must be authenticated.

**Test Steps:**

- Click on about tab.

### 5.2.6 Test Scenario TS-6: View Contact Us Page Functionality

**Pre-Conditions:**

- User must be authenticated.

**Test Steps:**

- Click on Contact Us tab.

# Chapter 6

## Results

### 6.1 Web Application

#### 6.1.1 Test Scenario TS-1: User Registration Functionality

Postconditions:

- User data successfully sent to admin request approval page.

Test Case Id	Description	Expected Result	Actual Result	Executed By	Status
TC-1	Enter all valid credentials	Successful registration and pop up message "User Successfully registered"	Successful registration and pop up message "User Successfully registered"	Haris	Pass
TC-2	Enter Invalid First Name	Sign up button disabled	Sign up button disabled	Haris	Pass
TC-3	Enter Invalid Last Name	Sign up button disabled	Sign up button disabled	Haris	Pass

TC-4	Enter Invalid Email	Sign up button disabled	Sign up button disabled	Haris	Pass
TC-5	Enter Invalid Password	Sign up button disabled	Sign up button disabled	Haris	Pass
TC-6	Enter Invalid Registration Number	Sign up button disabled	Sign up button disabled	Haris	Pass

TABLE 6.1: Web App: Test Scenario TS-1 Results

### 6.1.2 Test Scenario TS-2: User Login Functionality

#### Pre-Conditions:

- User is approved by the admin.
- User identified and authenticated.
- User's record is saved.

#### Postconditions:

- User is successfully log in to the system.

Test Case Id	Description	Expected Result	Actual Result	Executed By	Status
TC-1	Enter all valid credentials	Successful login	Successful login	Haris	Pass
TC-2	Enter Invalid Email	Login button disabled	Login button disabled	Haris	Pass
TC-3	Enter Invalid Password	Login button disabled	Login button disabled	Haris	Pass

TABLE 6.2: Web App: Test Scenario TS-2 Results

### 6.1.3 Test Scenario TS-3: Teacher's Request Approval Functionality

**Pre-Conditions:**

- Admin is logged into the system.
- Admin is identified and authenticated.
- Registration request is sent by the teacher.

**Post-Conditions:** Request is approved by system and approval email is sent to the teacher.

Expected Result	Actual Result	Executed By	Status
Teacher's request approved and teacher can now login	Teacher's request approved and teacher can now login	Haris	Pass

TABLE 6.3: Web App: Test Scenario TS-3 Results

### 6.1.4 Test Scenario TS-4: Teacher's Request Disapproval Functionality

**Pre-Conditions:**

- Admin is logged into the system.
- Admin is identified and authenticated.
- Registration request is sent by the teacher.

**Post-Conditions:**

- Request is disapproved by system and disapproval email is sent to the teacher.

Expected Result	Actual Result	Executed By	Status
Teacher's request disapproved and teacher cannot login	Teacher's request disapproved and teacher cannot login	Haris	Pass

TABLE 6.4: Web App: Test Scenario TS-4 Results

### 6.1.5 Test Scenario TS-5: Students' Request Approval Functionality

**Pre-Conditions:**

- Admin is logged into the system.
- Admin is identified and authenticated.
- Registration request is sent by the student.

**Post-Conditions:** Request is approved by system and approval email is sent to the student.

Expected Result	Actual Result	Executed By	Status
Student's request approved and student can now login	Student's request approved and student can now login	Haris	Pass

TABLE 6.5: Web App: Test Scenario TS-5 Results

### 6.1.6 Test Scenario TS-6: Students' Request Disapproval Functionality

**Pre-Conditions:**

- Admin is logged into the system.
- Admin is identified and authenticated.
- Registration request is sent by the student.

**Post-Conditions:** Request is approved by system and approval email is sent to the teacher.

Expected Result	Actual Result	Executed By	Status
Student's request dis-approved and student cannot login	Student's request dis-approved and student cannot login	Haris	Pass

TABLE 6.6: Web App: Test Scenario TS-6 Results

### 6.1.7 Test Scenario TS-7: Add Course Functionality

**Pre-Conditions:**

- Admin is logged into the system.
- Admin is identified and authenticated.

