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Smart Classroom Attendance System Using Face Recognition and Raspberry Pi

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Abstract: ***Face detection in real-time is a component of an automated face recognition system that is also employed in the development of a separate research subject. As a result, there are a variety of ways for dealing with face detection issues. The goal of our proposed project is to detect and recognize faces, as well as to record attendance for each face. The camera connected to Raspberry pi USB port will capture the faces of students in real-time who are available in the class for face detection using Viola Jones Algorithm. The image which is captured is compared with stored images in database and then recognize the faces of every student using LBPH and according to that, attendance will be given to that class for that particular student. The details of the students are stored in MySQL database. The proposed project is being presented as a solution for the Manual Attendance Marking System. It is designed to be efficient and reliable.***

Keywords: Attendance, Facial Detection and Recognition, Raspberry Pi, Viola Jones Algorithm, LBPH, OpenCV-Python, MySQL Database.

I. INTRODUCTION

Existing system of attendance system is a manual entry of the students attendance. Handwritten registers will be used to keep track of attendance. The user's record will need to be maintained, which will take more time. The human effort is more here. The face is the most distinguishing feature of any human. As a result, automating the attendance process will enhance class productivity. The proposed system automates the attendance system of educational institutions and reduces the shortcoming of the existing manual system. Smart device that can identify each student will be created and it will eventually record each student's attendance data into an excel database and connect to a GUI system. Takes out the plausibility of proxy and keeps record of attendance of students in a well viable way. This technique replaces traditional attendance system such as calling students' names or checking their ID cards, which can disturb the teaching process and also be unpleasant for students during exam periods.

II. PROBLEM STATEMENT

A. Literature Survey

Traditional system of taking attendance manually is very time consuming and often leads to error. The old method of taking attendance of students on paper sheets is no longer applicable. According to the research, numerous options are present for resolving the problem.

The paper [1] describes about the usage of algorithms for the
real-time recognition of traffic signs to alert the driver. This system
is a part of Intelligent Transport System(ITS) which can pave way as one of the dimension of a Smart system. Convolution Neural Network(CNN) classification model is used with inbuilt OpenCV functions to pre-process the images for detection of traffic sign and recognition using Binarization and Region Of Interest (ROI). The same mechanism can be used for the recognition of student faces to mark attendance and make this a smart system to be used in in universities.

The paper [2] gives solution for traditional attendance system's issues which is based on the identification of face-recognition. The recognition system detects and recognizes faces using a camera to capture photos of the student. The image which is captured is compared with the face database one by one to search for the student's face where attendance is recorded when a result is found in the face database. The accuracy of face detection algorithm is being improved but still the technology is not portable. This system requires a stand-alone computer with a constant power source, rendering it non-portable.

In paper [3], Face detection and recognition algorithms based on OpenCV are used to count the number of student in classroom and track each student's attendance. This allows for the specific identification of student so that it is clear which student is present. This is completed with the aid of OpenCV with haar cascades that are present in the OpenCV inbuilt.

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For this, the system associated digital camera is needed to require the input pictures in an exceedingly fastened space wherever the camera is located. Haar Cascade algorithm is used to detect faces in the images captured from the camera. LBPH algorithm is used to train the frontal face and eyes.

Then the trained faces are stored in a database, and compared to the images which are trained. After comparing it marks the attendance to the recognized student.

Other paper proposed by [4] introduced a real-time computer vision algorithm in automated attendance management system. The system deployed a non-intrusive camera in the classroom that can snap photographs, and compared the extracted face from the image captured by the camera with faces inside the system. This system made use of machine learning algorithms, which are frequently used in computer vision. Also, Haar Classifiers are used to train the images which are captured from the camera. The image of the face captured by the camera will be converted to grayscale and subtracted before being uploaded to the server and processed later.

Paper [5] prescribed the system with hardware such as Raspberry PI and a wired camera, but the software also consisted of using Open-CV. Identifying a face in a picture is the initial stage in facial recognition; the process is only carried out if there is a face present. The face pinning was performed using Haar Cascade Classifier.

