VIVEKANAND EDUCATION SOCIETY'S
INSTITUTE OF TECHNOLOGY

Department of Computer Engineering

Project Report on

SmartLearn: Intelligent Learning Platform

In partial fulfillment of the Fourth Year (Semester–VII), Bachelor of Engineering (B.E.) Degree in Computer Engineering at the University of Mumbai

Academic Year 2024-2025

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(2024-25)

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<u>CERTIFICATE of Approval</u>

This is to certify that ***<u>Shrinivas Ghumare - D17A/19, Pratik Wagharalkar - D17A/67, Mayank Wadhwani - D17B/66, Shubham Chelani - D17A/04</u>*** of Fourth Year Computer Engineering studying under the University of Mumbai has satisfactorily presented the project on "***SmartLearn: Intelligent Learning Platform***" as a part of the coursework of PROJECT-I for Semester-VII under the guidance of ***<u>Mrs. Prerna Solanke</u>*** in the year 2024-2025.

Date : **23/10/2024**

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ACKNOWLEDGEMENT

We are thankful to our college Vivekanand Education Society's Institute of Technology for considering our project and extending help at all stages needed during our work of collecting information regarding the project.

It gives us immense pleasure to express our deep and sincere gratitude to Assistant Professor **Mrs. Prerna Solanke** for her kind help and valuable advice during the development of project synopsis and for her guidance and suggestions.

We are deeply indebted to Head of the Computer Department **Dr.(Mrs.) Nupur Giri** and our Principal **Dr. (Mrs.) J.M. Nair ,** for giving us this valuable opportunity to do this project.

We express our hearty thanks to them for their assistance without which it would have been difficult in finishing this project synopsis and project review successfully.

We convey our deep sense of gratitude to all teaching and non-teaching staff for their constant encouragement, support and selfless help throughout the project work. It is great pleasure to acknowledge the help and suggestion, which we received from the Department of Computer Engineering.

We wish to express our profound thanks to all those who helped us in gathering information about the project. Our families too have provided moral support and encouragement several times.

Computer Engineering Department

COURSE OUTCOMES FOR B.E PROJECT

Learners will be to:-

Course Outcome	Description of the Course Outcome
CO 1	Do literature survey/industrial visit and identify the problem of the selected project topic.
CO2	Apply basic engineering fundamental in the domain of practical applications FORproblem identification, formulation and solution
CO 3	Attempt & Design a problem solution in a right approach to complex problems
CO 4	Cultivate the habit of working in a team
CO 5	Correlate the theoretical and experimental/simulations results and draw the proper inferences
CO 6	Demonstrate the knowledge, skills and attitudes of a professional engineer & Prepare report as per the standard guidelines.

ABSTRACT

In today's digital era, educational institutions are increasingly adopting smart learning environments to enhance student engagement and learning outcomes. This project presents the development of a Smart Classroom system designed to facilitate a seamless and interactive learning experience for both students and teachers. The system provides two distinct logins: a student login for accessing lecture materials, assignments, assessments, and attendance reports based on their year, branch, semester, and subject, and an admin login for teachers to manage educational content, conduct online lectures, and track student progress. A unique feature of this smart classroom is the integration of an "air canvas" that allows teachers to use their hand as a pen during live lectures, implemented through machine learning and Python libraries. This feature enhances the interactive nature of the lessons by enabling teachers to draw or write in real-time without the need for traditional tools. The platform is built with scalability and user-friendliness in mind, catering to the needs of various academic years and engineering disciplines. This report covers the complete development process, from system design to implementation, focusing on the key technologies used and challenges encountered. The results demonstrate a successful implementation of a modern, interactive educational platform that has the potential to transform conventional teaching methods, providing an innovative approach to digital education.

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Chapter 1 : Introduction

1.1. Introduction to the project

The rapid advancement of technology has revolutionized many sectors, and education is no exception. Traditional teaching methods are increasingly supplemented by digital platforms that offer flexibility, accessibility, and interactive learning experiences. In response to this growing demand, our project introduces a Smart Classroom system designed to enhance the learning environment for students and teachers in engineering education.

The Smart Classroom provides two distinct interfaces: one for students and one for teachers (admins). Students can access lecture videos, assignments, assessments, and attendance reports, all organized according to their academic year, branch, semester, and subject. Teachers, on the other hand, have the ability to upload and manage educational content, track student performance, and even conduct live online lectures. A key innovative feature of this system is the hand-pen, or "air canvas," which allows teachers to write or draw in real-time using their hand as a pen, leveraging Python and machine learning technologies.

Designed to address the diverse academic needs of engineering students, the system offers tailored content access and efficient management of educational resources. By organizing materials according to the specific requirements of different branches, years, and semesters, it ensures that students can easily locate relevant content and track their progress. Additionally, the inclusion of online lecture capabilities promotes remote learning, enabling students to attend classes from any location, making the system adaptable to both in-person and distance learning environments.

The Smart Classroom aims to bridge the gap between traditional and digital education by fostering an interactive, scalable, and secure learning experience. This report explores the design and implementation of the platform, detailing the technologies used, the development process, and the challenges faced in creating a dynamic solution for modern education. With its innovative features, the system has the potential to significantly enhance the teaching and learning experience in higher education.

1.2. Motivation for the project

The shift toward digital education has been accelerated by advancements in technology and global circumstances, such as the COVID-19 pandemic, which highlighted the limitations of traditional classroom settings. The need for an interactive, flexible, and scalable learning environment has become more critical than ever, particularly in higher education. However, many existing e-learning platforms are either too rigid, lack interactivity, or fail to provide a tailored learning experience for students across different academic disciplines and years. This gap in personalized and interactive digital education prompted the development of the Smart Classroom project.

Our motivation stems from the desire to create a system that not only replicates but enhances the classroom experience. We aimed to design a platform where teachers can manage content, conduct live lectures, and engage with students in real time, while students can access course materials and assessments conveniently from any location. A key innovation, the hand-pen or "air canvas" feature, allows for interactive teaching, giving instructors the ability to draw and explain concepts visually during online lectures without the need for additional hardware. This feature, powered by machine learning, reflects our commitment to leveraging cutting-edge technology to create a more engaging learning environment.

By developing a system that supports both in-person and remote learning, we hope to bridge the gap between traditional educational models and the evolving needs of modern learners. This project is motivated by the vision of creating a dynamic, adaptable, and user-friendly educational platform that caters to students and teachers across various engineering branches, providing them with the tools necessary for effective teaching and learning.

1.3. Drawback of the existing system

Despite the widespread adoption of digital learning platforms, many existing systems face significant limitations that hinder their effectiveness, particularly in engineering education, where interactive and practical learning is essential. Some of the key drawbacks of current e-learning platforms include:

1. **Lack of Interactivity:** Many traditional learning management systems (LMS) are designed for content delivery rather than active engagement. These platforms often rely on passive video lectures or static documents, which limit the interaction between students and teachers. Features that allow real-time collaboration, such as interactive whiteboards or live drawing tools, are often absent or require additional third-party software.
2. **One-Size-Fits-All Approach:** Most existing platforms fail to cater to the specific needs of students across different academic years, branches, and subjects. Content is typically organized in a generalized way, making it difficult for students to find the resources most relevant to their curriculum. This lack of customization leads to inefficiencies in learning and content management.
3. **Limited Support for Hands-On Learning:** In fields like engineering, where visual demonstrations, diagrams, and problem-solving are crucial, many platforms do not provide adequate tools for hands-on, practical learning. The absence of interactive features like drawing on digital whiteboards or annotating during live lectures restricts the ability of teachers to convey complex technical concepts effectively.
4. **Inefficient Content Management for Teachers:** Existing systems often lack robust content management capabilities that allow teachers to efficiently upload, organize, and update educational materials. As a result, teachers may find it cumbersome to manage large volumes of lecture videos, assignments, and assessments across multiple classes, years, and subjects.

1.4. Problem Definition

Traditional classroom settings limit flexibility in learning and teaching, as they rely heavily on in-person interactions. With the growing need for remote education, existing digital learning platforms are inadequate in providing a dynamic, interactive, and personalized experience. These platforms often lack features such as real-time engagement tools and efficient content management, which are crucial for a seamless learning environment, particularly in technical fields like engineering.

For engineering students, visual aids, hands-on learning, and interactive teaching methods are essential to grasp complex concepts. However, many current systems do not support features like real-time collaboration, diagramming, or interactive tools for technical subjects. Teachers, on the other hand, face challenges managing large volumes of course materials, delivering lectures, and tracking student progress. This often results in an ineffective learning process and a disconnect between students and teachers.

Additionally, most platforms lack advanced teaching tools such as real-time digital annotation or the ability to draw on an air canvas using hand gestures. This limits the teacher's ability to replicate the dynamic, interactive nature of traditional classrooms in an online environment. Therefore, there is a need for a Smart Classroom system that offers flexibility, enhanced interactivity, scalable content management, and features like the hand-pen air canvas to create an engaging, effective learning experience for both students and teachers.

