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Authorized Automatic Vehicle Allowance System

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Abstract: ***In most organizations, the ongoing vehicle entry registration process for visitors, staff, or students entering the organization includes a security guard checking the driver's identification card or looking for a membership sticker on the vehicle's windscreen, which can easily be lost or stolen. This writing process is tiresome and time-demanding, and it is prone to incorrect notes; additionally, backup and sharing of this vehicle information is difficult due to the data being a physical copy. The goal of the Automatic Authorized Vehicle Allowance System is to create a digital picture processing system with the Raspberry Pi that can be used in an entrance parking system. The Raspberry Pi will identify the car with an ultrasonic sensor and photograph it. The device then processes the picture using digital image processing techniques. The system incorporates various algorithms such as localization, normalization, orientation, segmentation, and optical character recognition (OCR), which examines picture characteristics and forecasts license plate numbers. The obtained number plate information is then cross-checked with records stored in a pre-existing database. An administration is in charge of designating a "whitelist," which is a list of vehicles that can join the suggested system. If the car registration is found in the database, a servo motor circuit connected to a Raspberry Pi will open the gate, and after a monitor delay, the gate will shut. The system is built in such a way that it is simple to apply in a short period of time and is cost-effective.***

Keywords: Raspberry Pi, Optical Character Recognition

I. INTRODUCTION

Due to the increase in today's population, the number of vehicles on the road is also expanding, hence the true identity of the driver and vehicle is a key worry presently. Manual entry of each car involves a security guard confirming membership details by checking the driver's identification card/sticker on the vehicle will require a significant amount of personnel and time, and 100 percent correctness cannot be guaranteed. Hence the traditional method of vehicle entry is not effective.

Other available access control methods like the usage of keypads, card readers, and biometric scanners that verifies the identity of drivers and passengers before granting access to the organization can be quite time-consuming. And the usage of RFID technology, where the tag is attached to the vehicle and the reader is placed at the entrance, can have high-cost installment.

To address this issue, we created a software system Automatic Vehicle Allowance System (AVAS) that automatically recognizes license plates and records them in a database. This technology aids in traffic control, and its primary use is security. It aids in the management of undesirable cars in limited regions and zones, as well as in the monitoring of vehicles on the road. Because of the nature of light, identifying a license plate is a difficult process. This system looks at an input picture region that contains a license plate. The spectral analysis approach is utilized in the ANPR system to capture the picture, then the system identifies and isolates the area containing the number plate from the input image, and then performs character segmentation to compare each extracted letter with the letters saved in the database[1]. The key benefit of this technology is that it can capture images of moving vehicles and then send them to be segmented and recognized. The system grants access to vehicles if their number plate matches the corresponding registered plate in the database; otherwise, access is denied.

II. RELATED WORK

Gaurav Srivastav…[2] presented a system that is constructed and simulated in MATLAB because large programs may be substituted directly with single preloaded procedures. In the study, he also mentioned specific topics and future research that may be done in the field of NPR for efficient use of the approach in the actual world.

Deepali Kamthania and Vanshika Rai.....[3] the authors utilized various image-processing techniques such as morphological transformation, gaussian thresholding, and gaussian smoothing in the pre-processing step. The study also involved applying contours through border following and filtering based on character dimensions and spatial localization for number plate segmentation, followed by using the K-nearest neighbor technique for character identification. According to the authors, the proposed system demonstrated high accuracy and can be applied in several scenarios such as e-challan surveillance and stolen car identification.

Sun et al. (2014) suggested activity categorization and quantitative indicators for traffic management based on vehicle trace attributes. Khare et al. (2020) presented a partial character reconstruction approach to segment license plate characters in order to increase LPRS performance.

