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Early Diabetic Retinopathy Detection Using Deep Learning Algorithms

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Abstract: Diabetic Retinopathy (DR) is caused by the high blood glucose level which causes micro vascular complications in eyes which lead to vision loss. (MA)Microaneurysms formation in the retinal is sign of diabetic rent ropy which can be cured at early stage.
Finding Microaneurysms (MA) presence in the eye image and recognition of diabetic retinopathy at early stage is difficult.
Technology of deep learning makes it easier and efficient for analysis of eyes to detect MA presence which can be done by image detection and segmentation with good performance and accuracy using deep learning algorithms. This will help us to differentiated between affected retina and non-affected one. The given system can use deep convolution neural network for semantic segmentation of fundus images which increase efficiency and accuracy of NPDR (non- proliferated diabetic retinopathy) prediction.
Keywords:
PCA Principle Component Analysis
DA Diabetic Retinopathy
MA Microaneurysms
NPDR Non proliferated diabetic retinopathy
BPNN Back propagation neural network.

I. INTRODUCTION

Predicting the presence of Microaneurysms in the fundus images and the identification of diabetic retinopathy in early-stage has always been a major challenge for decades.
Diabetic Retinopathy (DR) is affected by prolonged high blood glucose level which leads to micro vascular complications and irreversible vision loss. Microaneurysms formation and macular edema in the retinal is the initial sign of DR and diagnosis at the right time can reduce the risk of non-proliferated diabetic retinopathy.
The rapid improvement of deep learning makes it gradually become an efficient technique to provide an interesting solution for medical image analysis problems.
To analyse the presence of microaneuryms in fundus images using image segmentation , principle component analysis , deep learning algorithm and one rule classifier with high-performance and low-latency inference.
The semantic segmentation algorithm is utilized to classify the fundus picture as normal or infected. Semantic segmentation divides the image pixels based on their common semantic to identify the feature of microaneuryms. The proposed system can be trend effectively using deep convolution neural network and classifier for semantic segmentation of fundus images which can increase the efficiency and detect presence of diabetic retinopathy.

A. Related Work

1) *Wei Zhou: - Automatic microaneuryms detection using the sparse principal component analysis-based unsupervised classification methods.*

Methodology: - Sparse principal component analysis based unsupervised classification approach (SPCAUCM) for detecting presence of microaneurysms (MA).
The characteristics of the sparse Principal Component Analysis (PCA) are often used for choosing different features. The non-MAshas variety of data and may take large data set long time and affect classes which can create imbalance. As here we don’t have to consider the non- MA class samples this problem may be prevented.

2) *P. Wilkinson, T. Spencer, J. Orison, K.MC Hardy, p. Sharp and Forrester: - A photo Processing Strategy used for Segmentation and Quantification in Fluorescein Angiograms of the Ocular Fundus, Computers and Biomedical Research.*

Proposed Methodology Early Treatment Diabetic Retinopathy Study (ETDRS) reinforce preliminary association and built agreement regarding the classification of DR and diabetic macular edema clinical disorder category systems available improving and coordinating for treating among the doctors looking after diabetic patients. Research was distributed prior to of the Wisconsin Epidemiological Studies on Diabetic Retinopathy course. All Members cross examined it through mail for stratifying the responses which modified the Delphi framework which was used. Different macled edema and diabetic retinopathy (DR) systems were developed at a later workshop. The organization members re-examined those, and the modified Delphi system was used again to live degrees of agreement.

3) *Varun Gulshan: - Retina Lesion and Microaneuryms segmentation using Morphological Reconstruction methods with Ground-Truth Data*

Proposed Methodology: - Deep Convolutional Neural Net (DCNN) used to identify DA in retinal fundus images and using deep learning can be useful tool for retinal fundus images for creating an algorithm for finding DR and diabetic macular edema automatically Looking upon determining sensitivity and accuracy of the algorithms, team of doctors, and for determining if DR is more or worse both can be shown. An algorithm with 96.5 precent sensitivity and 92.4percent specificity is developed using DCNN a large set of data in many grades/images.

