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AI-BASED AUTOMATED COURSE GENERATOR USING MERN STACK FOR E-LEARNING CONTENT

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Abstract: The rapid expansion of online education necessitates the creation of scalable and automated learning frameworks. Existing e-learning platforms largely depend on manually curated content, which increases development time and limits adaptability. This paper presents an automated course generation system developed using the MERN stack (MongoDB, Express.js, React.js, and Node.js) for efficient elearning content delivery. The proposed system generates structured course modules, organizes learning resources, conducts automated assessments, and issues digital certificates based on user-selected topics and predefined templates. Educational video content is dynamically curated using the YouTube Data API, while rule-based logic and keyword filtering techniques are employed to organize course structure. The system significantly reduces human effort in course creation while ensuring consistency, usability, and scalability, making it suitable for academic institutions and online learning platforms.

Keywords—Automated course generation, MERN stack, e-learning, course automation, web application.

1. INTRODUCTION

Digital learning platforms have fundamentally altered the landscape of modern education, facilitating accessible learning across geographical and temporal boundaries. However, a majority of current e-learning models offer static courses that require substantial, time-consuming manual intervention from instructors for initial design, routine updating, and continuous maintenance. Given the escalating need for learning content that is both personalized and current, there is a clear demand for intelligent systems capable of automating the entire curriculum development pipeline.

Automation techniques combined with modern web technologies play a vital role in improving the efficiency of digital education platforms. By utilizing predefined templates, structured workflows, and API-based data retrieval, it is possible to develop systems that automatically organize educational resources into meaningful learning modules. Such systems reduce manual intervention while maintaining consistency and scalability in course delivery.

This study proposes an automated course generator constructed using the full-stack MERN architecture (MongoDB for the database, Express.js for the routing layer, React.js for the user interface, and Node.js for the server runtime). Upon receiving a target subject from the user, the system curates external educational video resources using API-based retrieval and organizes them into a structured learning framework using predefined templates and automation logic. The system also generates quizzes and manages the issuance of completion certificates, thereby reducing manual effort in traditional course creation.

2. LITERATURE SURVEY

Recent progress in artificial intelligence has profoundly influenced the capacity for automating educational content production. A body of research explores the application of generative AI, sophisticated natural language processing (NLP), and machine learning in areas such as curriculum design, content personalization, and objective assessment.

Rouabhia [1] conducted a detailed analysis of course generation powered by AI, specifically employing large language models (LLMs) like ChatGPT. The research evaluated the academic rigor, structural coherence, and originality of university level course materials produced autonomously by the AI. The results established that LLMs can effectively generate structured, logically consistent, and academically sound content, thereby demonstrating a clear path to significantly reduce reliance on manual instructional design efforts.

The investigation by Ullmann et al. [2] focused on implementing generative AI for the automated creation of course content. Their proposed framework utilized an integrated AI pipeline to generate course outlines, define learning objectives, and produce assessment components. The synergy of NLP and machine learning techniques highlighted how these AI-assisted systems can enhance both the efficiency and inherent quality of educational development processes.

Patel et al. [3] introduced a novel AI-based personalized learning architecture, utilizing the YouTube Data API to curate relevant content in a dynamic, real-time manner. Their methodology integrates recommendation algorithms and NLP techniques to analyse individual learner behaviours and stated preferences. This dynamic approach led to documented improvements in learner engagement and retention by providing customized learning pathways that adapt to the individual's pace and needs.

Joshi et al. [4] specifically addressed the automatic generation of reliable question papers using a combination of NLP and machine learning. Their technique involved performing deep syntactic and semantic analysis of academic source material to ensure the creation of questions that are relevant, balanced, and appropriately distributed across various difficulty strata. This demonstrated the power of AI in automating the crucial assessment creation phase of intelligent learning systems.

Finally, Gotavade et al. [5] proposed an end-to-end AI-driven ecosystem designed for adaptive and self-directed learning. The system utilized machine learning for robust learner profiling, enabling adaptive content selection and optimization of the entire course structure. This work reinforced the necessity of personalization and dynamic adaptability as core features of contemporary e-learning environments.