This study [4] demonstrates the precision and successful application of the Otsu technique in combination with K closest neighbor (KNN). The Otsu method is utilized to convert RGB images to binary images and obtain picture attributes, while KNN is employed for classification and is known for its resistance to noise. In pattern recognition, feature extraction is used to convert pixels into binary form, and the Otsu method achieves this by extracting features and using KNN for classification, which compares the test data from surrounding areas with the available training data. The test data is obtained through a learning process and classified using a specific procedure. The Otsu approach, which is based on pattern recognition, utilizes a binary vector without altering the threshold value. To obtain optimal results and enhance binary segmentation, it is recommended to modify the distribution of picture pixel values.

In reference [5], the authors describe the creation of a license plate character recognition system that uploads license plate information to a server. The process faces several challenges, including unclear or distorted images, which must first be isolated to extract the license plate picture. The system involves segmenting the characters from the license plate and utilizing KNN to extract these characters. Subsequently, the extracted information is uploaded to the server.

H.Erdinc Kocer [6] utilized several techniques such as median filtering, contrast extension, and coloring techniques for character segmentation. The contrast extension technique is used to sharpen an image. According to Kocer, histogram equalization is a popular method to enhance the appearance of a low-contrast image. The blob coloring technique is applied to identify closed and contact-less regions in binary images. In this method, an L-shaped template is used to scan images from left to right and top to bottom. By finding connections in four directions from a zero-valued background, this scanning technique detects independent regions. The four-directional blob coloring process is employed to color the binary-coded license plate image.

Prathamesh Kulkarni et al. [7] proposed that blob coloring and peak-to-valley methods are not appropriate for recognizing Indian number plates. Instead, the authors suggested an image scissoring algorithm that involves vertical scanning of the number plate and cutting it at the row where no white pixels are found. The resulting information is saved in a matrix. If multiple matrices are generated, the algorithm rejects a false matrix using a specified procedure. The same approach is then applied in the horizontal direction using the width as a threshold. This procedure is effective in recognizing Indian number plates.

III. SYSTEM DESCRIPTION

The Raspberry Pi 3 Model B acts as a central processing unit that manages all the other system elements. Raspberry Pi 3 Model B comes with standard HDMI and USB ports, has a memory capacity of 1GB RAM, and Bluetooth and Wi-Fi connections, which allows for easy wireless communication with other devices. The software that manages the camera, LCD, servo motor, and IR sensor will be run on the Raspberry Pi.

An IR sensor, also known as an infrared sensor, is a device that detects the presence of an object by using infrared radiation. To determine when a vehicle is entering an organization an IR sensor is used. The IR sensor is interfaced with Raspberry Pi to detect the presence of a vehicle and to trigger the Raspberry Pi to instruct Pi Camera to capture the image of the vehicle. IR sensors are highly accurate and reliable, and they are not affected by ambient light conditions.

The vehicle image will be captured as it approaches the system using a Raspberry Pi Camera. A Pi camera is a type of camera module usually designed for Raspberry Pi boards. It is a small and low-cost camera and has the ability to capture high-quality images and videos. the captured photograph which is stored in jpeg format.

The LCD is used to display information about the vehicle's user, such as the extracted vehicle number and whether the entry is permitted or denied. The LCD used in the system is a 16x2 LCD, which means it can display up to two lines of 16 characters each.

A servo motor is made up of a direct current (DC) motor, a gearbox, a position sensor, and a control circuit. The position sensor detects the motor shaft's actual position, which the control circuit compares to the desired position to provide a control signal. The control signal is then utilized to modify the motor's direction and speed to achieve the desired position. To permit or prohibit entry of the vehicle, a gate will be controlled by a servo motor. When a vehicle is authorized, the servo motor rotates by 90° and after entry then comes to its original state, and remains stationary when a vehicle is not authorized. This process eliminates the need for manual labor.

Flask is a Python framework generally used to build web applications. The web app is built to provide the administrator with an easy-to-use interface to manage the entry of a list of authorized vehicles.

