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Automated Attendance Monitoring System

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Abstract: Covid-19 has caused an unprecedented paradigm shift in the daily, quotidian tasks. The current world needs social distancing and minimal physical interaction. Despite all these hardships, an educational institution must keep working. The methods currently used in the majority of institutions, for recording attendance in the classroom, involve manually writing the student's signature and then uploading these sheets into the system for further analysis. This method is now highly obsolete and anachronistic. Moreover, it is deleterious as it hardly corroborates with the contactless guidelines. This paper describes a system, where the user can record his/her attendance using face recognition, and all the statistics will be inherently calculated by our system for the teachers to analyze in a contactless but efficient manner. Index TermsAttendance System, Facial Recognition, Webbased application, Online classroom, Open source

I. INTRODUCTION

Face recognition remains the top pick for authentication amongst various other forms such as fingerprints [1], RFID [2], passcodes, etc. Even though the other forms are more accurate, face recognition is still evolving to accurately predict [3] and authenticate the user. Owing to the current COVID-19 situation, it is essential to have a system that has minimum contact and is thorough for recording attendance. The traditional way of taking attendance possesses the risk of spreading bacteria and viruses among its users. In pursuit of finding a solution, this web-based application was developed for providing a contactless attendance system that records the attendance of students using a face recognition model [4]. In addition to this, it automates all possible statistical analysis for providing hassle-free management of attendance for the teachers as well as the students and obviates the need for any physical contact. The paper begins with an introduction and is followed by a literature review in section 2. Section 3 delineates the proposed system. The proposed solution and methodology are expounded in detail in section 4. Section 5 deals with the experimental results. The paper ends with the conclusion and future scope given in the last section, section6.

II. RELATED WORK

A. Literature Review

A real-time face recognition model that provides an accurate service with the least possible discrepancies is required for building the system. After exploring various models mentioned in [5][6][7][9][13][14], it was concluded that the best accuracy was provided by the 'python3 face-recognition' package developed by Adam Geitgey [4]. This package is built using dlib's state-of-the-art face recognition which is a deep learning-based architecture and the cited accuracy on the Labeled Faces in the Wild benchmark dataset is 99.38% [4]. In [5], a 20 layered CNN model is used for face recognition. The proposed application [5] falls short in describing a robust server and a database architecture for real-time attendance management. [6] follows the Dlib CNN library for face detection. Data Analytics for this system is unavailable and the system falls short in communicating with its stakeholders in the form of emails or notifications. In [7], the face recognition model was developed using a haar-cascade classifier combined with local binary pattern histograms (LBPH) for face recognition. The database used is a SQL database. The proposed system [7] has an inadequate database design, therefore results in limited data analytics. In [9], Haar Cascade and LBPH are used as face recognizers. This paper is still working on providing an accuracy of over 90% along with making a more portable device. The data analytics provided to its stakeholders was inadequate.

In [14], an improved Alexnet model is used which provides better training time (109ms), reduced network parameters and significant reduction in feature extraction time (98ms). Although the model is promising, the overall application falls short in many aspects such as, absence of an user friendly interface, very limited data analysis and lack of multiplatform support. Eliminating the shortcomings of the above-mentioned references, CaptureIt provides a robust application with an exacting database management system. It renders in-depth data analytics for its users to provide more insights. It also has multi-device support for mobile as well as computer devices. Moreover, in order to obviate the dependency of the students as well as the teachers from the handwritten marking of attendance for a wide range of subjects that are taught in different batches, a 'Google Classroom' [8] like architecture is incorporated within this system.

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This structure provides a way of marking attendance separately for each individual class that the student enrolls in. The classroom architecture combined with the face recognition system for recording attendance provides a myriad of opportunities for the educational institution to keep a calculative and statistical record of students, teachers, attendance, absentees, mass bunks, online coursework, and email facility, that the existing systems [5][6][7][9][13][14] fail to provide collectively in one single system.

B. Mitigating bias in visual recognition and data security.

Most commercial facial analysis systems arebiased against certain categories of race, ethnicity, culture, age, and gender [10]. The proposed system leverages python's face recognition model built by Adam Geitgey [4]. The model is trained on Labeled Faces InThe Wild (LFW) and has an accuracy of 99.38%. For mitigating bias in visual face recognition, the LFW dataset has a uniform distribution of demography [10], subsuming a wide range of faces belonging to different ethnicities, races, and gender. Cross-Site Reference Forgery (CSRF) remains a major concern for many web applications [11]. To mitigate the threat of a data breach resulting in the promulgation of sensitive information, primarily images of users, the proposed system utilizes an express.js middleware named CSURF. It generates a random CSRF token for each user request and saves it as a session cookie for authentication of that session user. In addition, all the sensitive data such as passwords or personal information like a home address and phone number is protected by storing it as a hash [12].

