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License Plate Detection Applying Contours

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Abstract: ***A vehicle is a machine that can convey people and goods from a source to a destination. When vehicles ply on roads, it can lead to traffic. Traffic has to be managed on a day to day basis in villages, towns, cities and the freeway. A vehicle license plate is affixed to the vehicle at the time of registration or at some other possible event. A vehicle license plate can help in identification, management and routing of vehicles. Lately, high security registration plates (HSRP) have been assigned in India. Vehicle license plate localization is a well-known and well-studied problem. By localizing the license plate on a vehicle, it is possible to get the image of the license plate. In this research article, a new algorithm – license plate localization applying contours (LILY) is presented.***

Keywords: Vehicle, License plate, HSRP, LILY, RTO

I. INTRODUCTION

A vehicle plies from a source to a destination. Typically, a vehicle is affixed with a registration plate that can help in identifying the vehicle, managing the vehicle, parking the vehicle and in routine maintenance of the vehicle.
License plate detection (also called localization) is a well-known and well-studied problem.
Typically image processing along with some machine learning is required to localize a license plate.
Generally techniques like connected component analysis (CCA), morphological operations, edge detection etc. Are the most popular methods for the detection (localization) of a registration plate.

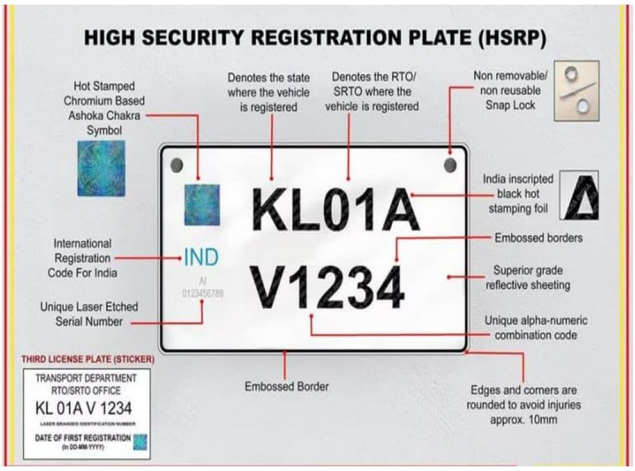

Fig.1: High Security Registration Plate.

Lately, in India a high security registration plate is being affixed to vehicles that offer better security.

II. LICENSE PLATE DETECTION SYSTEM

A License Plate Detection system has the following components.

1) Camera : A camera helps in acquiring the image of a vehicle containing the registration plate
2) Personal Computer – A personal computer has the required technology to process the input image.
3) Application Software – Application software containing components like image processing routines can help in detecting (localizing) the registration plate.

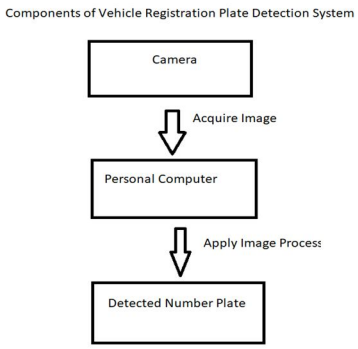

Fig2. License Plate Detection Process

III.RELATED RESEARCH WORK

A variety of research work has been done on license plate recognition system. Most can be classified as differing on the plate detection method, character segmentation methods and the character recognition methods.

In [1] (Jacob, S., Jeyakumar, M. K. (2025)) explore new fashion number plate recognition with efficiency by a Squeezenet.

The following are the steps in the algorithm

1) Acquire an Input Image
2) Convert to Grey Scale
3) Do blurring by a Gaussian filter
4) Perform Adaptive Thresholding
5) Do Morphological operations
6) Select a Region of Interest (ROI)
7) Find Contours
8) Train a Model
a. Look at Alphabet and Number Dataset
b. Apply a proposed SqueezeNet Model
9) Get the License plate number

In [2] (Satya, B., Manongga, D., Hendry, Aminuddin, A. (2024)) look at optimized YOLO version 8 for mechanized number plate identification.

The proposed methodology has the following steps

1) Evaluate Cov multiple times
2) Evaluate Conv multiple times
3) Do Concatenations
4) Unsample
5) Detect LPR
6) Apply Image Processing
7) ALPR
8) Get the license plate number

In [3] (Asaju, C. B., Owolawi, P. A., Tu, C., Wyk, E. V. (2025)) perform ANPR using cloud based technology by looking at YOLO versions 5, 7, 8 and 9.

