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Vehicle and Parking Slot Detection using Image Processing and Open CV

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Abstract: ***This paper provides a smart parking system based on open CV that was created for open parking lots, multi-story parking garages, and many more applications. The suggested system design makes use of the coordinate bound pixel and combined bound pixel and combined edge detection sections in python and the open CV library to determine whether or not a parking space in the captured footage is occupied. Additionally, it shows how to convert images to text. Text is extracted from the processed image using Tesseract. To ensure that various slots receive varying degrees of treatment to yield optimal text results, image processing is variable.One of the key functionalities of these systems is automated occupancy detection. Through the use of edge detection and pixel analysis techniques provided by OpenCV, the system can determine in real-time whether a parking spot is occupied or vacant. This information is crucial for drivers seeking available spaces and for parking facility managers to monitor occupancy levels efficiently.The variable level of image processing ensures adaptability across different environments and lighting conditions. By adjusting the image processing algorithms, the system can effectively handle variations in image quality and environmental factors, providing consistent and reliable results regardless of the setting.***
Keywords: OpenCV, Image Processing, Optical Character Recognition.

I. INTRODUCTION

These days, a few people are purchasing vehicles regardless of whether they have no place to put them, and a few streets are in any event, turning out to be parking spaces which at that point causes substantial traffic. Ordinary parking regions are typically simply vacant spaces, and individuals needed to search for an empty one manually. Not just that this parking technique is very tedious, it is also inefficient particularly for multi-storey structures where drivers need to survey each spot and experience different floors just to find and make sure about a parking slot.

In the modern urban landscape, the challenge of finding parking spaces has become increasingly significant due to the rapid growth in the number of vehicles. This has led to traffic congestion, increased fuel consumption, and heightened pollution levels, all of which contribute to urban inefficiency and environmental degradation. To address these issues, the development of a Smart Parking System using Image Processing technologies offers a promising solution.

A smart parking system efficiently detects and manages parking spaces by utilizing sophisticated image processing techniques. Real-time photos of the parking area are captured by the system through the smart placement of cameras within parking facilities. The availability of parking spaces, the tracking of vehicle movements, and he occupancy status are all monitored by processing these photos using advanced algorithms. This method improves the overall user experience in addition to increasing parking management efficiency. The ability to distinguish between occupied and vacant parking spaces is one of a smart parking system's main features. To evaluate the collected photos, image processing and the open CV algorithms are used,including edge detection, background subtraction, and machine learning-based classification. These algorithms provide real-time parking information by correctly identifying between parked cars and empty spaces.

Further improving the system's accuracy and dependability is the integration of machine learning algorithms. The system can become more adept at identifying various car kinds and adjusting to changing weather and lighting conditions by training models on large datasets of parking lot photos. To continue doing well in a variety of settings, this adaptability is essential. Furthermore, the Smart Parking System can be enhanced with further functions like automation and license plate recognition, which provide automated payment solutions, enforce parking restrictions, and manage parking duration by recognizing and recording license plates.

The traffic control system provides advance notice to cars at the parking lots situated within the rest areas of the highway regarding the current level of congestion. The sensors that detects cars have previously been installed at the parking section's entry and exit, or beneath the road surface, in order to identify this state of congestion. On the other hand, image processing has recently been used for a wide range of purpose due to advancements in hardware.

II. RELATED WORK

Many systems focus on detecting vehicles within parking spaces using image processing techniques such as background subtraction, contour detection, and machine learning classi-fiers. These methods help in distinguishing between different types of vehicles and determining occupancy status accurately.

A. An embedded real-time vision system for 24-hour

[1]an embedded vision system, which integrates a Web-cam quality CMOS imaging chip with a RISC processor, to perform real-time car-counting functions in the indoor and outdoor en-vironment. The challenge of this application, especially for the outdoor environment, is to develop vision algorithms for day and night, and during the light-transition periods (i.e., dawn and dusk). The vision system also needs to accommodate a tremendous range of illumination change (from sunny summer to snowy winter). Finally, we report briefly the result of an outdoor system we deployed in Germany since June 2003. The entire system consists of a network of 13 embedded vision systems covering a parking facility over 1 square kilometer.