4) *Kedir M. Adal: - Using an Automatic system for detecting and classify the changes in Retina because of the Red Lesions in Longitudinal Fundus pictures.*

Proposed Methodology: - Detecting spatiotemporal retinal changes and also the difference between the extremes of the multiscale boldness responses of fundus images from two time points is simpler and effective boldness measure.

II. TECHNICAL APPROACH

A. Selection of Retinal Fundus Image

To use selection of image of dataset proper to early identification of disease. This data set was used for image pre-processing and extraction of features for classifying the images into category normal or abnormal. Total of 89 images are used from this database.

1) *Pre-processing of Images:* The medical image data sets are available in different sizes as they are taken from different data bases.
2) *Feature Extraction:* After image pre-processing features are extracted, like, the area of blood vessels, exudates and M A within the images are calculated. Area calculation is done by using loop from top left to bottom right corners of image and the binary 1 i.e., white pixels are counted. This process is used for calculating the blood vessel area, exudates and MA respectively from final segmented images.
3) *Feature Selection:* To pick out prominent features, Haar wavelet transform technique is employed, which can convert the extracted 41 features into 65 different discrete features. These wavelets are often used for pattern recognition because of its low computing requirements.
4) *Classification:* Here data is segregated in different non overlapping classes for further operations. Data mining type.
5) *BPNN Classifier:* The BPNN algorithm should be trained with the samples of intended output. It can adapt the weights of the network very quickly.

One Rule is further used to classify image as diabetic or not.

III.PROPOSED SYSTEM

In proposed system we are using standard diabetic retinopathy dataset calibration level1 for testing.

We are using canny detection for image segmentation and principal component analysis to detect optimal features. Image is analysed and feature extraction is done using principle component analysis for microaneuryms, haemorrhages, soft exudates and hard exudates in eye.

BPNN algorithm is used for training data set using fuzzyC rule and classification is done using oneR algorithm. ll paragraphs must be indented. All paragraphs must be justified, i.e. both left-justified and right-justified.