Here are the steps of the algorithm

1) Acquire a sample dataset of plate numbers
2) Do Feature Extraction
3) Evaluate YOLO models
4) Detect License Plate
5) Deploy on the Cloud
6) Recognize number plate

In [4] (Gode, A., Dogan, A. (2023)) discuss a number plate identification system applying a new approach with Artificial Intelligence.
The basic architecture of a digital image processing system derives input from the physical 3-d world by capturing an image with a camera, applies digital image processing and then outputs the processed image.
Pre-processing involves gathering an image from a camera, application of filtering, conversion of an image in RGB to gray scale, application of linearity and finally application of morphological operations to clarify object details.
In order to apply OCR the following steps need to be taken – feature extraction from an image, correction of tilt, linearization, segmentation and recognition and finally output of text.
The following is the recommended methodology – read an input image, convert to gray-scale, apply a bilateral filter, apply canny filter, discover the area to contour, sort the contour regions, find the approximate contour value, detect the number of corner points in contour, create a gray-level shape, draw outline contour, crop drawn contour region, draw cropped region on shape, convert image characters to text, output text, and then show the original image, and finally show the cropped image.

In [5] (Ibitoye, O., Edijokun, T., Dada, O., Omitola, O. (2020)) explore the application of a CNN to recognize license plates in a short overview.
A typical license plate recognition process involves the following – acquisition of an image, pre-processing, detect and localize license plate, segment the characters of a license plate, and finally recognize the characters on the license plate.
In this review the following are some of the vignettes of the phases of licnese plate recognition described above

1) Image acquisition – an RGB image is acquired by a camera
2) Image pre-processing – Different methods like grayscale conversion, top-hat transformation, binary morphological, otsu threshold and binary image projection are applied.
3) License plate detection and localization – Color, edge and region-based methods are normally applied for license plate localization.
4) License plate character segmentation – The techniques involved are bounding box , CNN, morphological operations, improved blob detection algorithm, CCA etc.
5) License plate character recognition – A CNN is utilized.

In [6] (Islam, D., Mahmud, T., Chowdhury, T. (2023)) explore an optimal mechanized vehicle number plate recognition system that applies image processing.
The various steps involved in license plate recogntion are pre-processing, plate extraction, character segmentation and character recogntion.
The following are the details of the steps

1) Acquire an input image
2) Resize the image
3) Convert RGB to gray-scale
4) Remove noise applying a bilateral filter
5) Convert gray-scale to binary
6) Edge detection by Sobel operator
7) Apply morphological operations like erosion
8) Subtract the eroded image fro, the binary image
9) Label the connected components and remove the small unnecessary objects
10) Compare the connected objects with stored database of characters applying the template matching technique
11) Get the best match applying correlation
12) Identify the set of characters in the number plate as the final output

In [7] (Hefnawy, K., Lila, A., Hemayed, E., Elshenawy, M. (2024)) look at a robust license plate localization and recognition system for Arabic number plates with tilt angles.
The basic system – does a segmentation of the licnese plate, corners estimation, plate warping and finally has a plate recognition module.

The Mask R-CNN works in the following manner – Resnet with FPN, feature vector, regition proposal network, ROI alignment, a fully connected network and finally a class prediction, a bounding box and mask prediction.

In [8] (Naik, N., Pooja, Rashmitha, Fernandes, R., Sneha, S. (2022)) evaluate number plate recognition.
A typical number plate recognition system involves acquisitpion of an image, extracton of the license plate, segmentation of license plate, and recognition of the character.
The following are the steps of the algorithm

1) Acquire the frame of an input image
2) Pre-process the frame
3) Based on aspect ratio, plate localization is accomplished on the pre-processed frame.
4) Decoding of the separate characters of the licnese plate
5) Segment the input in order to detect the segmented characters and apply a CNN to recognize the characters.

In [9] (Omar, N., Zeebaree, S. R. M., Sadeeq, M. A. M., Zebari, R. R., Shukur, H., Alkhayyat, A., Haji, L. Kak, S. F. (2023)) explore detection and recognition of license plate as a study of review.
The following are the steps of the license plate recognition algorithm

1) Image acquisition – The photos of the license plate are captured in real-time and in different weather conditions such as day, night, rain, snow, shadow, fog, overcast etc.
2) License plate localization – This is achieved with the help of one of the following processes – Adaboost algorithm, Multi-box detector (SSD), and R-CNN.
3) Character recognition – This is evaluated with the help of one of the following processes – Convolutional Neural Network (CNN), Artificial Neural Network (ANN).

