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AI-Driven Student Support System using Retrieval-Augmented Generation in Academic ERP

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Abstract: ***The fast pace digital evolution in the field of higher education has made the use of Enterprise Resource Planning (ERP) and Learning Management Systems (LMS) inevitable for all sorts of learning and administrative functions. Unfortunately, the currently available systems do not offer a consolidated solution as they require interacting with numerous applications in order to manage attendance, assignments, schedule, and other academic operations. In addition to being inefficient, such a design creates challenges in terms of data synchronization and visibility as well as increasing the burden on administration. In this paper, Campus Nova, a web platform that allows inte-grating academic ERP functionality and an AI-driven chatbot, is proposed. Built using React.js and Firebase, the system employs serverless computing to facilitate data synchronization and scaling. The proposed web application provides a dual-access interface with separate modules for tracking attendance, managing assignments, scheduling classes, and tracking students' academic performance. One of the significant contributions lies in using a Retrieval-Augmented Generation (RAG) enabled chatbot that allows interacting with the data through a natural language processor. Furthermore, the system uses the concept of differential attendance updates with the help of session locking mechanism.***

Index Terms: ***Smart Campus, Academic ERP, Retrieval Aug-mented Generation (RAG), Conversational AI, Large Language Models, Firebase Firestore, Serverless Architecture, Attendance Management System, EdTech, Role-Based Access Control, Real-time Web Applications***

I. INTRODUCTION

The growing sophistication of modern technology solutions has resulted in an extensive application of Enterprise Re-source Planning (ERP) and Learning Management System (LMS) software in educational organizations. The primary purpose of the software is to handle administrative processes associated with managing enrollments, schedules, attendance, and assignments in one platform. The use of modern ERP software has greatly streamlined data integration and processes at educational institutions through the incorporation of various services in a single system [1], [2]. Despite these advances, the majority of existing solutions continue to depend on traditional dashboard interface solutions that force users to manually browse through different modules to obtain academic data.

The current generation of education involves the use of scattered systems for performing activities like tracking atten-dance, submission of assignments, and accessing schedules. This results in a lot of hassle on behalf of the users due to several actions needed to be performed for completion of each task. Another drawback of such systems is the absence of an intelligent way of interaction with these platforms. It has been noted in research papers that the existing generation of academic management systems does not have the ability to offer real-time guidance to the users [3].

Advancements in AI and especially in LLMs have opened up possibilities for improving the experience of using digital services by users. Conversational AI platforms can com-prehend natural language queries and provide contextually appropriate answers, facilitating a seamless search process. Nevertheless, pure conversational AI systems using LLMs lack capabilities like access to fresh institutional data and some-times give inaccurate responses [4]. As a way to overcome the aforementioned shortcomings, RAG has been found to be a viable solution, integrating language models with external data retrieval techniques [5].

In view of these developments, this paper introduces Cam-pus Nova, an intelligent campus management system, that brings together ERPs with Retrieval-Augmented Generation based conversational agent capabilities. This system employs modern React-based frontend, cloud-based database powered by Firebase Firestore, as well as machine learning model for query processing. The integration of real-time academic data fetched from university databases makes it possible to perform natural language conversations accurately and intelligently.

These are some of the key contributions of this paper: (i) design and realization of a holistic academic ERP platform that brings various student and faculty services under one roof; (ii) design of a RAG-based conversational agent that is capable of processing academic data in real-time; (iii) design of a mechanism to ensure differential update of data in terms of attendance with session control enabled via time-based approach; and (iv) implementation of a scalable serverless architecture based on modern web technologies.

The rest of this paper is designed as follows. In Section II, we provide an overview of the literature related to AI-powered academic applications, chatbots, and RAGs. The architecture of our proposed Campus Nova system is described in Sec-tion III. The methodology and RAG-based query processing pipeline are presented in Section IV. Implementation and experimentation are detailed in Section V.