While current research successfully addresses AI-based content generation, personalization, and assessment in isolation, there remains a notable gap in fully integrated platforms that seamlessly combine automated course structuring, comprehensive assessment, responsive chatbot assistance, and formal certification. The system proposed herein aims to bridge this integration gap by providing a comprehensive, AI-driven solution for the entire e-learning lifecycle.

3. SYSTEM ARCHITECTURE

The developed system operates on a robust client-server model, utilizing the MERN stack for implementation simplicity and efficiency. Figure 1 illustrates the overall components within the platform.

1. User Interface (React.js): Serves as the interactive frontend, enabling users to register, authenticate, submit course topics,access structured learning materials, attempt quizzes, and download their digital certificates.

2. Backend Server (Node.js/Express.js): Manages all API endpoints, handles user authentication workflows, oversees coursestate management, processes quiz submissions, and executes the certificate generation logic.

3. Database (MongoDB): A flexible NoSQL database utilized for persistent storage of user profiles, dynamic course progresstracking, detailed quiz results, and certification records.

4. Course Generation Engine: This module processes user-selected topics and generates structured courses using rule-basedlogic and predefined templates. It utilizes the YouTube Data API to retrieve relevant educational videos and organizes them into logical learning modules. Module-wise quizzes and a final assessment are generated to evaluate learner understanding upon course completion.

5. User Assistance Module: This module provides basic user support through predefined responses and navigation guidance,helping learners access course materials, quizzes, and certificates efficiently.

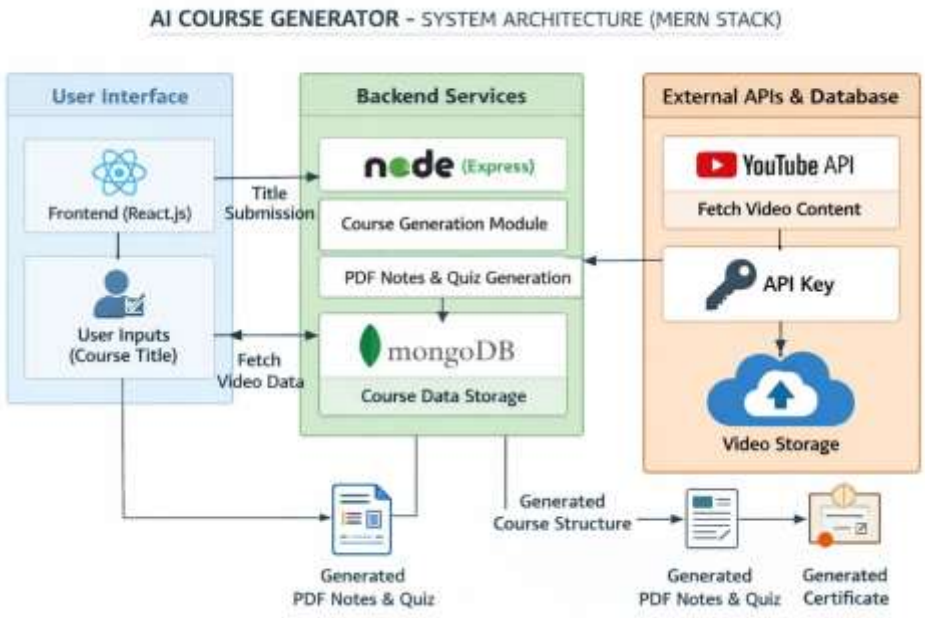

Figure 1: system architecture of the automated course generator.

4. METHODOLOGY

The operational flow of the proposed automated course generator is executed through a sequential, six-step process, as detailed below and visually represented in Figure 2.

1. User Topic Input: The process initiates when the user inputs a specific topic of interest (e.g., "Introduction to QuantumComputing") via the dedicated web interface.

2. Content Retrieval: The system activates the YouTube Data API to search and filter high-quality, relevant educational videoresources based on the submitted topic and predefined quality criteria.