In [10] (Kranthi, S., Pranathi, K., Srisaila) look at automatic license plate recognition.
The following are the details of the license plate recognition algorithm

1) License plate localization
    a. Acquisition of image
    b. Extraction of license plate
    c. Segmentation of character
    d. Identfication of character
    e. Display ID
2) OCR Process
    a. Input the image
    b. Segment the characters and numbers
    c. Extract features from segmented characters
    d. Recognition applying template matching
    e. Output image

In [11] (Sidhu, S. K. S., Maini, R., Rattan, D. (2021)) look at mechanized license plate recognition process by the application of Connected Component Analysis (CCA) and CNN.
The most common method of automated license plate recognition involves the following steps

1) Acqisition of an image
2) Extraction of license plate
3) Segmentation of license plate
4) Recognition of characters

The following are the detailed steps of the automated license plate recognition algorithm

1) Acquisition of video
2) Acquire frames
3) Convert from RGB to gray

4) Filter using WLS and FFT
5) Connected Component Analysis
6) Region props for centroid, orientation, bounding box and extrema
7) Select cluster having larger number of objects
8) Further filtering applying orientation region props and centroid
9) Segmentation of characters
10) Applying bounding box, save the image for each and every character needed for training a CNN
11) Train a CNN
12) Test a CNN

In [12] (Ramani, S., Vardhan, G. R., Goud, K. S., Hrudai, K. A. (2022)) evaluate recognition of vehicle licnese plate applying MATLAB.
The following is the general description of the algorithm
1) Acquire an input image
2) Pre-process the image
3) Extract the plate region
4) Segment the characters
5) Recognize the characters
6) Display the results
The following is the detailed workflow of the algorithm
1) Acquire an image
2) Pre-process the image
3) Do gray processing
4) Apply the median filter
5) Extract the plate region
6) Do character segmentation
7) Apply a hardware model

In [13] (Rao, P. N., Srinivas, Y. (2019)) explain the application of hybrid models to real time vehicle license plate recognition.
The following is the general workflow of the algorithm
1) Acquire an image
2) Localize and extract the license plate
3) Segmentation
4) Character recognition

The following describes the particular template matching algorithm
1) Detect the segmented image
2) If k < number of characters
3) Select the character
4) Do template correlation
5) Store the highest match as the recognized character

In [14] (Kumar, J. M. S. V. R., Sujatha, B., Leelavathi, N. (2020)) discuss mechanized vehicle license plate recognition system applying machine learning.
The following is the detailed steps of the algorithm
1) Acquire an image
2) Do de-saturation of the image
3) Apply linearization on the image
4) Apply optical character recognition

In [15] (Shelkikar, R., Jagade, S. (2019)) look at number plate localization and segmentation in a review.
The proposed system has the following general design.
The input is a vehicle image
1) Pre-processing is applied on the input image
2) Noise reduction is then performed
3) License plate is then detected
4) Character segmentation is performed
5) Character recognition is applied
6) Finally, the output is the recognized license plate

The following are some of the details about the process
1) For pre-processing, choice of a frame is done using the equation F=N*t/T
2) Noise reduction is done using median filtering
3) License plate is localized using the image segmentation method
4) Connected component analysis is used for character segmentation
5) Character recognition is performed using standardized cross correlation method

In [16] (Rajebi, S., Pedrammehr, S., Mohajerpoor, R. (2023)) discuss a number plate recognition system having resistance to strong environmental conditions applying Hopfiled's Neural Network.
The typical configuration of a number plate recognition system involves a traffic management personal computer and a license plate readers.
The following is the methodology of the number plate recognition system
1) Pre-process the input image and determine the approximate location of the number plate
2) Remove unwanted noise because of air pollution and fog
3) Apply approximate filters on the image and determine the exact location of the number plate
4) Extract the image segments in the number plate
5) Apply a Hopfield neural network to recognize the extracted segments with the existing character pattern

In[17] (Qian, Y., Gan, S. J. (2016)) examine research on number plate recognition based on HSV space.
The following are the steps of the licnese plate location algorithms
1) Select the threshold of each constituent of HSV
2) Color primary location
    a. Given an RGB image in HSV space, do image histogram equalization
    b. Calculate the threshold range of hue (H), saturation (S) and value (V).
    c. Take the contours
    d. Do template matching
3) Do a bettered Sobel filter secondary positioning
4) Do tilt correction
5) Do character segmentation
6) Do character recognition with a back propogation neural network.