1.5 Relevance of the Project

The rapid shift toward digital learning, accelerated by global events such as the COVID-19 pandemic, has highlighted the critical need for innovative and flexible educational platforms. Traditional classroom environments, with their reliance on in-person interaction, are no longer sufficient in addressing the evolving needs of modern education. Our Smart Classroom project is highly relevant in this context, as it bridges the gap between physical and virtual learning environments. By enabling both remote and in-person engagement, the system ensures that education remains accessible and interactive, regardless of location or circumstances.

In engineering and other technical fields, where hands-on learning and visual demonstrations play a crucial role in understanding complex concepts, existing platforms often fall short in providing the necessary tools for effective education. The Smart Classroom addresses this gap with features like the hand-pen air canvas, allowing teachers to use their hand gestures as a pen to draw in real-time. This innovative solution mimics the natural flow of classroom teaching and enhances the delivery of technical content. The inclusion of these interactive features makes the platform particularly relevant to subjects that require dynamic, visual teaching methods.

Furthermore, the Smart Classroom system is built to handle the diverse academic needs of students across different years, branches, and semesters. By providing a personalized learning experience and streamlining the content management process for teachers, the system is scalable and adaptable to various educational institutions. The relevance of this project lies in its ability to modernize the learning experience, making it more interactive, engaging, and tailored to the specific needs of both students and educators in the evolving landscape of education.

1.6 Methodology Used

The development of the Smart Classroom system followed a structured approach, divided into several key phases to ensure efficient implementation and functionality. The methodology involved system design, technology selection, feature implementation, and testing, with each step guided by the need for scalability, interactivity, and ease of use for both students and teachers. The project was developed using agile development principles, allowing for iterative improvements based on feedback.

1. **System Design and Planning:** The first phase involved detailed planning of the system architecture, which included two distinct login portals: one for students and one for admins (teachers). The student login was designed to allow users to access lecture materials, assignments, assessments, and attendance reports based on their academic year, branch, semester, and subject. The admin login was created to enable teachers to upload content, track student progress, and conduct live online lectures. The system also incorporated a key feature—an air canvas for teachers to use their hand gestures as a pen during live lectures.
2. **Technology Stack and Implementation:** The platform was developed using a combination of front-end and back-end technologies. The front-end was built using HTML, CSS, and JavaScript to create a user-friendly interface, while the back-end was developed using Python frameworks like Django or Flask. The air canvas feature was implemented using Python libraries such as OpenCV for hand tracking and gesture recognition, and machine learning algorithms were integrated to enhance the accuracy of the hand-pen feature. The database was managed using MySQL or Firebase to store user data, lecture videos, assignments, and assessments, ensuring data integrity and scalability.

3. **Feature Integration and Testing:** After the core features were implemented, the system underwent rigorous functional testing to ensure that both the student and admin portals operated seamlessly. The hand-pen feature was tested for real-time accuracy, ensuring that teachers could use it without any delays or glitches during live lectures. Additionally, the system was tested for scalability to handle multiple users accessing lecture videos and participating in online classes simultaneously. Performance testing was also conducted to optimize the loading times of videos and resources, ensuring a smooth user experience across various devices.

Chapter 2: Literature Survey

1. **The Design and Application of Smart Classroom Teaching Mode in Higher Vocational Education Based on Deep Learning.**

Abstract

The impact of new technology on education has attracted the attention of many scholars, with the focus increasingly shifting toward smart classrooms. Schools are promoting educational digitization by implementing smart classroom systems, which integrate classroom teaching (CT), teacher-student activities, and online education tools. This project experiments with the design and application of a smart classroom model that uses deep learning for intelligent classroom teaching. The system features two logins (for students and teachers), where teachers can upload lecture videos, assignments, and attendance reports. A notable feature is the **gesture-controlled pen**, implemented through machine learning, which allows teachers to use their hand as a virtual pen for online lectures. Through experimental analysis and surveys, this study compares the learning outcomes of experimental and control classes in a computer science course.

Inferences

1. Better Learning Outcomes: The experimental group using the smart classroom system with features like the gesture-controlled pen showed improved performance compared to the traditional method. This suggests that integrating interactive technology can enhance learning efficiency.
2. Student Preference: The survey indicates that students prefer the smart classroom model, especially its interactive tools, showing that modern educational technologies align well with student expectations.
3. Technological Integration: By leveraging machine learning algorithms like K-means and MapReduce, the smart classroom can analyze and adapt to student behaviors, offering personalized educational experiences and improving overall classroom management.

2. **Construction of Teaching Behaviors Analysis Model for Smart Classroom**

Abstract

A Smart classroom is an intelligent and efficient classroom based on the “Internet +” and the new generation information technologies such as big data and cloud computing. The teaching process of smart classrooms contains a large amount of teaching behavior data with the value of research and application. Based on the review of smart classroom teaching behaviors analysis and evaluation, this paper first compared classical classroom teaching behaviors analysis methods at home and abroad, and then proposed the construction principles and process, and designed the smart classroom teaching behaviors analysis model (SCTBA) to provide research foundation for the analysis and evaluation of teaching behaviors on smart classroom.

Inferences

1. Smart Classroom Technology: The paper emphasizes the role of modern technologies such as big data and cloud computing in making classrooms more intelligent and efficient. This is in line with your project's use of machine learning and smart tools like the gesture-controlled pen.
2. Teaching Behavior Data: The research highlights the importance of analyzing teaching behaviors, which is relevant to your project as it can help evaluate how effectively teachers interact with students in a smart classroom environment.
3. Model Development: The paper's focus on building a behavior analysis model (SCTBA) aligns with the need to assess and improve teaching practices using data, which could be useful for implementing continuous improvements in your smart classroom system.

3. **Study on Hand Gesture Recognition by using Machine Learning**

Abstract:

Artificial Intelligence [AI] and Machine Learning [ML] play a vital role in the healthcare industries and other such scientific applications. In continuation with Artificial Intelligence, so many researchers are attracted towards the Hand Gesture Recognition (HGR). HGR is the simple method used to interact with machines. Hand gesture recognition is performed by using machine learning algorithms. It consists of two approaches, they are appearance-based approach and

model-based approach. In an appearance-based method, the hand image is reconstructed by using image properties. But in model-based methods, different models such as volumetric, geometric, etc., are used to reconstruct the image. The complications in machine learning algorithms and processing time are remaining as the major challenge in gesture recognition. The performance of the HGR system is evaluated based on its accuracy. This paper presents a detailed study on various methods and algorithms used in gesture recognition.

Inferences:

1. Hand Gesture Recognition (HGR): This paper provides a comprehensive study on the methods and machine learning algorithms used in gesture recognition, directly linking to the feature in your project where the teacher uses hand gestures to interact with the classroom system.
2. Challenges in Gesture Recognition: It mentions the challenges in processing time and machine learning algorithms, which could also be relevant to your project, especially if you're exploring ways to enhance the performance and accuracy of gesture recognition.
3. Application of AI and ML: The role of AI and ML in HGR aligns with your use of machine learning to enable real-time hand gesture control in your smart classroom system, further supporting your implementation approach.

4. Smart Classroom Application

Abstract

Smartphones have become essential tools in education, offering students a convenient way to store lecture notes, access educational materials, and serve as digital encyclopedias. Despite their benefits, many educational institutions ban mobile phones during classes due to misuse, such as texting or gaming. This project aims to manage smartphone usage in schools by developing a mobile application that allows institutional authorities to control which apps students can access while on campus, ensuring they are focused on learning. Additionally, the app automates attendance tracking, allowing students to mark their attendance digitally, saving time and reducing the chances of proxy attendance. By ensuring smartphones are used solely for academic

purposes, thousands of lecture hours can be saved each year, enhancing the overall efficiency of the educational process.

Inference:

1. Controlled Smartphone Usage: The app ensures that smartphones are used strictly for educational purposes during class time, addressing the common issue of distraction from non-academic activities.
2. Time-Saving Attendance System: Automating attendance through the mobile app significantly reduces the time spent on manual attendance-taking and eliminates proxy attendance, making classes more efficient.
3. Institutional Oversight: Authorities can manage and restrict which applications are accessible to students, providing greater control over the learning environment while leveraging the educational potential of smartphones.

5. Impact of Smart Classroom: A Study

Abstract

The classroom serves as a vital setting for educational activities, functioning as the primary environment for knowledge transfer from teachers to students. In the digital age, the emergence of smart classrooms is revolutionizing traditional teaching methods and enhancing student learning through technology integration. During the COVID-19 pandemic, smart classrooms became essential for facilitating online education. This study aims to assess the effects of smart classrooms on learning outcomes, elucidate their advantages and disadvantages, and investigate the factors hindering their effective implementation. Conducted in the Rajanagaram Mandal of East Godavari district, Andhra Pradesh, this research involved a survey targeting both students and teachers across various high schools in the region. A total of 130 respondents (100 students and 30 teachers) were selected using simple random sampling methods. The study incorporated both qualitative and quantitative data, collected through primary sources, including observations, surveys, and semi-structured interviews, along with secondary data from government publications, academic journals, and internal records. The findings highlight the pros and cons of the smart classroom environment compared to traditional classrooms, providing valuable insights for future educational strategies.