**Post-Conditions:**

- Course is successfully added into system.

Test Case Id	Description	Expected Result	Actual Result	Executed By	Status
TC-1	Enter all valid data	Pop up message "Course Added Successfully"	Pop up message "Course Added Successfully"	Haris	Pass
TC-2	Enter Invalid Course Name	Add button disabled	Add button disabled	Haris	Pass
TC-3	Enter Invalid Course Code	Add button disabled	Add button disabled	Haris	Pass

TABLE 6.7: Web App: Test Scenario TS-7 Results

### 6.1.8 Test Scenario TS-8: Update Course Functionality

**Pre-Conditions:**

- Admin is logged into the system.
- Admin is identified and authenticated.

**Post-Conditions:**

- Course is successfully updated.

Test Case Id	Description	Expected Result	Actual Result	Executed By	Status
TC-1	Enter all valid data	Pop up message "Course Updated Successfully"	Pop up message "Course Updated Successfully"	Haris	Pass
TC-2	Enter Invalid Course Name	Save button disabled	Save button disabled	Haris	Pass
TC-3	Enter Invalid Course Code	Save button disabled	Save button disabled	Haris	Pass

TABLE 6.8: Web App: Test Scenario TS-8 Results

### 6.1.9 Test Scenario TS-9: Course Deletion Functionality

**Pre-Conditions:**

- Admin is logged into the system.
- Admin is identified and authenticated.
- Registration request is sent by the student.

**Post-Conditions:** Request is approved by system and approval email is sent to the teacher.

Expected Result	Actual Result	Executed By	Status
Pop up message "Course deleted successfully"	Pop up message "Course deleted successfully"	Haris	Pass

TABLE 6.9: Web App: Test Scenario TS-9 Results

### 6.1.10 Test Scenario TS-10: View Course Functionality

**Pre-Conditions:**

- User is logged into the system.
- User is identified and authenticated.
- Course must be added successfully.

**Post-Conditions:**

- Course details are viewed.

Expected Result	Actual Result	Executed By	Status
Course details page opens on View button click	Course details page opens on View button click	Haris	Pass

TABLE 6.10: Web App: Test Scenario TS-10 Results

### 6.1.11 Test Scenario TS-11: Upload Course Assignment Functionality

**Pre-Conditions:**

- Teacher is logged into the system.
- Admin is identified and authenticated.

- Course is added in the system.
- Course is assigned to that teacher.

**Post-Conditions:**

- Course assignment is uploaded successfully updated.

Expected Result	Actual Result	Executed By	Status
Pop up message "Course Assignment Added Successfully	Pop up message "Course Assignment Added Successfully	Haris	Pass

TABLE 6.11: Web App: Test Scenario TS-11 Results

**6.1.12 Test Scenario TS-12: Downloading Assignment Functionality****Pre-Conditions:**

- User is logged into the system.
- User is identified and authenticated.
- Assignment must be uploaded successfully.

**Post-Conditions:**

- Assignment is downloaded successfully.

Expected Result	Actual Result	Executed By	Status
Assignment down- loaded successfully	Assignment down- loaded successfully	Haris	Pass

TABLE 6.12: Web App: Test Scenario TS-12 Results

### 6.1.13 Test Scenario TS-13: Assignment Deletion Functionality

**Pre-Conditions:**

- Teacher is logged into the system.
- Teacher is identified and authenticated.
- Assignment must be uploaded successfully.

**Post-Conditions:**

- Assignment is deleted successfully.

Expected Result	Actual Result	Executed By	Status
Pop up message "Assignment Deleted Successfully"	Pop up message "Assignment Deleted Successfully"	Haris	Pass

TABLE 6.13: Web App: Test Scenario TS-13 Results

### 6.1.14 Test Scenario TS-14: Add Course Announcement Functionality

**Pre-Conditions:**

- Teacher is logged in the system.
- Teacher is identified and authenticated.
- Course is assigned to the teacher.

