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Cloud-Based Video Management System with Automated Search and Progress Tracking

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ABSTRACT

Video Management Systems (VMS) have emerged as an essential component in digital education, offering structured access to video-based learning resources. This paper reviews a VMS application designed for students, enabling login-based access, package selection, and automatic course enrollment. The system provides topic-specific notes, progress tracking, and test scheduling, ensuring a guided and personalized learning experience. A key feature of the application is its AI-powered video processing, which allows students to locate solutions within videos by entering keywords or questions, thereby directing them to the exact timeline of the explanation.

Videos are uploaded in modular chunks directly to the cloud, ensuring scalability and efficiency. By integrating course management, intelligent video navigation, and performance assessment, the proposed VMS enhances learning outcomes while reducing time spent on content searching. This review highlights the potential of AI-integrated VMS to transform student learning through automation, accessibility, and intelligent content delivery.

I. INTRODUCTION

The rapid growth of digital technologies has transformed the education sector, shifting from traditional classroom learning to online and blended learning models. Among various e-learning approaches, video-based platforms have become one of the most effective tools for delivering knowledge, offering students flexibility, accessibility, and interactive engagement. However, despite their advantages, existing video learning platforms often face challenges such as unstructured content delivery, difficulty in locating specific solutions, limited progress tracking, and lack of personalized learning support. These gaps create inefficiencies for students who struggle to manage time and prepare systematically for exams.

To address these challenges, this review focuses on a Video Management System (VMS) designed as an all-in-one application for students. The system provides secure login, package selection, and automatic course enrollment, along with structured notes, topic-wise resources, and scheduled assessments. Unlike traditional video platforms, the proposed VMS integrates AI-driven video search and navigation, enabling students to directly jump to the exact video timeline where a solution or explanation is available. This not only reduces time spent on repetitive searching but also enhances efficiency in problem-solving and concept understanding.

The system finds applications across multiple domains of education. It can be used in schools, colleges, competitive exam preparation, online tutoring platforms, and professional skill-development programs. For students, it serves as a personalized study companion with progress visualization and test scheduling. For educators and institutions, it provides an efficient way to deliver modular video lectures, update solutions, and manage course enrollments. Ultimately, the VMS addresses the problem of time-consuming and unstructured video learning by introducing automation, AI-based search, and progress monitoring, making the overall process seamless, adaptive, and student-friendly.

II. LITERATURE SURVEY

A literature survey on video management systems for student learning, combined with AI-powered assessment and progress features, highlights extensive research and industry trends from past years and 2025. Video-based educational platforms, including Physics Wallah and Unacademy, have implemented technology-driven methods like AI tutors, personalized learning, and integrated assessment tools with significant impact.

- Student perceptions of custom video retrieval systems for academic tasks showed positive reception, valuing advanced search and segment sharing along with recommendations for automated summaries and improved text-based search within videos.
- Comprehensive reviews exist on the adoption and effectiveness of Learning Management Systems (LMS) that support asynchronous video learning, remote access, and AI-enhanced user engagement and evaluation.
- AI in education literature suggests major categories explored include adaptive assessment, personalized learning, intelligent tutoring, data analytics, and automated feedback—all supporting the kind of features described for your app.
- Smart classroom research highlights the value of interactive boards, audio/video integration, management systems, and mobile computing in modern learning environments.
- EdTech platforms using AI-driven adaptive learning, real-time feedback, and personalized content delivery have shown improved outcomes, especially for special needs and diverse learners.
- Reviews on digital technologies' role in education discuss challenges and solutions around implementation, accessibility, and learner-centered design.

Recent Technology Trends (2024–2025)

- Major EdTech trends include widespread use of AI-driven personalized learning, gamified AR/VR immersive experiences, micro-credentials, and digital badges for engagement and motivation.
- AI tools power adaptive learning, learning progress tracking, automatic grading, intelligent tutors, chatbots, curriculum planning, and smart content creation, which mirrors the features you plan for your app.
- Physics Wallah developed the "Alakh AI" platform by 2023, integrating personalized scalable learning with freemium business models, extensive online/offline education, and AI tutors that analyze student queries and learning progression.
- EdTech giants like Unacademy and Byju's use in-house AI platforms for personalized tutoring, exam preparation, and user analytics to stay competitive in the evolving education market.

