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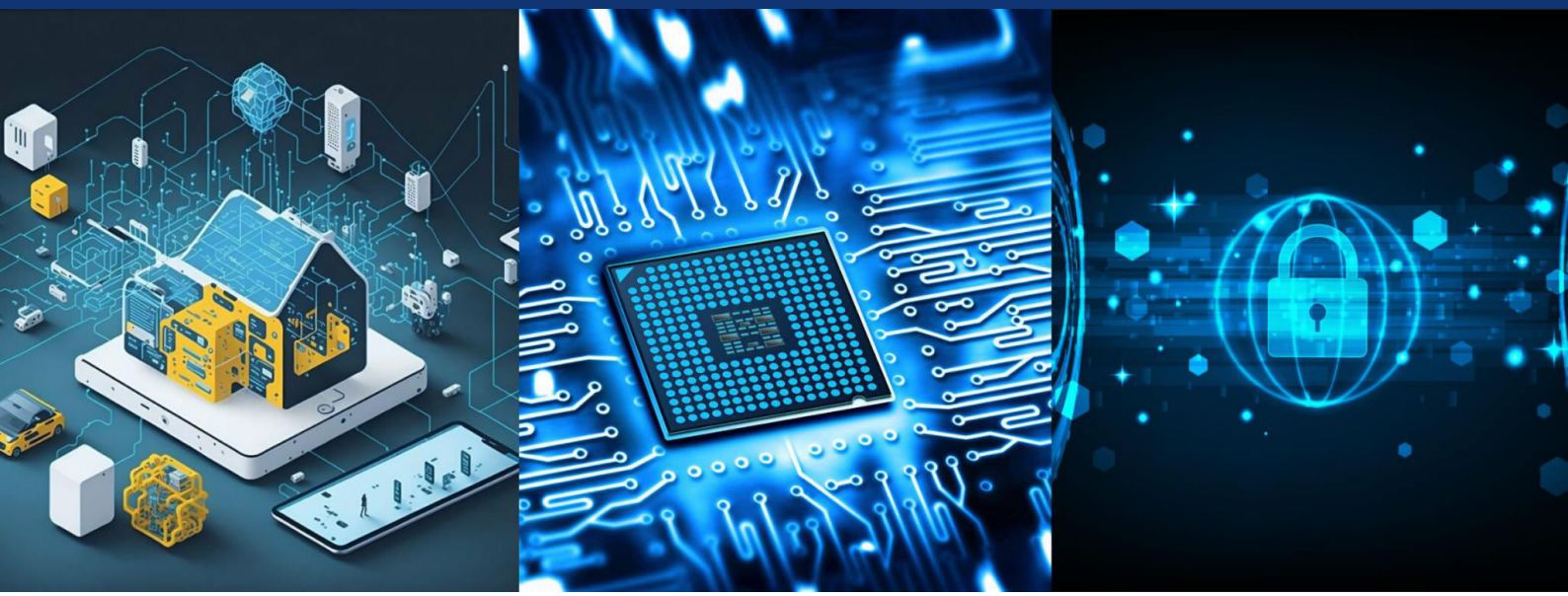
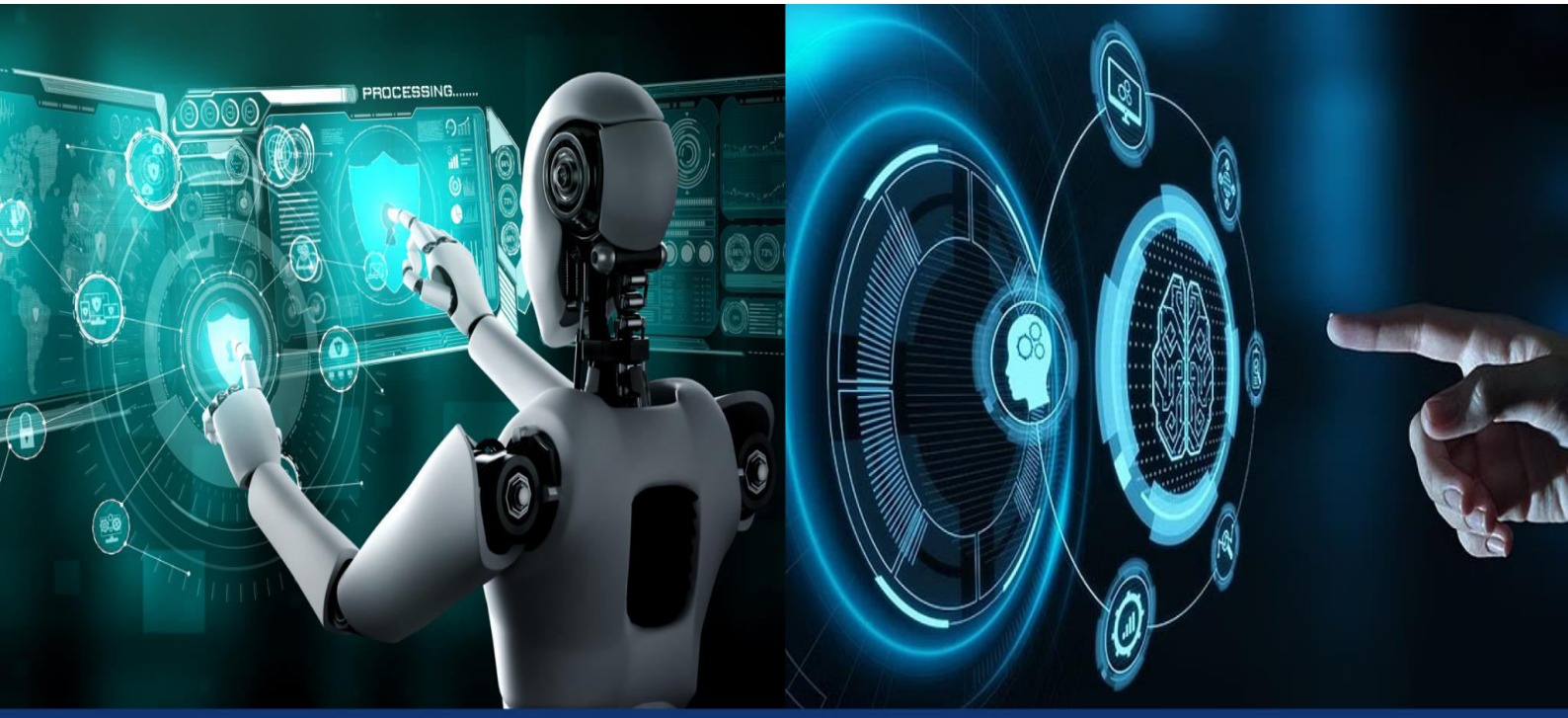