Open CV is a freely available software library utilized for image processing. The system uses OpenCV's features to perform functions such as localization, background removal, noise removal, and skew correction, so that system is capable to extract the vehicle number from the images accurately using OCR algorithm.

IV. PROPOSED SYSTEM

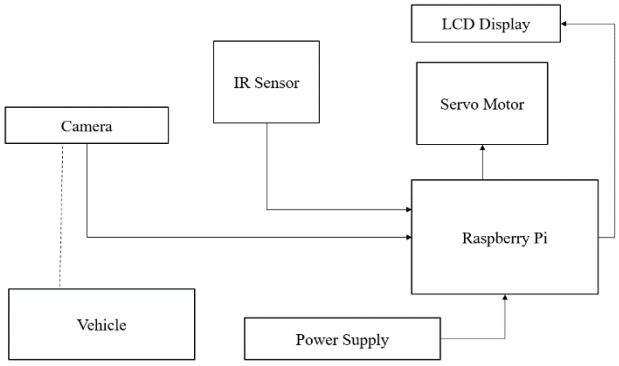

Fig. 1. Proposed System's Block Diagram

In the proposed automatic authorized vehicle allowance system, the IR sensor is interfaced with Raspberry Pi and it is used to detect the presence of the vehicle within a 5 cm range if the vehicle is detected, then the camera is triggered to capture the image of the vehicle.

Fig. 2. IR sensor and LCD Output When a Vehicle is Detected Within Range.

Following the vehicle image capture, image processing techniques are applied to enhance the quality of the image for optimal character extraction and to localize the position of the license plate.

Fig. 3. Image Captured by Raspberry Pi Camera after IR Sensor detected a vehicle

Algorithm for plate localization and background removal:

1) Resize the image to a width of 500 pixels.
2) Convert the resized image to grayscale.
3) Apply bilateral filtering to the grayscale image.
4) Apply the Canny edge detection algorithm to the filtered grayscale image.
5) Find the contours of the edges in the image.
6) Sort the contours in descending order based on their areas.
7) Select the top 30 contours from the sorted list of contours.
8) Iterate through the selected contours and obtain a polygonal approximation of each contour.
9) If the polygonal approximation has four vertices, select it as the contour of the number plate.
10) Create a binary mask of the same size as the grayscale image.
11) Draw the selected contour of the number plate on the binary mask.
12) Apply bitwise AND operation on the binary mask and the resized.

Following image processing, optical character recognition (OCR) identifies each character in the image and transforms it into text that can be read by humans. Character segmentation, feature extraction, and classification are the first phases of OCR. The open-source tesseract-ocr package contains an OCR engine for removing text from images. The recovered text is converted from an image into a string of characters and then filtered to only contain alphanumeric letters.

The extracted vehicle number is checked against authorized vehicle number records from a CRUD flask web application. The proposed system's Flask web application serves as an effective tool for controlling authorized vehicles access to a facility. The web application needs to have authorized vehicle numbers entered by an organization administrator. This application facilitates admission and guarantee that only approved cars are permitted on the property. In the event that the database contains the extracted vehicle number, the interfaced servo motor rotates by 90 degrees and then, after 20 seconds, rotates in the opposite direction. If the vehicle number is not present in the database, then the gate controlled by the servo motor remains closed.

V. RESULTS AND DISCUSSION

The web app built using Flask has the following features: administrator authorization, the ability to add or delete authorized vehicle numbers, to view all the authorized vehicles in the organization.