II. RELATED WORK

A. AI Applications in Education

The introduction of artificial intelligence in the educa-tion sector has brought substantial advancements in educa-tion management through automated procedures and anal-ysis. Academic systems using ERP technology have been found to optimize education management by consolidating institutional procedures in unified systems [1], [2]. Current studies emphasize the application of academic systems based on artificial intelligence that improve students' performance tracking and institutional decision-making capabilities through analytics [3], [6]. In addition, AI-based models for creating a smart campus have implemented advanced data processing techniques to facilitate education procedures and resource management [7]. However, current frameworks lack interactive dialogue systems.

B. Applications of Chatbots in Education

There are numerous applications of chatbots in education since they may be helpful for people who need answers to edu-cational problems. The first iterations of such chatbot programs utilized rule-based methods and could not understand context [8]. However, with modern advancements in AI, there has been a rise in the number of applications of natural language processing and transformer models in designing chatbots that can respond to more complicated queries and hold more dialogues [9], [10]. In addition, chatbot AI assistants integrated with LMS became easier to use and assisted with reducing administrative work [11].

C. Retrieval-Augmented Generation Systems

A retrieval-augmented generation (RAG) model is becoming increasingly prevalent as an effective method of enhancing the dependability of LLMs through knowledge retrieval systems. Existing LLMs are often plagued by problems such as hal-lucinations and a lack of access to real-world data, reducing their usefulness in domain-specific systems [4]. RAG models overcome such limitations through retrieval of context-relevant data from external databases before generating outputs, thus ensuring enhanced precision and contextual accuracy [5], [12]. There have been recent developments in hybrid retrieval systems and vector retrieval to augment AI knowledge systems and enterprise operations [13], [14]. Furthermore, intelligent digital assistants based on AI technology can access organi-zational data in real time [15].

D. Research Gap

Even though significant advancements have been achieved regarding AI-driven academic systems, chatbots, and RAG models, there is still room for improvement within the frame-work of the present-day technology. Although modern ERP systems successfully handle the process of data management, none of them utilizes an advanced conversational system. Chatbot systems can prove to be highly interactive; never-theless, their operation relies on a static database and does not involve any academic information in the real-time mode.

At the same time, while many studies have focused on the issue of RAG models, their implementation in the context of academic ERPs is rare.

This means that there is a notable gap in research related to designing solutions featuring: (i) the integration of ERP data, (ii) Retrieval-Augmented Generation for the contextual gen-eration of responses, and (iii) multi-role academic processes involving both students and instructors.

TABLE I: Literature Review of AI-Based Academic Assis-tance Systems

Author	Year	Focus Area	Description
Brown et al.	2024	ERP in Edu-cation	This study analyzes ERP systems in higher educa-tion, focusing on architec-ture, scalability, and inte-gration challenges.
Pasaribu et al.	2024	Cloud ERP Systems	The authors propose a cloud-based ERP system for universities, emphasiz-ing scalability and real-time data access.
Daryanto	2025	Smart Academic Systems	This work presents an AI-based academic management system that enhances institutional decision-making using analytics.
Gemma Team et al.	2024	LLM Devel-opment	This study introduces open large language models for AI applications, highlighting their potential in conversational systems.
Qin et al.	2023	RAG Foun-dations	The authors present retrieval-augmented generation for knowledge-intensive tasks, demonstrating improved response accuracy.
Wuttke et al.	2025	RAG Systems	This paper explores RAG-based conversational AI systems, showing improved contextual accuracy and reduced hallucination.
Alahmari et al.	2024	Smart Cam-pus AI	The study proposes an AI framework for smart campus environments, in-tegrating analytics and au-tomation.
Maity et al.	2025	NLP Chatbot	The authors develop a chatbot for academic queries using NLP techniques. While improving accessibility, the system relies on predefined responses and lacks dynamic data integration.
Kim et al.	2025	Academic Analytics	This work applies deep learning for predicting student performance using historical data.
Pathak & Pandey	2025	Conversati onal AI	This study integrates con-versational AI into LMS platforms, enhancing aca-demic support.
Uppalapat i et al.	2025	Transforme r Chatbots	This work proposes transformer-based chatbots for academic assistance.
Professor & M.M.R	2025	Knowledge Systems	The study introduces AI-driven knowledge man-agement systems for aca-demic support.
Xinyue et al.	2024	RAG QA Systems	This paper demonstrates RAG-based question an-swering systems with im-proved accuracy.
Zhalgasba ye et al.	v 2024	Vector Retrieval	The authors explore vector-based retrieval methods for generative AI systems.
Rao et al.	2025	Hybrid RAG Systems	This study presents a hybrid RAG architecture combining retrieval and reasoning.
Selvam et al.	2025	Digital Assistants	The paper discusses AI-based digital assistants for organizational systems, enabling real-time data access.
Dettmers et al.	2023	LLM Optimizatio n	This work focuses on effi-cient training of large lan-guage models, improving computational efficiency.
Lee & Kim	2023	Educational Chatbots	This study explores chat-bot systems in education, highlighting their role in student support.