International Journal of Innovative Research in Computer and Communication Engineering

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



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GEN-AI Powered Personalized Learning Management System

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ABSTRACT: This work introduces a GEN-AI powered personalized learning management system designed to revolutionize educational content creation. The system, named GRASP, utilizes generative artificial intelligence to automate and streamline the course development process, creating tailored educational experiences based on user-defined inputs. By leveraging advanced APIs including Clerk for authentication, Drizzle for backend management, and Gemini for content generation, the platform delivers structured, personalized course content with minimal user effort. The integration of YouTube API further enhances learning resources by curating relevant video content. Our system addresses the limitations of traditional course creation methods, offering significant time savings, improved content relevance, and enhanced learning outcomes. Performance testing confirms the system's efficiency, responsiveness, and accuracy in generating educational content across diverse subjects. This platform represents a significant advancement in education technology, democratizing course creation and fostering a more inclusive and personalized learning ecosystem.

KEYWORDS: Generative AI, Personalized Learning, Course Generation, Learning Management System, Artificial Intelligence in Education, Education Technology.

I. INTRODUCTION

Traditional course creation methods are often time-consuming, rigid, and fail to adapt to the diverse learning needs of individuals. In an age where personalized learning is crucial, generic educational content leads to disengagement and poor knowledge retention. To bridge this gap, we introduce GRASP (Generative AI-based Responsive Academic Structure Platform)—an AI-powered system that automates the creation of customized educational courses based on user inputs such as skill level, goals, and learning preferences. GRASP intelligently structures content, organizes chapters, and curates relevant multimedia resources, significantly reducing manual effort and enhancing the overall learning experience.

Built using cutting-edge technologies, GRASP integrates Clerk for secure authentication, Drizzle for efficient backend operations, and APIs like YouTube and Gemini for content enrichment. Whether it's a student seeking to master a new subject, a professional upskilling for career growth, or an institution aiming to deliver scalable digital education, GRASP provides a seamless, adaptive platform for all. With a focus on automation, personalization, and scalability, the platform sets a new benchmark in education technology by making learning faster, smarter, and more impactful.

II. RELATED WORK

Recent advancements in AI-powered educational systems have demonstrated the potential of technology in enhancing learning experiences. Several studies have explored similar domains, providing valuable insights for the development of GRASP.

Murtaza et al. (2024) highlighted AI-based personalized e-learning systems that utilize learner profiles, assessments, and usage patterns to deliver tailored learning paths. While effective, these systems face challenges including dependency on advanced ML/DL techniques and maintaining real-time responsiveness. GRASP addresses these limitations by focusing on explicit user inputs and efficient API integration, simplifying content structuring and enhancing modular course creation.

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Dhairya et al. (2024) introduced Skillify, an enhanced learning management system using generative AI. The platform focuses on features like text-to-speech for visually impaired learners and course recommendation systems. While Skillify offers distinct modules for various stakeholders, GRASP concentrates on automating the course creation process itself.

Wijayawardena et al. (2024) developed an AI and machine learning-based e-learning system for secondary education, addressing challenges faced during the transition to online platforms. Their system includes chatbots for real-time assistance and grade prediction using ML algorithms. GRASP differs by focusing specifically on dynamic course generation rather than comprehensive e-learning management.

III. PROPOSED ALGORITHM

A. System Architecture

The system architecture of GRASP is structured into three primary layers: the User Interface Layer, Application Logic Layer, and Core Integration Layer, each designed for specific functionality and seamless interaction.

1. User Interface Layer: This layer encompasses the Dashboard, serving as the main point of interaction. Users can view course content, generate customized courses through specific prompts, and navigate individual chapters structured from video timestamps or API-generated metadata. The interface simplifies interaction by presenting generated content in a clean, accessible manner.
2. Application Logic Layer: Acting as the backbone of the system, this layer ensures smooth data flow between the user interface and core integrations. It contains:
    - Drizzle ORM: Handles user prompts and coordinates data flow between APIs and the dashboard.
    - API Integration Management: Processes video keys from YouTube V3 API to fetch chapters and timestamps, while retrieving enriched course details from the Gemini API.
    - User Prompt Handling: Accepts input from users regarding topics or customization requests and combines chapter data with metadata to create cohesive course content.
3. Core Integration Layer: This layer includes external systems essential for content generation:
    - YouTube V3 API: Extracts chapters and timestamps from educational videos.
    - Gemini API: Adds supplementary data like learning objectives and course summaries.
    - Generative AI Components: Synthesizes user inputs with video and API data to produce customized course content.

B. Methodology

The methodology follows a structured approach where the user interacts with the system through several sequential processes:

1. Authentication: Users log in or register to access the course generation platform, ensuring secure entry and data protection.
2. Input Provision: Users specify topics, preferences, and requirements for their desired course content, enabling customization to meet specific needs.
3. Content Generation and Preview: The system processes inputs through its AI engine, generating a structured course layout that users can preview and verify before proceeding.
4. Content Customization: Users can make adjustments to the generated content, ensuring alignment with their specific requirements.
5. Course Finalization: Once content is finalized, users can download the course for offline use or publish it for distribution.

This methodical approach ensures a seamless workflow while maximizing the benefits of AI-powered content generation.