B. Parking guidance system based on ZigBee and geomag-netic sensor technology

The growth in low-cost, low-power sensing and com-munication technologies is creating a pervasive network in-frastructure called the Internet of Things (IoT), which enables a wide range of physical objects and environments to be moni-tored in fine spatial and temporal detail. The detailed, dynamic data that can be collected from these devices provide the basis for new business and government applications in areas such as public safety, transport logistics and environmental management. There has been growing interest in the IoT for realising smart cities, in order to maximise the productivity and reliability of urban infrastructure, such as minimising road congestion and making better use of the limited car parking facilities. In this work, we consider two smart car parking scenarios based on real- time car parking information that has been collected and disseminated by the City of San Francisco, USA and the City of Melbourne, Australia. We present a prediction mechanism for the parking occupancy rate using three feature sets with selected parameters to illustrate the utility of these features. Furthermore, we analyse the relative strengths of different machine learning methods in using these features for prediction.

C. Parking availability prediction for sensor- enabled car parks

[3]Concerning the phenomenon that common parking ser-vice could not satisfy the increasing demand of the private vehicle owners, an intelligent parking guidance system based on Zig Bee network and geomagnetic sensors was designed. Real-time vehicle position and related traffic information were collected by geomagnetic sensors around parking lots and updated to center server via Zig Bee network. On the other hand, out-door Liquid Crystal Display screens controlled by center server can display information of available parking places. In this paper, guidance strategy was divided into four levels, which could provide clear and effective information to drivers. The experimental results prove that the distance detection accuracy of geomagnetic sensors was within 0.4m, and the lowest package loss rate of the wireless network in the range of 150m is 0parking service in intelligent cities.

D. IoT based smart parking system

[4]In recent times the concept of smart cities have gained grate popularity. Thanks to the evolution of Internet of things the idea of smart city now seems to be achievable. Consistent efforts are being made in the field of IoT in order to maximize the productivity and reliability of urban infrastructure. Prob-lems such as, traffic congestion, limited car parking facilities and road safety are being addressed by IoT. In this paper, we present an IoT based cloud integrated smart parking system. The proposed Smart Parking system consists of an on-site deployment of an IoT module that is used to monitor and signalize the state of availability of each single parking space. A mobile application is also provided that allows an end user to check the availability of parking space and book a parking slot accordingly. The paper also describes a high-level view of the system architecture. Towards the end, the paper discusses the working of the system in form of a use case that proves the correctness of the proposed model.

III. PROPOSED SYSTEM

Our proposed smart parking system leverages image pro-cessing techniques and computer vision algorithms to au-tomate and optimize the management of parking spaces in diverse environments such as multi-storey parking garages and open parking lots. Using Python programming language and the OpenCV library, the system employs advanced edge detection and coordinate-based pixel analysis to accurately de-tect and classify vehicle occupancy in real-time.

By analyzing video footage from strategically placed cameras, the system identifies vacant and occupied parking spaces, providing users with up-to-date information on parking availability via a user-friendly interface. [5] Integration with Optical Character Recognition (OCR), specifically Tesseract, enables the system to extract and interpret text information from signage within the parking area, such as reserved parking indications or instructions, further enhancing its functionality. The proposed system aims to improve overall parking efficiency, reduce congestion, and enhance user experience by providing accu-rate and timely information, contributing to sustainable urban development and improved resource utilization.

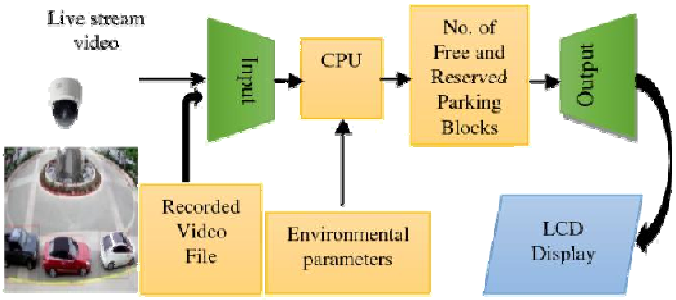

Fig. 1. Block diagram of proposed system

Two algorithms were utilized in the development of the OpenCV Smart Parking System. Application: The still picture file, which is a frame of the video file, appears when the code is executed. From its three input points, a quadrilateral can be created with the mouse. The input points coordinates are saved in a YAML file, and pressing the letter ”q” will start the video stream display. Red or green outline lines demarcate the quadrilaterals that were used to zone each parking space. Green indicates that the parking place is available for use, while red indicates that the computer has determined that it is currently occupied by a car.