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III. SYSTEM ARCHITECTURE

The architecture of the Campus Nova platform under de-velopment includes modularity and scalability to incorporate academic management capabilities as well as an intelligent AI-powered conversational assistant. In its implementation, the system uses a three-layer architecture made up of the *User Interface Layer*, *Data Management Layer*, and *AI Reasoning Layer* to facilitate modular design that enhances system inter-actions.

The architecture allows for effective communication be-tween the frontend application, backend database, and the intelligent query processing system. As depicted in Fig. 1, the platform uses a Retrieval-Augmented Generation (RAG) pipeline to retrieve and generate context-aware responses.

A. System Structure

The system architecture is structured into three main tiers:

- User Interface Tier: Offers an interactive interface en-abling users to engage with the academic services and communicate with the chatbot.
- Data Storage Tier: Manages the storage and retrieval of the academic data stored in a cloud database.
- AI Reasoning Tier: Features the RAG-enabled chatbot responsible for processing user queries and providing relevant answers.

B. Front End Architecture

Campus Nova uses React with Vite for efficient rendering and modularity of components. TailwindCSS is also used to ensure responsiveness and the creation of a modern UI. The dashboard offers several components such as attendance, assignments, courses, timetables, and academic performance. Chat bot is used as an additional feature where users can engage in conversation with the software using natural language questions. The front end communicates with backend services asynchronously through API calls for fetching and updating real-time data.

C. Back End and Database Architecture

The back end services use Firebase Firestore as their main data store. Firebase Firestore is a NoSQL database that ensures scalability and real-time data synchronization. The database consists of several collections such as users, courses, atten-dance, assignments, and timetables.

The collections share relationships through unique IDs enabling easy access to individual students' academic information.

D. RAG Chatbot Architecture

Campus Nova's AI component follows the architecture of RAG. The RAG-based chatbot uses a pipeline approach to process user queries. The first step is the intent analysis of the user query. After that, the retrieval component retrieves related academic information from the Firestore database. This information is then merged with the user query and fed into an LLM to generate the final response.

IV. METHODOLOGY AND IMPLEMENTATION

In this section, the methodology and implementation of the proposed Campus Nova system have been discussed. The system is based on a RAG framework that allows real-time academic query processing using the integration of structured institutional data with a large language model. The methodology primarily discusses the design of the RAG pipeline, mathematical formulation of response generation, and the implementation of the system using state-of-the-art web development practices.

A. Query Processing Using RAG-based Approach

The Campus Nova platform handles user queries in a multi-step pipeline that allows effective and context-aware response generation. As depicted in the image below, the processing of queries involves the following steps:

Firstly, the user inputs a natural language query to the chat-bot. The system detects the intent of the query, which could be for obtaining attendance data, assignment status, or timetable details. Accordingly, the retrieval mechanism gathers relevant information from the Firestore database hosted on Firebase. This information is used to generate a structured context that is further provided to the language model (Gemini).