**Post-Conditions:**

- Course Announcement is added successfully.

Expected Result	Actual Result	Executed By	Status
Toast message "Announcement Added Successfully"	Toast message "Announcement Added Successfully"	Haris	Pass

TABLE 6.14: Web App: Test Scenario TS-14 Results

### 6.1.15 Test Scenario TS-15: Edit Course Announcement Functionality

#### Pre-Conditions:

- Teacher is identified and authenticated.
- Teacher is logged in the system.
- Course is assigned to the teacher.

#### Post-Conditions:

- Course Announcement is updated successfully.

Expected Result	Actual Result	Executed By	Status
Toast message "Announcement Updated Successfully"	Toast message "Announcement Updated Successfully"	Haris	Pass

TABLE 6.15: Web App: Test Scenario TS-15 Results

### 6.1.16 Test Scenario TS-16: Delete Course Announcement Functionality

#### Pre-Conditions:

- User is identified and authenticated.
- User is logged in the system.

- Course is assigned to the teacher.

**Post-Conditions:**

- Course announcement is deleted successfully.

Expected Result	Actual Result	Executed By	Status
Toast message "Announcement Deleted Successfully"	Toast message "Announcement Deleted Successfully"	Haris	Pass

TABLE 6.16: Web App: Test Scenario TS-16 Results

### 6.1.17 Test Scenario TS-17: Students Assignment Submission Functionality

**Pre-Conditions:**

- User is identified and authenticated.
- User is logged in the system.
- Student is enrolled in that course.

**Post-Conditions:**

- Assignment is submitted successfully.

Expected Result	Actual Result	Executed By	Status
Toast message "Assignment Submitted Successfully"	Toast message "Assignment Submitted Successfully"	Haris	Pass

TABLE 6.17: Web App: Test Scenario TS-17 Results

### 6.1.18 Test Scenario TS-18: Upload Course Notes Functionality

#### Pre-Conditions:

- Teacher is logged in the system.
- User is identified and authenticated.
- Course is assigned to the teacher.

#### Post-Conditions:

- Course notes uploaded successfully.

Expected Result	Actual Result	Executed By	Status
Toast message "Notes Added Successfully"	Toast message "Notes Added Successfully"	Haris	Pass

TABLE 6.18: Web App: Test Scenario TS-18 Results

### 6.1.19 Test Scenario TS-19: View Course Notes Functionality

#### Pre-Conditions:

- User is identified and authenticated.
- User is logged in the system.
- Student is enrolled in that course.
- Course is assigned to teacher.
- Course Notes are added.

#### Post-Conditions:

- Course notes viewed successfully.

Expected Result	Actual Result	Executed By	Status
Notes list shown	Notes list shown	Haris	Pass

TABLE 6.19: Web App: Test Scenario TS-19 Results

### 6.1.20 Test Scenario TS-20: Download Course Notes Functionality

**Pre-Conditions:**

- User is logged in the system.
- User is identified and authenticated.
- Course is assigned to the teacher.
- Student is enrolled in that course.
- Course notes are added.

**Post-Conditions:**

- Course notes downloaded successfully.

Expected Result	Actual Result	Executed By	Status
Notes file downloaded successfully	Notes file downloaded successfully	Haris	Pass

TABLE 6.20: Web App: Test Scenario TS-20 Results

### 6.1.21 Test Scenario TS-21: Delete Course Notes Functionality

**Pre-Conditions:**

- Teacher is logged in the system.
- User is identified and authenticated.

- Course is assigned to the teacher.
- Course lectures are added.

**Post-Conditions:**

- Course lectures deleted successfully.