III. PROPOSED SYSTEM – CAPTUREIT

A. System Architecture

The figure below(Fig1) represents the system architecture of CaptureIt. The architecture subsumes the following modules:

- Training layer: It consists of training the face recognition model on training images for face detection and extracting it's features and storing it in a database.
- Recognition layer/ML layer: This layer uses the pretrained model to extract and detect facial features from the current real time video frame provided to it by camera module and mark attendance in database.
- Internet layer: Store the marked attendance in the database so that API's can be leveraged for future analysis.

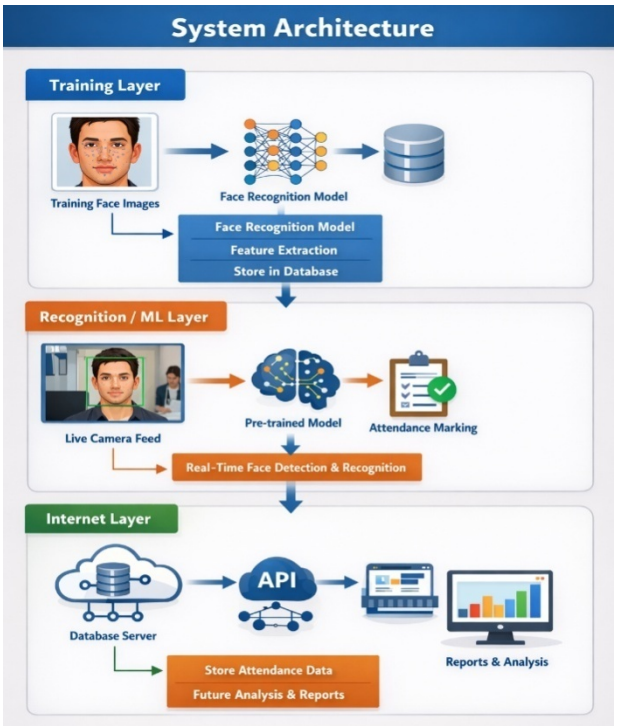


Fig. 1. System Architecture

B. Scope

CaptureIt considers two main stakeholders: Teacher and the students.

For Teachers, CaptureIt has following key features:

- Attendance recording: Teachers can successfully record attendance for each student and can also get the average attendance of the whole class.
- Lists: Teachers have access to the list of all registered students along with the list of the defaulters.
- Monthly analysis: A graphical representation of the number of lectures conducted, attended and mass bunked is provided.
- Filtering and Downloading: Teachers can filter students by Yea, Batch and Class and can further download the colour coded attendance excel sheet and absentee excel sheet from the system.
- Creating a unique code **for student enrollment in the classroom:** The individual subject teachers can create a unique classroom code for their subject and share the same with their students for sharing the coursework**.**

For Students, CaptureIt has following key features:

- Check attendance: A student can view his/her average attendance in all the classes he/she has enrolled in.
- Defaulters list: The students can view the attendance of those classes that are marked in red on account of having an attendance lower than the threshold value of 75
- Enrolling in a classroom: The students can join a classroom with a unique code provided by their subject teacher.

IV. PROPOSED SYSTEM AND METHODOLOGY

A. Technology Stack

The figure below (Fig2) represents the technologies that were leveraged in development of CaptureIt. The technology primarily entails a javascript server (nodejs and expressjs), a python flask server and a nosqlmongoDB database. Node.js is a cross-platform and open-source, back-end JavaScript runtime environment that runs on the V8 engine. Handlebars is the templating engine that provides dynamic data interaction between front-end and back-end API. Express.js is a backend framework for Node.js which is used for designing APIs. The face recognition model [4] is hosted on a python flask server. Opencv is also integrated in the python server for capturing real time camera streams. All the data is stored in the mongodb database which supports concurrency for multiple users to read or write the same data.