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A. Proposed Block Diagram

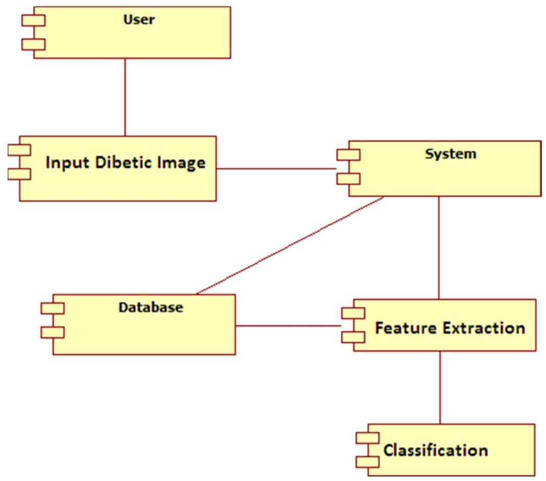

Fig.1 Block Diagram

B. Proposed Development Diagram

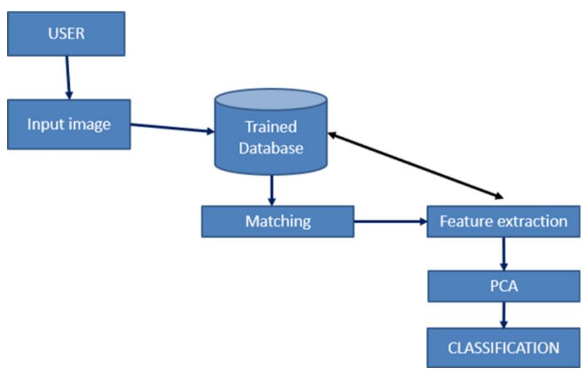

Fig.2 Development Diagram

C. Proposed Class Diagram

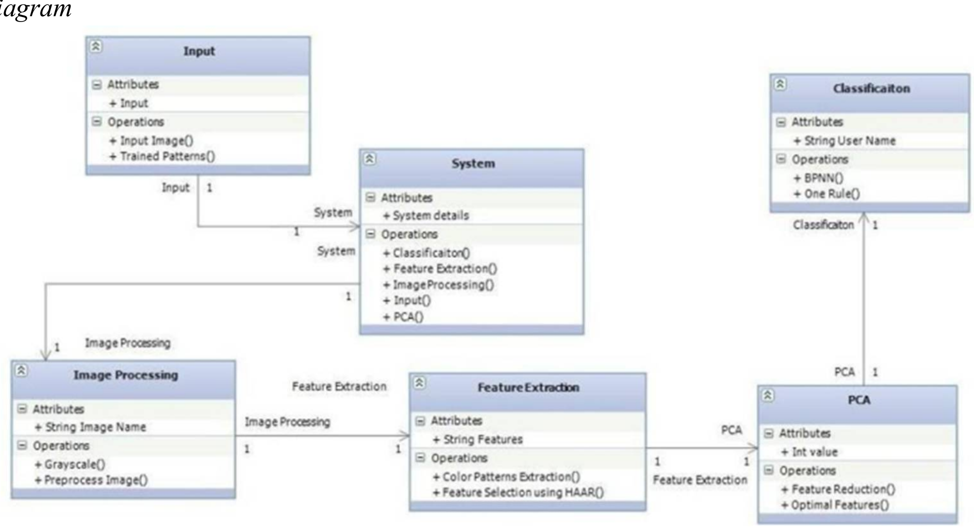

Fig.3 Class Diagram

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1) *Input Image:* Here input image of the patients' eyes is taken for processing and scanned. Trained patterns are also taken.
2) *Image Preprocessing:* Here grey scaling of image is gone along with reducing intensity of the image to reduce noise as much as possible.
3) *Features Extraction:* Here Harr wavelets are used for processing of an image and reducing noise also colored pattern is obtained after feature extraction process.
4) *Principal Component Analysis (PCA):* Here feature reduction is done and the optimal features from the image are been extracted for further segregation. These images are sent to classification further.
5) *Classification:* Here one rule and BPNN algorithms are used for finding out the defected eye and non-defected ones.

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IV. SYSTEM DESIGN

A. Login Page

For a doctor to start the software on visual studio we have given login form as security measurement with password to access system.

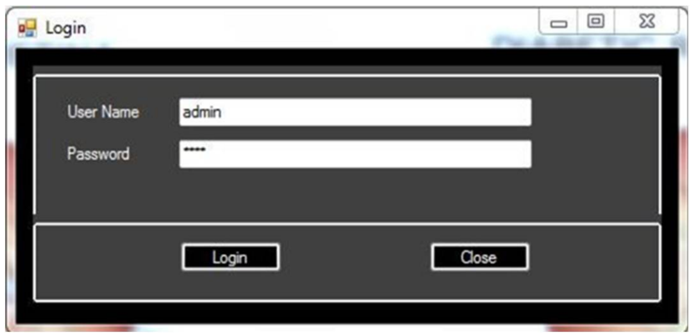

Fig. 4 Login page

B. Grey Scaling

Here the grey scale of input selected image is obtained.
Each pixel of image has 4 components red, blue, green and alpha.
Grey scaling of image is done by taking mean of Red, Blue and Green component of pixel and replacing it with mean value.