Expected Result	Actual Result	Executed By	Status
Toast message "Notes file deleted successfully"	Toast message "Notes file deleted successfully"	Haris	Pass

TABLE 6.21: Web App: Test Scenario TS-21 Results

### 6.1.22 Test Scenario TS-22: Student Enrolment in Course Functionality

**Pre-Conditions:**

- User is identified and authenticated.
- User is logged in the system.
- Course must be added.

**Post-Conditions:**

- Course enrolment request sent to the teacher successfully.

Expected Result	Actual Result	Executed By	Status
Student enrolment request sent to admin. Enrol button changes to pending.	Student enrolment request sent to admin. Enrol button changes to pending.	Haris Haris	Pass Pass

TABLE 6.22: Web App: Test Scenario TS-22 Results

### 6.1.23 Test Scenario TS-23: Course Enrolment Requests Disapproval Functionality

**Pre-Conditions:**

- Teacher is identified and authenticated.
- Teacher is logged in the system.
- Course is added.
- Teacher is assigned a course.

**Post-Conditions:**

- Course enrolment requests are approved.
- On disapproval email is sent to the student.

Expected Result	Actual Result	Executed By	Status
Disapproval mail is sent	Disapproval mail is sent	Haris	Pass

TABLE 6.23: Web App: Test Scenario TS-23 Results

### 6.1.24 Test Scenario TS-24: Course Enrolment Requests Approval Functionality

**Pre-Conditions:**

- Teacher is identified and authenticated.
- Teacher is logged in the system.
- Course is added.
- Teacher is assigned a course.

**Post-Conditions:**

- Course enrolment requests are approved.

- On approval email is sent to the student.
- Students can view course details.

Expected Result	Actual Result	Executed By	Status
Approval mail is sent	Approval mail is sent	Haris	Pass

TABLE 6.24: Web App: Test Scenario TS-24 Results

### 6.1.25 Test Scenario TS-25: Assign Courses Functionality

#### Pre-Conditions:

- User is logged in the system.
- User is identified and authenticated.
- Courses must be added.

#### Post-Conditions:

- Course is assigned successfully.

Expected Result	Actual Result	Executed By	Status
Selected course get assigned to teacher and he can now manage that course	Selected course get assigned to teacher and he can now manage that course	Haris	Pass

TABLE 6.25: Web App: Test Scenario TS-25 Results

### 6.1.26 Test Scenario TS-26: View Students' Assignments Functionality

#### Pre-Conditions:

- Teacher is identified and authenticated.
- Teacher is logged in the system.

- Course is added.
- Teacher is assigned a course.
- Course assignments uploaded.

**Post-Conditions:**

- Students assignments viewed successfully.

Expected Result	Actual Result	Executed By	Status
Students assignment page shows all students assignment	Students assignment page shows all students assignment	Haris	Pass

TABLE 6.26: Web App: Test Scenario TS-26 Results

**6.1.27 Test Scenario TS-27: Download Students' Assignments Functionality****Pre-Conditions:**

- Teacher is identified and authenticated.
- Teacher is logged in the system.
- Course is added.
- Teacher is assigned a course.
- Students have submitted the assignments.

**Post-Conditions:**

- Teacher downloaded the assignments successfully.

Expected Result	Actual Result	Executed By	Status
Assignment file downloaded successfully	Assignment file downloaded successfully	Haris	Pass

TABLE 6.27: Web App: Test Scenario TS-27 Results

## 6.2 Offline Player Application

### 6.2.1 Test Scenario TS-1: User Authentication Functionality

**Post-Conditions:**

- User data successfully sent to server and token successfully saved in local database.

Test Case Id	Description	Expected Result	Actual Result	Executed By	Status
TC-1	Enter Valid Credentials	Successful login	Successful login	Hamza	Pass
TC-2	Enter Invalid Email	Pop up message "Invalid email or password"	Pop up message "Invalid email or password"	Hamza	Pass
TC-3	Enter Invalid Password	Pop up message "Invalid email or password"	Pop up message "Invalid email or password"	Hamza	Pass
TC-4	Enter all invalid credentials	Pop up message "Invalid email or password"	Pop up message "Invalid email or password"	Hamza	Pass

TABLE 6.28: Offline Player App: Test Scenario TS-1 Results

### 6.2.2 Test Scenario TS-2: View Lecture Functionality

**Pre-Conditions:**

- User must be authenticated.