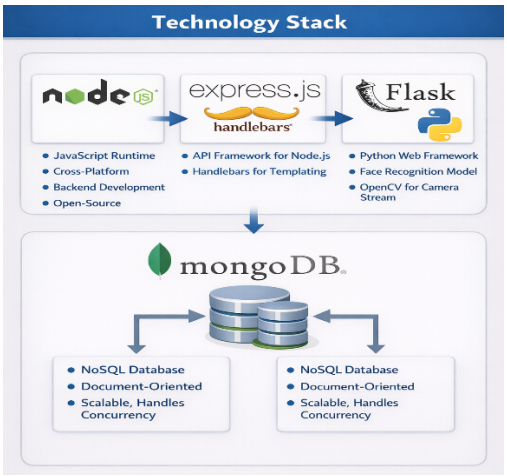


Fig. 2. Tech Stack

B. System Modules

The proposed system CaptureIt has 6 major modules as follows:

- User Registration/Authentication: The user is required to register when he/she visits the portal for the first time. During registration, all the input fields are validated such as email field, roll number field, password field and so on. Registration for students and teachers are done separately to record important details for future reference.Users are required to login with those same credentials.
- Face Recognition[4]: Once registered, this module is responsible for taking the attendance of that student. It opens a webcam and captures the face of the student in that frame, based on these captured faces, it stores the attendance of that student in the database.
- Classrooms: Teachers can create their subject classrooms using a unique class code and can further add students to each class either manually or the code.

- Attendance module: This module calculates the average attendance of each class once created, average attendance of each student in every enrolled class, average attendance of all classes and also segregates the defaulters list.
- Email notification: Notifies the students via email when they are added to a new class by a teacher or when they fall into the category of defaulters (attendance below 75
- Statistics and graphs: Attendance stats are shown on both student and teacher portal, i.e. the monthly graph analysis of both total lectures conducted and total mass bunks by students.

C. Database Design

The diagram below (Fig3) represents the database Entity Relationship for this system.The Database is a NoSQL based database i.eMongodb (Fig2).

The main entities in the database are users, classes, images and attendance. The internal relationship of these entities can be detailed as,

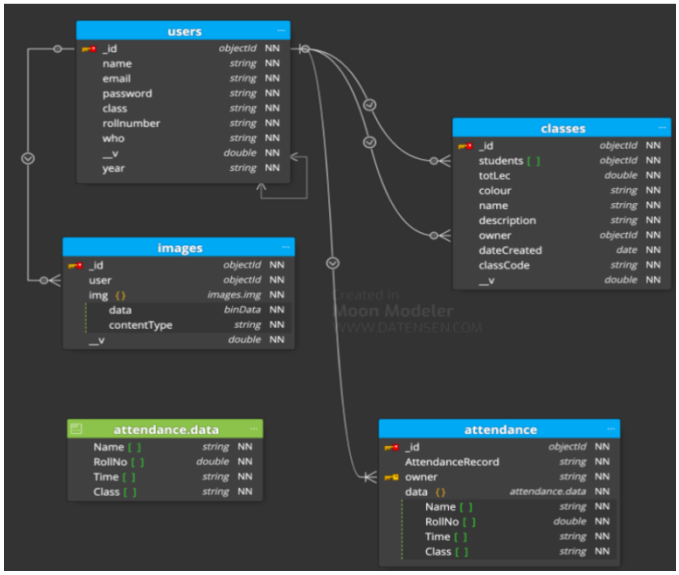


Fig. 3. Database ER Diagram

V. EXPERIMENTAL RESULTS

The key features mentioned in Table II were incorporated in the system based on a survey conducted as a part of requirement elicitation. Five teachers who participated in this survey, elicited details about data analysis and features that they would expect from this system. Table III contains key performance indicators of the system that were calculated after rigorous testing on a class of 20 students. The experiment was conducted via an online meeting software due to restrictions on gathering in person because of COVID 19 norms. The meeting software permitted a total of 9 students in a single view (Fig. 4) and the system successfully identified the students with an average accuracy of 98%. The system was tested on a 2.3GHz dual core processor with 8GB RAM. Figures (Fig. 4,5,6,7,8,9,10, 11,12, 13) are the results obtained on a web browser of a teacher conducting a lectureonline meeting *application.*

TABLE I FEATURE ANALYSIS OF

Face recognition for recording attendance	Yes
Face recognition model used for CaptureIt!	python3 faceRecognitionpackage(by Adam Geitgey)
Mass Bunk Indicators	Yes
Statistical analysis of attendance and absenteeism	Yes
Export to detailed color	Yes

coded excel shee	
Multi-platform	Yes
Spoof detection	No
Notification alerts	Via Emails

