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A Review Article on Brain Tumor Detection and Optimization using Hybrid Classification Algorithm

Nitesh Yadav[1], Dr. Prashant Kumar Jain[2]
[1]ME (Master of Engineering), Department of Electronics and Telecommunication Jabalpur Engineering College, 482011, Jabalpur M.P., India
[2]HOD of Electronics and Communication, Department Jabalpur Engineering College, 482011, Jabalpur M.P., India

Abstract: This review focuses on different imaging techniques such as MRI. This survey identifies a different approach with better accuracy for tumor detection. This further includes the image processing method. In most applications, machine learning shows better performance than manual segmentation of the brain tumors from MRI images as it is a difficult and time-consuming task. For fast and better computational results, radiology used a different approach with MRI, CT-scan, X-ray, and PET. Furthermore, summarizing the literature, this paper also provides a critical evaluation of the surveyed literature which reveals new facets of research.
Keywords: Brain tumor, data mining techniques, filtering techniques, MRI, classifiers, feature selection.

I. INTRODUCTION

Image segmentation is the way toward parceling an advanced picture into numerous sections (sets of pixels, otherwise called super pixels). The objective of division is to disentangle as well as change the portrayal of a picture into something that is more important and simpler to investigate. Segmentation is regularly used to find articles and limits (lines, bends, and so forth.) in pictures[1]. All the more exactly, picture division is the way toward doling out a name to each pixel in a picture to such an extent that pixels with a similar mark share certain visual attributes The aftereffect of segmentation is an arrangement of fragments that on the whole cover the whole picture, or an arrangement of forms separated from the picture (see edge identification). Each of the pixels in a district is comparable as for some trademark or registered property, for example, shading, force, or surface. Neighboring areas are altogether unique regarding the same characteristic(s). At the point when connected to a pile of pictures, common in medicinal imaging, the subsequent forms after picture division can be utilized to make 3D recreations with the assistance of addition calculations like walking 3D squares [1].

II. MAGNETIC RESONANCE IMAGING (MRI)

A magnetic resonance imaging instrument or MRI Scanner [2] uses powerful magnets to polarize and excite hydrogen nuclei i.e. proton in water molecules in human tissue, producing a detectable signal which is spatially encoded, resulting in images of the body [3]. MRI mainly uses three electromagnetic fields they are:
i) A very strong static magnetic field to polarize the hydrogen nuclei, named as the static field,
ii) A weaker time varying field(s) for spatial encoding, named as the gradient field,
iii) A weak radio frequency field for manipulation of hydrogen nuclei to produce measurable signals collected through RF antenna.
The variable behaviour of protons within different tissues leads to differences in tissue appearance. The different positioning of MRI of brain with T1 and T2 weight is shown below.

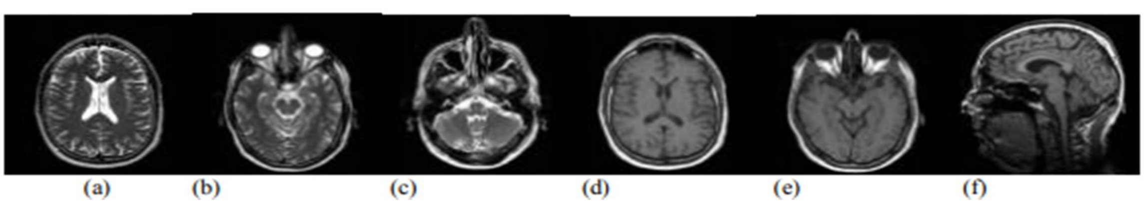

Fig. 1: MRI of brain cited by http://www.mr-tip.com/serv1.php?type=isimg. T2 weighted MR image (a) brain shows cortex, lateral ventricle, and falx cerebri, (b) brain shows eyeballs with optic nerve, medulla, vermis, and temporal lobes with hippocampal regions, (c) head shows maxillary sinus, nasal septum, clivus, inner ear, medulla, and cerebellum. T1 weighted MR image (d) brain shows cortex, white and grey matter, third and lateral venticles, putamen, frontal sinus and superior sagittal sinus, (e) brain shows eyeballs with optic nerve, medulla, vermis, and temporal lobes with hippocampal regions,(f) brain shows cortex with white and grey matter, corpus callosum, lateral ventricle, thalamus, pons and cerebellum from the same patients.

