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Real time Drowsy Driver Detection using Polynomial Kernel based Support Vector Machine

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***Abstract:** Casualty increases from road accidents day by day. There are so many reasons that accident causes and mostly due to human errors. Driver drowsiness is one of them. A small drowsiness may turn it into a big accident that resulted heavy casualties. If any of the system automatically detects the driver's drowsiness and alert at real time may secure many lives. Drowsiness can be recognized by different situations such as by opening full mouth, by closing both the eyes and a combination of both. This may advised not to drive at drowsy state. There are various techniques through which drowsiness can be detected at real time but accuracy matters. OpenCV is a highly utilized open source computer vision library through which facial features can be recognized effectively. Polynomial kernel based support vector machine (SVM) is an advanced classification technique through which drowsiness can be classified from face. SVM is advanced machine learning approach through which linear and non-linear data can be classified with higher level of accuracy. System pertained 96.17 % of accuracy. Polynomial kernel is useful for non-linear data separation. Here system classifies the expressional features of face and result accordingly for drowsiness detection.*

***Keywords:** Support Vector Machine (SVM), OpenCV, Machine Learning, Non-Linear SVM Model, Drowsiness Detection, Face Detection, Computer Vision.*

I. INTRODUCTION

Driver fatigue is a critical factor in countless vehicle mishaps. Driver fatigue is a huge factor in countless vehicle mishaps. Ongoing measurements gauge that every year 1,50,785 passing and 76,000 injuries can be ascribed to fatigue related accidents in India. The improvement of advances for distinguishing or forestalling drowsiness in the driver's seat is a significant test in the field of mishap evasion frameworks. In light of the peril that drowsiness presents out and about, techniques should be created for checking its effects. The point of this task is to foster a model drowsiness detection framework. The spotlight will be set on planning a framework that will precisely screen the open or shut condition of the driver's eyes progressively. By observing the eyes, it is accepted that the side effects of driver fatigue can be distinguished early enough to keep away from an auto collision. Detection of fatigue includes the perception of eye developments and squint examples in an arrangement of pictures of a face. The improvement of innovations for identifying or forestalling drowsiness has been done through a few strategies, some examination utilized EEG for sluggish detection and some pre-owned eye flicker sensors, this undertaking utilizes web camera for Sleepy detection. The point of this examination is to foster a model drowsiness detection framework. The spotlight will be set on planning a framework that will precisely screen the eye developments of a driver progressively. By observing the eye developments, it is accepted that the manifestations of driver fatigue can be recognized early enough to keep away from an auto collision. As such, around 400 individuals on a normal are losing their lives each day on Indian streets. I shiver to consider 16 valuable lives being sucked out each moment! What a bleak image of our street wellbeing. We regularly know about tanked driving, no safety belt, speeding, street condition, terrible climate and mechanical disappointments. However, one of the greatest but then regularly unnoticed human blunders is sluggish driving. A significant issue in India as well as across the globe. The danger, peril, and regularly unfortunate after-effects of sluggish driving are disturbing to be sure. Clearly absence of rest is the principle offender. Furthermore, add to it the impetus specialists like drugs, liquor and rest issues, tiredness gets irritated. Numerous drivers in the nation penance rest, a regularly disregarded and perilous conduct that outcomes in dominant part of them being sleepless while in the driver's seat each day. There is no authority include of lives lost in lazy driving-related accidents in our country. Nodding off at the worst possible time is self-destructive. It isn't simply perilous to the driver however to any remaining street clients. Here are a few signs that should advise a driver to pause and rest: Hanging eyelids, yawning over and again or scouring eyes, hazy vision and gesturing head are the main indications of drowsiness. Floating from path, closely following, feeling anxious and peevish are yet some more sign of drowsiness [1].