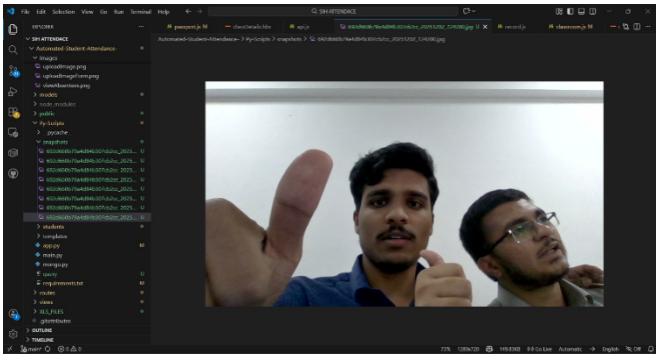


Fig. 4. Multiple face detection in an online classroom

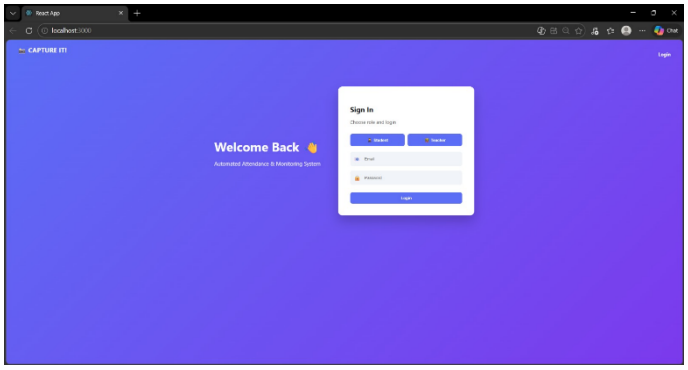


Fig. 5. Dashboard

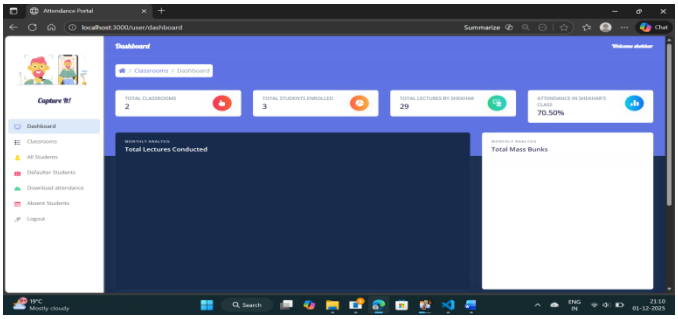


Fig. 6. Teacher Dashboard

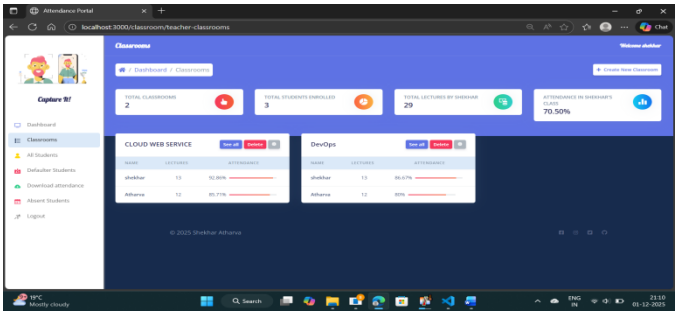


Fig. 7. Class Details Page

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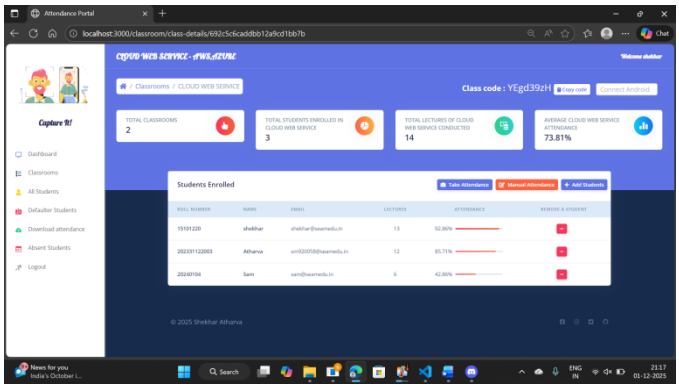