III. PREPROCESSING

Pre-processing mainly involves those operations that are normally necessarily prior to the main goal analysis and extraction of the desired information and normally geometric corrections of the original actual image. These improvements include correcting the data for irregularities and unwanted atmospheric noise, removal of non-brain element image and converting the data so they correctly reflected in the original image. Segmentation is the process of partitioning an image to several segments but the main difficulties in segmenting an images are i) Noise, ii) Blur Low Contrast, iii) The bias field (the occurrence of smoothly varying intensities within tissues) , iv) The partial-volume effect (a voxel contributes in multiple tissue types) . Image filtering and enhancement stage is the most obvious part of medical image processing. This pre-processing stage is used for reducing image noise, highlighting important portions, or displaying obvious portions of digital images [4]. Some more techniques can employ medical image processing of coherent echo signals prior to image generation and some of the images are hanging from clip hence they may produce noise. The enhancement stage includes resolution enhancement; contrast enhancement. These are used to suppress noise and imaging of spectral parameters. After this stage the medical image is converted into standard image without noise, film artefacts and labels [4,5, 6].

IV. THRESHOLD BASED SEGMENTATION

Threshold is one of the aged procedures for image segmentation. These threshold techniques are very much useful for image binarization which is very essential task for any type of segmentation. It assumes that images are composed of regions with different gray level ranges. A thresholding procedure determines an intensity value, called the threshold, which separates the desired classes [7]. There are several threshold segmentation techniques exist, among them here describe some well known and well established thresholding techniques such as Otsu method , Bernsen method, Sauvola method , Niblack method , Kapur method , Th-mean method, Iterative as frame work to all existing method, Balance Histogram [8,9,10].

V. LITERATURE REVIEW

MAISHA FARZANA, Semantic Segmentation of Brain Tumor from 3D Structural MRI Using U-Net Autoencoder: Automated semantic segmentation of brain tumors from 3D MRI images plays a significant role in medical image processing, monitoring and diagnosis. Early detection of these brain tumors is highly requisite for the treatment, diagnosis and surgical pre-planning of the anomalies. The physicians normally follow the manual way of delineation for diagnosis of tumors which is time consuming and requires too much knowledge of anatomy. To resolve these limitations, convolutional neural network (CNN) based U-Net autoencoder model is proposed which performs automated segmentation of brain tumors from 3D MRI brain images by extracting the key features of the tumor. Additionally, Image normalization, image augmentation, image binarization etc. are applied for data pre-processing. Later on, the model is applied to the new 3D MRI brain images to test the accuracy of it. Applying the proposed method, the accuracy is obtained upto 96.06% considering the 18 subjects. Finally, this approach is a well-structured model for segmenting the tumor region from MRI brain images as compare to the other existing models which may assist the physicians for better diagnosis and therefore, opening the door for more precise therapy and better treatment to the patient [1].

Afsara Mashiat, Detection of Brain Tumor and Identification of Tumor Region Using Deep Neural Network On FMRI Images: As brain is the most vital organ of the human body, the affects of brain related diseases can be severe. One of the most harmful diseases is brain tumor, which results in a very short life expectancy of the affected patient. Detection of brain tumor is a challenging task in the early stages. Still, with the help of modern technology and machine learning algorithms, it has become a matter of great interest for research. While detecting the brain tumor of an affected person, we are considering the fMRI data of the patient. Our aim is to identify whether the tumor is present in the patient's brain or not. We use a Convolutional Neural Network(CNN) that is good enough to generate high accuracy. We have used some deeper architecture design VGG16, VGG19, and Inception v3 for better accuracy. Three classification techniques are used namely binary classification, lobe based classification, and position based classification. The main contribution of our proposed work is that we have identified the specific region of the brain where the tumor is located. The region-based classification distinguishes our work from others that are applied on the same dataset [2].

Adnan Hanif, Graph Laplacian-based Tumor Segmentation and Denoising in Brain Magnetic Resonance Imaging: Brain tumor segmentation in Magnetic Resonance Imaging (MRI) scans provides vital information to radiologists in the diagnosis and staging of disease. However, these MRI scans are often corrupted with noise during its acquisition. Traditional approaches to this problem employ denoising which leads, in general, to edge smoothing and development of artifacts in MRI slices, thereby affecting tumor segmentation performance. In this paper, we employed graph signal processing (GSP) theory to first segment tumor core in each MRI slice using graph Laplacian followed by edge-aware denoising which is performed in synergy.

The paper aims to present a novel technique to tackle the two problems of segmentation and denoising both under the GSP framework. The experimental results demonstrated on simulated and clinical brain MRI datasets, show highly competitive performance both in terms of tumor core segmentation under Dice and Sensitivity measures, and in terms of edge-aware denoising under PSNR and SSIM measures [3].