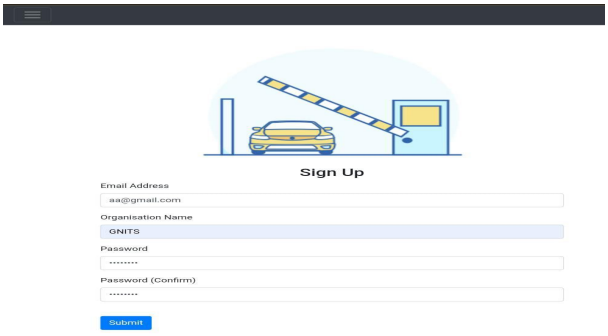

Fig. 4. Admin Sign-Up Page

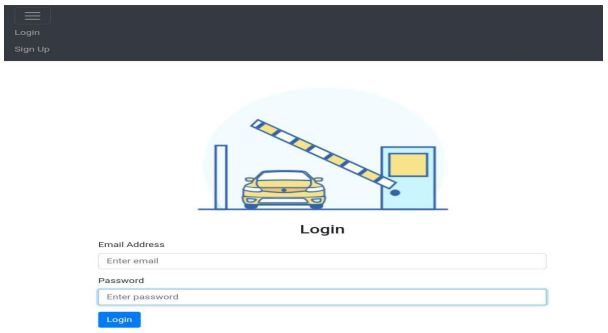

Fig. 5. Admin Login Page

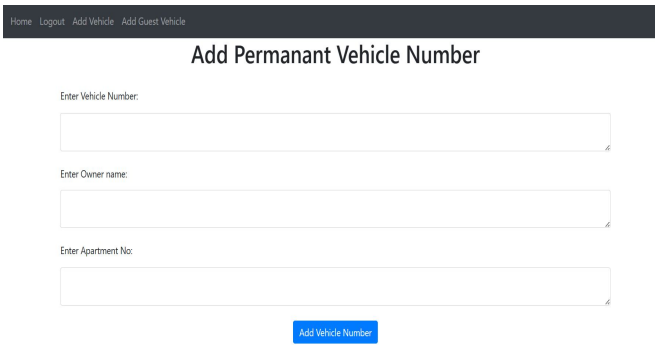

Fig. 6. Web Page to Add Permanent Vehicle Number

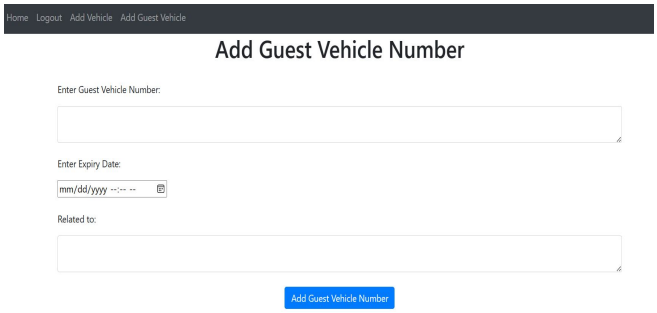

Fig. 7. Web Page to Add Guest Vehicle Number

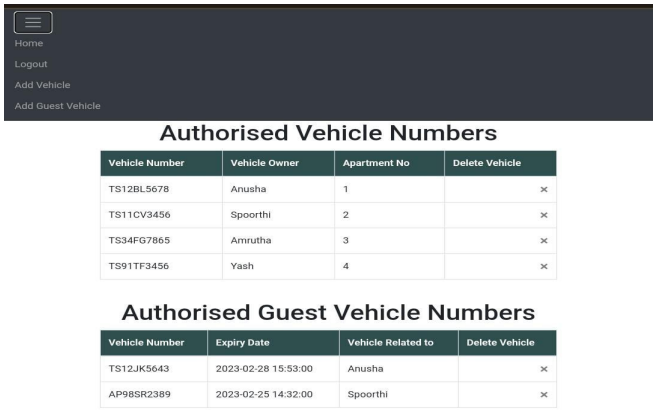

Fig. 8. Admin Home Page

A. Scenario 1: When the Vehicle Entering is Authorized

We added vehicle number 22BH6517A to the database to make it authorized. When the number plate 22BH6517A was captured by the pi camera, the servo motor rotated indicating the opening of the gate, and the LCD screen displayed “authorized vehicle”.