Fig. 1.Drowsiness while Driving [2]

The proposed calculation leads the detection cycle by recording the video sequences of the drivers and image processing technique. The framework comprises of four stages, in particular the face detection, eye traking, yawning detection and detection of head bringing down. Because of horrible lighting conditions or beginning head direction of the driver, the confinement may come up short. So the framework snatches another edge and rehashes a similar interaction until the face area is distinguished with conviction [1]. OpenCV stands for Open Source Computer Vision which is a machine learning library for computer vision tasks. There are various companies that use this library for real time object classification, 3d modeling, object extraction, face detection and many more. It can also be used for automatic drivers drowsiness detection with real time callibration. OpenCV is a trending approach that resulted high level of accuracy in real time based systems.

II. RELATED WORKS

A. Related Works

Fouzia et al. [7] proposed a framework that presents a drowsiness detection structure dependent on shape indicator calculation, that recognizes the eyes, and furthermore checks the eye flicker rate followed by drowsiness detection at continuous. In the proposed framework, the insights regarding the eye status is gotten through image processing calculations, which offer a non-intrusive way to deal with recognize drowsiness with no inconvenience and obstruction. In future, the detection of yawning of the driver can be likewise be carried out utilizing same casing work for identifying further insights regarding the drowsiness of driver.

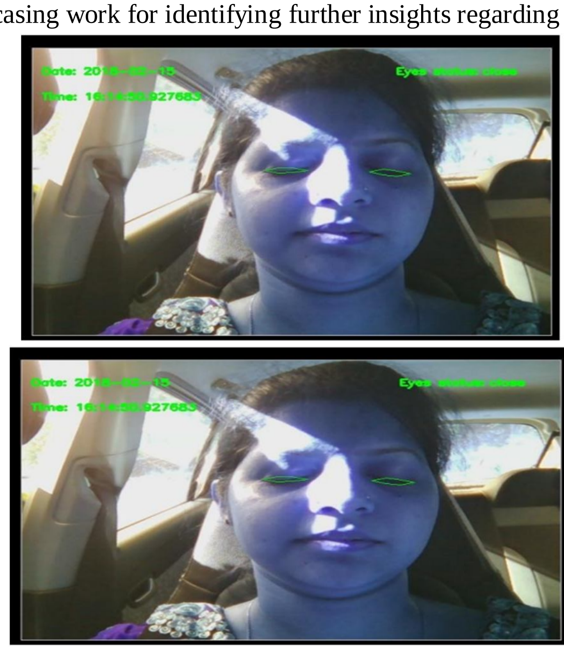

Fig. 2.Drowsiness Detection [7]

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Federico Guede-Fernández et.al. [8] proposed a technique to give a certainty quality level of the respiratory sign. Also, the acquired quality sign level has been joined with the drowsiness detection calculation to improve the arrangement results through lessening the quantity of bogus positives because of changes of estimated RRV related not to drowsiness but rather body developments or talking. Moreover, the planned calculation has been approved under a driving test system and a few drowsiness scenes have been distinguished for every last one of 15 test meetings. The best quality level of drowsiness occasions has been produced by outer eyewitnesses from video chronicles of the subject while driving. The presentation results have been gotten following LOSOCV system to accomplish an impartial gauge of the summed up calculation execution. The improvement of drowsiness arrangement results because of the sign quality calculation has been additionally surveyed and the distinctions for every advancement models and AT have been talked about. Akshay Bhaskar et al. [9] proposed EyeAwake in its flow stage makes a decent gadget for sluggish driver detection and giving essential vehicle adjustment as far as easing back down and in the long run halting the vehicle. The model expense roughly US$40 to construct and test. To keep the expense low, a basic plan was followed which utilizes fundamental yet precise sensors. By utilizing various such sensor segments, detection of sluggish driving was genuinely precise. Beginning on street tests show a 70% exactness in distinguishing lazy driving. Besides, EyeAwake has remarkable highlights that most existing items don't like outside notice to different drivers and people on foot, and a fundamental vehicle revision instrument. Xiaoxi Mama et al. [10] proposed a driver fatigue detection framework dependent on CNN utilizing profundity video groupings is proposed. To use the spatial and worldly data for profundity based activity acknowledgment issue, another engineering called profundity video-based two-transfer CNN is proposed. In addition, a foundation expulsion framework for profundity video arrangement of driving is proposed. The proposed strategy can viably distinguish whether the driver is fatigue driving or ordinary driving during the evening, with an exactness of 91.57%, utilizing our gathered profundity based driver fatigue dataset. Our framework can be utilized to give cautions appropriately to fatigue drivers, which will diminish and forestall the event of car crashes. Aldila Riztiane et al. [11] proposed a framework that planned to alarm drivers so they can be advised to pull over and quit driving in a lazy state. The application "Driver Drowsiness Detection" uses Haar-course Detection just as layout coordinating in OpenCV to recognize and follow the eyes utilizing the front camera of an Android gadget. Testing has been directed to guarantee that the usefulness, conduct, execution and client fulfillment are true to form. Despite the fact that, the information got by the application actually has a few limitations, explicitly in relationship to adequate lighting and haziness of the face and eyes territory, the application has effectively identified the eye flickers at the point of 30 to 60 degrees and distance of 20-50 cm, just as estimating the pulse. Sanya Gupta et al. [12] proposed a work which is tried and checked to give high exactness in the dynamic of the driver's lazy conditions. Simultaneously, the framework achieved a few execution boundaries of ongoing designs in cars. The framework gave in this paper is convenient, since it doesn't need a force source from a PC and should be associated with a PC just at the hour of setup of the framework. Since the framework deals with the standard of equal processing which definitely decreases the processing time needed by the framework to give the choice, it makes it an ongoing arrangement. Also, FPGA is an adaptable gadget that can be totally reconfigured for higher or better calculation.