Sultan B. Fayyadh, Brain Tumor Detection and Classifiaction Using CNN Algorithm and Deep Learning Techniques: Detection of brain tumors through image processing is done by using an integrated approach. This work was planned to present a system to classify and detect brain tumors using the CNN algorithm and deep learning techniques from MRI images to the most popular tumors in the world. This work was performed using an MRI image dataset as input, Preprocessing and segmentation were performed to enhance the images. Our neural network design is simpler to train and it's possible to run it on another computer because the designed algorithm requires fewer resources. The dataset was used contains 3064 images related to different tumors meningioma (708 slices), glioma (1426 slices), and pituitary tumor (930 slices), the convolution neural network (CNN) was used through which the brain tumor is classified according to a special structure of this algorithm consisting of several layers, The implementation of the neural network consist blocks each block include many types of layer, first, the input layer then followed by convolution layer, then the activation function that used was Rectified Linear Units (ReLU), normalization layer, and pooling layer. Also, it contains the classification layer fully connected and softmax layer the overall accuracy rate obtained from the proposed approach was (98,029%) in the testing stage and (98.29%) in the training stage for the data set were used [4].

Md. Akram Hossan Tuhin, Detection and 3D Visualization of Brain Tumor using Deep Learning and Polynomial Interpolation: Among different imaging techniques MRI, MRSI and CT scans are some of the widely use techniques to visualize brain structures to point out brain anomalies especially brain tumor. Identification of brain tumor accurately in clinical practices has always been a hard decision for neurologist as multiple exceptions might present in images which may lead dubious suggestion from neurologist. In our proposed model we are aiming towards brain tumor detection and 3d visualization of tumor more accurately in effcient way. Our proposed model composed of three stages such as classification of image using CNN whether any tumor exists of not; segmentation using multi-thresholding to extract the detected tumor; and 3d visualization using polynomial interpolation. the proposed model enables enhancing the accuracy of tumor detection as compare to existing models as well as segmenting and 3d visualizing the detected tumor. we get 85% accuracy on our model comparing with others which is slightly more efficient in terms of classification and detection [5].

Sajana Shresta, Advanced Cascaded Anisotropic Convolutional Neural Network Architecture Based Optimized Feature Selection Brain Tumour Segmentation and Classification: The purpose of the research is to find out how deep learning and the convolutional neural network will contribute to diagnosis, early detection and segmentation of brain tumors such as glioma, benign, malignant, etc. The aim is to achieve a higher degree of segmentation quality to resolve issues related to lack of the classification accuracy and poor performance in the segmentation and detection of tumors. The presented solution is an Advanced Cascaded Anisotropic Convolutional Neural Network (CA-CNN) architecture with an optimized feature selection method. The DFP (Data collection, feature extraction & selection and prediction) taxonomy is presented that involves data acquiring, data pre-processing, feature extraction, selection and prediction methods for effective tumor segmentation and detection. The presented system will enhance the prediction accuracy and involves the genetic algorithm for effective selection of features which prevents data redundancy and reduce the delay in the detection of tumors. The utilization of genetic algorithm minimizes the redundancy within input voxels and facilitates in the optimal selection of features which improves the classification accuracy of the solution. The research conducted is to improve the brain tumor segmentation and detection process in terms of accuracy, specificity and sensitivity using multi-scale prediction and cross-validation [6].

Milan Acharya, MRI-based Diagnosis of Brain Tumours Using a Deep Neural Network Framework: The median survival time of patients with high grade glioma, a form of brain tumour, is 1-3 years. The current best practice adopts Convolutional Neural Network (CNN) for image classification and tumour detection. This method provides a significant improvement in brain tumour segmentation of Magnetic Resonance Imaging (MRI) images in comparison to other frameworks, but it is nonetheless slow and lacks precision. We sought to build upon the current best practice model by utilising a Deep Neural Network (DNN) model, which entailed modification of the segmentation and feature-extraction stages in order to improve the accuracy of those stages and the resulting segmentation. We contrasted the accuracy and efficiency of our model to the current best practice model using 10 brain tumour patient MRI datasets. First, the segmentation accuracy of our proposed model (M= 90%) outperformed that of the current best practice (M=78%). Second, the tumour detection processing time of our proposed model (M=34 ms) also outperformed that of the current best practice (M=73 ms).