Fig.5 Grey Scale

C. Image Segmentation

After Grey scaling image segmentation of image is done using canny edge detection.
This algorithm is used to detect wide range of edges in an image.
Canny edge detection algorithm is used in five steps:

1) Applying Gaussian filter to smothering image in order to remove noise. Edges affected my noise are reduced by convoluting them with Gaussian filter.
2) Finding Gradient intensity. Gradient intensity is image intensity at different points in all directions which is determined using sobel and Laplace derivatives.
3) Apply gradient magnitude thresholding or lower bound cut-off suppression to get rid of spurious response to edge detection. comparing strength of current pixel to on in both neighbouring direction positive and negative. If strength of current pixel is highest compared to others in same direction its value will be preserved otherwise it will be suppressed. Here non maxima suppression is used.

4) Apply double threshold to determine potential edges
5) Track edges by hysteresis. Finally suppressing of all edges weak or not connected to strong edge.

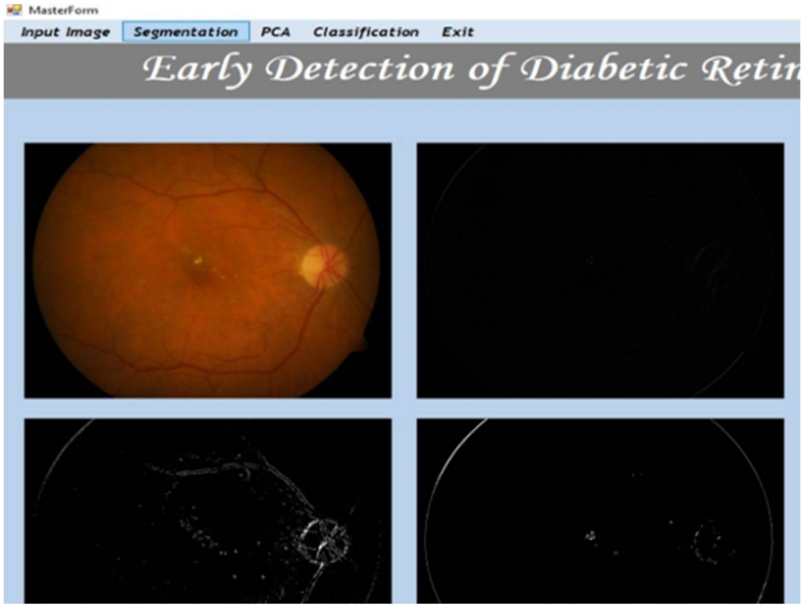

Fig.6 Segmentation

D. Principal Component Analysis

Principal Component Analysis. The central idea of principal component analysis (PCA) is to reduce the dimensionality of a data set consisting of a large number of interrelated variables , while retaining as much as possible of the variation present in the data set. Here principal component analysis is done to detect

1) *Microaneuryms:* Tiny area of blood protruding from an artery or vein in the back of the eye. These protrusions may open and leak blood into the retinal tissue surrounding it.Matched filter and thresholding technique can be used to detect microaneuryms and haemorrhages. Extended minima transformation is done to detect this in eye. Discrete Harr wavelet 2D transform is used to get this image feature.
2) *Haemorrhages:* Caused by swelling in retina when nerve breaks producing spot in retina. New nerve growing can cause vision loss and can lead to blockage of other small nerves causing damage in eye.
3) *Hard Exudates:* Hard exudates are distinct yellow-white intra-retinal deposits which can vary from small specks to larger patches and which may evolve into rings known as circulate ultimately large confluent plaques can form. Here Inverse Haar Wavelet 2D Transform is used to detect it.
4) *Soft Exudates:* Cotton-wool spots (CWS), also sometimes referred to as soft exudates, are nerve fibre layer infarcts, or pre-capillary arterial occlusions. In other words they are an ischemic event of a very small amount of tissue.