III. PROPOSED WORK & IMPLEMENTATION

Proposed system is intended to recognize drivers drowsiness for casualties prevention in terms of road accidents. System is able to recognize facial expression at real time and able to notify whether the drowsiness appears or not. System is also able to recognize facial features and classify them for drowsiness detection. System is also monitoring motions at real time for current transition and alert when drowsiness has been detected. System is able to sense whether the eyes are open or not along with mouth. It is helpful for getting prior notification if drowsiness has been detected or in a simple word it may helpful for monitoring against road accidents related to the drowsiness.

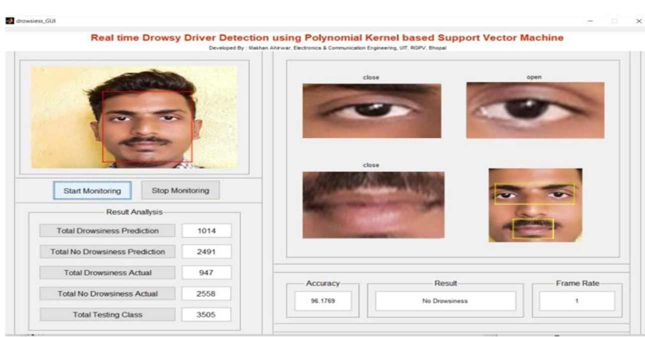

Fig. 3.Proposed Work API

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Fig. 5 shows the feature classification at real time for drowsiness detection. Proposed system is intelligent enough to identify the facial features. System uses Polynomial SVM method to recognize the facial expression and able to classify by its feature classification. If the ratio satisfy the threshold value then it will be correctly considered as drowsiness. System can work at real time with less processing time and respond immediately when transition occurred. Co-ordinates have been updated as per the face appeared at real time. Only contouring area can detect the density and rest area is not considered as region of interest but motion can be detected in entire frame. Driver drowsiness is the most basic reason for car crashes, subsequently drowsiness detection assume an indispensable part in forestalling auto collisions. By fostering a programmed answer for cautioning drivers of drowsing, before a mishap happens, this could decrease the quantity of auto collisions. Along these lines, this exploration proposes a constant detection approach for driver drowsiness. The proposed approach has two stages: image processing and AI. The part of image processing stage is to perceive the essence of the driver and afterward removes the image of the eyes of the driver. This stage utilizes Haar face detection calculation that accepts caught edges of image as info and afterward the identified face as yield. Then, Haar is likewise used to remove the eyes image from the distinguished face which will be utilized as a contribution for the AI stage. The fundamental job of the AI is to arrange either the eyes of the driver are shut or opened utilizing Backing Vector Machine (SVM). On the off chance that the aftereffect of the order demonstrates that the driver's eyes is shut for a predefined timeframe, the eyes of the driver will be viewed as shut and henceforth a caution will be begun to alarm the driver. The proposed philosophy has been tried on accessible benchmark information. The outcome shows the exactness and power of the hybridized of image processing method with AI procedure. Consequently, it tends to be reasoned that the proposed approach is a successful arrangement technique for an ongoing frame of driver drowsiness detection. The point of this examination is to deliver an answer for one of the significant reasons for the street mishap, the driver drowsiness; the