We, therefore, replicated previous studies by showing that automatic segmentation can aid in brain tumour detection. Importantly, we extended previous studies by proposing a model that classifies a brain tumour with greater accuracy and within lower processing times. Validation of the model with a larger dataset is recommended [7].

Ritu Joshi, Pixel-Level Feature Space Modeling and Brain Tumor Detection Using Machine Learning: We present a feature learning technique that enhances the performance of a machine learning technique to detect brain tumor regions at pixel-level in a magnetic resonance imaging (MRI) brain scan. This technique utilizes the image filtering based feature extraction techniques (e.g., Laplacian, Gradient, and Sobel filters) to construct a feature space. It then maps the feature space to a response set that has predefined labels (manual or automated). Feature space and the response set are constructed using a reference frame of a volumetric MRI brain scan, and then used for developing a ML model. We applied the learned models, as the automated techniques to other frames of the MRI scan for detecting tumor and non-tumor regions. We adapted the Brain Tumor Segmentation (BraTS 2015) datasets to develop and validate the proposed computational framework. We also used the ground truth labels (or response sets) delivered by the BraTS 2015 datasets. We evaluated the support vector machine (SVM), random forest (RF), and artificial neural network (ANN) models using various quantitative and qualitative measures. We determined, based on precision-recall curve, that the RF model acquired 92% of the tumor detection skills of a perfect model, while ANN and SVM acquired 90% and 88% tumor detection skills of a perfect model [8].

Deepak O. Patil, Monogenic Wavelet Phase Encoded Descriptors for Brain Tumor Image Detection: Brain tumor has a low survival rate and also affect a patient's social life. Early detection and further treatment of the abnormal growth of mass is a significant step during treatment to restrict the progression. MR image screening by the medical expert is a time-consuming and tedious task. This paper presents the development of computer-aided tool to detect brain tumor images. The proposed algorithm employs monogenic wavelet phase-encoded features for tumor detection. Phase component of the monogenic wavelet efficiently extracts the structural information from the input magnetic resonance images. The dimensionality of CLBP textural descriptors extracted from the phase component is further reduced using neighborhood component analysis feature selection. Finally, the support vector machine classifies the test magnetic resonance image as healthy or abnormal. The proposed approach is evaluated using two popular MR imaging databases and simulation results show enhanced performance compared to other existing algorithms [9].

Sneha Grampurohit, Brain Tumor Detection Using Deep Learning Models: A brain tumor is a disease caused due to the growth of abnormal cells in the brain. There are two main categories of brain tumor, they are non-cancerous (benign) brain tumor and cancerous(malignant) brain tumor. Survival rate of a tumor prone patient is difficult to predict because brain tumor is uncommon and are different types. As per the cancer research by United Kingdom, around 15 out of every 100 people with brain cancer will be able to survive for ten or more years after being diagnosed. Treatment for brain tumor depends on various factors like: the type of tumor, how abnormal the cells are and where it is in the brain etc. With the growth of Artificial Intelligence, Deep learning models are used to diagnose the brain tumor by taking the images of magnetic resonance imaging. Magnetic Resonances Imaging (MRI) is a type of scanning method that uses strong magnetic fields and radio waves to produce detailed images of the inner body. The research work carried out uses Deep learning models like convolutional neural network (CNN) model and VGG-16 architecture (built from scratch) to detect the tumor region in the scanned brain images. We have considered Brain MRI images of 253 patients, out of which 155 MRI images are tumorous and 98 of them are non-tumorous. The paper presents a comparative study of the outcomes of CNN model and VGG-16 architecture used [10].

Manu Singh, Two-level Combined Classification Technique using Ranklet Transformation for the Detection of MRI Brain Tumor: These days, medical sector plays significant role as people have become more aware towards their health issues. However, it is observed that by and large the medical analyses towards diagnosis of disease are accomplished by medical experts, which is not only a very time-consuming process but also involves subjectivity. Thus, a methodology has been proposed for the detection of the anomalies to overcome the above constraints. In this paper, we have mainly focused on brain tumor diagnosis using MRI modality. Initially, Expectation Maximization Algorithm is used for segmentation. Thereafter, for feature extraction we have implemented Ranklet Transformation. Finally, combined classification technique has been implemented in such a way that Auto-Encoder classifier is followed by Binary SVM classifier. In this paper, we have also compared our results with traditional SVM, and with the accuracy rate of 94.6% it is concluded that the performance of our proposed model is effective and robust [11].