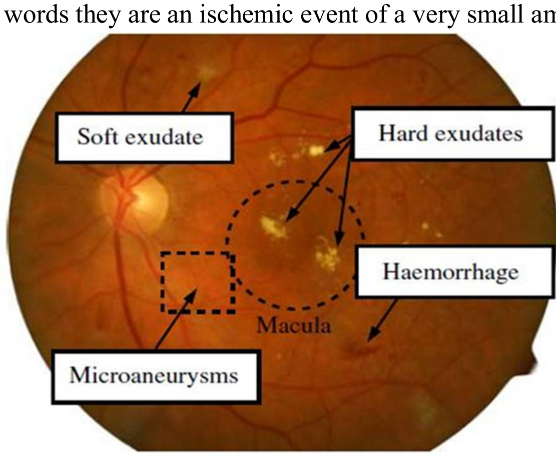

Fig.7 Eye defects

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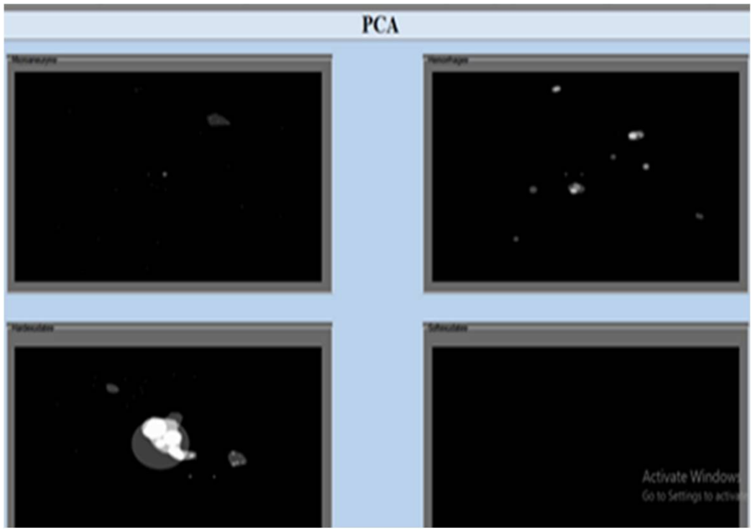

Fig.8 Principle component analysis

E. Classification Of Image

For training of dataset from 89 image standard dataset 1 which has 84 diabetic retinopathy images we used BPNN (back propagation neural network algorithm).

Back Propagation Neural network is a multi-layered feed forward neural network. In this the training is done by updating the internal weights of the nodes for the accuracy. The training data set are taken for the training of the neural network which has defined output which is given to the neural network. Difference between the actual and required output is used to update the nodes in back propagation in a way where the updating of the nodes travel from the output nodes to the internal nodes and the weights are the adjusted approximately and new output result is achieved This process is repeated until minimum error is achieved. Here fuzzy logic along with clustering of centroids is used. Fuzzy logic is used to define weights from fuzzy set in neural network.

One Rule Classifier:

OneR, short for One Rule, is a simple, yet accurate, classification algorithm that generates One rule for each predictor in the data, then selects the rule with the smallest total error as its one rule. To create a rule for a predictor, we construct a frequency table for each predictor against the target.

In diabetic retinopathy detection this is determined by calculating the total number of Opaque points in images from principal component analysis result.

Summation of all opaque points of all 4 images is calculated and if sum is greater than 10000 people suffer from diabetic retinopathy else not suffering.

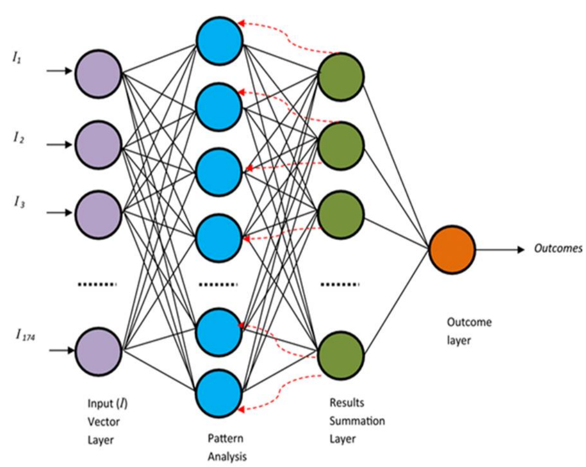

Fig. 9 BPNN diagram

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V. SIMULATION RESULTS

After training of dataset of images different images were tested having following results were observed.