3. Structural Organization: Retrieved video metadata such as titles and descriptions are analyzed using keyword-based filteringtechniques. Based on this information, the content is organized into sequential learning modules using predefined course templates.

4. Course Material Synthesis: For each module, concise study material is prepared using predefined content formats and storedin PDF form. These materials summarize the learning objectives and references associated with each module.

5. Quiz and Assessment Generation: Automated quizzes are generated using rule-based question templates aligned with eachmodule. These assessments evaluate learner understanding and ensure coverage of essential course concepts.

6. Assistance and Certification: The integrated Chatbot provides continuous support. Upon successful completion of all coursemodules and passing the final assessment, the system automatically generates a certificate which can be downloaded by user.

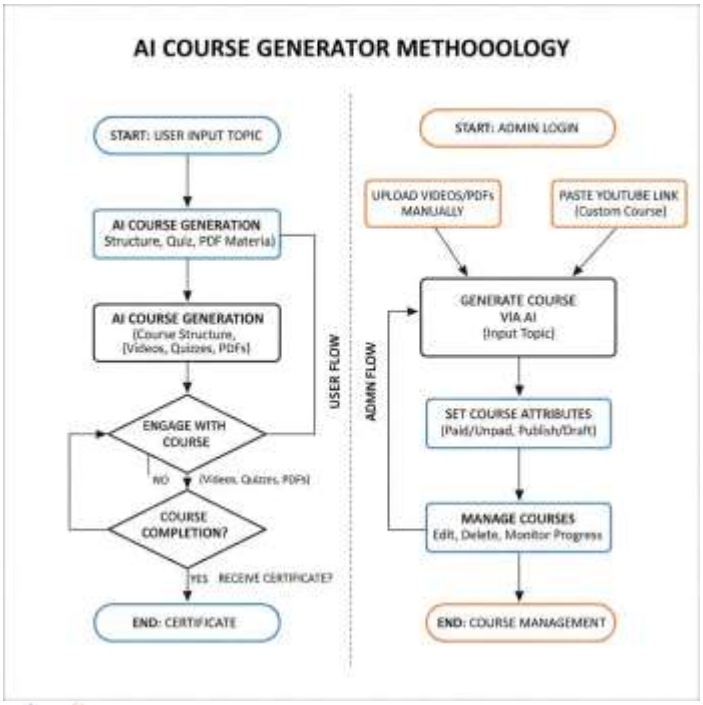

Figure 2: the operational flowchart of the automated course generator.

5. TECHNOLOGIES UTILIZED

The successful implementation of this integrated system relies on a stack of contemporary web and AI technologies:

- MongoDB: A flexible, document-based NoSQL database, ideal for storing the dynamically generated course structures anduser-specific progress data.
- Express.js: A minimalist, fast, and unopinionated web application framework for Node.js, forming the robust backend APIlayer.
- React.js: A declarative, component-based JavaScript library for building the highly interactive and responsive user interface(UI).
- Node.js: The server-side JavaScript runtime environment that allows for efficient, non-blocking I/O operations, ensuring highscalability of the backend.
- Artificial Intelligence and API keys: Utilized for keyword-based content filtering, rule-driven course structuring, quiz gener-ation, and certificate issuance.
- YouTube Data API: The critical data source for programmatic access to the vast repository of educational video content,enabling dynamic content curation.

6. RESULTS AND DISCUSSION

The proposed system successfully delivers a fully automated workflow for generating structured educational courses based on user-selected topics. The automation logic and predefined templates ensure consistency, relevance, and reduced development time compared to manual course creation.

The integration of the MERN stack guarantees the platform is scalable, responsive, and maintainable. The user assistance module improves learner interaction by providing predefined guidance and navigation support throughout the course workflow. This enhances usability and overall learner engagement.

Figures 3 through 10 demonstrate the visual components and operational interfaces of the system. The system's effectiveness is marked by its ability to deliver personalized learning pathways, which are critical features in modern EDTECH.