**Post-Conditions:**

- All the downloaded and recently fetched lectures from website are shown in lecture play list.

Expected Result	Actual Result	Executed By	Status
Lectures view successfully	Lectures view successfully	Hamza	Pass

TABLE 6.29: Offline Player App: Test Scenario TS-2 Results

**6.2.3 Test Scenario TS-3: Play Lecture Functionality****Pre-Conditions:**

- User must be authenticated.

**Post-Conditions:**

- All the downloaded and recently fetched lectures from website are shown in lecture play list.

Expected Result	Actual Result	Executed By	Status
Player screen opens and lecture start.	Player screen opens and lecture start.	Hamza	Pass

TABLE 6.30: Offline Player App: Test Scenario TS-3 Results

**6.2.4 Test Scenario TS-4: Download Lecture Functionality****Pre-Conditions:**

- User must be authenticated.

**Post-Conditions:**

- Lecture is downloaded

Expected Result	Actual Result	Executed By	Status
Lecture downloaded successfully	Lecture downloaded successfully	Hamza	Pass

TABLE 6.31: Offline Player App: Test Scenario TS-4 Results

### 6.2.5 Test Scenario TS-5: View About Page Functionality

**Pre-Conditions:**

- User must be authenticated.

Expected Result	Actual Result	Executed By	Status
About page opens	About page opens	Hamza	Pass

TABLE 6.32: Offline Player App: Test Scenario TS-5 Results

### 6.2.6 Test Scenario TS-6: View Contact Us Page Functionality

**Pre-Conditions:**

- User must be authenticated.

Expected Result	Actual Result	Executed By	Status
Contact Us page opens	Contact Us page opens	Hamza	Pass

TABLE 6.33: Offline Player App: Test Scenario TS-6 Results

# **Chapter 7**

## **Future Work**

Future work of this project will be to enhance its scope by adding on the concept of machine learning in the web portal and to make hardware module more portable and easy to use. Following are some improvements that can be made in future:

- Use of ordinary board marker:**

If the proposed system hardware is implemented using computer vision techniques then stereo vision cameras will be easily used to detect the position and orientation of even ordinary board marker.

- Increase in Board Dimension:**

With the use of high resolution cameras, the proposed system can be used to record the lecture i.e orientation and position extraction with large board dimensions.

- Noise removal in audio:**

With the implementation of different filtering techniques like adaptive filtering, Kalman filtering, sub-band filtering, gamma filtering and modified Wiener in the proposed project, the noise will be easily removed from the voice recorded.

- Automatic notes generation:**

With the implementation of machine learning algorithm in the online lecture, proposed project will be used for automatic notes generation of each lecture against each video provided on the web portal.

- Complete LMS:**

By adding more functionalities in the web portal e.g admission system, Fee

submission etc. the proposed can be used as a complete LMS for any educational institution in replacement with the manual work.

- **Recording in uncontrolled environment:**

By making proposed system much more efficient i.e. training system on different conditions, the proposed system will be used to record the lecture in any environment mean under dim light of any colored light.

- **Automatic Google searching:**

If the system is trained using machine learning algorithm then proposed system will be used for Google searching of tough terms of unique terms related to lectures automatically to provide the ease for the students to understand the lecture in a better way.