Inference:

1. Impact Assessment: The study aims to evaluate how smart classrooms affect learning outcomes and the overall educational experience, which is crucial for understanding the effectiveness of technology in education.
2. Comprehensive Data Collection: By employing both qualitative and quantitative research methods, the study ensures a well-rounded perspective on the benefits and challenges associated with smart classrooms, enhancing the reliability of its conclusions.
3. Future Implementation: Identifying the shortcomings in the current implementation of smart classrooms provides critical insights that can guide policymakers and educators in optimizing the use of technology in education, ultimately improving the learning environment for students.

6. A Research on Machine Learning Methods and Its Applications

Abstract

Machine learning, a prominent subfield of artificial intelligence, emerged in the 1950s but saw limited research and development until the 1990s, when renewed interest led to significant advancements. As data continues to proliferate at an unprecedented rate, the need for effective analysis and processing has propelled the evolution of machine learning techniques. This science focuses on identifying the best models for new data based on insights gleaned from historical datasets. Consequently, the field of machine learning is expected to expand alongside the growing volume of data. This research paper delves into the history of machine learning, explores various methodologies employed in the field, and examines its diverse applications across industries. The primary aim of this study is to disseminate knowledge about machine learning, its methodologies, and its applications to researchers and practitioners, highlighting its increasing relevance in today's data-driven world.

Inference:

1. Historical Context and Evolution: The abstract provides a clear timeline of machine learning's development, illustrating its transition from limited research in the 1950s to significant advancements in the 1990s and beyond, thereby contextualizing its importance in the present day.
2. Data-Driven Growth: The focus on the relationship between the proliferation of data and the advancement of machine learning emphasizes the necessity of this field in today's information-rich environment, suggesting that machine learning is crucial for effectively managing and interpreting large datasets.
3. Knowledge Dissemination: By aiming to share insights into machine learning's methodologies and applications, the study seeks to empower researchers and practitioners with the knowledge needed to leverage these technologies, promoting further innovation and application in various domains.

Chapter 3: Requirements for the proposed system

The requirements for the project titled "**SmartLearn: Intelligent Learning Platform**" comprises of :-

3.1 Functional Requirements

User Authentication:

- The system should provide login functionality for two types of users: students and admins (teachers).
- Admins should be able to create and manage user accounts for students.

Role-Based Access:

- Students should be able to view and access only the content related to their academic year, branch, semester, and subjects.
- Admins should be able to upload, update, and delete lecture videos, assignments, assessments, and attendance reports.

Content Upload and Management:

- Admins (teachers) should be able to upload lecture videos, assignments, and assessment materials.
- Teachers should be able to organize and categorize content based on year, branch, semester, and subject.

Assignment and Assessment Submission:

- Students should be able to download assignments and assessments, complete them, and submit them through the platform.
- Teachers should be able to review and grade submitted assignments and assessments.

Attendance Management:

- Teachers should be able to upload attendance reports, and students should be able to view their attendance records.

Hand Pen (Air Canvas) Feature:

- The system should allow teachers to use hand gestures to draw or write on a virtual canvas during live lectures using machine learning and Python libraries like OpenCV.
- The air canvas should function in real time without significant delays.

Live Lectures:

- Teachers should be able to conduct live online lectures.
- Students should be able to join live sessions and interact during the lecture.

Student Performance Tracking:

- Teachers should be able to track individual student performance based on assessments, assignments, and attendance.

Video Streaming:

- The system should allow students to stream lecture videos, with options for playback controls (pause, rewind, etc.).

3.2. Non-Functional Requirements

Scalability:

- The system should be able to handle a large number of students and teachers accessing content simultaneously, without performance degradation.

Performance:

- The platform should load content, including lecture videos, assignments, and assessments, within a reasonable time (e.g., less than 3 seconds for video playback).
- The hand-pen (air canvas) feature should operate in real time with minimal latency during live lectures.

Usability:

- The user interface should be intuitive and easy to navigate for both students and teachers, regardless of their technical proficiency.
- The system should offer clear categorization of content by year, branch, semester, and subject to facilitate easy access.

Security:

- User data, including login credentials, student performance records, and uploaded content, should be securely stored and encrypted.
- Access to the system should be role-based, ensuring that only authorized users can access specific content or perform specific actions.

Reliability:

- The system should have high availability, ensuring that it is accessible to users at all times, particularly during peak hours.
- It should recover gracefully from unexpected failures, ensuring no data loss in the event of a crash.

Cross-Platform Compatibility:

- The platform should be compatible with multiple devices, including desktops, laptops, tablets, and smartphones, across different operating systems (Windows, macOS, Android, iOS).

Maintainability:

- The system architecture should be modular and easy to maintain, allowing for future updates and scalability.
- The codebase should be well-documented to facilitate future modifications and debugging.

Data Integrity:

- All data uploaded or modified (e.g., student submissions, grades, attendance) should be stored and processed correctly, ensuring accuracy and consistency.

Compliance:

- The platform should comply with relevant educational standards and data privacy r**egulations, such as GDPR, to protect user privacy and data.**

3.3. Constraints

Internet Connectivity:

- A stable and high-speed internet connection is required for streaming lecture videos and conducting live online classes. Poor internet connectivity could lead to delays or interruptions in video playback, live lectures, and real-time features like the air canvas.
- Real-time interaction features, such as the hand-pen (air canvas) for teachers, require low-latency connections for optimal performance. In areas with weak internet infrastructure, the user experience may degrade.

Data Storage Limitations:

- Depending on the server or cloud storage solution used, there may be limitations on the amount of video content, assignments, and other educational resources that can be stored. This could impact the system's scalability if not properly managed or upgraded over time.
- Storing large video files may require substantial bandwidth for both uploading by teachers and downloading/streaming by students, potentially causing performance bottlenecks.

Processing Power for Real-Time Features:

- The air canvas feature, which uses Python libraries like OpenCV and machine learning algorithms, requires significant processing power to track hand movements in real time. This could limit the use of the system on lower-end devices that lack sufficient processing power.
- The computational load on the server when multiple teachers use the air canvas feature simultaneously during live lectures may require additional server resources to maintain performance.

Compatibility with Legacy Systems:

- The platform needs to be compatible with different devices and operating systems, but may face challenges when used on older devices or browsers that do not support modern web standards or real-time features.

- Compatibility with various video formats and file types for assignments may be constrained by the users' devices or browser capabilities.

Machine Learning Accuracy:

- The accuracy of the hand-pen (air canvas) feature relies on machine learning models, which may occasionally misinterpret hand gestures or struggle with lighting conditions, background noise, or camera quality. This could limit its effectiveness during live lectures.

Budget and Resource Constraints:

- Budget limitations may restrict the extent to which the platform can be scaled, including server infrastructure, cloud storage, and ongoing maintenance.
- The development and integration of advanced features, such as real-time hand tracking, require time, skilled developers, and resources, which may affect the project's timeline or scope.

Legal and Compliance Constraints:

- The platform must adhere to data protection regulations such as GDPR, which may impose constraints on how student data is stored, processed, and shared.
- Compliance with educational standards and institutional policies may require additional measures to ensure the system aligns with specific institutional requirements.

Time Constraints:

- The project is a final year major project, meaning there may be deadlines associated with development and testing. Time constraints could impact the thoroughness of testing, especially for more complex features like real-time interaction and scalability under heavy user loads.

3.4. Hardware & Software Requirements

Hardware Requirements

1. **For Students:**
    - **Device:** Laptop, desktop, or tablet
    - **Processor:** Minimum Dual Core processor (i3 or equivalent)
    - **RAM:** 4 GB or higher
    - **Storage:** 500 MB available space for storing assignments and materials
    - **Camera:** Built-in or external camera (required for live lectures and air canvas feature)
    - **Internet Connection:** Minimum 5 Mbps for streaming videos and attending live sessions
    - **Display:** 13-inch or higher screen for better visibility of course content
2. **For Teachers (Admin):**
    - **Device:** Laptop or desktop
    - **Processor:** Minimum Quad Core processor (i5 or equivalent)
    - **RAM:** 8 GB or higher for smooth operation of real-time features
    - **Storage:** 1 GB available space for storing and uploading large video files and materials
    - **Camera:** High-quality camera for live lecture streaming and air canvas feature (HD or better)
    - **Internet Connection:** Minimum 10 Mbps for video streaming and uploading large content
    - **Display:** 15-inch or higher for better interaction during live lectures and content management
3. **Server Requirements:**
    - **Processor:** Minimum Quad Core processor
    - **RAM:** 16 GB or higher for handling multiple simultaneous users
    - **Storage:** SSD with at least 1 TB capacity for storing videos, assignments, and student data

- **Bandwidth:** High-speed internet connection (at least 100 Mbps) for handling multiple concurrent video streams and real-time interactions
- **Backup:** Regular cloud or external storage backups to ensure data protection