In [18] (Tripathi, P., Singh, P., Bano, M., Sharma, K., Shahi, A. (2023)) perform a review on helmet and license plate detection.
The proposed method contains the following steps
1) Gather and perform annotation of a dataset
2) Give a definition of the subject of the dataset
3) Collect videos and images
4) Pre-process the video and images
5) Resize the images
6) Normalize the images
7) Make the choice of a detection model (like YOLO algorithm)

8) Perform training on the model
9) Do evaluation of the model
10) Intersection alongside Union
11) Check Precision and Recall
12) Test the model

In [19] (Hansika, A., Sony, T., Ibrahim, S) look at vehicle license plate detection under various environmental conditions.
The proposed system has the following steps
1) Pre-processing – Techniques like gray-scaling, adaptive thresholding, and noise removal are applied.
2) Extraction of features – Pertinent features are gathered using methods like morphological operations and edge detection.
3) Extraction of text – PyTesseract is utilized for this purpose.

In [20] (Surekha, P., Gurudath, P., Prithvi, R., Ananth, V. G. R. (2018)) discuss mechanized number plate recognition applying neural networks and image processing.
The proposed technique has the following steps
1) Acquire an image – Utilization of a sensor network and an imaging system.
2) Pre-process the image – Application of a Region of Interest (ROI), Conversion to gray-scale, and morphological operations.
3) Localize the license plate – Edge processing and morphological operations.
4) Extract the characters – Binarization, otsu, and connect component analysis.
5) Apply a neural network
6) Build a GUI (Graphical User Interface)

In [21] (Sutar, G. T., Shah, A. V. (2014)) explore license plate recognition applying a bettered segmentation.
The following are the steps in the algorithm
1) Acquire an image
2) Pre-process the image
3) Extract the region of the plate
4) Segment the characters in the extracted license plate
5) Recognize the characters
6) Perform a comparison with database
7) Output the results

In [22] (Wang, S. (2022)) perform research on number plate recognition.
The following are the steps of the method
1) Collect the image in a natural environment
2) Perform pre-processing of the image by gray-level and linearization.
3) Adjust the pose of the image applying affine transforms.
4) Finally utilize an OCR classifier based on neural network to recognize the characters.

IV. METHODOLOGY

The following is the methodology of the LILY algorithm
1) Pre-processing
   a. The input image is resized to 500 pixels in width
   b. The input image is converted to gray-scale
   c. Noise is removed from the image
   d. Digitization is performed on the image to convert pixels into 0 or 1 in value
2) Canny edge detection is applied on the input image
3) Contours are found in the edge detected image applying the cv2.findContours() method
4) Any contour having area less than 30 is discarded.
5) Left out contours are processed further

6) Approximation of a contour is done as a polygon
7) If the contour is a quadrilateral then it is considered as a licence plate

V. RESULTS

The following images show the graphical output of the LILY algorithm on a sample image