IV. PSEUDO CODE

Step 1: User Registration and Authentication

→ User logs in or registers using secure authentication (via Clerk)

→ Role-based access ensures only verified users can create, view, or manage course content

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Step 2: User Provides Input for Course Generation
→ From the dashboard, users enter a prompt or topic of interest
→ The input can include YouTube video keys, custom instructions, or preferred structure

Step 3: Request Routed to Application Logic Layer
→ Prompt sent to the backend, handled by Drizzle (core orchestrator)
→ System initiates YouTube V3 API to extract video metadata and chapter timestamps
→ Structured outline of video content is created (based on timestamps or segments)

Step 4: AI-Powered Content Generation Triggered
→ Gemini API processes the user prompt and video metadata
→ It generates learning objectives, summaries, and enriched course descriptions
→ Generative AI ensures customization based on user's learning goals

Step 5: Combining Data into Structured Course Format
→ Backend merges structured video data with AI-generated metadata
→ Chapters are logically ordered and labeled
→ Resulting content is stored in the PostgreSQL database via Drizzle ORM

Step 6: Media Optimization and Storage
→ If multimedia files are added, they are uploaded to Firebase Storage
→ Cloudinary optimizes images and videos automatically for smooth rendering

Step 7: Display of Course Content on Dashboard
→ React + Next.js frontend renders the newly generated course
→ Tailwind CSS provides a clean, consistent design
→ React Query ensures real-time content updates on the interface
→ Users can preview, scroll through chapters, and verify structured output

Step 8: User Reviews and Finalizes Course
→ Users can approve, regenerate, or export the content
→ All interactions and preferences are logged for feedback analysis
→ Optional modifications can be made before publishing

Step 9: Session Handling and Data Security
→ All data transactions are secured
→ Sessions end cleanly, and activity metadata is logged
→ The system ensures that no unauthorized access occurs post-session

Step 10: End – Course Ready for Use or Sharing
→ Generated course content can now be used for study, shared with peers, or exported
→ System ready for next input or new course generation cycle

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V. SIMULATION RESULTS

The AI-Powered Personalized Course Generation System** was thoroughly tested in a controlled environment to ensure the reliability, accuracy, and performance of its modules. Unit testing was conducted across all major components including user authentication, AI content generation, database operations, and API integrations. All test cases passed successfully, verifying that each module functioned as expected.

Integration testing focused on the interaction between frontend, backend, and external services. Scenarios such as user login flow, content display, media uploads, and YouTube video processing were validated. The system demonstrated seamless communication between modules, with no data inconsistencies or interface delays.

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Performance evaluations confirmed that course generation was completed in under 5 seconds on average, even with varying inputs. The frontend remained highly responsive across devices and browsers, and the backend efficiently handled database queries and media uploads of different sizes and formats. The system showed excellent scalability, maintaining consistent behavior under increased user load and concurrent operations, confirming its readiness for real-world deployment.

VI. CONCLUSION AND FUTURE WORK

The GRASP platform has laid a strong foundation in automating personalized course creation using cutting-edge AI technologies, and its future roadmap envisions a wide array of enhancements to elevate its usability and global reach. Upcoming features include multilingual content generation to support learners from diverse linguistic backgrounds, powered by AI-driven translation tools for inclusive learning. Real-time analytics and advanced insight modules will enable educators to monitor user engagement and learning progress, facilitating data-driven refinements. By improving the AI's ability to handle niche and complex topics and integrating adaptive learning mechanisms, the system can further personalize the educational experience based on individual learning styles. The addition of video generation and interactive modules like quizzes, simulations, and assignments will make content more engaging and immersive. Moreover, the platform aims to offer seamless integration with popular LMS platforms like Moodle and Google Classroom through dedicated APIs, while cloud scalability and backend performance optimization will ensure smooth operation at scale. These forward-looking upgrades will not only expand the platform's capabilities but also position GRASP as a transformative educational tool that brings personalized, accessible, and high-quality learning to users around the world

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