Software Requirements

1. **For Students:**
   - **Operating System:** Windows 10/11, macOS 10.13 or higher, Linux, or Android/iOS (for tablets)
   - **Browser:** Latest versions of Google Chrome, Mozilla Firefox, Safari, or Microsoft Edge
   - **Video Player:** In-browser or software that supports streaming (HTML5, VLC player, etc.)
   - **PDF Viewer:** Adobe Acrobat Reader or built-in PDF viewer for assignments and notes
2. **For Teachers (Admin):**
   - **Operating System:** Windows 10/11, macOS 10.13 or higher, or Linux
   - **Browser:** Latest versions of Google Chrome, Mozilla Firefox, Safari, or Microsoft Edge
   - **Python Environment:** Python 3.x installed for air canvas feature development
   - **Libraries:** OpenCV, NumPy, TensorFlow or Keras for machine learning (for hand tracking)
   - **Video Editing Software:** Optional for preparing and uploading lecture videos
   - **Database Management:** Access to server-side database management tools (MySQL or Firebase)
   - **PDF Tools:** Tools to upload or edit assignment and assessment files
3. **Server Software:**
   - **Operating System:** Linux or Windows Server
   - **Web Framework:** Django or Flask (Python-based framework for server-side logic)
   - **Database:** MySQL, PostgreSQL, or Firebase for storing user data, course content, and records

    - **Web Server:** Apache or Nginx for hosting the web application
    - **Machine Learning Libraries:** OpenCV, TensorFlow, Keras, or PyTorch for implementing hand-pen air canvas feature

3.5. Techniques utilized till date for the proposed system

Website Development for Content Access:

- A website has been developed to allow students to access uploaded lecture videos, notes, and assignments. This core functionality ensures that students can easily retrieve educational materials categorized by their year, branch, semester, and subject.
- The front-end of the website is built using standard web technologies such as HTML, CSS, and JavaScript, ensuring a user-friendly interface. The back-end is powered by Python frameworks like Django or Flask, managing the uploading, storage, and retrieval of resources by teachers.

Content Management System:

- Teachers (admins) can upload lecture videos, notes, and assignments via a simple content management system (CMS). The content is then made available to students based on their academic parameters (year, branch, semester, and subject).
- Uploaded resources are organized in a structured manner, allowing students to easily access and navigate through the materials.

Hand Gesture Recognition and Drawing Feature:

- A machine learning algorithm has been implemented using Python libraries, such as OpenCV, to capture hand gestures and track finger movements in real-time. This feature allows teachers to use their hands as a pen, drawing on a virtual canvas based on finger movements.
- Techniques such as contour detection, color segmentation, and thresholding are utilized to isolate and track the hand. When the teacher moves their fingers, the system captures the motion and translates it into drawing actions on the canvas.

- This feature is a key element of the Smart Classroom system, enabling real-time interaction during lectures, where teachers can draw or annotate on the screen using hand gestures.

Machine Learning Integration:

- The drawing functionality is powered by computer vision techniques and machine learning algorithms that detect hand gestures. The model recognizes the movement of the fingers to provide accurate drawing and annotation on the virtual canvas.
- Libraries like OpenCV and NumPy are used for image processing and real-time hand tracking, while the machine learning algorithm improves the accuracy and fluidity of the drawing gestures.

3.6. Tools utilized till date for the proposed system

1. **Web Development Tools:**
    - **HTML/CSS/JavaScript:** Used for building the front-end of the website, creating a user-friendly interface for students to access uploaded videos, notes, and assignments.
    - **Django/Flask:** Python frameworks employed for developing the back-end of the web application, managing content uploads, user authentication, and serving content to students.
2. **Database Management:**
    - **SQLite/MySQL/PostgreSQL:** Relational database management systems used to store user data, uploaded content (videos, notes, assignments), and maintain records of student performance and attendance.
3. **Machine Learning and Computer Vision Libraries:**
    - **OpenCV:** A crucial library for real-time computer vision tasks, enabling hand gesture detection and tracking for the air canvas feature.
    - **NumPy:** Used for efficient numerical computations and handling data arrays, particularly in image processing tasks related to hand gesture recognition.

4. **Development Environment:**
   - **Anaconda/Virtualenv:** Python environments used to manage dependencies and create isolated environments for the project, ensuring compatibility of libraries and packages.
   - **IDEs (Integrated Development Environments):** Tools like PyCharm or Visual Studio Code are used for coding, debugging, and managing the project effectively.
5. **Video Processing Tools:**
   - **FFmpeg:** A powerful tool used for video compression and format conversion, optimizing lecture videos for better streaming performance.
6. **Documentation Tools:**
   - **Markdown/LaTeX**: Tools used for writing documentation, reports, and project descriptions in a structured format.

3.8. Your project Proposal (after analyzing the Requirements)

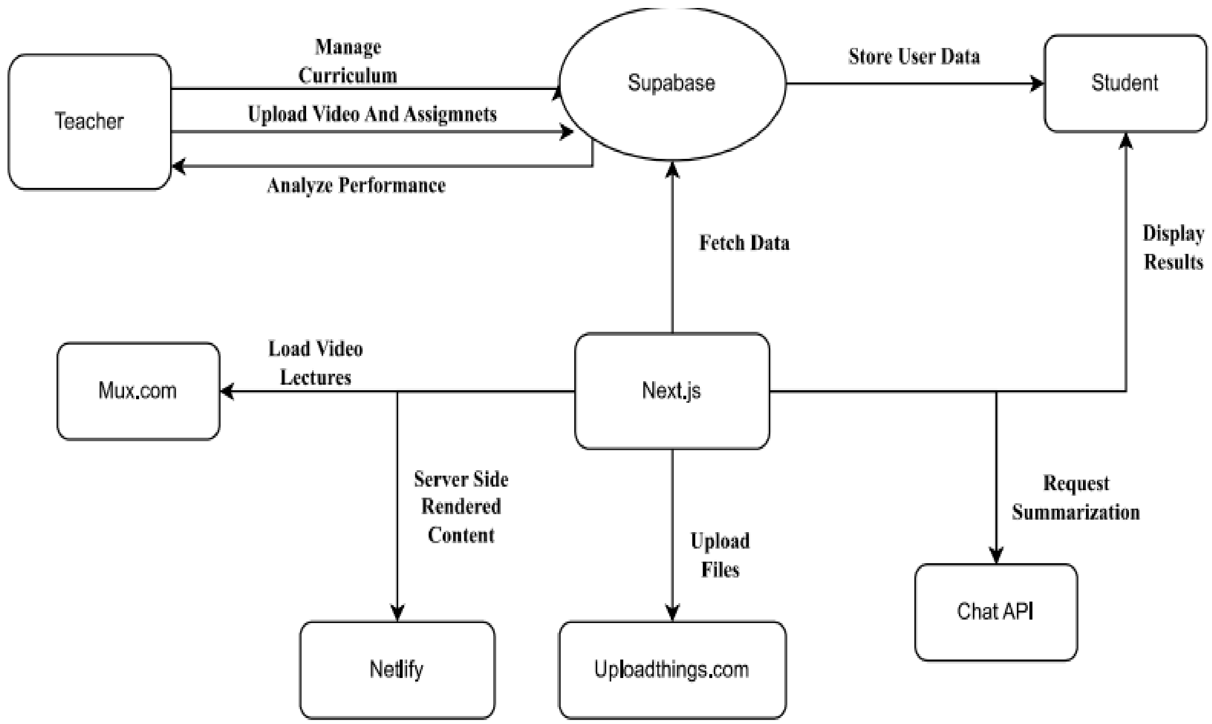
The Smart Classroom System aims to revolutionize the educational experience by integrating advanced technology into traditional teaching methods. This web-based platform will enable students to easily access lecture videos, notes, and assignments tailored to their specific academic requirements, such as year, branch, semester, and subject. Additionally, the system will feature a hand gesture recognition tool that allows teachers to use their hands as pens for real-time drawing and annotation during lectures, promoting interactivity and engagement.

To achieve these objectives, the project will implement a secure user authentication system with role-based access for both students and teachers. Teachers will have access to a content management system (CMS) that facilitates the uploading and organization of educational resources, while students will benefit from a user-friendly dashboard for accessing materials and tracking their performance. The application will also include video streaming capabilities to support seamless playback of lectures, ensuring a comprehensive learning experience.

The project will follow an Agile methodology, allowing for iterative development and continuous feedback throughout the process. With robust functional and non-functional requirements in place, the Smart Classroom System is designed to foster an enriched and collaborative learning environment that empowers both students and teachers.