Mohammad Omid Khairandish, The Performance of Brain Tumor Diagnosis Based on Machine Learning Techniques Evaluation - A Systematic Review: This research aims to investigate the performance of brain tumor diagnosis and treatment using machine learning algorithms. This study provides systematic review of papers on the improvement of human life. The papers reviewed are taken from relevant articles published between October 2012 and December 2019. The investigation is done against the algorithm type, dataset, the proposed model, and the performance in each of the papers.

The accuracy result among the papers papers studied is ranged between 79% - 97.7%. The algorithms they used are CNN, KNN, C-means, RF, respectively, ordered from the highest frequency of use to the lowest. In the papers studied, it was shown that various methods had been used with good results. However, the confidence in the research results in term of accuracy for the detection of brain tumors still needs to be increased. Furthermore, building a software applications can be very useful to solve real cases [12].

Ahmad Saleh, Brain Tumor Classification Using Deep Learning: Brain tumor is a very common and destructive malignant tumor disease that leads to a shorter life if it is not diagnosed early enough. Brain tumor classification is a very critical step after detection of the tumor to be able to attain an effective treatment plan. This research paper aims to increase the level and efficiency of MRI machines in classifying brain tumors and identifying their types, using AI Algorithm, CNN and Deep Learning. We have trained our brain tumor dataset using five pre-trained models: Xception, ResNet50, InceptionV3, VGG16, and MobileNet. The F1-scores measure of unseen images were 98.75%, 98.50%, 98.00%, 97.50%, and 97.25% respectively. These accuracies have a positive impact on early detection of tumors before the tumor causes physical side effects, such as paralysis and others disabilities [13].

Ravindra Sugdeo Sonavane, Classification of MRI Brain Tumor and Mammogram Images using Adaboost and Learning Vector Quantization Neural Network: Classification and accurate detection of brain tumor using MRI is essential for purpose of treatment and diagnosis of tumor. In this paper we propose and developed system using four stages namely image normalization, Image Binarization with morphological operation, Anisotropic Diffusion filtering and feature extraction using GLCM. The system evaluated on two types of database, Clinical Brain MRI Images and Digital Database for Screening Mammogram (DDSM). Normalization is process of contrast stretching which changes value of pixel intensity and Image Binarization is processing of Grey scale image into black and white image by fixing threshold level of pixel. If value of pixel above the threshold level is white either Black followed by steps of morphological operation i.e. Erosion and Dilation by processing MRI images. Apart from that anisotropic diffusion (ADF) is applied for detection and sharpen the edge detection. Features taken or extracted by using GLCM from filtered MR images. In the stage of classification, two Neural Networks have been implemented. The first Neural Network is Adaboost NN is based on boosting method which yields classification accurately and the second neural network, LVQ is feed forward network which uses Quantization machine learning algorithm and Lossy compression techniques. The extracted features hence given to train Neural Network for classification. Accuracy with success has been obtain 95% and 80.6% for Clinical Brain MRI images with 79.3% and 69.9% for DDSM [14].

Gajendra Raut, Deep Learning Approach for Brain Tumor Detection and Segmentation: Brain tumor is a serious health condition which can be fatal if not treated on time. Hence it becomes necessary to detect the tumor in initial stages for planning treatment at the earliest. In this paper we have proposed a CNN model for detection of brain tumor. Firstly brain MRI images are augmented to generate sufficient data for deep learning. The images are then pre-processed to remove noise and make images suitable for further steps. The proposed system is trained with pre-processed MRI brain images that classifies newly input image as tumorous or normal based on features extracted during training. Back propagation is used while training to minimize the error and generate more accurate results. Autoencoders are used to generated image which removes irrelevant features and further tumor region is segmented using K-Means algorithm which is a unsupervised learning method [15].

VI. SCOPE OF COMPARATIVE STUDY

Brain Tumor detection techniques are integrated with digital image processing and it has found to be challenging task in medical research. Scope of comparative study is to improve accuracy of brain tumor detection. This paper has presented a review on various brain tumor detection techniques. There are four main techniques for brain tumour detection as given follows:

1) Tumor Detection Using Active Contour: The system depends on dynamic forms advancing in time as indicated by natural geometric measures of the picture. The advancing forms actually split and union, permitting the synchronous recognition of a few items and both inside and outside limits. This approach depends on the connection between dynamic forms and the calculation of geodesics or negligible separation bends [11, 12].
2) Based on Region Growing Region developing is a straightforward district based picture division technique. It is additionally delegated a pixel-based picture division strategy since it includes the choice of beginning seed focuses. This way to deal with division looks at neighboring pixels of beginning "seed focuses" and figures out if the pixel neighbors ought to be added to the area. The procedure is iterated on, in an indistinguishable way from general information grouping calculations [13].