III. OBJECTIVE

Primary Objectives

1. **To analyze the effectiveness of AI-driven video search and navigation systems** in educational platforms that enable students to jump directly to specific video timelines for solutions and explanations.
2. **To evaluate the impact of structured content delivery and automated course enrollment** on student learning outcomes and time management efficiency.
3. **To investigate the role of progress tracking and assessment integration** in video-based learning management systems for personalized education delivery.
4. **To examine the implementation of secure login and package selection features** in comprehensive video management platforms for educational institutions.

Secondary Objectives

5. **To assess the effectiveness of topic-wise resource organization** and scheduled assessments in reducing time spent on repetitive content searching.
6. **To analyze the integration of AI-powered video analytics** for automated content management and personalized learning path recommendations.
7. **To evaluate the scalability of video management systems** across multiple educational domains including schools, colleges, competitive exam preparation, and professional skill development.
8. **To investigate the technical infrastructure requirements** for implementing comprehensive video management systems with real-time search capabilities.

Application-Specific Objectives

9. **To examine the applicability of video management systems** in competitive exam preparation platforms and their impact on systematic study planning.
10. **To assess the effectiveness of progress visualization and test scheduling features** in improving student engagement and academic performance.
11. **To analyze the role of modular video lectures and automatic content updates** in maintaining current and relevant educational resources.

12. **To evaluate the user experience and accessibility** of all-in-one video management applications across different device platforms and connectivity conditions.

These objectives focus specifically on understanding how comprehensive video management systems address the challenges of unstructured content delivery, inefficient searching, limited progress tracking, and lack of personalized learning support in educational technology.

IV. METHODOLOGY USED IN OUR SYSTEM

System Architecture Design

- Design a modular system architecture consisting of:
- **Frontend:** React Native for cross-platform mobile usability
- **Backend:** Node.js for API services and business logic
- **Databases:** Supabase (relational data) and MongoDB (unstructured data)
- **Hosting:** Vercel for deployment efficiency
- **Video Processing:** AWS for transcoding and CDN delivery
- **AI Services:** OpenAI Whisper for transcription, Google Gemini API for semantic search, AWS SNS for notifications
- Create flow diagrams and data models to detail system interactions and data flows.

5. System Development

- Adopt Agile methodology with iterative development cycles.
- Develop key modules in sprints: user authentication, package management, video streaming, AI-based search, test scheduling, and progress tracking.
- Integrate AI services to automate transcription, semantic search, and personalized recommendations.
- Perform continuous unit, integration, and system testing to ensure functionality and robustness.

6. Prototype Deployment

- Deploy the application on staging servers using Vercel.
- Host all media content on AWS S3 and deliver video streams via CloudFront CDN for global accessibility.
- Ensure environment configuration for AI API keys, secure authentication, and real-time notifications.

7. User Evaluation and Usability Testing

- Recruit students from diverse educational backgrounds for pilot testing.
- Use usability testing methods such as task-based assessments, think-aloud protocols, and user satisfaction surveys.
- Measure metrics like task success rate, time to complete tasks, error frequency, and System Usability Scale (SUS) scores.
- Collect qualitative feedback on ease of navigation, AI assistance, and overall satisfaction.

8. Learning Effectiveness Assessment

- Design a pre-test/post-test control study to evaluate the impact on student learning outcomes.
- Monitor student engagement metrics including video watch time, quiz performance, and revision frequency via backend analytics.
- Analyze learning gains using statistical methods (e.g., paired t-tests) to validate educational effectiveness.

9. Data Analysis and Reporting

- Quantitatively analyze usability and learning data using statistical software.
- Qualitatively analyze user feedback through thematic coding for feature enhancement insights.
- Prepare comprehensive reports detailing findings, challenges, and recommendations for future improvements.

10. System Refinement and Final Deployment

- Incorporate feedback from user evaluations and learning assessments to optimize features and performance.
- Enhance AI models for better search accuracy and personalized suggestions based on real-world use