Tesseract: The photograph of the license plate is taken when the vehicle pulls into the parking lot. We process the collected image using several image processing techniques. Next, we identify the plate’s contours and crop the picture to fit within them. To recognize characters, the processed image is passed into the Tesseract algorithm. Next, the existence of the re-trieved image in the cloud is verified. We get the data from the plate, if it is already in the cloud, and generate a bill based on the length of stay.

Approach: When a car pulls into parking lot, it is inspected to make sure there are no empty spaces. In the event that there are any, the first camera scans he vehicle’s license plate, stores it in the cloud, and grants access to the parking lot by displaying the open spaces. The same will be shown if there are no open unfilled spots. The second camera scans the number plate once more as the automobile leaves and compares it to the arrival time. A bill is produced according to the duration of the vehicle’s stay. [6]

A. Merits of Proposed System

Efficient: The technology decreases the amount of time vehicles spend looking for parking by automating the detection of available spaces, while eases traffic congestion.

User Convenience: Vehicle can make parking easier by using smartphone apps or electronic displays to get real-time infor-mation about parking availability.

Cost-Effective: Parking operators save money because less infrastructure and manual labor are required than in traditional parking management.

Environmental Benefits: Cutting down on the amount of time car idle or circle around parking spaces reduces fuel use and carbon emissions, which helps maintain a sustainable environment.

B. Methodology

The methodology for implementing a smart parking system using image processing begins with the acquisition of high-quality images or video footage from strategically placed cameras covering the parking area. These images undergo preprocessing steps such as resizing, noise reduction, and normalization to ensure uniformity and clarity. Vehicle detection algorithms are then applied to identify and localize vehicles within the captured frames, employing techniques such as background subtraction or deep learning-based object detection. Subsequently, the parking area is segmented into individual spaces using edge detection or clustering algorithms, defining boundaries for accurate occupancy detection. Occupancy status is determined by analyzing the presence of vehicles within each segmented space, facilitated by pixel-wise comparison or machine learning classifiers trained on annotated data.

Real-time monitoring of parking availability is provided through an intuitive user interface that displays current occupancy status, leveraging updates based on continuous image analysis. Optionally, Optical Character Recognition (OCR) may be integrated to extract text from signage, aiding in the management of reserved spaces or other relevant information. This methodology ensures efficient parking resource utilization, improves user convenience, and contributes to sustainable urban management practices through automated image processing technologies [7] The management of many parking lots keep track of how many cars arrive and depart by using the counter at the checkpoint. Advanced systems locate the precise spots that are vacant and direct the approaching cars appropriately. Even though some modern cars have built-in parking systems, it might be challenging for the systems to determine if a space is indeed empty or not.

After that, photos are processed to create virtual parking spots with the proper dimensions. These places are then tracked and can be used by arriving drivers via a mobile app to direct them. If any cars are misplaced in the parking lot and obstructing any routes, an additional software interface alerts the area manager or administrator to the same. A parking system that makes use of image processing offers a cutting-edge and inventive way to manage temporary parking spaces. It lessens traffic during peak hours and facilitates users in parking their vehicles correctly and conveniently. The growing number of vehicles in today's urban development scenario has made parking a major concern. [8]

Using cutting-edge technologies, a smart parking system with image processing monitors and controls parking spots in real time. Usually =, the system makes use of cameras that are positioned carefully throughput parking lots. These camera record live feed of the parking lot, which are subsequently analyzed using several image processing techniques to track vehicle movements, detect parking space availability and monitor total occupancy. [9]