proposed arrangement tracks the driver's eyes and afterward inform him when his eyes get shut to try not to lose the control of the vehicle and causing auto collisions. The present proposed strategy dependent on two primary stages, the main stage is to recognize and pre-measure the eye images utilizing the image processing procedure and the subsequent stage is to fabricate an arrangement model that will actually want to characterize whether the eye is opened or shut and afterward start a caution likewise.

A. Polynomial based SVM

A non linear transformation of the support vectors can be used and classified. The proposed classification calculates the CDR value of the respected image and the presence / absence of the drowsiness. The properties of the images are collected using PCA (Principal Component Analysis). The accuracy and efficiency of the proposed classification are compared with the methods used by morphology based image classification with fused method and support vector machines. In AI, the polynomial kernel is a part work usually utilized with support vector machines (SVMs) and other kernelized models, that addresses the comparability of vectors (preparing tests) in an element space over polynomials of the first factors, permitting learning of non-straight models. Naturally, the polynomial part looks not just at the given highlights of information tests to decide their similitude, yet additionally mixes of these. With regards to relapse examination, such blends are known as connection highlights. The (implied) include space of a polynomial bit is comparable to that of polynomial relapse, yet without the combinatorial blowup in the quantity of boundaries to be learned. At the point when the information highlights are paired esteemed (booleans), at that point the highlights relate to sensible conjunctions of information highlights. For degree-d polynomials, the polynomial part is characterized as

$$K(x, y) = (x^T y + c)^d$$

where x and y are vectors in the info space, for example vectors of highlights figured from preparing or test tests and $c \geq 0$ is a free boundary compromising the impact of higher-request versus lower-request terms in the polynomial. At the point when $c = 0$, the piece is called homogeneous. (A further summed up polykernel partitions xTy by a client indicated scalar boundary a.) The idea of φ can be seen from a model. Let $d = 2$, so we get the extraordinary instance of the quadratic piece. In the wake of utilizing the multinomial hypothesis (twice—the peripheral application is the binomial hypothesis) and refocusing.

$$K(x, y) = (\sum_{i=1}^{n} x_i y_i + c)^2$$

$$= \sum_{i=1}^{n} (x_i^2)(y_i^2) + \sum_{i=2}^{n} \sum_{j=1}^{n} (\sqrt{2}\, x_i x_j)(\sqrt{2}\, y_i y_j) + \sum_{i=1}^{n} (\sqrt{2}\, c x_i)(\sqrt{2}\, c y_i) + c^2$$

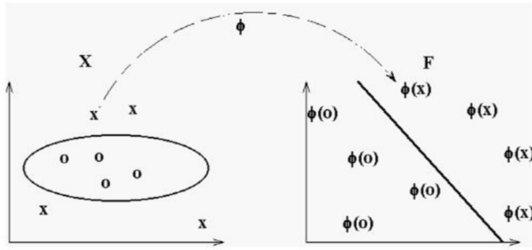

Fig. 4.SVM Polynomial Classification

B. Polynomial Kernel SVM Algorithm

Input: 2-D Image Matrix

Output: Polynomial Classification

Step 1: Define data points

$x = (x_1, x_2, x_{3 \ldots Xn})^T$

$y = (y_1, y_2, y_3 .. y_n)^T$

Here x & y are two data points

Step 2: Compute dimensional space

$\Phi(x) = (x_1^2, x_1 x_2, x_1 x_3, x_2 x_1, x_2^2, x_2 x_3, x_3 x_1, x_3 x_2, x_3^2)^T$