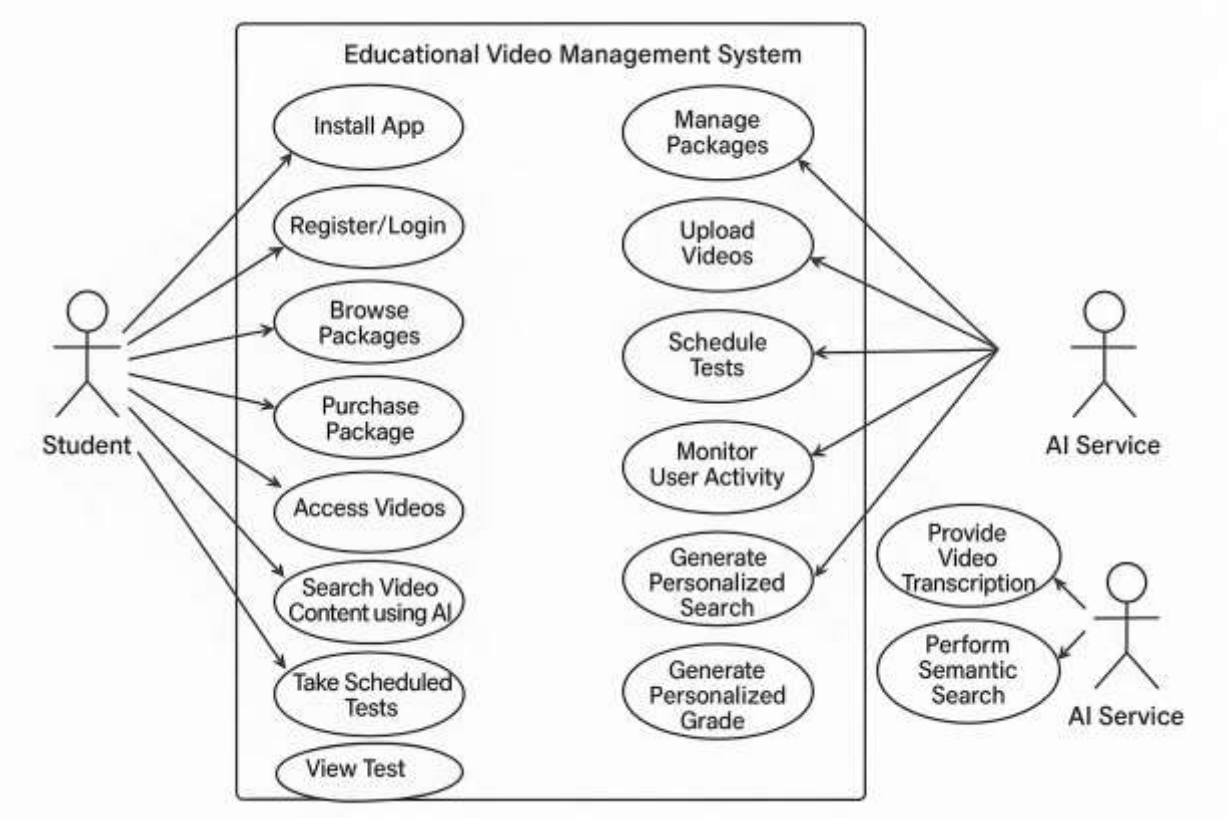

Figure 3.1. USE CASE DIAGRAM

- Perform security audits and scalability testing prior to full production deployment.

11. Maintenance and Continuous Improvement

- Implement monitoring tools for system health, performance, and error tracking.
- Schedule periodic updates integrating new AI capabilities and expanding multilingual content libraries.
- Establish user support channels and feedback loops to maintain system relevance and user satisfaction.

V. REPORT GENERATION AND INSIGHT

1. Install and Launch

- Download and install the app from the app store.
- Open the app to reach the welcome screen.

2. User Authentication

- Tap **Login** and enter registered credentials (email/phone + password).
- Upon successful authentication, the student lands on the **Home** screen.

3. Package Purchase

- Navigate to **My Package** via the bottom navbar.
- Browse available test/video packages.
- Select a package and complete payment through integrated gateway.
- Upon payment confirmation, the package is activated in the account.

4. Accessing Videos and Tests

- Go to **Videos** from the navbar to view all unlocked video lectures.
- Tap any video to stream content via AWS-powered CDN.
- Go to **Home** or **My Package** to access unlocked tests associated with the package.

5. AI-Powered Solutions

- While watching a video, tap the **AI Help** icon.
- Enter a query; the app sends the timestamp and transcript to Whisper for transcription and Gemini API for semantic search.
- Receive instant in-video jump links to exact solution segments.

6. Test Scheduling and Progress Tracking

- Under **Home**, view upcoming test schedules and reminders via AWS SNS notifications.
- Tap **Profile → Test Calendar** to see scheduled assessments.

7. Taking Tests

- From **Home** or **My Package**, tap a scheduled or on-demand test.
- Complete questions; submit answers when finished.
- The backend Node.js API records responses in Supabase and MongoDB.