Fig. 8.Take Attendance Interface

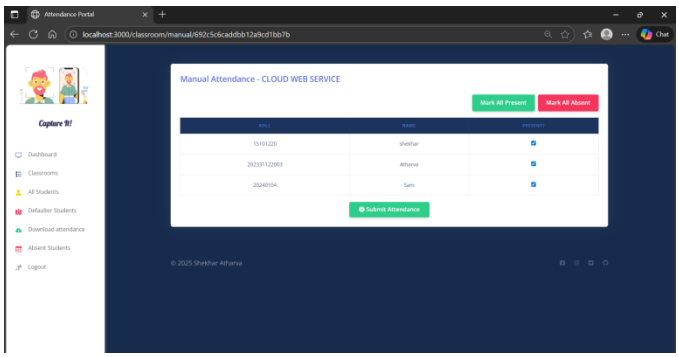


Fig. 9. Manual Attendance Screen

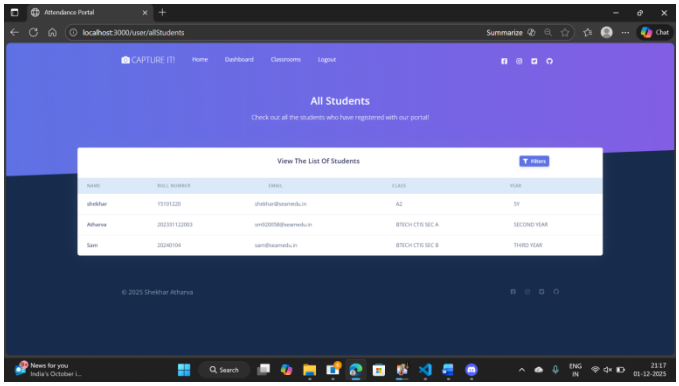


Fig. 10. List of Students in teacher dashboard

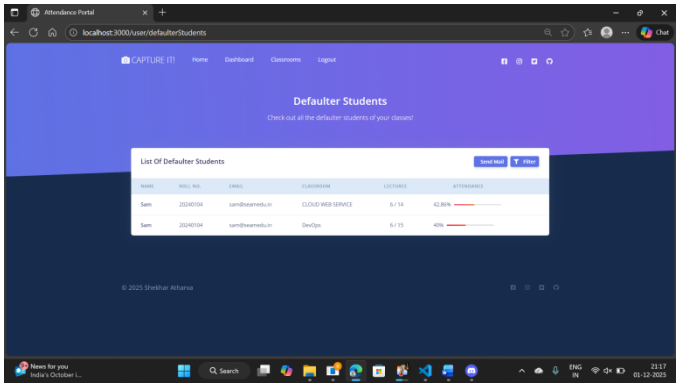


Fig. 11. Defaulter Student

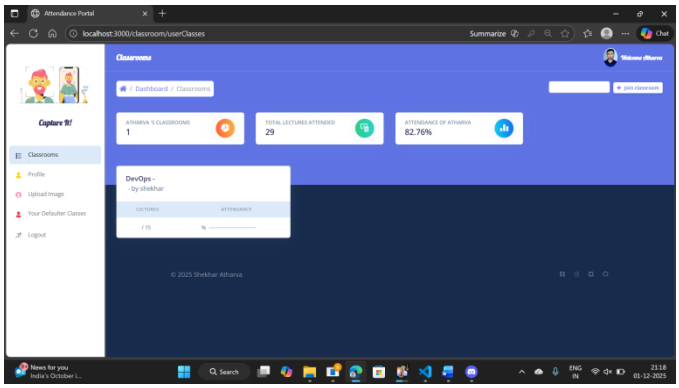


Fig.12. Student Dashboard

VI. CONCLUSION AND FUTURE SCOPE

This web-based application (CaptureIt!) provides a range comprehensive functionalities, which are yet to be explored in systems similar to this[5][6][7][9][13][14]. The seamless integration of facial recognition and custom API's along with the interaction between the students and the teachers through the web application, gives a complete automated experience. Further aim is to perpetuate developing this application in the future. This project is an open source project, therefore further iterations of development will be provided by the open source community to enhance the usability and functionality of the application. Different experimentation such as UI enhancements, modular developments for prevention of spoofing while marking the attendance and performance enhancements have been left for future work. The future work takes a deeper dive into leveraging the classroom schema to subsume more features pertaining to teacher and student interactions, such as conduction of quizzes and file sharing. The performance of the system can be improved by experimenting and testing to reduce the latency of various tasks mentioned earlier. Various models for detection of liveliness will be tested to make the system spoof proof.