# References

- [1] MuzhirShaban Al Ani and Talal Ali Hammouri. Video Compression Algorithm Based on Frame Difference Approaches. *International Journal on Soft Computing*, 2(4):67–79, 2011. ISSN 22297103. doi: 10.5121/ijsc.2011.2407.
- [2] Jack Barokas, Markus Ketterl, Christopher Brooks, and Jim Greer. Lecture Capture : Student Perceptions , Expectations , and Behaviors. *Digital Media*, pages 1–8, 2010. URL [http://www.informatik.uni-osnabrueck.de/papers\\_pdf/2010\\_02.pdf](http://www.informatik.uni-osnabrueck.de/papers_pdf/2010_02.pdf).
- [3] Christopher Brooks, Graham Erickson, Jim Greer, and Carl Gutwin. Modelling and quantifying the behaviours of students in lecture capture environments. *Computers and Education*, 75:282–292, 2014. ISSN 03601315. doi: 10.1016/j.compedu.2014.03.002. URL <http://dx.doi.org/10.1016/j.compedu.2014.03.002>.
- [4] Niklas Carlsson, Derek Eager, Vengatanathan Krishnamoorthi, and Tatiana Polishchuk. Optimized adaptive streaming of multi-video stream bundles. *IEEE Transactions on Multimedia*, 19(7):1637–1653, 2017. ISSN 15209210. doi: 10.1109/TMM.2017.2673412.
- [5] Chih Ming Chen and Chung Hsin Wu. Effects of different video lecture types on sustained attention, emotion, cognitive load, and learning performance. *Computers and Education*, 80:108–121, 2015. ISSN 03601315. doi: 10.1016/j.compedu.2014.08.015. URL <http://dx.doi.org/10.1016/j.compedu.2014.08.015>.
- [6] Han Ping Chou, Jung Ming Wang, Chiou Shann Fuh, Shih Chi Lin, and Sei Wang Chen. Automated lecture recording system. *2010 International Conference on System Science and Engineering, ICSSE 2010*, pages 167–172, 2010. doi: 10.1109/ICSSE.2010.5551811.
- [7] Benilde García-Cabrero, Michael L. Hoover, Susanne P. Lajoie, Nadia L. Andrade-Santoyo, Lídice M. Quevedo-Rodríguez, and Janice Wong. Design

- of a learning-centered online environment: a cognitive apprenticeship approach. *Educational Technology Research and Development*, 66(3):813–835, 2018. ISSN 15566501. doi: 10.1007/s11423-018-9582-1.
- [8] Michail N. Giannakos, Letizia Jaccheri, and John Krogstie. Exploring the relationship between video lecture usage patterns and students' attitudes. *British Journal of Educational Technology*, 47(6):1259–1275, 2016. ISSN 14678535. doi: 10.1111/bjet.12313.
- [9] Elisardo Gonzalez-Agulla, Jose L. Alba-Castro, Hector Canto, and Vicente Goyanes. GaliTracker: Real-time lecturer-tracking for lecture capturing. *Proceedings - 2013 IEEE International Symposium on Multimedia, ISM 2013*, (Vc):462–467, 2013. doi: 10.1109/ISM.2013.89.
- [10] Paola Iannone and Dominic Miller. Guided notes for university mathematics and their impact on students' note-taking behaviour. *Educational Studies in Mathematics*, pages 387–404, 2019. ISSN 15730816. doi: 10.1007/s10649-018-9872-x.
- [11] Kenneth A. Kiewra, Tiphaine Colliot, and Junrong Lu. Note This: How to Improve Student Note Taking. *Idea*, (September):1–18, 2018. URL [https://www.ideaedu.org/Portals/0/Uploads/Documents/IDEAPapers/IDEAPapers/IDEA\\_Paper\\_73.pdf](https://www.ideaedu.org/Portals/0/Uploads/Documents/IDEAPapers/IDEAPapers/IDEA_Paper_73.pdf).
- [12] Didier J. Le Gall. The MPEG video compression algorithm. *Signal Processing: Image Communication*, 4(2):129–140, apr 1992. ISSN 0923-5965. doi: 10.1016/0923-5965(92)90019-C. URL <https://www.sciencedirect.com/science/article/abs/pii/092359659290019C>.
- [13] Liang Yi Li. Effect of Prior Knowledge on Attitudes, Behavior, and Learning Performance in Video Lecture Viewing. *International Journal of Human-Computer Interaction*, 35(4-5):415–426, 2019. ISSN 15327590. doi: 10.1080/10447318.2018.1543086. URL <https://doi.org/10.1080/10447318.2018.1543086>.
- [14] Yong Teng Lin and Chih Ming Chen. Improving effectiveness of learners' review of video lectures by using an attention-based video lecture review mechanism based on brainwave signals. *Interactive Learning Environments*, 27(1):86–102, 2019. ISSN 17445191. doi: 10.1080/10494820.2018.1451899.
- [15] Chung Kwan Lo and Khe Foon Hew. The impact of flipped classrooms on student achievement in engineering education: A meta-analysis of 10 years