VII. CONCLUSION

This paper has presented a comparison between some well known brain tumor detection techniques. Recent method which utilized was K-means clustering technique integrated with NN algorithm and it gave better results as comparison to others. The review has clearly shown that each technique has its own benefits and limitations as well. . In near future, brain tumor detection will be improved further using decision based alpha trimmed filter which can give more better results.

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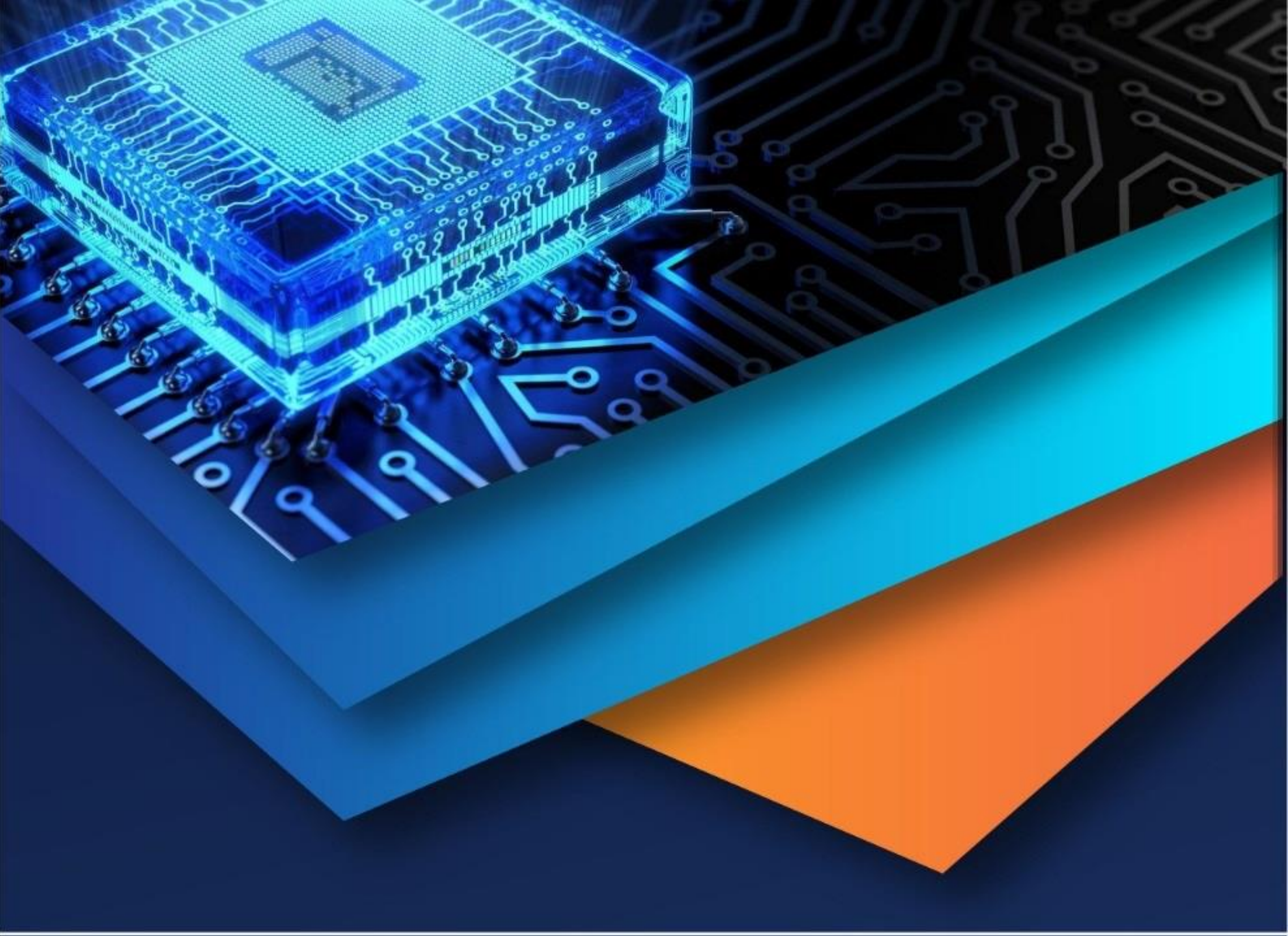

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