A. Testing Result for this Image say Eye1

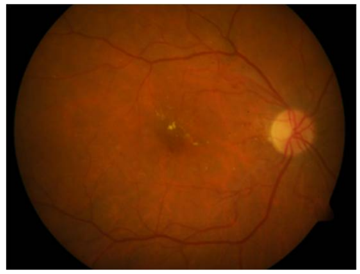

Fig.10 Eye1 testing

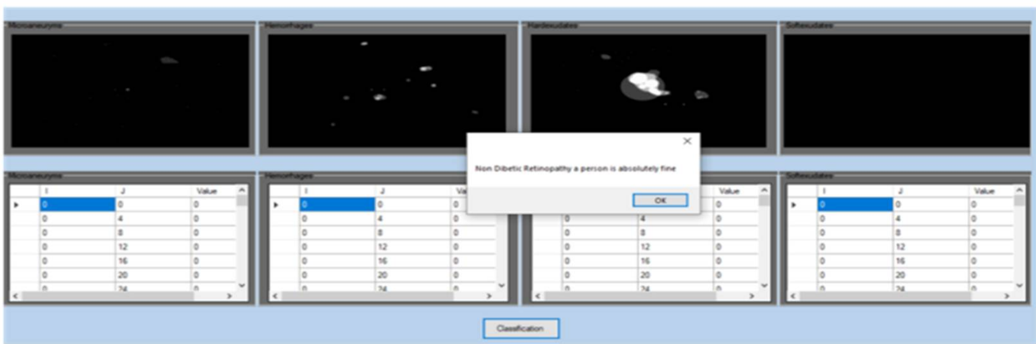

Fig. 11 Eye1 Result

Result: Total 5928, Non diabetic absolutely fine.

B. Testing Result for Image eye2

Fig. 12 Eye2 testing

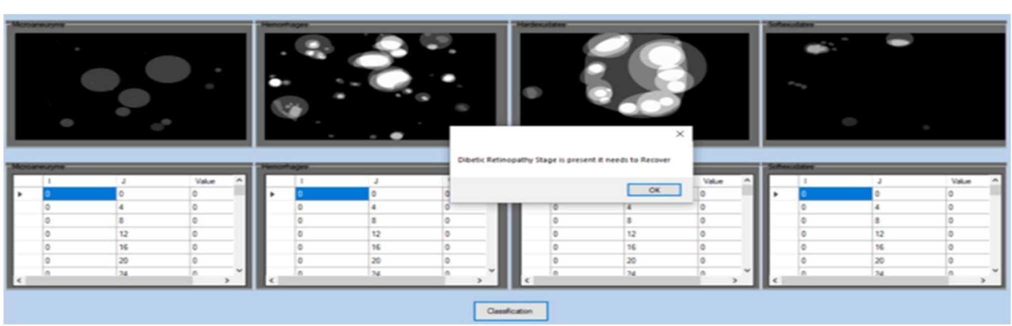

Fig.13 Eye2 Result

Result: Total 66879, Diabetic retinopathy stage detected needs recovery.

VI. CONCLUSIONS

Identification of diabetic at an early stage is the best solution for the early discovery of DR. Here, classification of digital retinal fundus images is performed by employing proposed algorithm and back propagation neural networks for two classes namely diabetic and non- non diabetic.

In this project we studied different types of approach for detecting MA in fundus. This project also gives idea of deep learning algorithms and how useful of a tool it will be in future for big data analysis.

We were able to use one rule algorithm to segregate diabetic and non-diabetic defeated patient and also learned principal component analyses for getting different optimal features from eyes.

Image segmentation algorithms helped us to segregate image as well.