Fig 1. Input Image to the LILY algorithm

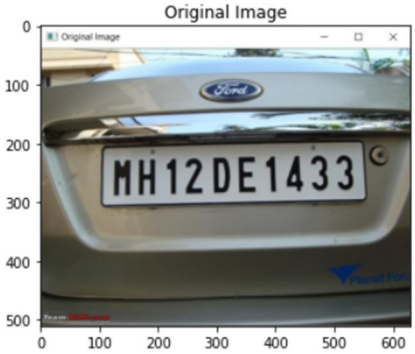

Fig 2. Input image as per cv2

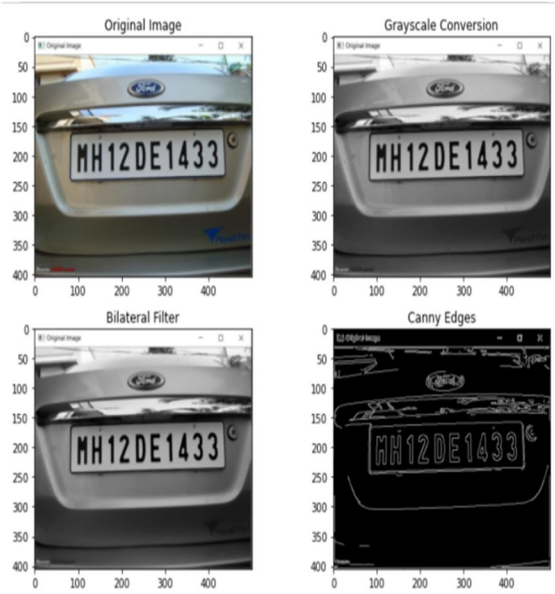

Fig 3. Pre-processing and edge detection

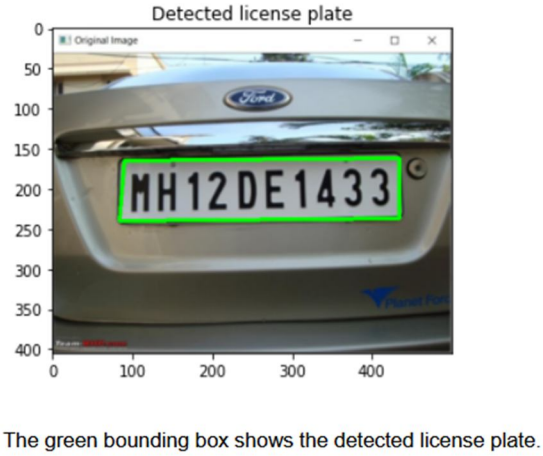

Fig 4. Detected License Plate

Fig 5. Extracted license plate

VI. CONCLUSION

License plate detection has been a well-researched problem.
This research article presents a thorough review of the literature in this subject.
A new algorithm called LILY (License plate detection applying contours) is presented.
The LILY algorithm has satisfactory results.

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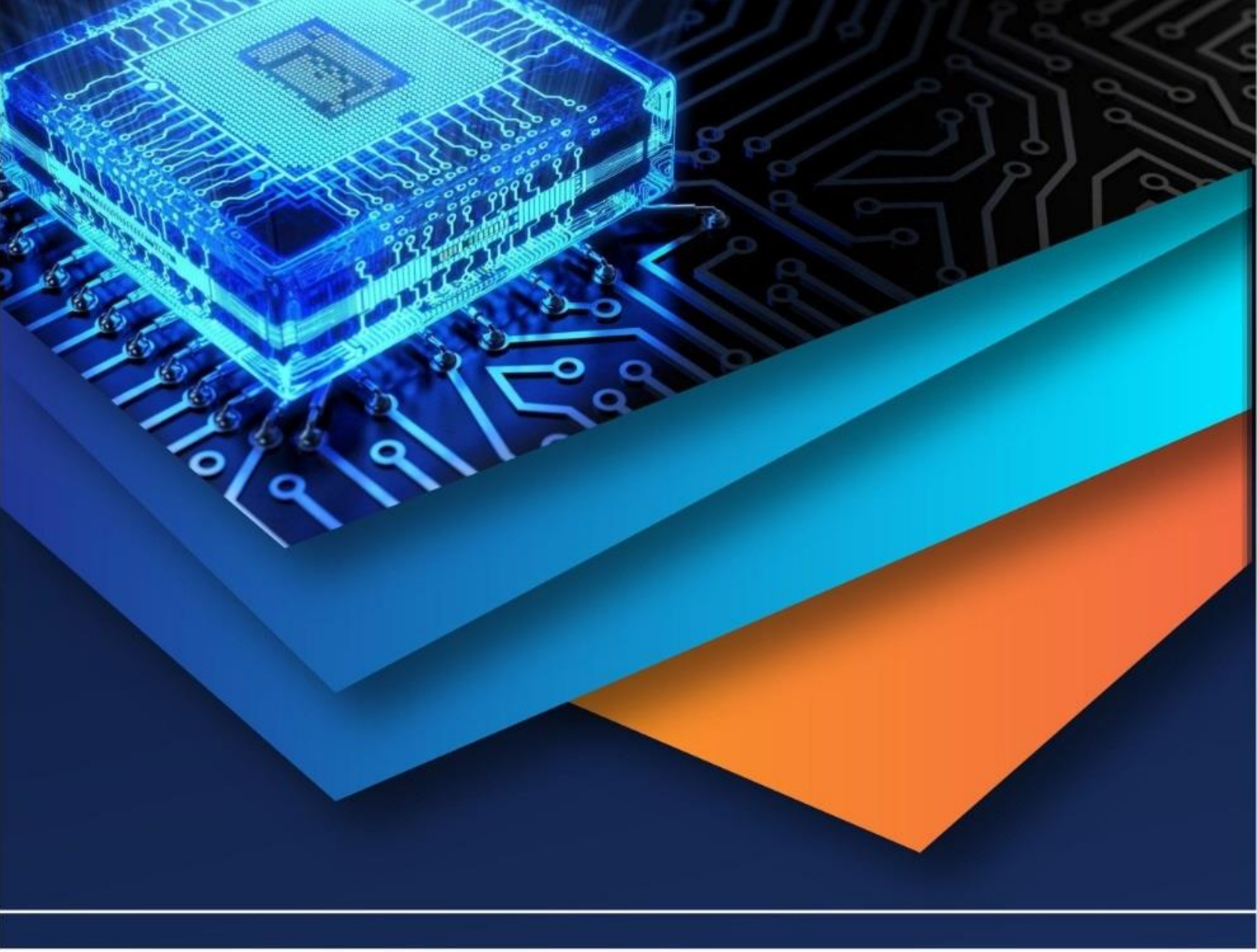

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