Paper[6] describes a system in which a camera is positioned in the front of the classroom and is used to capture face and then create a face dataset.

The server, where the photographs are transferred, is connected to the system. The other modules of the system include Face Detector and Face Recognizer.

Face Detection is done using HAAR classifier and also OpenCV library. Here, EigenFaces algorithm is used for face recognition is a very fast algorithm.

The face which is captured through the camera is converted into gray scale. The faces in the student image database will undergo the same modification. Raspberry Pi is the perfect tool that is used as a desktop computer or a server so that all computations can be done without the requirement of a large desktop computer to be placed in every classroom. In the database, each image is stored with date and time. And each time the face is successfully recognized, the new image is stored and the older images are deleted gradually. This provides the system to adapt to the changes in appearance of the student over time.

B. Objectives

To make sure that the process of recording attendance is quicker than the old one, which could record the attendance of each student is as little as 3 seconds. The objective is to develop a self-powered, mobile smart attendance system. Be able to store the database in memory with enough space.

Based on a face database, be able to reliably detect an individual's face. Create a database for the system to track attendance. Give admins access to the attendance database through a user-friendly interface, and allow non-admins to monitor their attendance. Allow new students or staff to enter their faces into the database via a graphical user interface. Ability to show the user whether or not the face-recognition process was effective.

C. Existing System

For students, the current method is a manual entry system. The attendance will be kept on handwritten registers in this location. Maintaining the record of the user's will be a time-consuming task.

The effort of human is more here. The use of fingerprint technology as identification verification allows for the recording of students' attendance..

The system takes finger patterns from the fingerprint module and compares them to patterns already stored in its database to verify the data. When stakeholders pass within the RFID attendance reader's radiofrequency range, the RFID attendance system delivers wireless identification. Students and staff must wear an RFID tag that provides unique information about them, such as their class/section/name/ID number, in order for attendance to be automatically recorded.

D. Proposed System

The proposed system automates the attendance system of educational institutions and reduces the shortcoming of the existing manual system. A smart device that can recognize each person's identification and eventually save attendance information in a database system will be created.

III. METHODOLOGY

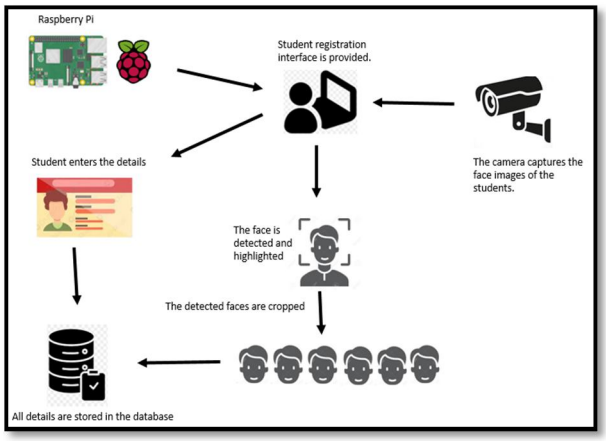

Fig 3.1

The methodology is as shown in Fig 3.1

1) *Image Capture:* The students images are captured who are present in the class.
2) *Face Detection:* The performance of face recognition systems is always improved by a good and effective face detection algorithm.
3) *Pre-Processing:* Pre-processing is applied after the detected face is extracted.. This step involves with histogram equalization of the extracted face image.
4) *Database Development:* Images of each student is collected as training images for this project.
5) *Feature Extraction and Classification:* Feature Extraction and Classification: In order to obtain correct results, the performance of a Face Recognition system is also dependent on feature extraction and classification. Either feature-based or comprehensive techniques can be used for feature extraction.
6) *Post-Processing:* After identifying a student's face in the proposed system, the date, in time, and out time of that student are displayed or updated in the database.