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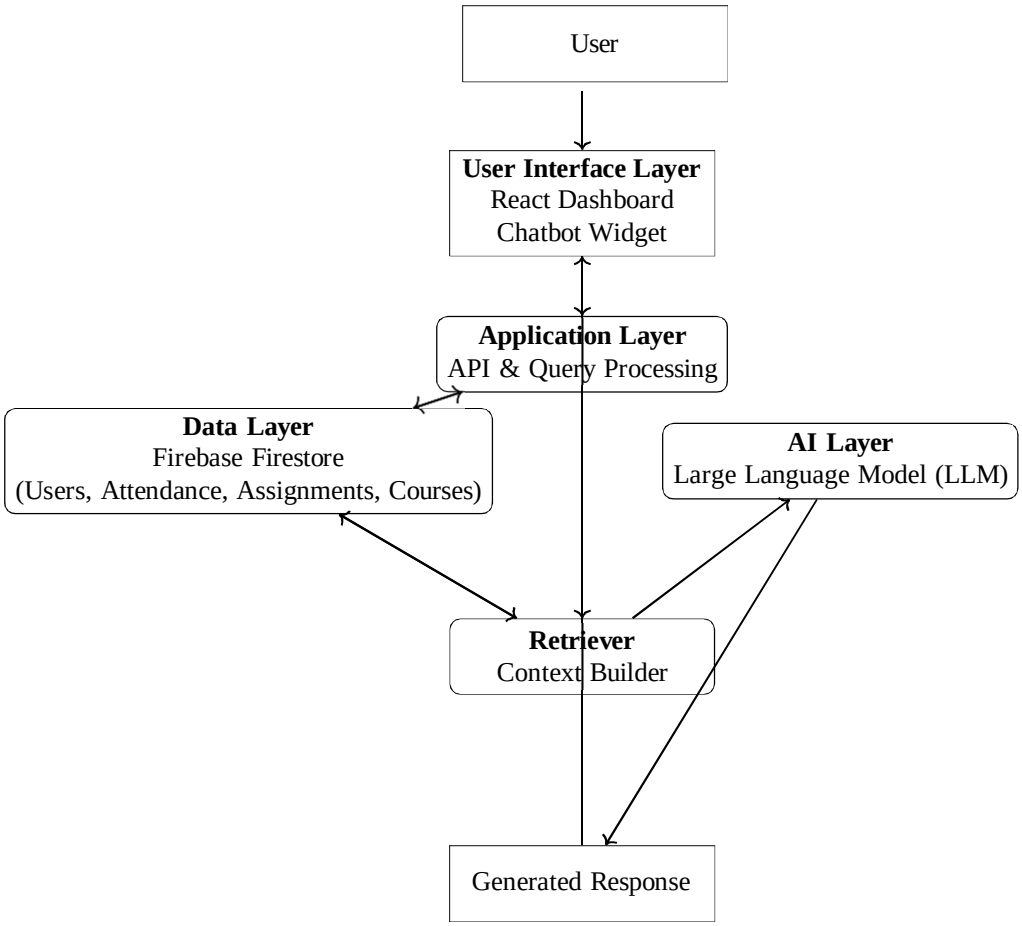

Fig. 1: System Architecture of Campus Nova showing the integration of User Interface, Data Management, and AI Reasoning layers with a Retrieval-Augmented Generation pipeline.

B. Mathematical Representation

The mathematical notation is as follows: Let Q be the user's question and D be the academic database. The retrieval process $R(Q)$ pulls out context from the database that matches the user's query. The large language model then answers the question using the query and context.

$$Response = LLM(Q + R(Q)) \quad (1)$$

This formulation ensures that the generated response is grounded in real-time academic data while leveraging the reasoning capabilities of the language model.