$\Phi(y) = (y_1^2, y_1 y_2, y_1 y_3, y_2 y_1, y_2^2, y_2 y_3, y_3 y_1, y_3 y_2, y_3^2)^T$

k(x, y) is a kernel function

$k(x, y) = (x^T y)^2$

$= (x_1 y_1 + x_2 y_2 + x_3 y_3)^2$

$= \sum_{i,j=1}^{3} x_i x_j y_i y_j$

$k(x, y) = \Phi(x)^T \Phi(y)$

Step 3: Kernels are similarity functions between vectors of data points in an image

$K: X * X \rightarrow R$

$K(\vec{x}, \vec{y}) = < \Phi(\vec{x}), \Phi(\vec{y}) >$

It has been computed for higher dimensional spaces.

Step 4: Let K is equivalent to Φ, with n features and d degrees of polynomial

$k(x, y) = (x^T y+1)^d$

Step 5: Compute kernel matrix to find decision boundary

$C^T Kc = \sum_i \sum_j c_i c_j k_{i,j}$

$= \sum_i \sum_j c_i c_j \Phi(x_i) \Phi(x_j)$

$= (\sum_i c_i \Phi(x_i)) (\sum_j c_j \Phi(x_j))$

$= \| (\sum_j c_j \Phi(x_j)) \|^2 \geq 0$

Step 6: Plotting new data

Step 7: Predicting the data for facial feature classification

Step 8: **if** left eye = close || right eye = close **then**

Drowsiness Predicted;

elseif mouth = open || left eye = close || right eye = close **then**

Drowsiness Predicted;

else

No Drowsiness Predicted;

end else

end if

Step 9: End

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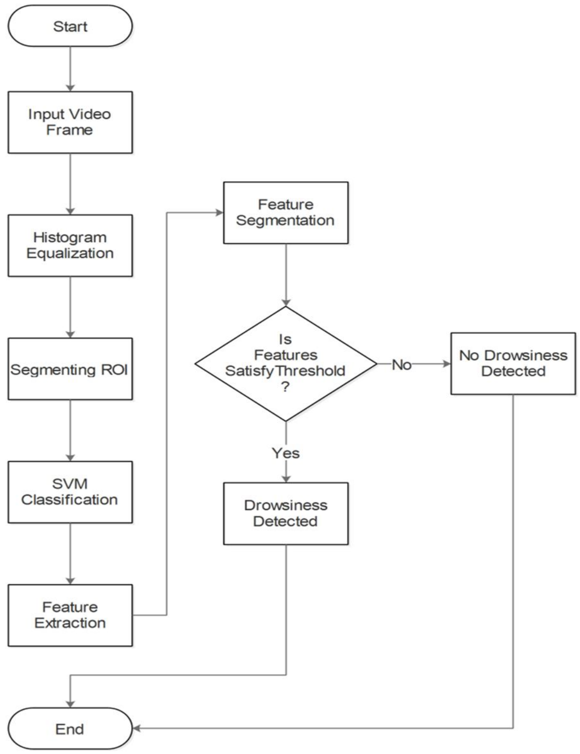
C. Flow Chart

In flow chart, first of all video sequence frame will be acquired for feature extraction. Then it will rectify whether frame is about to end or not, if it becomes end then the process will get expired otherwise process get accessed till frames acquisition. Then histogram equalization has been applied once the frame is acquired. Then SVM classification has been done for feature classification whether the eyes and mouth are open or not and as per the feature extraction the decision will be taken accordingly.