8. Viewing Results and Analytics

- After submission, view instant results with AI-driven grading insights (AI Grader for subjective answers).
- Navigate to **Profile → Progress** to see individual subject progress charts and overall performance analytics.

9. Continuous Learning Loop

- Based on performance, the **AI Service** recommends targeted videos under **Videos**.
- Students replay or bookmark critical segments using in-app controls.
- Repeat watching, AI-aided search, and testing to reinforce learning.

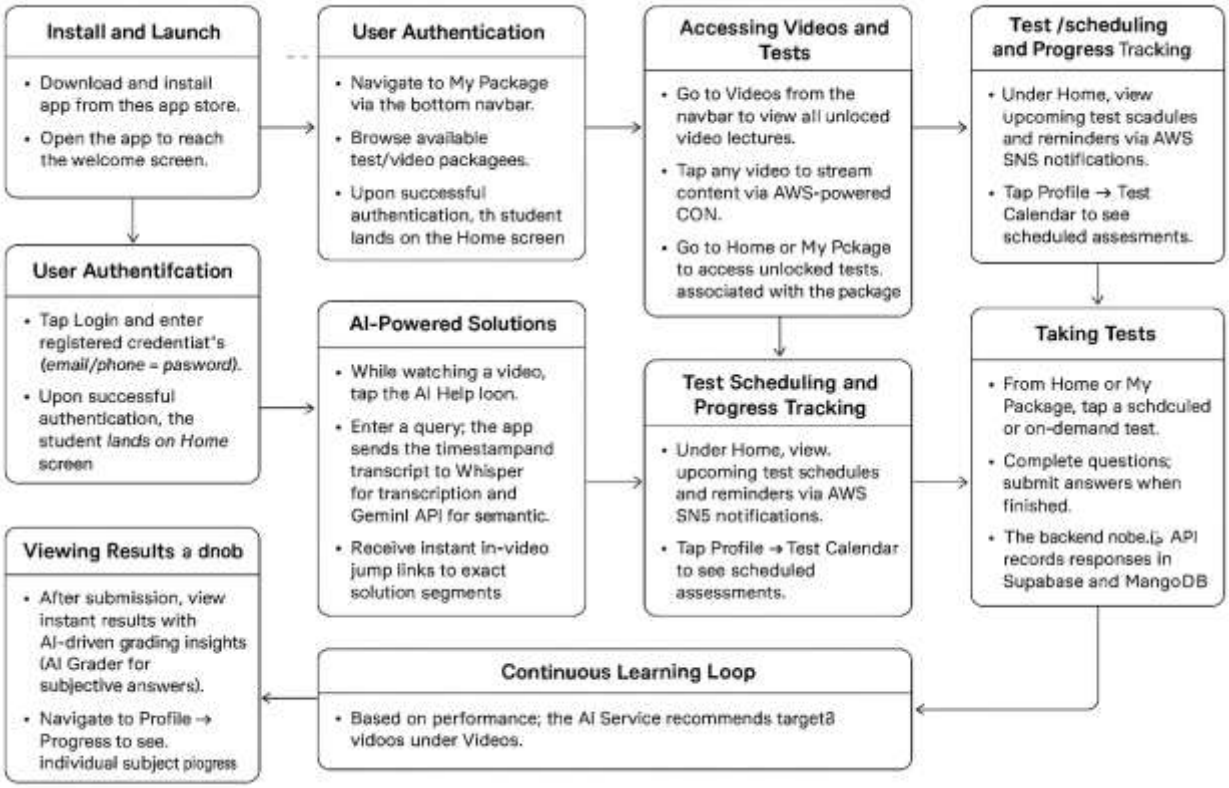

Figure 4.1. Flowchart

VI. TECHNOLOGY USED

- **Frontend (React Native):**

The frontend is developed using React Native for cross-platform mobile applications (Android and iOS). State management is handled through Redux Toolkit for predictable and scalable data flow, while React Navigation manages stack and tab-based user flows. The UI employs reusable components designed with Styled Components to ensure consistency. Unit and integration testing are performed using Jest and React Native Testing Library. Continuous integration pipelines are configured via GitHub Actions, with automated preview deployments to Vercel's staging environment.

- **Backend (Node.js with Express.js):**

The backend is built using Node.js and Express.js to provide RESTful APIs for user, course, video, and AI services. Authentication and authorization are implemented using JWT integrated with Supabase Auth. Middleware functionalities include input validation (Joi), logging and monitoring (Winston, Sentry), and rate limiting (express-rate-limit) to enhance reliability and security.