Table 1: sample course module structure and duration

Module No.	Module Title	Duration (Hrs)
I	Introduction to MERN Stack	2.5
II	MongoDB Fundamentals	3.0
III	Building Node.js/Express APIs	4.5
IV	React Frontend Development	5.0

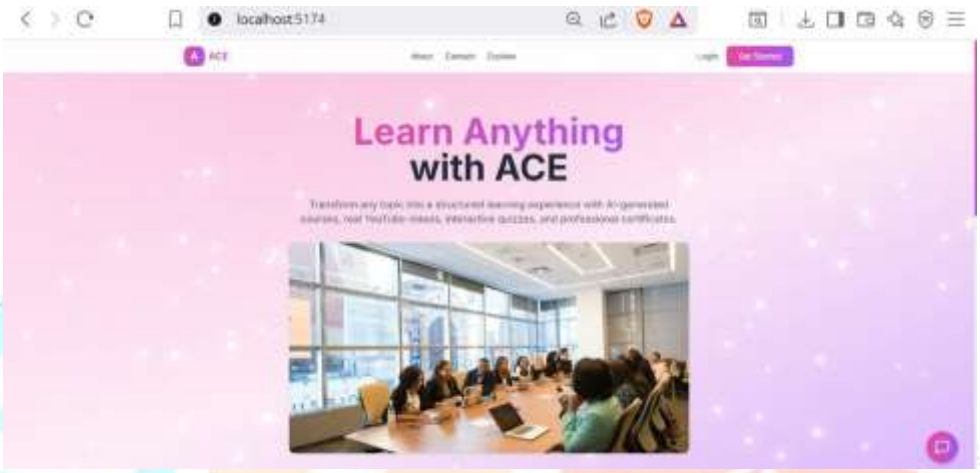

Figure 3: the main landing page of the application.

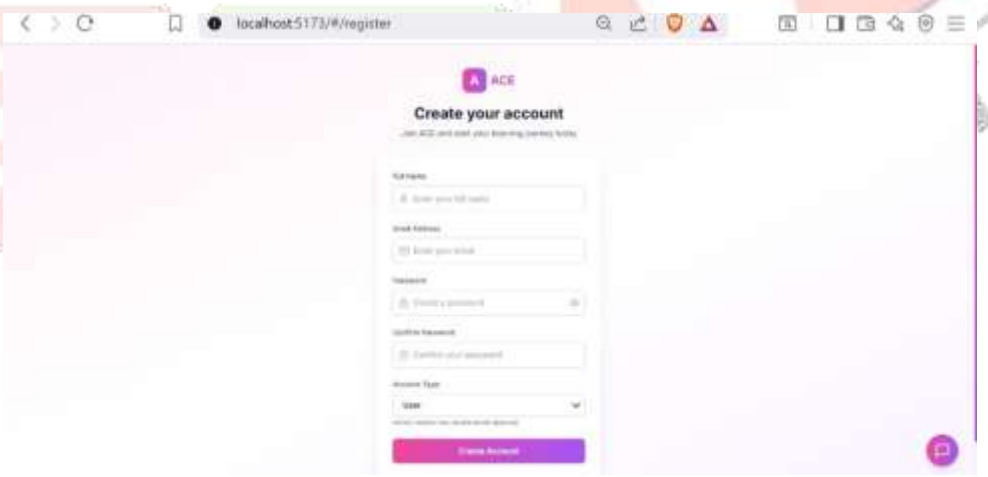

Figure 4: the user account registration interface.