A. UML Use-Case Diagram

As shown in Fig. 3.2, a use-case diagram is used to show the different ways a user can interact with a system. A use case diagram is brief and to-the-point. Instead, a proper use case diagram depicts an overview of the relationship b/w use cases, actors and systems. In the below diagram, there are 3 actors named Admin, Professor / Faculty and student. There are a total of 5 use cases that illustrate how the Smart Attendance system's various features work. A specific use case is how each actor interacts with it.

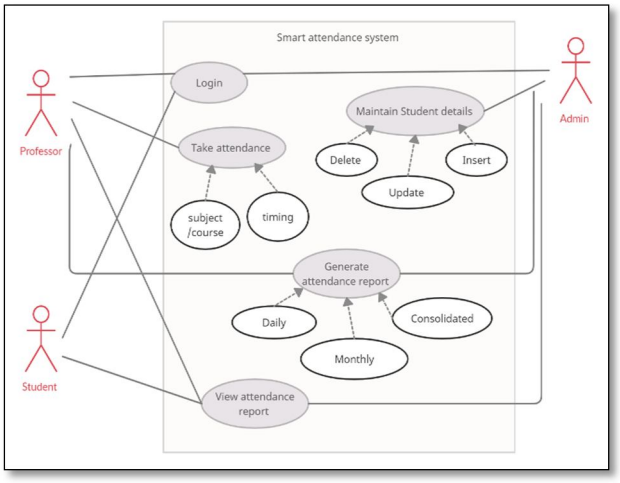

Fig 3.2

Each actor need not partake in every use case, but it is acceptable. Each actor has to first login into the system. An admin actor can maintain the student details that are to enroll/register the students to the system. It includes insert, update & delete operations. He is the one who has all the control over the database. He can generate reports i.e., export the details into a .csv file. He can do that daily or get complete attendance of a month or consolidated i.e., a particular student. He can also view the attendance directly in the portal itself. The second actor Professor interacts with 4 functionalities. He takes the attendance as per the subject or just the timing of the class. He can also generate & view attendance reports for his reference. The third actor Student can only view the attendance.

IV. ALGORITHM OF THE PROPOSED SYSTEM

A. Viola Jones Algorithm

Viola-Jones is a Face Detection Technique, which is popularly known as the Haar-Cascades.The Viola-Jones algorithm has 4 main steps as shown in Fig 4.1.

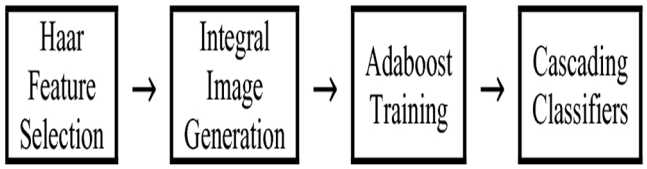

Fig 4.1

1) *Haar features :* These features on the image make it easy to find edges and lines in the image and select areas where pixel intensities change suddenly**.** The Haar Features are shown in Fig 4.2.

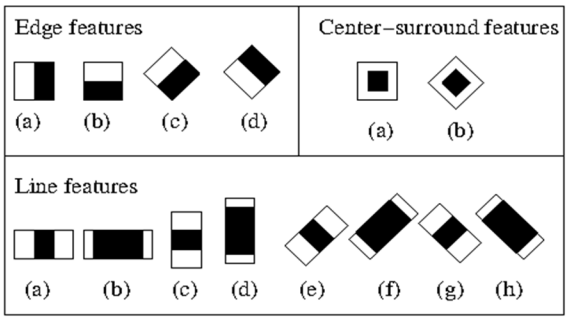

Fig 4.2

2) *Integral Image:* The summation of the pixel values of an image can be quickly and effectively determined using an integral image.
3) *Adaboost Technique:* AdaBoost is a feature selection strategy that allows you to choose a small subset of features from a large set while excluding any that aren't performing as well as the others.
4) *Cascading Classifier:* Each weak classifier serves as a stage in a cascade created by the strong classifier. The cascade's role is to quickly eliminate non-faces and prevent the loss of valuable time and calculations.
   Summarizing and comparing the pixel values of both regions is a straightforward way to determine which zone is lighter or darker It follows that the total of the pixel values in the darker and lighter regions would differ. Haar-like properties can be used to do this. A Haar-like feature is created by dividing a rectangular section of an image into several parts. They're frequently depicted as adjacent black and white rectangles.