- **Database (Supabase and MongoDB):**

Supabase, powered by PostgreSQL, manages structured data such as user profiles, authentication details, and course enrollments, supporting real-time updates. MongoDB serves as a NoSQL store for unstructured data, including AI-generated transcripts, user logs, and analytics, utilizing sharding for scalability during high-volume operations.

- **Hosting and Deployment (Vercel):**

The frontend and selective backend functions are deployed on Vercel, leveraging its serverless architecture for low-latency global access. Separate staging and production environments are maintained with encrypted environment variables. Continuous integration and deployment pipelines perform automated testing and smoke validation after each release.

- **Video Processing (AWS):**

AWS services manage all video-related operations. Video assets are stored on Amazon S3, transcoded using AWS Elastic Transcoder into adaptive bitrate HLS formats, and distributed globally via Amazon CloudFront CDN. Monitoring and event tracking are handled through AWS CloudWatch.

- **AI Integration:**

AI functionalities are incorporated using a hybrid architecture. The OpenAI Whisper model (self-hosted via Docker) performs speech-to-text transcription, while semantic search and content recommendations are handled via the Google Gemini API. Notifications and assessment reminders are managed through AWS SNS.

- **Monitoring, Logging, and Security:**

System observability is achieved through Prometheus and Grafana for performance metrics, along with the ELK (Elasticsearch, Logstash, Kibana) stack for centralized logging. Security mechanisms include HTTPS enforcement, OWASP-compliant headers via Helmet, and periodic vulnerability scanning using Snyk.

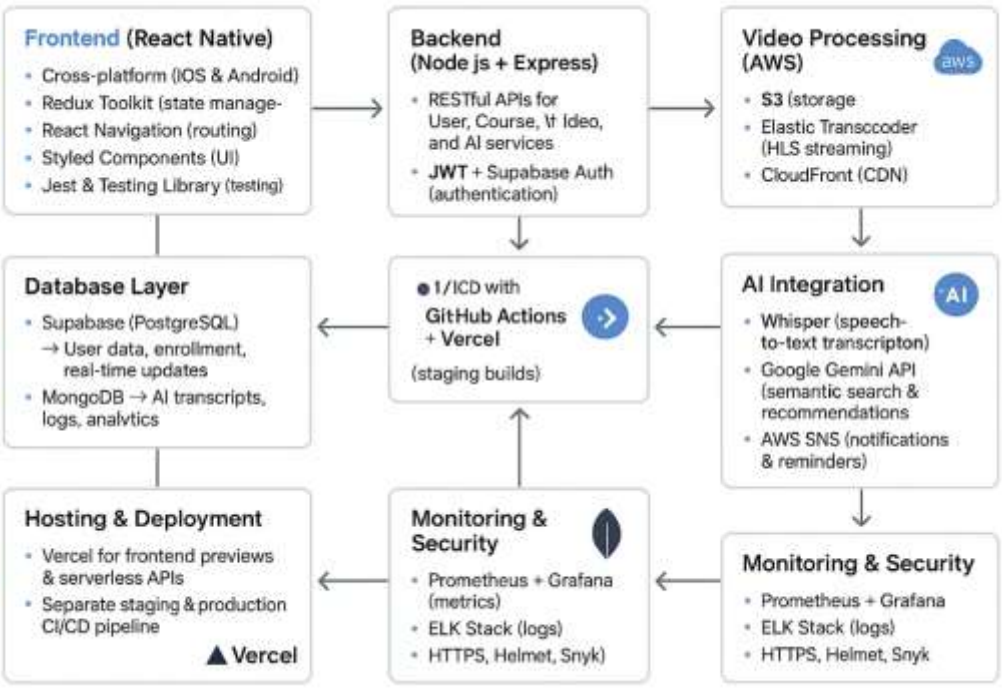

Figure 6.1. Technology used

VII. CONCLUSION

The app provides a seamless and personalized learning experience by guiding students through installation, secure login, and access to premium content only after payment. It offers a structured navigation with four main sections — Home, My Package, Videos, and Profile — enabling easy access to video lectures, tests, and personal progress tracking. AI-powered features enhance learning by allowing students to quickly find solutions within videos, receive personalized study plans, and get real-time doubt resolution. The integrated test scheduling, performance analytics, and progress visualization tools support systematic exam preparation and continuous improvement. Overall, the app combines convenience, interactivity, and intelligent support to make learning efficient, engaging, and tailored to individual needs.

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