C. Algorithm for Query Processing

D. Differential Attendance Engine

An important innovation in the design of this attendance system involves the use of differential attendance updates. This differs from typical attendance systems where the old data gets replaced by the new one. In this model, an update is performed incrementally in order to preserve correctness and consistency. Denoting the attendance state of the system at t as A_t, and the difference change as ΔA, we calculate the new attendance using:

Algorithm 1 RAG-based Academic Query Processing

```
Input: User Query Q
Output: Generated Response Res
Preprocess query Q (tokenization, normalization)
Identify intent I and entities E from Q
if I = Attendance then
    Retrieve attendance records from database D
else if I = Assignment then
    Retrieve assignment details from D
else if I = Timetable then
    Retrieve schedule information from D
else
    Retrieve general academic data from D
end if
Store retrieved data as R
Rank and filter relevant information from R
Construct contextual input C
Combine query and context: Q' = Q + C
Generate response Res ← LLM(Q')
Format response into structured output
return Res
```

$$A_{t+1} = A_t + \Delta A \quad (2)$$

Moreover, to avoid concurrency problems during the update process, this model utilizes time-based session locks.

E. System Implementation

Campus Nova's implementation uses an up-to-date full-stack approach. For building the front-end, React with Vite is used in order to create modular and responsive UIs. In terms of styling, TailwindCSS is used for consistency and scalability. For the back-end infrastructure, Firebase Firestore was chosen as it is a scalable and cloud-based NoSQL database which provides real-time synchronization. Data organization within the database occurs via collections such as users, courses, attendance, assignments, and timetables which allows for structured retrieval of academic data.

Role-based access is provided for both students and faculty members. The student's part of the application allows for visualization, attendance recording, assignment submission, and viewing of timetables. The faculty side of the application allows for course management, attendance recording, and assignment generation.

In addition, the AI part of the system consists of integration of a large language model (specifically, the Gemini API) with the Retrieval-Augmented Generation Pipeline in order to perform intelligent queries. Front-end communicates with back-end services via asynchronous API calls.

V. EXPERIMENTAL EVALUATION AND PERFORMANCE

The following section highlights an experimental evaluation that aims to analyze the performance of the proposed Campus Nova system and compare its performance with other conven-tional ERP software in academia.

A. Performance Metrics

Four performance metrics have been selected for evaluating the performance of the system, including data processing time, effort required by users, accuracy of responses, and degree of automation. Table II displays a comparative study between traditional ERP systems and the proposed Campus Nova platform.

TABLE II: Performance Comparison Between Traditional ERP and Campus Nova

Metric	Traditional ERP	Campus Nova
Data Access Time	High	Low
User Effort	High	Low
Accuracy	Medium	High
Automation Level	Low	High

It shows that the implementation of the system greatly reduces the time taken for the process of accessing information by the use of natural language communication without putting much effort by the user.

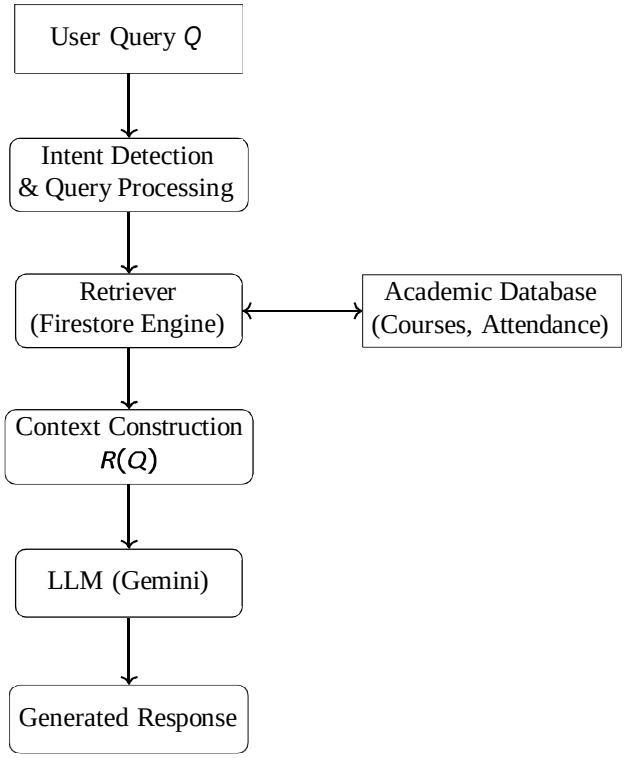

Fig. 2: Vertical RAG architecture for Campus Nova showing query processing, retrieval from academic database, context construction, and response generation using a large language model.