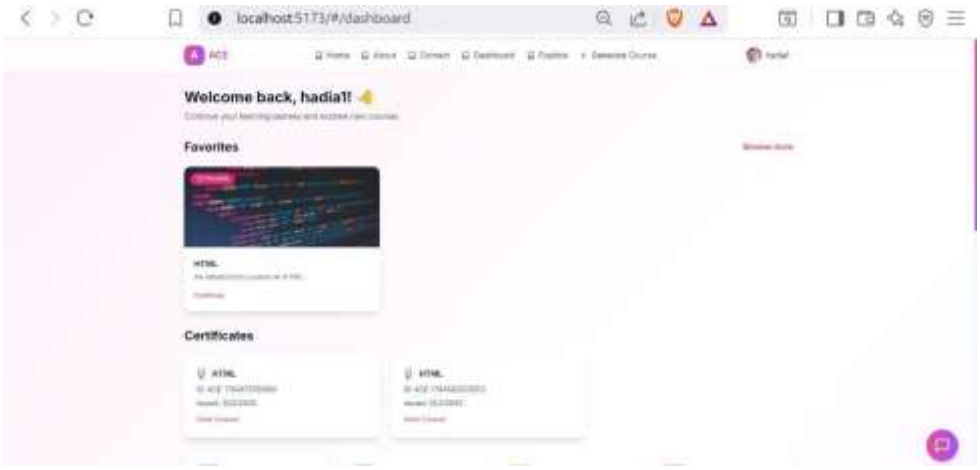

Figure 5: the main user dashboard showing available courses.

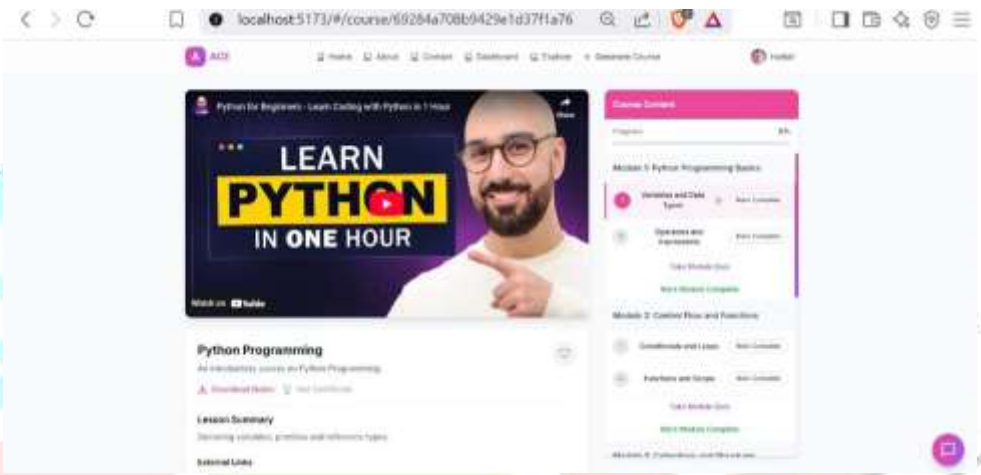

Figure 6: display of structured course modules and video content.

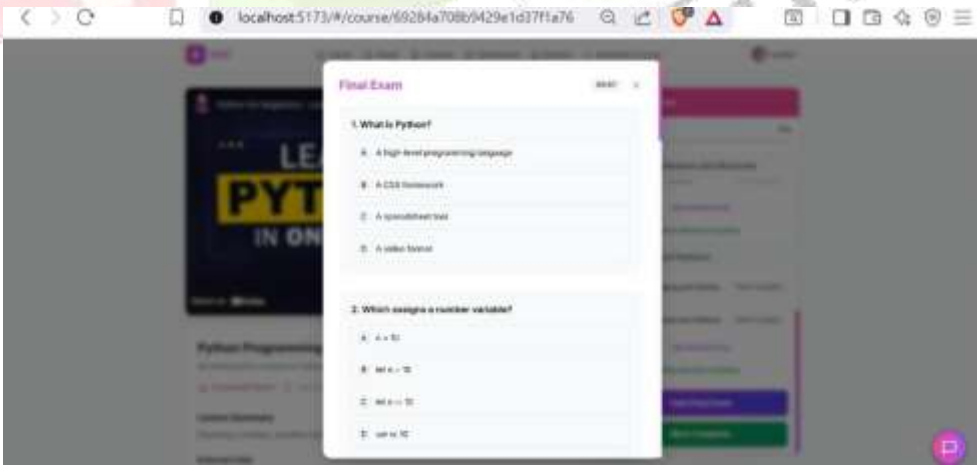

Figure 7: the interface for module-wise quizzes and assessments.