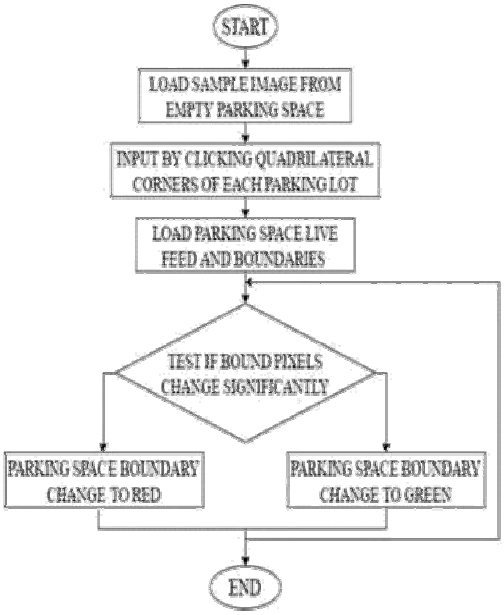

Fig. 2. Flow chart of car slot parking System using image processing

Essential Elements and methods: Image Acquisition: The initial stage is employing digital cameras to take clear pictures of the parking lot. To cover the entire parking lot,these cameras are positioned at key locations.

Preprocessing:To improve the quality, the collected photos are frequently subjected to preprocessing. Methods like contrast improvement, image normalization, and noise reduction are used.

Segmentation: This process divides a picture into various areas. To divide the image into separate regions, such as moving cars and vacant parking spots, methods like edge detection, thresholding, and clustering are applied.

Feature Extraction: To enable precise detection and classi-fication, pertinent features from the segmented images are extracted. Features that identify between moving cars and empty spaces could include edges, forms, texture and colors. Classification: To classify the divided zones, machine learning algorithms are frequently used. Parking lot data can be used to train models like Convolutional Neural Networks(CNNs) can be trained on enormous datasets of parking lot photos.

Occupancy Detection: The system assesses the status of each parking space's occupancy by examining the designated area. Then, this data is transmitted to a central system and updated in real-time.

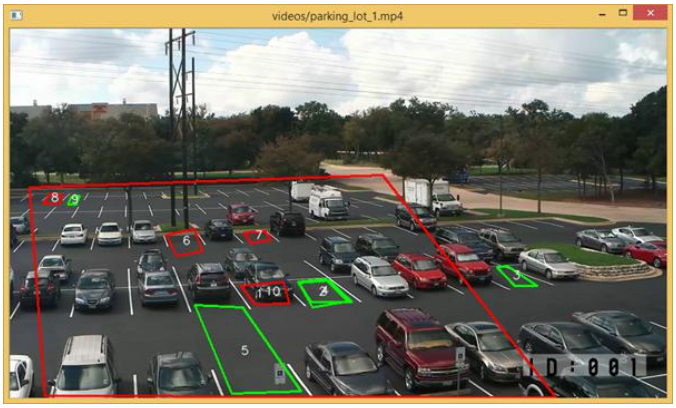

Fig. 3. Fig shows the empty slot in parking

IV. IMPLEMENTATION AND RESULTS

A. Algorithms

Background Subtraction:Background subtraction algorithms are fundamental for detecting moving objects (vehicles) against a stationary background. They help in identifying changes in pixel values over time, indicating the presence of vehicles in parking spaces. [10]

Edge Detection:Edge detection algorithms (e.g., Canny edge detector) are used to identify boundaries of objects within images. In smart parking systems, edge detection can be employed to delineate parking space markings and vehicle outlines, facilitating accurate segmentation. Contour Detec-tion:Contour detection algorithms extract continuous outlines of objects in images. In the context of smart parking systems, contour detection helps in identifying and delineating the boundaries of vehicles and parking spaces.