Fig. 3: Campus Nova Student Dashboard Interface

B. Performance Analysis

The performance of the system is analyzed through query response time, system latency, and data retrieval efficiency. Through the use of the RAG architecture, the system is able to resolve queries in an efficient manner by fetching academic data from the database and supplying it to the language model. As the user does not have to go through various elements of the dashboard to get the required results, the average response time is lower than that in conventional systems. The latency in the system is kept minimal since the database used for this application, Firebase Firestore, allows real-time synchronization of data.

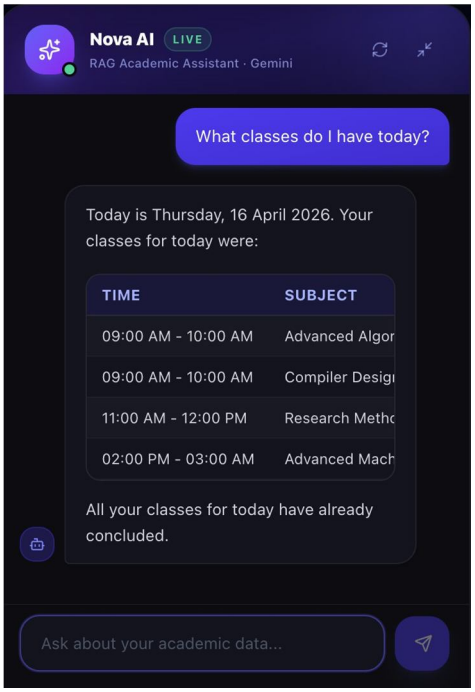

Fig. 4: RAG-based Chatbot Interface demonstrating real-time academic query response.

The student dashboard of Campus Nova, illustrated in Fig. 3, is shown. This solution helps to access various aca-demic data such as attendance, assignments, and timetables through a single interface. As a result, it facilitates the navi-gation and data visualization processes, which greatly reduces the necessity to interact with the different system modules manually.

Fig. 4 shows the RAG-based chatbot that is integrated into the system. Thanks to the chatbot, it is possible to get academic data by using natural language questions. Thus, by making use of real-time data and large language models, the system provides an opportunity to generate contextually appropriate answers.

C. Results and Discussion

It is evident from the results of the experiment that the suggested Campus Nova platform is an efficient tool for increasing the efficiency and access to academic information. Integration with Retrieval-Augmented Generation makes the system's responses more accurate since they are grounded in actual data collected in the institution at that moment, which minimizes hallucinations.

As opposed to traditional ERP systems, the suggested method allows users to get information quickly, saves time, and automates intelligence about academic questions. Thus, integration of ERP capabilities with conversational AI turns out to be a useful solution for the modern smart campus environment.

VI. CONCLUSION AND FUTURE RESEARCH DIRECTIONS

This study introduced a platform known as **Campus Nova**, which is a smart campus management tool that unites all the functionality of an academic ERP system and a retrieval-augmented generation conversational assistant. This approach eliminates problems associated with traditional academic plat-forms through the creation of non-fragmented user interfaces that allow users to easily interact with their academic accounts. The experiments have shown that the developed system makes working with academic information easier by making the data accessible, requiring less effort from the user. The combination of real-time retrieval systems with large language models proved to be very efficient.

Among other future work that will be done includes use of AI algorithms to predict attendance, creation of a mobile app, ability to push alerts, and development of a data analysis tool for better insight. Integration of a multi-agent intelligent agent system can add more intelligence to the platform.