B. LBPH

A person's face can be recognized using the Face-Recognition algorithm LBPH (Local Binary Pattern Histogram). It is renowned for its effectiveness and capacity to distinguish between a person's face from both the front and the side. It's based on the concept of Local Features. LBP is described as an ordered collection of binary pixel intensity comparisons between the center pixel and the eight pixels surrounding it. Selecting the center pixel and applying a condition is the most basic computation. If the value is more than or equal to the value in the center pixel, the outcome is "1".If the value is less than zero, the result is zero. The process of LBPH is shown in Fig 4.3.

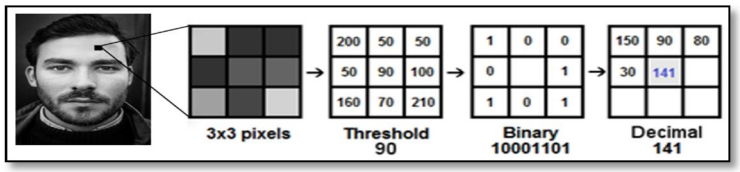

Fig 4.3

C. Python IDE

A powerful and simple to learn programming language is Python. It has effective high-level data structures and a straightforward but efficient object-oriented programming approach. Python is a superb language for scripting and speedy application development across a wide range of platforms thanks to its lovely syntax, dynamic typing, and interpreted nature. The Python interpreter can easily be expanded with new C or C++ (or other languages callable from C) functions and data types. Python can also be applied as a bespoke programming language extension.

D. OpenCV

A programming environment called OpenCV is predominantly focused on real-time computer vision. Its modular design suggests that it comprises a number of shared or static libraries. We employ a module for image processing that does geometric picture modifications (such as resizing, affine and perspective warping, and generic table-based remapping), color space conversion, histograms, and other operations on the images. Among the libraries utilized in our research were those for Haar classifiers, LBPH face classifier, and Histogram of Oriented Gradients (HOG).

E. Raspberry Pi

The Raspberry Pi is a compact, affordable computer about the size of a credit card that utilizes a regular keyboard and mouse and connects to a computer monitor or television. People of all ages can use this smart little gadget to learn about computers and programming languages like Scratch and Python. This Raspberry Pi can connect to the internet since it features an Ethernet chip, the ENC28J60.

F. MySQL Database

A database is a systematic collection of data. A more secure database is MySQL. Different operating systems, such as Windows, Linux, Solaris, and other UNIX variants, support MySQL. MySQL enables you to run the client and server programs simultaneously or autonomously, via a local network or the internet MySQL is a simple database management system.

G. Tkinter

Tkinter is a Python library for designing graphical user interfaces (GUIs) for desktop applications. Python and Tkinter work well together to efficiently and simply create graphical user interfaces. The Tk GUI framework contains Tkinter, a powerful object-oriented interface. It features a large number of widgets to pick from and is by far the most user-friendly. It offers a number of geometry management techniques, including pack(), grid(), and place(). Many GUI programming controls, including buttons, and text boxes, are supported by Tkinter. These controls are generally referred to as widgets.

V. RESULTS AND DISCUSSION

The face dataset for this experiment is created by taking 150 photographs of each participant, and each image in the face database has a unique ID number as shown in Fig. 6.1. At first CNN Algorithm was used for face recognition. since GPU Requirement is higher than what is available in Raspberry Pi, the training time taken by this algorithm is very high. Here only frontal faces are recognized more accurately. Due to these drawbacks, the LBPH algorithm was taken. It was found that GPU requirements are lesser and it takes lesser time for training. Here both frontal and side faces are detected and recognized. Once the face is recognized the details of the student are stored in the excel sheet in the particular subject folder in the .csv file as shown in fig 6.2. The details of the students taken during registration are stored in MySQL Database which is easier to retrieve and update. Sometimes the face is not recognized properly due to poor lighting conditions but works best in an ideal environment. We have established a wireless connection between Raspberry Pi and Desktop both connected to the same network within the range of 15 meters. Hence, this attendance system can be accessed on a desktop remotely.