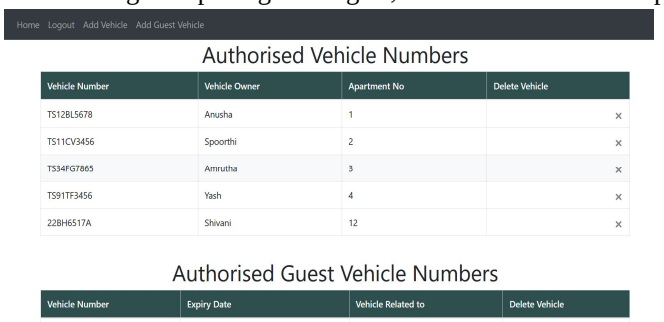

Fig. 9. Admin Home Page After Adding Vehicle Number 22BH6517A

Fig. 10. Image Captured by Pi Camera

Fig. 11. LCD Output After Extracting Vehicle Number from the Captured Image

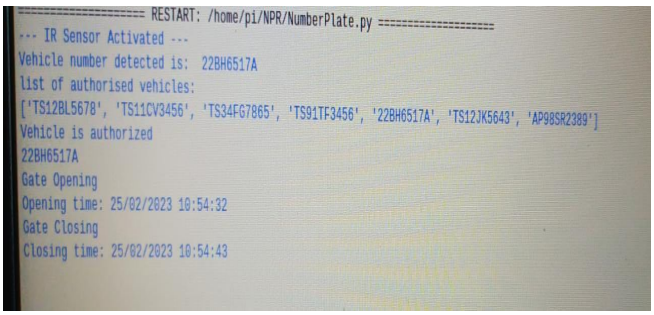

Fig. 12. Python Shell Output When an Authorized Vehicle Enters

Fig. 13. LCD Output When an Authorized Vehicle Enters

B. Scenario 2: When the Vehicle Entering is Unauthorized

We have considered that vehicle number DL1CAC7637
to be illegal as it's not prestored in the admin's database. When the number DL1CAC7637 plate was captured by the pi camera, the servo motor did not rotate indicating that the gate is closed, and the LCD screen displayed "Please contact the administrator".

Fig. 14. Image Captured by Pi Camera

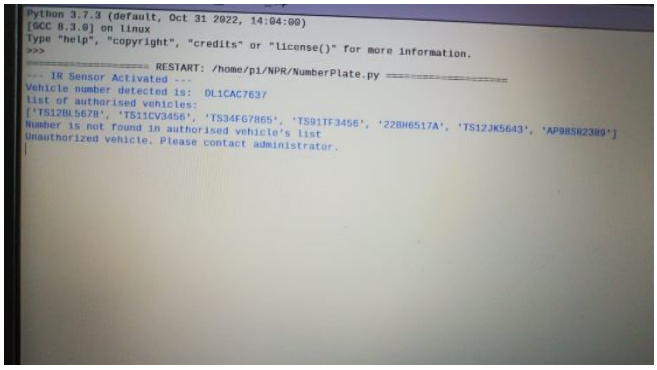

Fig. 15. Python Shell Output When an Unauthorized Vehicle Enters

Fig. 16. LCD Output When an Unauthorized Vehicle Enters

VI. CONCLUSION

An automatic allowance system for authorized vehicles using number plate recognition has been proposed. In the proposed system a web app is designed using Flask, allowing the administrator to input authorized vehicle numbers. When a vehicle approaches, it is detected using an IR sensor, and an image of its number plate is captured using a Raspberry Pi camera. The image is then processed by the Raspberry Pi (RPi) through various techniques such as number plate localization, background and noise removal, and character enhancement. An OCR algorithm is employed to extract the characters from the number plate. If the recognized vehicle number matches an entry in the administrator's database, the gate is automatically opened using a servo motor; otherwise, access is restricted. While the system has shown accurate results for most tested number plates, it may encounter challenges under poor lighting conditions. To enhance accuracy, a thermal web camera could be used instead of a Pi camera.