Chapter 4: Proposed Design

4.1 Block diagram representation of the proposed system

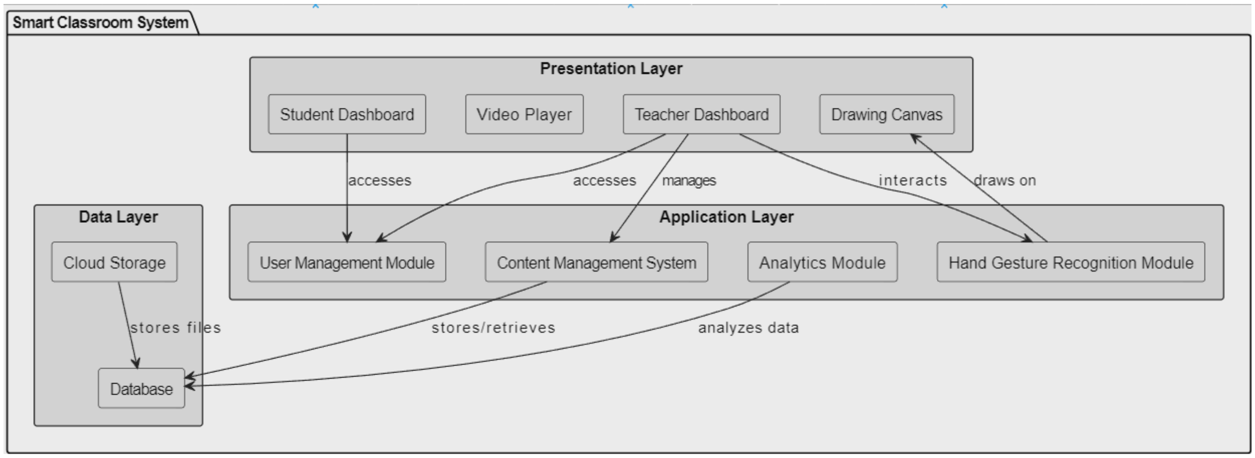


4.1.1. Block diagram representation of the proposed system

Explanation for the block diagram

- **Teacher** uploads videos and assignments via the **Next.js** interface, which stores them in **Supabase** and potentially uploads media files to **Mux.com** and **Uploadthings.com**.
- Students access these uploaded materials via **Next.js**, which fetches the necessary data from **Supabase** and streams content through **Mux.com**.
- Performance analytics and summarization (through the **Chat API**) can be accessed by both teachers and students, allowing for easier understanding and better performance monitoring.
- **Supabase** is the central point for data management, handling everything from user data storage to data fetching and analytics.

4.2 Modular diagram representation of the proposed system



4.1.2. Modular diagram representation of the proposed system

Explanation for the modular block diagram

The modular diagram visually represents the different components (modules) of the Smart Classroom System and their interactions. Here's a breakdown of each layer and the modules contained within:

1. **Presentation Layer:**
    - **Student Dashboard (SD):** This module provides students with a user-friendly interface to access educational resources, such as lecture videos and assignments. It allows students to track their performance and engagement.
    - **Teacher Dashboard (TD):** Designed for teachers, this module enables them to manage content, monitor student performance, and utilize interactive tools during lectures.
    - **Video Player (VP):** A module dedicated to streaming lecture videos, allowing for smooth playback and navigation.
    - **Drawing Canvas (DC):** This module allows teachers to draw or annotate in real-time using hand gestures, enhancing the interactive learning experience.
2. **Application Layer:**
    - **User Management Module (UMM):** This module manages user authentication, registration, and role-based access control, ensuring secure access to the system for students and teachers.

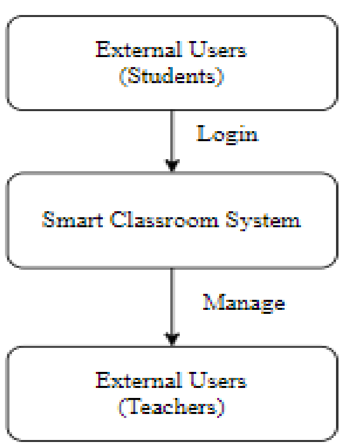
- **Content Management System (CMS):** Facilitates the upload, categorization, and retrieval of educational materials, providing a streamlined process for teachers to manage resources.
- **Hand Gesture Recognition Module (HGR):** Utilizes machine learning and computer vision techniques to interpret hand gestures, enabling interactive teaching.
- **Analytics Module (AM):** This module tracks and analyzes student engagement and performance, generating insights that help teachers evaluate student progress.

3. **Data Layer:**
    - **Database (DB):** Responsible for storing and retrieving all user data, educational content, and performance metrics, ensuring data integrity and security.
    - **Cloud Storage (CS):** Provides storage for larger files, such as lecture videos, and implements backup solutions to prevent data loss.

4.3 Design of the proposed system with proper explanation of each :

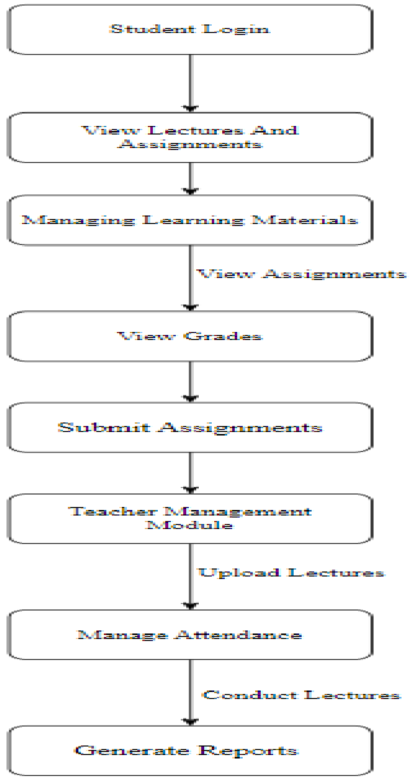
a. Data Flow Diagram (Level 0,1,2)