Machine Learning Classifiers:Supervised machine learning classifiers (e.g., SVM, Random Forests) are trained on labeled data to classify whether a parking space is occupied or vacant based on features extracted from images. These classifiers learn patterns from historical data and make predictions in real-time. Optical Character Recognition (OCR):OCR algo-rithms like Tesseract are utilized to extract text information from images, particularly for reading signage within parking facilities. This includes interpreting reserved parking signs, license plates, or other textual information relevant to parking management. [11] Motion Detection and Tracking:Motion detection algorithms detect changes in pixel values between consecutive frames, indicating the movement of vehicles. Object tracking algorithms then track these detected objects over time, enabling continuous monitoring of vehicle positions within the parking area.

Feature Matching and Template Matching:Feature matching algorithms (e.g., SIFT, SURF) and template matching tech-niques are used for recognizing specific patterns or templates within images. This can be applied in smart parking systems for recognizing parking space markings or identifying unique features on vehicles. [12]

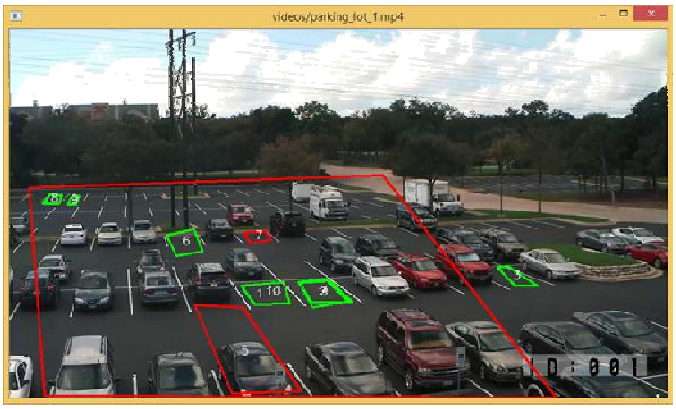

Fig. 4. The color of slot turns green to red as car occupied the slot

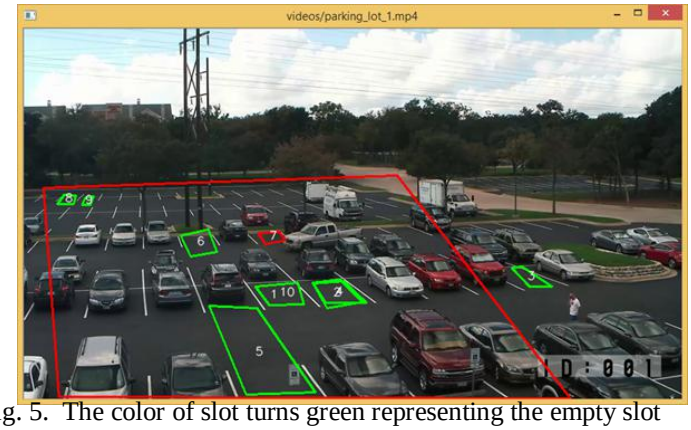

Fig. 5. The color of slot turns green representing the empty slot

B. Results

The openCV video and image processing programming approach combined with python is being used to identify unoccupied parking places in a parking lot. This program initially accepts a video file as inout. It then uses video frame images to determine empty coordinates. It identifies empty spaces with green lines; if an automobile is present, the lines turn red. To obtain all the coordinates with black empty spaces, video frames(pictures) will be removed and the grayscale approach used to the image. The OpenCV approach will be used for grayscale processing.

V. CONCLUSION AND FUTURE SCOPE

Image Processing is very crucial for extracting any informa-tion from an image. In this study, a proposed plan for a smart parking system based on image processing has been effectively tried and run with a few videos taken from indoor parking garages. The system works precisely in deciding regardless of whether the parking slots are occupied or not by showing a red outline if a vehicle is inside or consuming a parking spot and afterward turns green when it is unoccupied. In the number plate detection, we first applied image processing algorithms to images and afterward those images were utilized in Tesseract software to acquire the text from the images. Different images have distinctive text styles, length, width and font, so different images require different levels of digital image processing techniques. Out of these image results for a single image the most appropriate image is then applied to Tesseract for obtaining the text from an image. Therefore, after digitally processing the image we have accomplished better and near to perfection outputs.