The application was developed in the hope of creating a safe educational ecosystem in this pandemic caused by coronavirus, to adhere to the safety norms and guidelines of the governing entities

Urban resilience is a foundational cornerstone for achieving the full mandate of SDG 11. Shahid and Ahmed (2022) stress the immense importance of systematically embedding resilience indicators into urban development frameworks and policy structures to enhance the long-term sustainability of cities and communities. Cybersecurity serves as a fundamental protective component of this resilience by securing the digital infrastructures and complex information systems that are integral to the efficient operation of modern urban environments (smart grids, traffic, public safety). By effectively mitigating dynamic cyber threats, a strong cybersecurity posture reinforces the ability of cities to withstand disruptions, ensuring operational continuity and allowing progress to continue toward sustainability goals.

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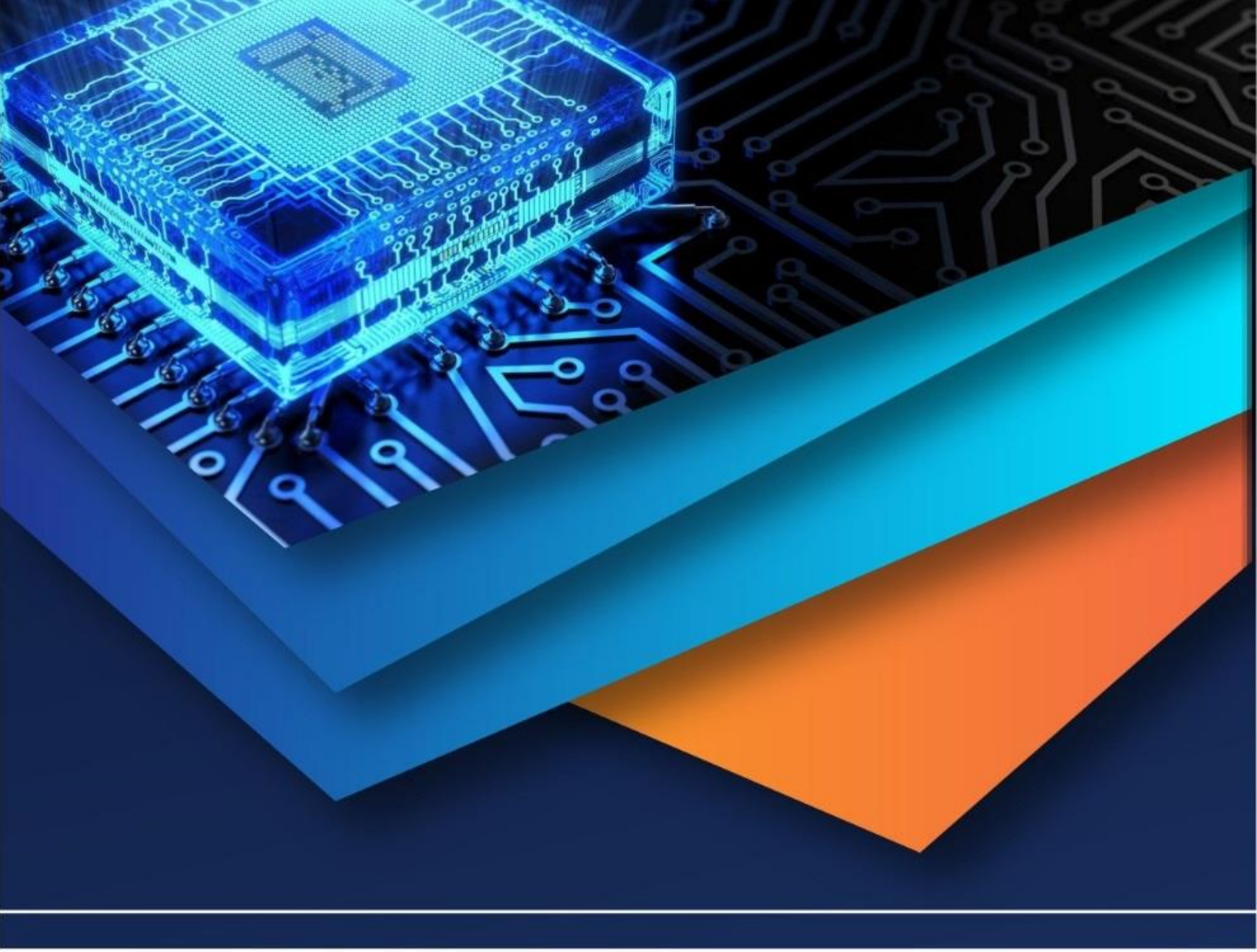
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