- of research. *Journal of Engineering Education*, (March):523–546, 2019. ISSN 10694730. doi: 10.1002/jee.20293.
- [16] Florence Martin and Doris U. Bolliger. Engagement matters: Student perceptions on the importance of engagement strategies in the online learning environment. *Online Learning Journal*, 22(1):205–222, 2018. ISSN 24725730. doi: 10.24059/olj.v22i1.1092.
- [17] Florence Martin, Chuang Wang, and Ayesha Sadaf. Student perception of helpfulness of facilitation strategies that enhance instructor presence, connectedness, engagement and learning in online courses. *Internet and Higher Education*, 37(March 2017):52–65, 2018. ISSN 10967516. doi: 10.1016/j.iheduc.2018.01.003. URL <https://doi.org/10.1016/j.iheduc.2018.01.003>.
- [18] Maria Meehan and John McCallig. Effects on learning of time spent by university students attending lectures and/or watching online videos. *Journal of Computer Assisted Learning*, 35(2):283–293, 2019. ISSN 13652729. doi: 10.1111/jcal.12329.
- [19] S.V.N. Murthy and B.K. Sujatha. *Multi-Level Optimization in Encoding to Balance Video Compression and Retention of 8K Resolution*. Elsevier GmbH, 2016.
- [20] Frances V. O’Callaghan, David L. Neumann, Liz Jones, and Peter A. Creed. The use of lecture recordings in higher education: A review of institutional, student, and lecturer issues. *Education and Information Technologies*, 22(1):399–415, 2017. ISSN 15737608. doi: 10.1007/s10639-015-9451-z. URL <http://dx.doi.org/10.1007/s10639-015-9451-z>.
- [21] Bianka Patel, Sarah Mislan, Grace Yook, and Adam M. Persky. Recorded lectures as a source of cognitive off-loading. *American Journal of Pharmaceutical Education*, 83(5), 2019. ISSN 15536467. doi: 10.5688/ajpe6793.
- [22] Maria da Graça C. Pimentel, Diogo S. Martins, Cristiane A. Yaguinuma, and Isabela Zaine. Anchoring interactive points of interest on web-based instructional video: Effects on students’ interaction behavior and perceived experience. *Proceedings of the ACM Symposium on Applied Computing*, Part F1477:2445–2452, 2019. doi: 10.1145/3297280.3297521.
- [23] J Renz, M Bauer, M Malchow, T Staubitz, and C Meinel. Optimizing the Video Experience in Moocs. *EDULEARN15 Proceedings*, (July):5150–5158, 2015. ISSN 2340-1117.

- [24] Diyi Yang, MiaoMiao Wen, Iris Howley, Robert Kraut, and Carolyn Rosé. Exploring the effect of confusion in discussion forums of massive open online courses. *L@S 2015 - 2nd ACM Conference on Learning at Scale*, pages 121–130, 2015. doi: 10.1145/2724660.2724677.
- [25] Diyi Yang, Robert Kraut, and Carolyn Rose. Exploring the Effect of Student Confusion in Massive Open Online Courses. *Journal of Educational Data Mining*, 8(1):52–83, 2016. URL <http://www.educationaldatamining.org/JEDM/index.php/JEDM/article/view/JEDM2016-8-1>.