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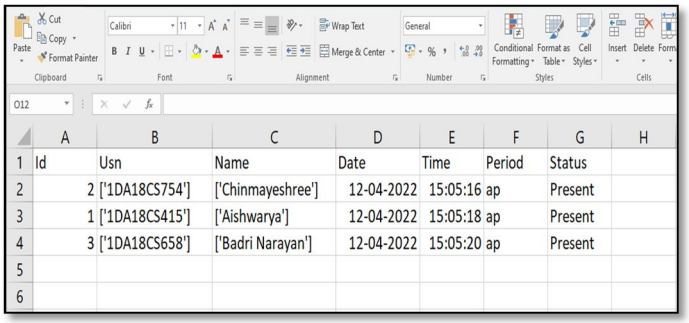
Fig 6.1



	A	B	C	D	E	F	G	H
1	Id	Usn	Name	Date	Time	Period	Status	
2	2	['1DA18CS754']	['Chinmayeshree']	12-04-2022	15:05:16	ap	Present	
3	1	['1DA18CS415']	['Aishwarya']	12-04-2022	15:05:18	ap	Present	
4	3	['1DA18CS658']	['Badri Narayan']	12-04-2022	15:05:20	ap	Present	
5								
6								

Fig 6.2

The complete system majorly consisting of raspberry pi board, web camera and monitor are connected as shown in Fig 6.3.

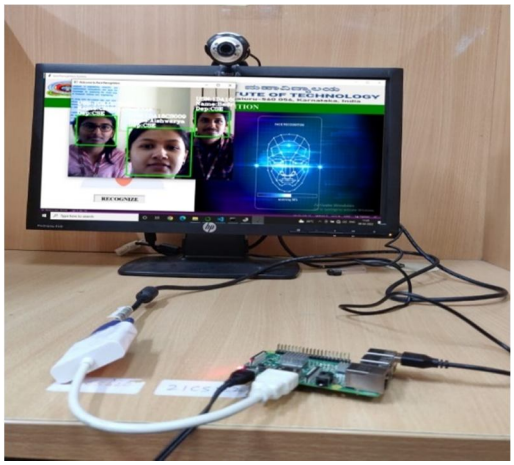


Fig 6.3

Some of the Snapshots of our project as shown in Fig 6.4, Fig 6.5 .

Fig 6.4

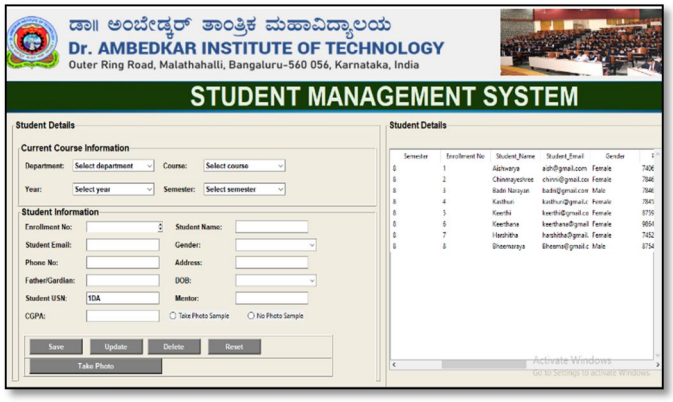


Fig 6.5

VI. CONCLUSION AND FUTURE WORK

We observed that there are numerous time-consuming and ineffective alternatives, including biometric, and based on RFID, and others. Therefore, the better and more reliable arrangement is the better and more reliable arrangement from each perspective of time to surpass the prior framework.. As a result, we were able to create a robust and productive participation structure in order to implement an image handling algorithm for identifying faces in the classroom.