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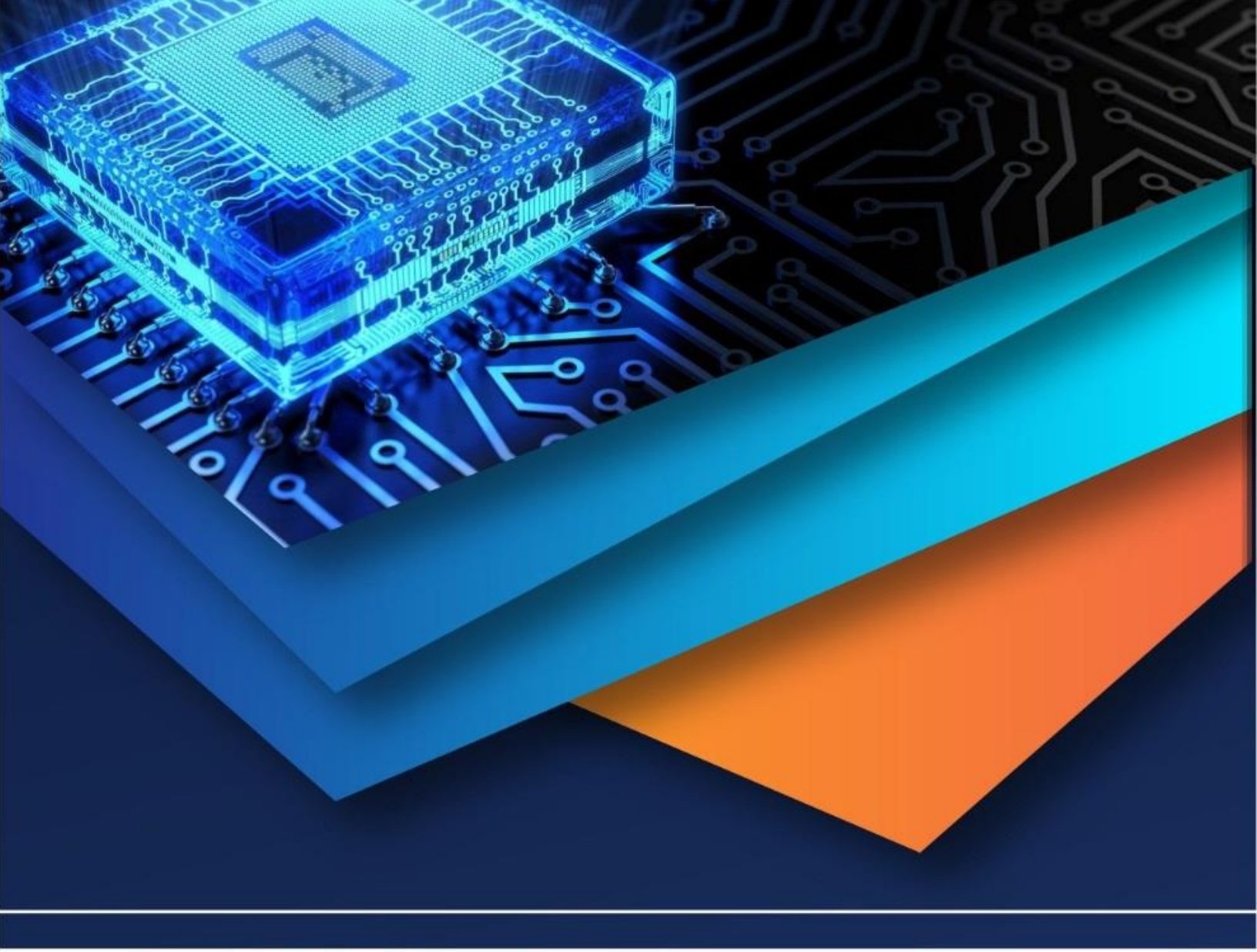

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