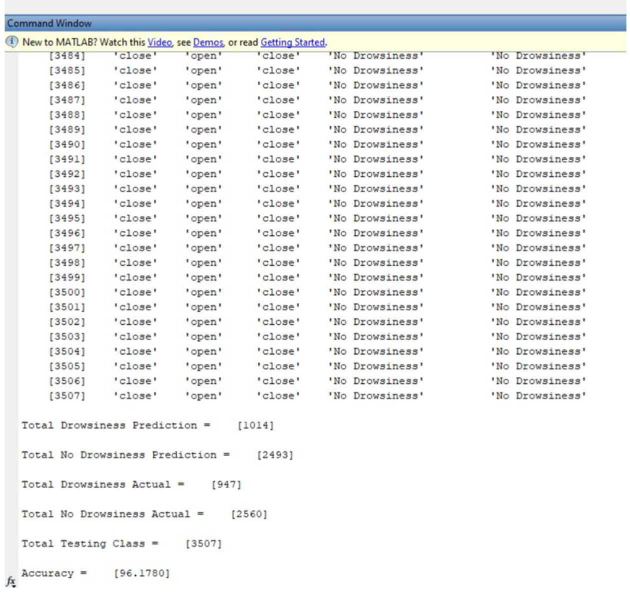


Flow Chart

IV. RESULT ANALYSIS

A. Result Simulation

There are total no. of 3507 frames have been tested and results are obtained accordingly. So the system recorded 1014 frames where drowsiness detected and 2493 frames where as no drowsiness detected. But the actual data for actual drowsiness is 947 and no actual drowsiness is 2560. So, the accuracy has been computed on the basis of all the parameters i.e. 96.17%.



V. RESULT CONSOLE

Drowsiness Predicted = 1014, No Drowsiness Predicted = 2493, Actual Drowsiness= 947, No Actual Drowsiness = 2560, Total Testing Class = 3507

Drowsiness Predicted -DP, No Drowsiness Predicted -NDP, Actual Drowsiness-AD, No Actual Drowsiness - NAD, Total Testing Class- TTC

$$\text{Accuracy} = \frac{TTC-((DP-AD)+(NDP-NAD)}{TTC} * 100\ \%$$

$$= 96.17\ \%$$

Table No. I Result Comparison

	Tatulea, Paula **[21]**	**Proposed**
Frame Rate	24 fps	24 fps
Image Resolution	640*480	1280*720
Method	DCCNN	Polynomial SVM
Accuracy	94.80	96.17

Table I shows the result comparison with previous result where 94.80 % of accuracy has been obtained during test wiith correct recognition. So, the overall accuracy has been recorded as 94.80 % after 10 experiments as per the base paper. In proposed system, 3507 frames have been tested that resulted 1014 as drowsiness, 2493 as non drowsiness where as the actual drowsiness is 947 and actual non drowsiness is 2560 and the overall accuracy has been calculated as 96.17 % which is bit higher than the previous one. The frame rate for both the system is same but bit differ in the frame resolution.

VI. CONCLUSION & FUTURE SCOPE

The systems which have been proposed till now are not reliable because those systems are not efficient to extract the useful information. The information is missing the sensitive edges that trail the accuracy in order to achieve the correct recognition. The proposed system is capable enough to efficiently identify drowsiness by using polynomial support vector machine which enhances the accuracy and proficiency of the system up to a great extent. Automatic Drivers Drowsiness Detection is a useful concept for implementing safe driving that may aware drivers for any type of accidental casualties. The aim of this study is to address a solution to one of the major causes of the road accident, the driver drowsiness; the proposed solution does track the driver's eyes and then notify him when his eyes get closed in order to avoid losing the control of the car and causing traffic accidents. If the result of the classification indicates that the driver's eyes is closed for a predefined period of time, the eyes of the driver will be considered closed and hence an alarm will be started to alert the driver. The proposed methodology has been tested on available benchmark data. The result demonstrates the accuracy and robustness of the hybridized of image processing technique with machine learning technique. Accuracy is very important with respect to the correct and incorrect recognition for ideal system. Polynomial based SVM can be enhanced in future where accuracy depends by appending various tensorflow based packing that works effectively in computer vision especially in real time. Here system pertained 96.17 % of accuracy with 3507 as total tested frames.