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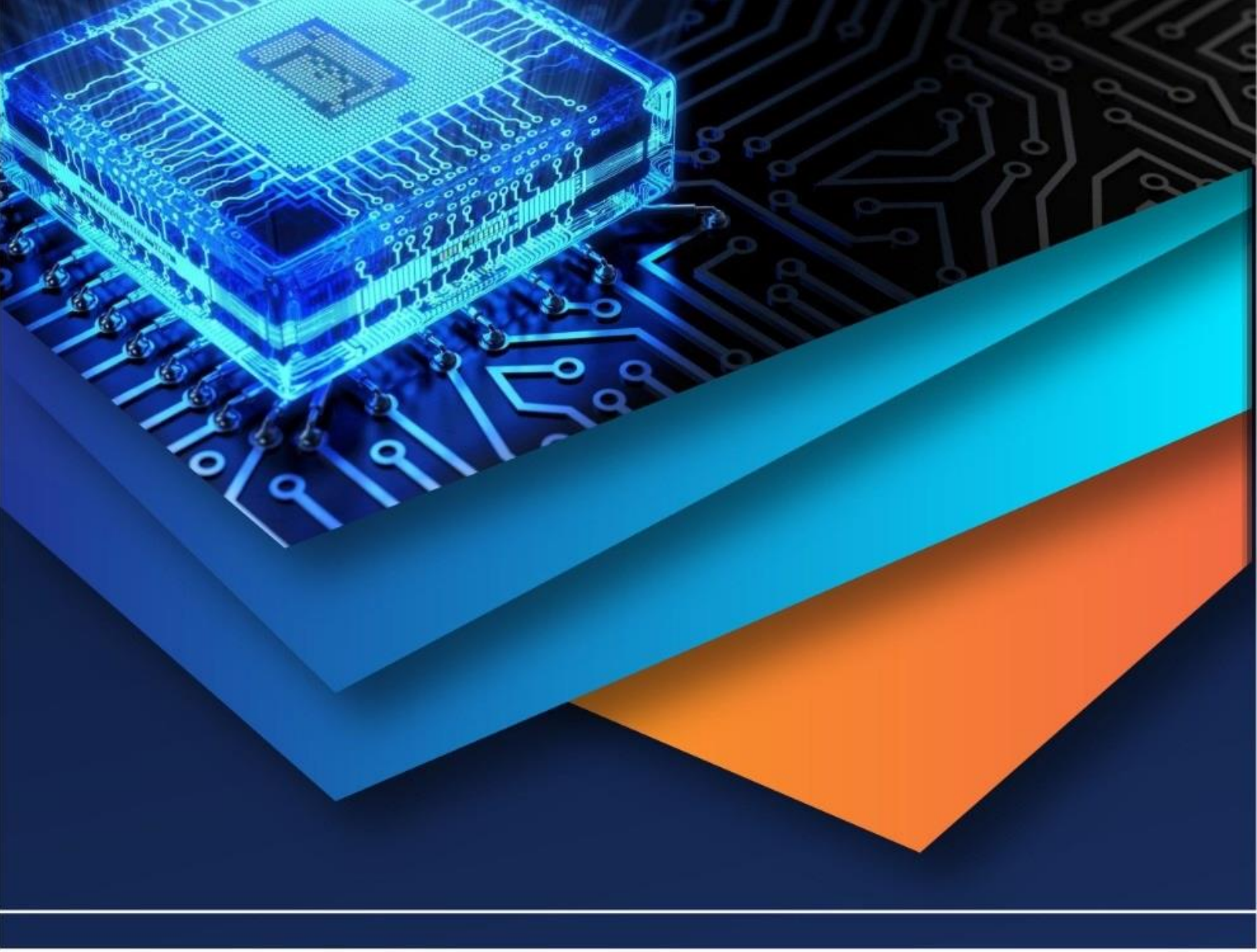

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