In future, the system can be made more efficient so that it can recognize the faces in all lighting conditions and with more accuracy. The algorithm can be improved to recognise students through eyes so that identical twins can be differentiated.

VII. ACKNOWLEDGEMENT

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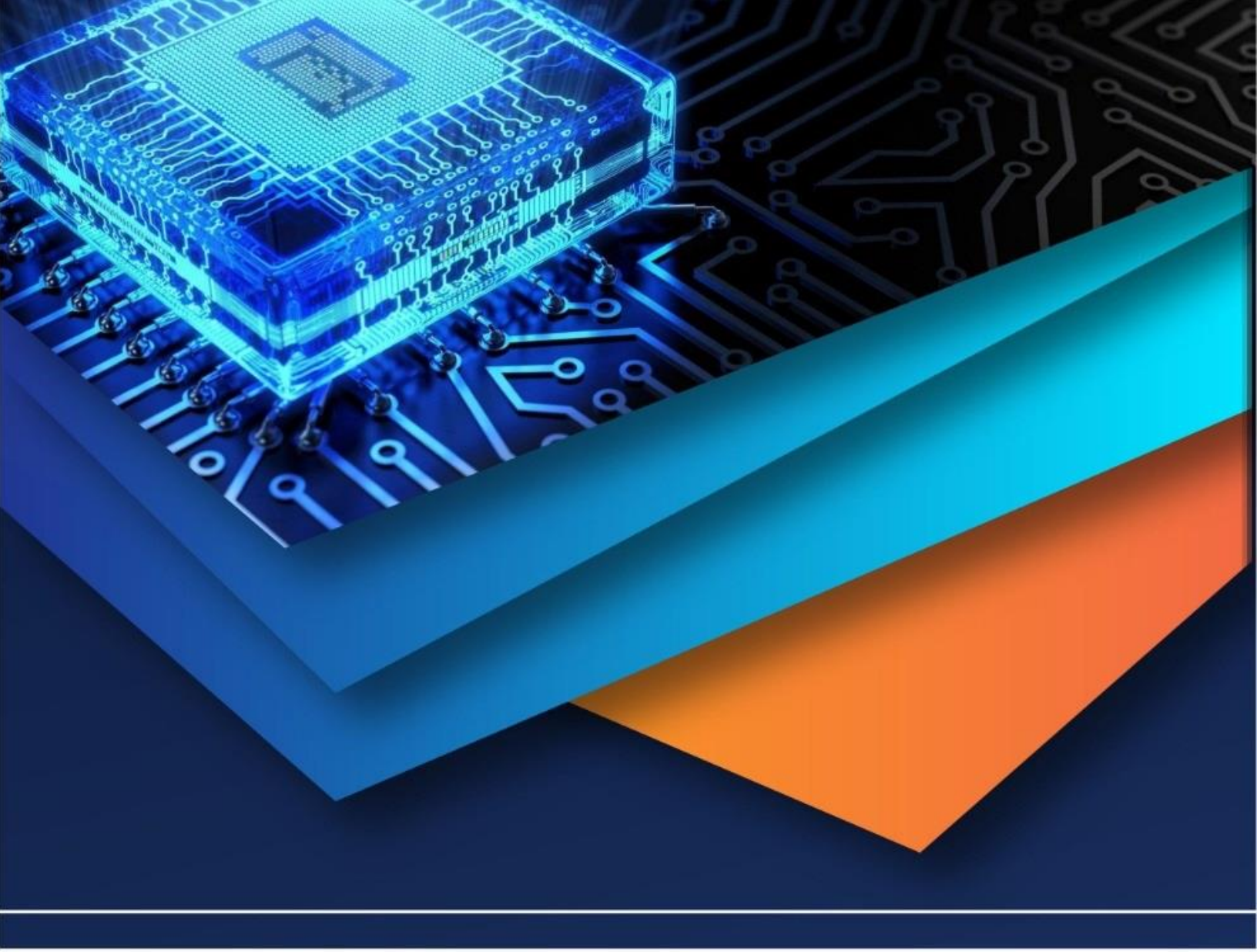

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