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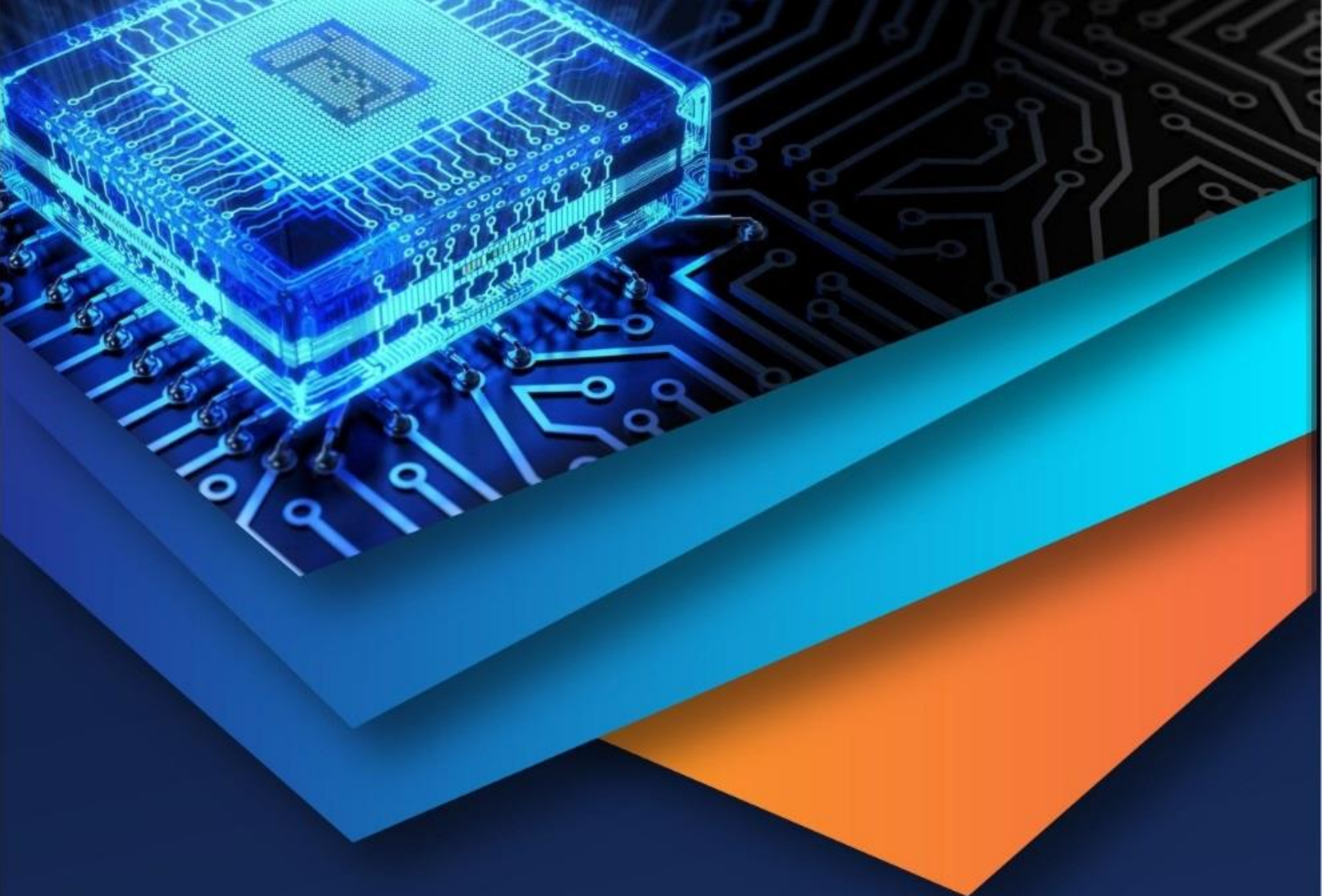

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