- **Level 0:**



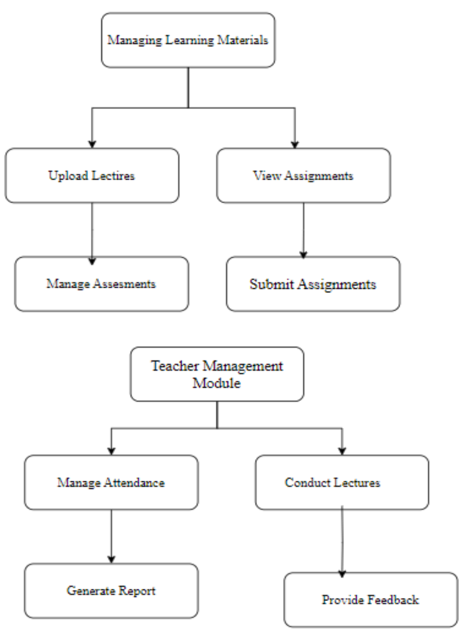
4.2.1 Level 0

- **Level 1:**



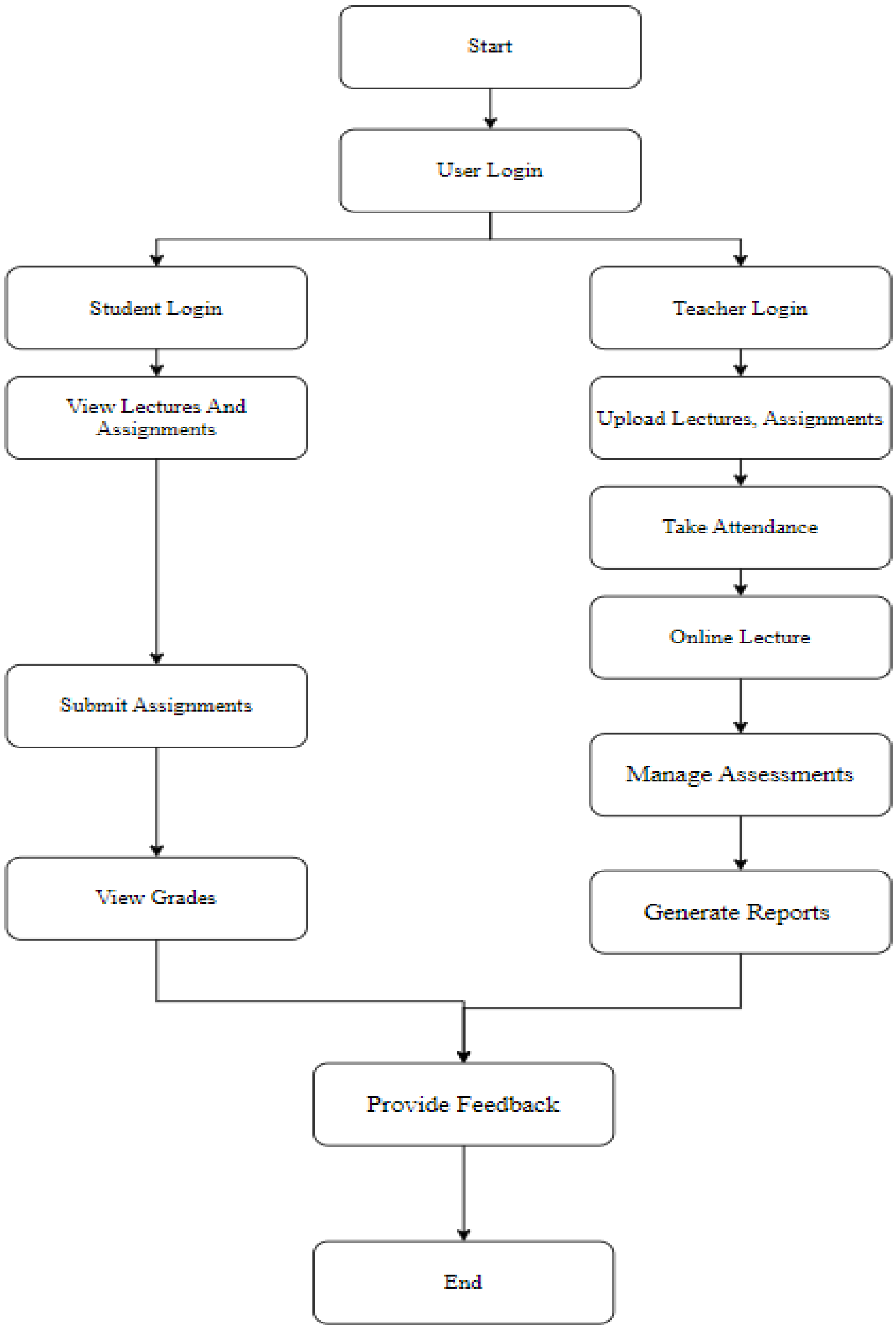
4.2.2 Level 1

- **Level 2:**



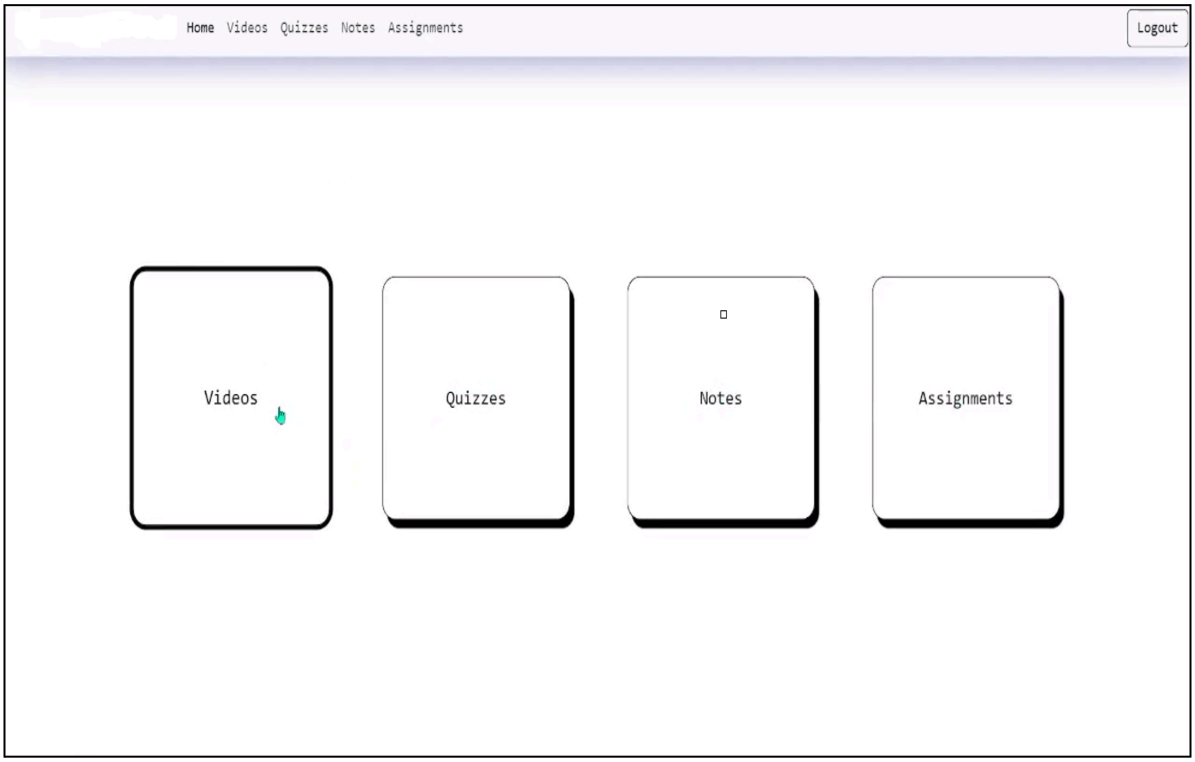
4.2.3 Level 2

b. Flowchart for the proposed system

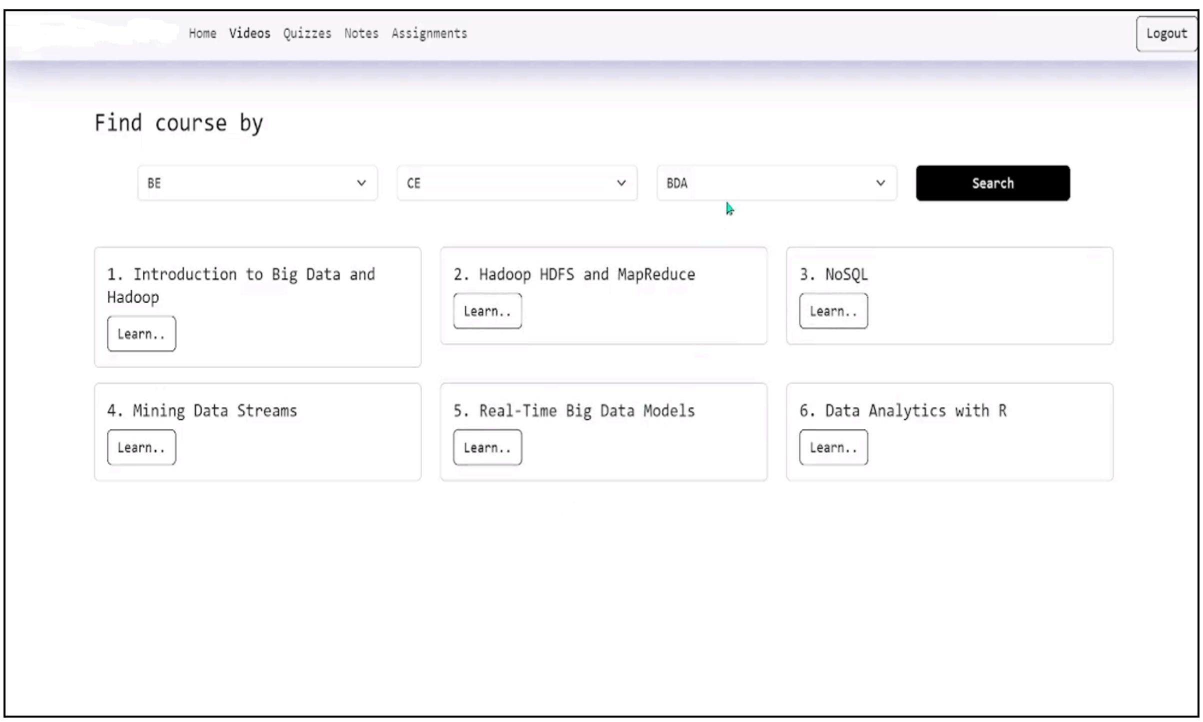


4.2.4 Flowchart for the proposed system

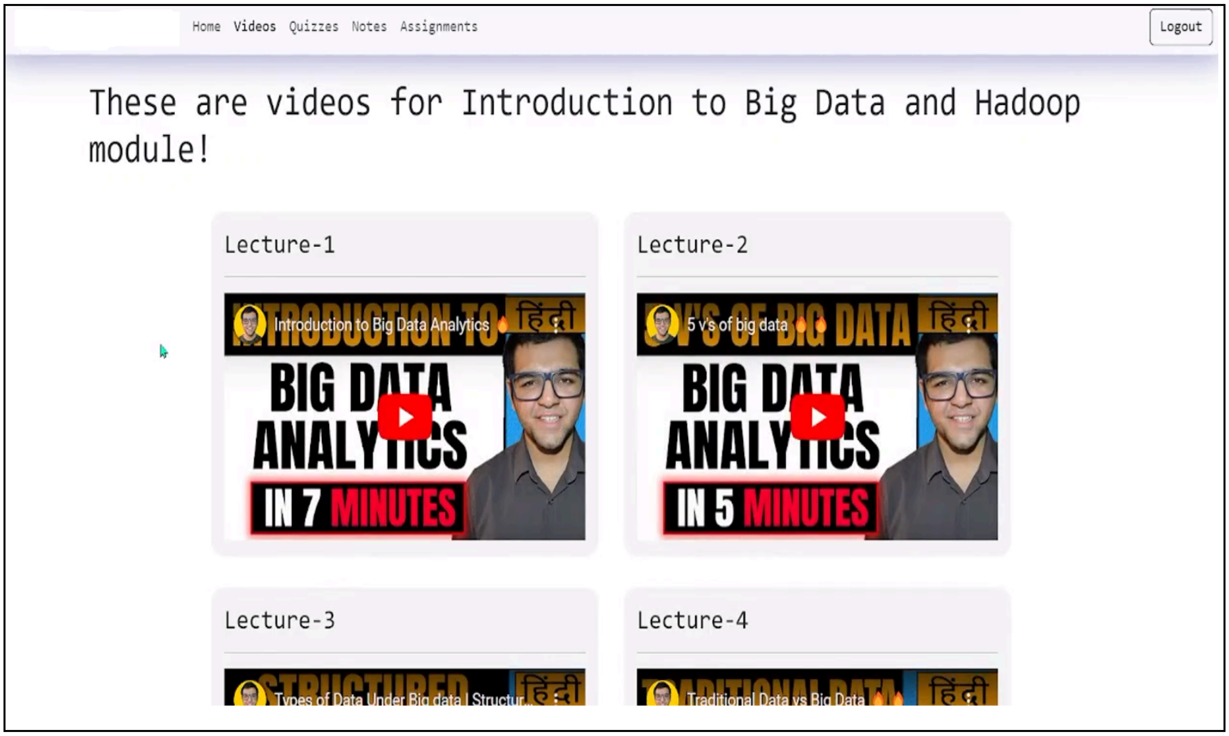
c. Screenshot of implementation



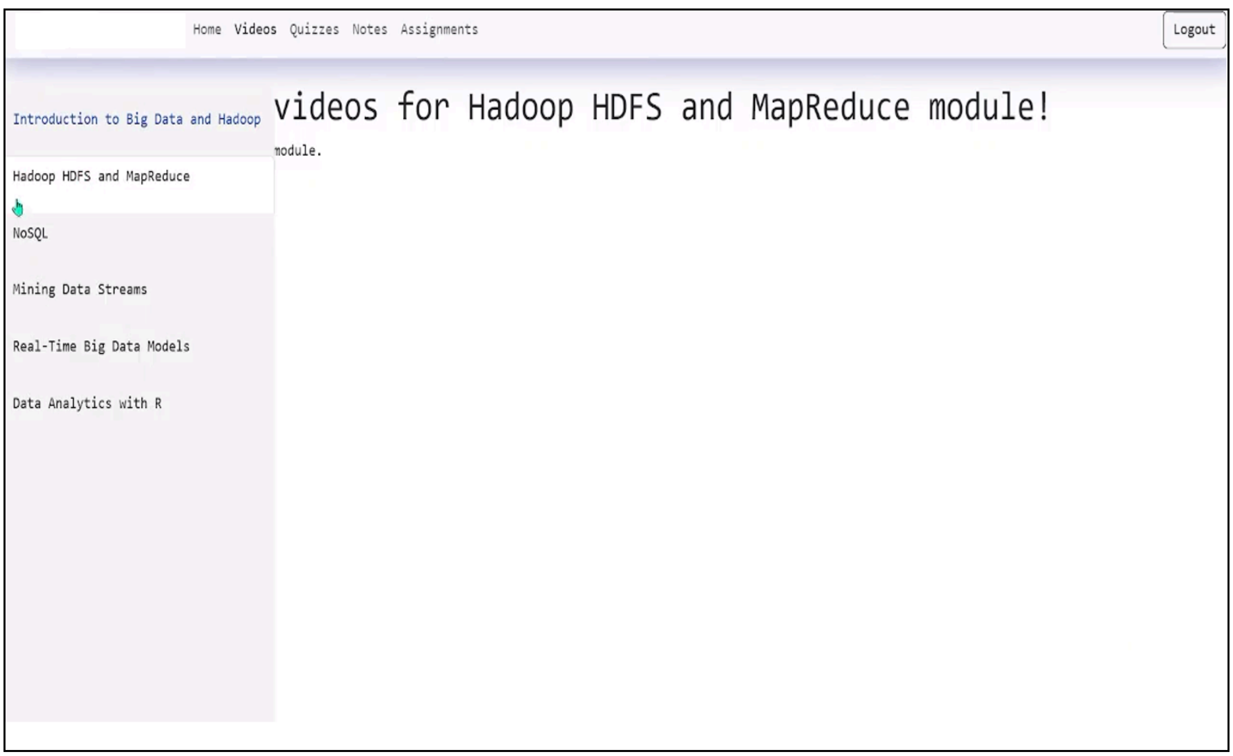
4.2.5 Home Page



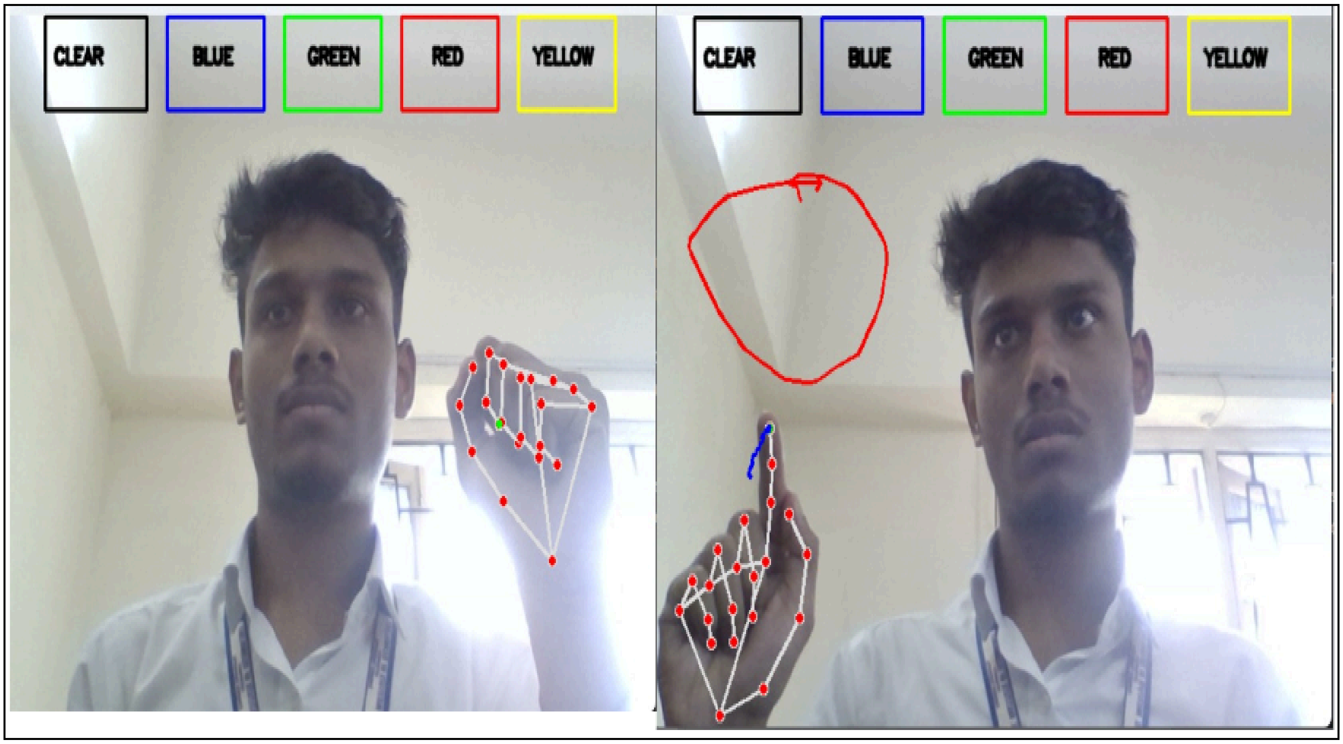
4.2.6 Searching for Videos



4.2.7 Result for Searched Videos

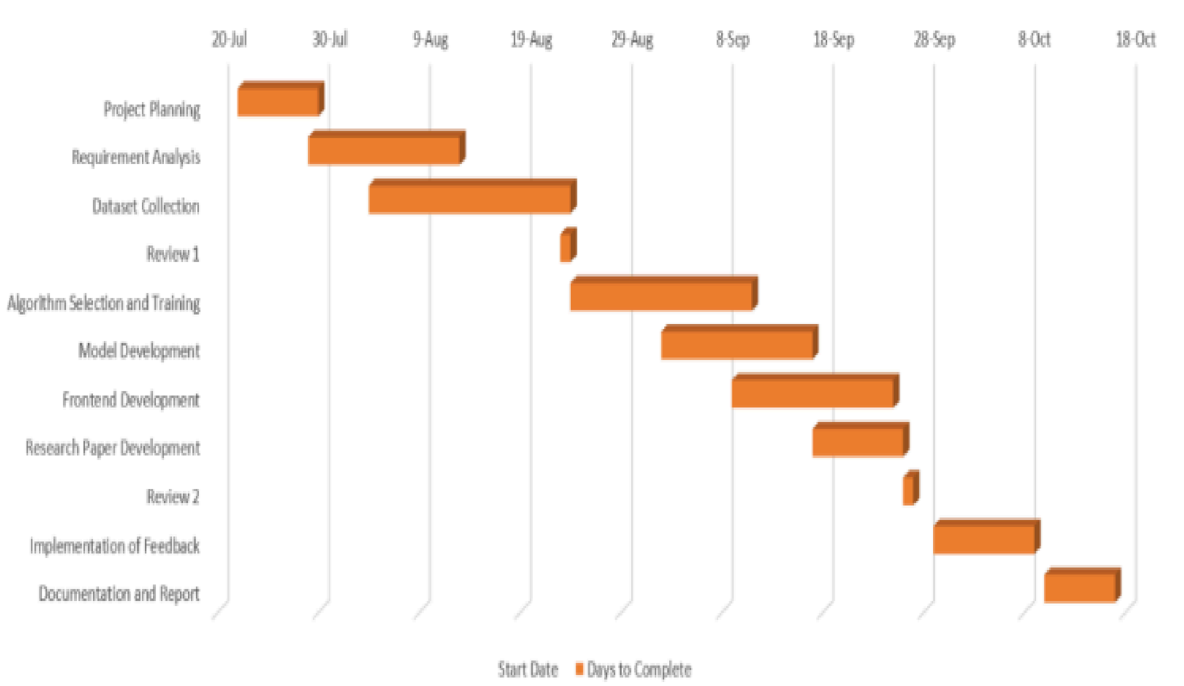


4.2.8 Videos For each module



4.2.9 Drawing Pictures with Air - Canvas

4.3. Project Scheduling & Tracking using Timeline / Gnatt Chart



4.3.1 Project Scheduling & Tracking using Timeline / Gnatt Chart

Chapter 5. Proposed Results and Discussions

5.1 Determination of Efficiency

- **Definition**: Efficiency in the context of the smart classroom system refers to how well the system utilizes resources (time, effort, and computational power) to achieve its objectives, such as managing attendance and facilitating learning.
- **Metrics**:
- Time taken for students to log in and access materials.
  - Time saved in attendance taking (automated vs. manual).
  - Number of successful interactions (submissions, uploads) within a given timeframe.
- **Methods**:
  - Conduct user surveys to gather feedback on perceived efficiency.
  - Analyze system logs to measure average response times and resource usage.

5.2 Determination of Accuracy

- **Definition**: Accuracy measures how correctly the system performs tasks, such as attendance marking and assignment submissions.
- **Metrics**:
  - Percentage of accurate attendance records (comparison between automated and manual records).
  - Rate of correct submissions (number of assignments submitted correctly vs. errors).
- **Methods**:
  - Cross-reference automated attendance with physical roll calls.
  - Analyze data logs to identify discrepancies in submissions.

5.3 Reports on Sensitivity Analysis

- **Definition**: Sensitivity analysis examines how the variation in input parameters (e.g., gesture recognition thresholds, attendance criteria) affects the output results (e.g., accuracy of attendance marking).
- **Metrics**:
  - Identify key variables impacting system performance.
  - Measure changes in accuracy or efficiency with different parameter settings.
- **Methods**:
  - Run simulations with varying thresholds for gesture recognition and analyze the impact on system performance.
  - Generate reports summarizing findings and providing recommendations for optimal settings.

5.4 Graphs of Accuracy vs. Time

- **Purpose**: Visual representation of the relationship between accuracy and the time taken to perform various tasks within the smart classroom system.
- **Data to Include**:
  - Plot graphs showing accuracy (y-axis) against time (x-axis) for different tasks, such as attendance marking and assignment submissions.