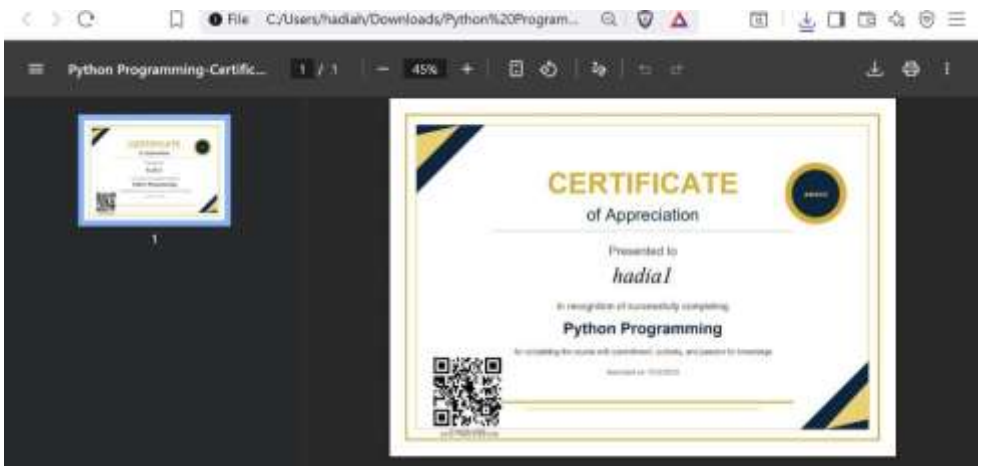

Figure 8: generated digital certificate after course completion.

Figure 9: the integrated user assistance chatbot interface.

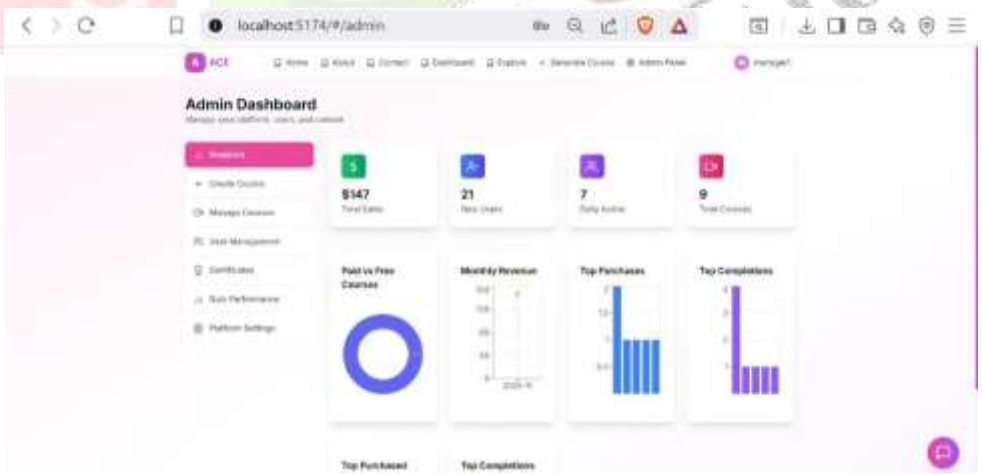

Figure 10: the administrator dashboard for content management.

7. CONCLUSION

This paper successfully presented the architecture and methodology for an automated course generator implemented using the MERN stack. The system effectively generates structured courses, supplementary learning materials, quizzes, and formal certificates with minimal human intervention. By combining automation logic with modern web development technologies, the platform enhances scalability, consistency, and efficiency in e-learning environments.

8. FUTURE SCOPE

Future enhancements may include improved recommendation logic, multilingual course support, adaptive assessment difficulty, mobile application integration, and advanced learning analytics dashboards.

9. REFERENCES

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