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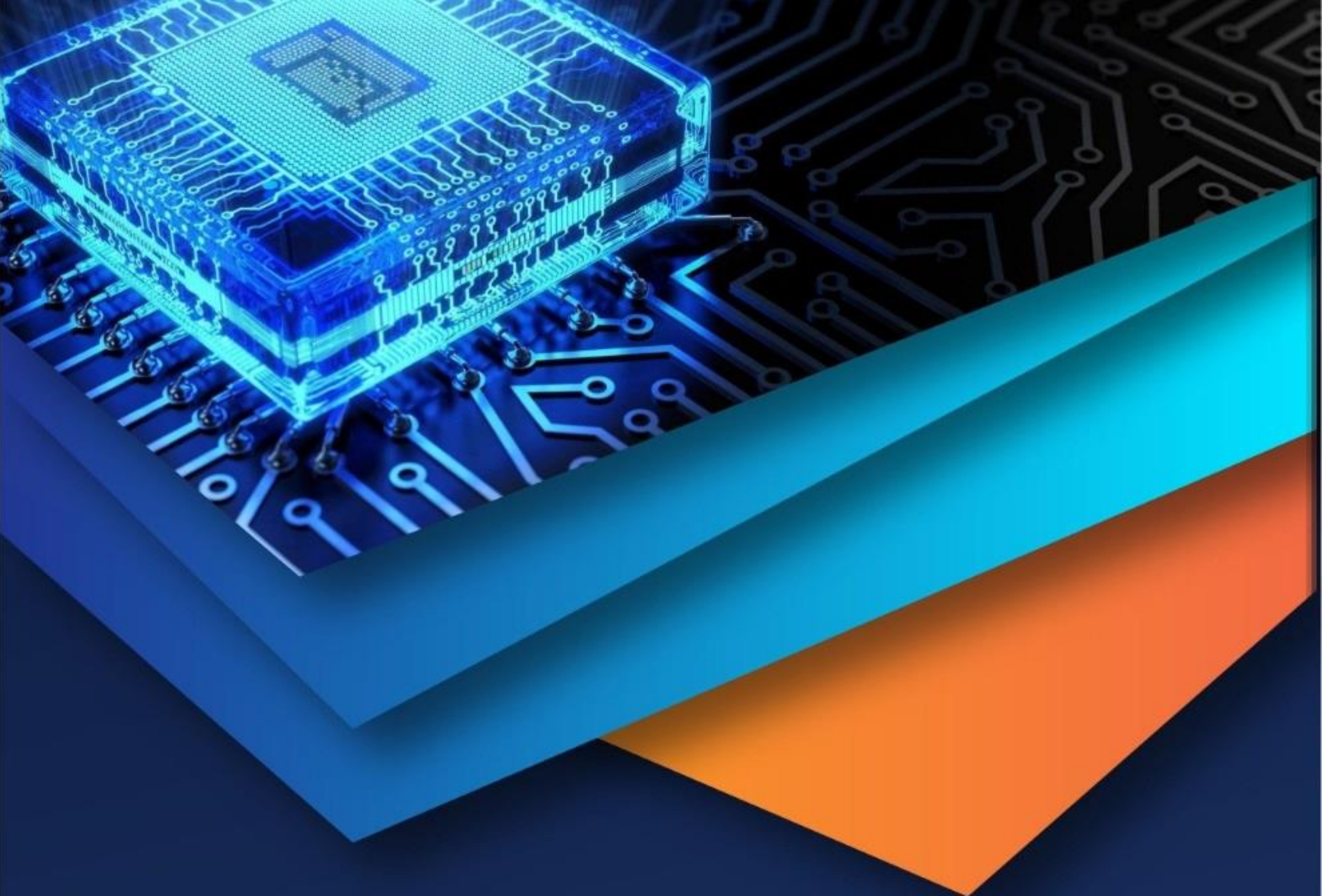

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