  - Include multiple lines for different scenarios (e.g., manual vs. automated processes) to compare performance visually.
- **Methods**:
  - Collect data during testing phases and compile results for graphing.
  - Use software tools like Excel, MATLAB, or Python libraries (e.g., Matplotlib, Seaborn) to create graphs.

Chapter 6. Plan of action for the next semester

A. Work done till date

We've made significant progress on our project, successfully developing the air canvas, which allows users to draw in the air using computer vision and machine learning for real-time tracking. We've also started building the website that will serve as the user interface, with 25% of the development completed, focusing on basic structure and initial functionality. The website will integrate with the air canvas tool to provide an intuitive experience. Our goal is to streamline educational resources and enhance teaching and learning. Overall, we're on track to achieve our objectives.

B. Plan of action for project II

In the next semester, we plan to complete the website and implement new user-friendly features in the air canvas. This will enhance the overall accessibility and functionality of our project. We're focused on creating a seamless user experience and ensuring all components work effectively together.

Chapter 7. Conclusions

The conclusion of the project emphasizes the comprehensive and forward-thinking nature of the platform, showcasing its ability to centralize and enhance educational resources and processes. By consolidating essential materials such as analytics, previous exam papers, and course content into a single, cohesive system, the platform facilitates a more streamlined approach to both teaching and learning. This centralization reduces the time and effort required to locate these resources, allowing educators to focus more on delivering quality instruction and students on effectively engaging with the material. This results in a more efficient learning experience for all users involved.

Additionally, the platform empowers both students and educators by leveraging the latest technological advancements. Students are given greater access to a wealth of information, while educators are equipped with powerful tools that support more dynamic and interactive instruction. This technological integration promotes personalized learning, where instruction can be tailored to individual needs, fostering a more engaging and effective educational environment. As a result, both teaching and learning are not only more interactive but also more responsive to the unique requirements of each student.

Moreover, the platform's adaptability ensures it remains relevant in the evolving landscape of education. Designed with a future-ready architecture, it supports data-driven decision-making, allowing it to stay ahead of emerging educational trends. This flexibility enables the platform to evolve alongside the changing demands of education, offering innovative solutions that prepare students and educators to face the challenges of tomorrow.