The future scope of smart parking systems using image pro-cessing holds tremendous potential for further advancements and integration with emerging technologies.Implementation of advanced security measures, such as encryption and secure data transmission protocols, to protect user information and ensure the integrity of system operations. Privacy concerns related to image data handling will also be addressed through robust policies and technologies.

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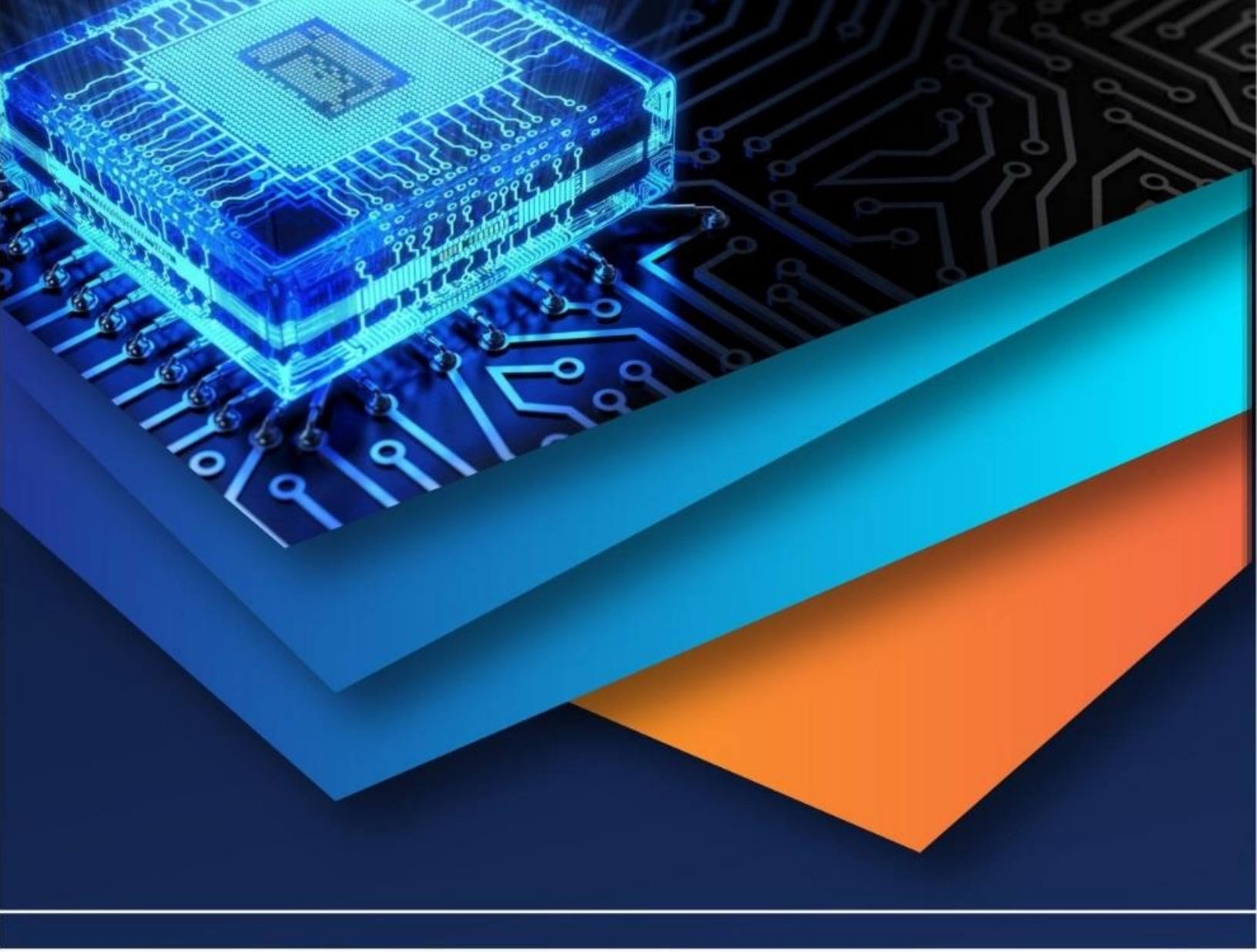

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