Chapter 8. References (In IEEE Format)

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Chapter 9. Appendix

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b. Xerox of project review sheet

52

Industry/Inhouse: **Project Evaluation Sheet 2024-25** **Class: D17** A,B.

Title of Project(Group no): SmartLearn (52): Intelligent learning platform

Group Members: Shrinivas Ghumare (D17A-19), Pratik Wagharalkar (D17A-67), Shubham Chelani (D17A-04) Mayank Wadhwani (D17B-66)

	Engineering Concepts & Knowledge	Interpretation of Problem & Analysis	Design / Prototype	Interpretation of Data & Dataset	Modern Tool Usage	Societal Benefit, Safety Consideration	Environ ment Friendly	Ethics	Team work	Presentati on Skills	Applied Engg &Mgmt principles	Life - long learning	Profess ional Skills	Innov ative Appr oach	Total Marks
	(5)	(5)	(5)	(3)	(5)	(2)	(2)	(2)	(2)	(3)	(3)	(3)	(5)	(5)	(50)
Review of Project Stage 1	3	4	4	2	3	2	2	2	2	2	2	3	4	3	38

Comments:

M.D. Patil
Name & Signature Reviewer1

	Engineering Concepts & Knowledge	Interpretation of Problem & Analysis	Design / Prototype	Interpretation of Data & Dataset	Modern Tool Usage	Societal Benefit, Safety Consideration	Environ ment Friendly	Ethics	Team work	Presentati on Skills	Applied Engg &Mgmt principles	Life - long learning	Profess ional Skills	Innov ative Appr oach	Total Marks
	(5)	(5)	(5)	(3)	(5)	(2)	(2)	(2)	(2)	(3)	(3)	(3)	(5)	(5)	(50)
Review of Project Stage 1	4	3	3	2	3	2	2	2	2	2	2	2	4	4	37

Comments:

Date: 23rd August, 2024

Mrs. Manile Mathur
Name & Signature Reviewer2

52

Industry/Inhouse: **Project Evaluation Sheet 2024-25** **Class: D17** A, B

Title of Project(Group no): SmartLearn :- Intelligent Learning Platform (52)

Group Members: Shubham Chelani, Mayank Wadhwani, Shrinivas Ghumare, Pratik Wagharalkar

	Engineering Concepts & Knowledge	Interpretation of Problem & Analysis	Design / Prototype	Interpretation of Data & Dataset	Modern Tool Usage	Societal Benefit, Safety Consideration	Environ ment Friendly	Ethics	Team work	Presentati on Skills	Applied Engg &Mgmt principles	Life - long learning	Profess ional Skills	Innov ative Appr oach	Total Marks
	(5)	(5)	(5)	(3)	(5)	(2)	(2)	(2)	(2)	(3)	(3)	(3)	(5)	(5)	(50)
Review of Project Stage 1	4	4	4	2	4	2	2	2	2	3	3	3	5	4	44

Comments:

26/09/24 M.D. Patil.
Name & Signature Reviewer1

	Engineering Concepts & Knowledge	Interpretation of Problem & Analysis	Design / Prototype	Interpretation of Data & Dataset	Modern Tool Usage	Societal Benefit, Safety Consideration	Environ ment Friendly	Ethics	Team work	Presentati on Skills	Applied Engg &Mgmt principles	Life - long learning	Profess ional Skills	Innov ative Appr oach	Total Marks
	(5)	(5)	(5)	(3)	(5)	(2)	(2)	(2)	(2)	(3)	(3)	(3)	(5)	(5)	(50)
Review of Project Stage 1	4	4	4	3	5	2	2	2	2	3	3	3	5	4	46

Comments:

Date: 26th September, 2024

8/10/24 Manile Mathur
Name & Signature Reviewer2