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Disease Diagnostic System Using Deep Learning

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Abstract: Early disease detection cannot be neglected in the healthcare domain and especially in the diseases where a person's life is at stake. According to the WHO, if the diseases are predicted on time, then the death rates could reduce. The paper's goal is to find out how to detect Breast Cancer, Skin Cancer, Lung Cancer, and Brain Tumor at the early stages with the help of Deep Learning techniques. The authors of different papers have used different techniques and Algorithms like Adaptive Median Filters, Gaussian Filters, CNN algorithms, etc.
Keywords: Breast Cancer, Skin Cancer, Brain Tumor, Lung Cancer, Deep Learning, CNN, SVM, Random Forest.

I. INTRODUCTION

In the medical sector, it is important to detect deadly diseases at the earliest possible stage to prevent deaths. The objective is to detect these diseases at the earliest stage possible with the help of different Deep Learning models. The diseases which we will be covering in our paper will be Breast Cancer, Lung Cancer, Skin Cancer, and Brain Tumour. As we all know, all these diseases are very much contributing to the increasing death rates, so our main aim is to decrease the death rates by predicting the same.

A. Breast Cancer

Breast Cancer is a disease disorder wherein the cells get obstinately enormous. Different types of breast cancers are there, which are determined by the type of cells in the affected area of the breast. Breast cancer can start in a variety of places in the breast. Ducts, Connective tissues, and lobules are the main and primary components of the breast. Lobules are the glands which produce the milk. The tubes which carry milk are known as ducts. Fatty tissue and fibrous tissues are present in connective tissue, which holds everything in place. Breast cancer initiates mainly from the lobules and ducts. This disease can expand to other parts of the body through lymph vessels and blood. It is metastasized when it expands to other regions.

B. Skin Cancer

Skin cancer is a condition in which the cells of the skin develop abnormally. It usually appears in locations that are exposed to the sun, but it can also appear in areas that are not generally exposed to the sun. The sun's harmful ultraviolet (UV) radiation and the usage of UV tanning beds are the two main causes of skin cancer. If the skin cancer is detected at the early stage, it can be treated with little or no scarring and a high chance of being completely removed. The doctor may even notice the development at a precancerous stage before it develops into full-fledged skin cancer or has entered the below. The most prevalent indicator of skin cancer is a change in your skin. This could be new growth, an unhealed sore, or a mole that has changed. Not all skin malignancies have the same appearance.

C. Brain Tumor

One of the most challenging jobs in medical image processing is detecting brain tumors. The job is tough to complete since the images have a lot of variety, as brain tumors appear in a variety of forms and textures. Brain tumors are made up of many types of cells, and the cells can reveal information about the tumor's origin, severity, and rarity. Tumors may appear in a variety of areas, and the location of a tumor can reveal information about the sort of cells that are generating it, which can help with further diagnosis.

D. Lung Cancer

A disease in the lungs where the cells grow uncontrollably immense is called Lung Cancer. Lung cancer initiates from the lung itself. Lung Cancer from the lungs can also expand to the other body organs. Cancer that has progressed to other organs can potentially spread to the lungs. Small cell and non-small cell lung tumors are the two most common kinds of lung cancer. These kinds of lung cancer grow and respond to treatment in different ways. Compared to small cell lung cancer, non-small cell lung

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cancer is more prevalent. Lungs cancer is more common in smokers. It is caused by smoking, secondhand smoke, exposure to specific chemicals, and a family history of the disease.

II. LITERATURE REVIEW

PAPER TITLE	AUTHOR	DISEASE	Features/ Dataset used	ALGO/ TECHNIQUE	RESULTS	REMARKS
Automatic Breast Cancer Detection Using Digital Thermal Images	Ola O. Soliman, Nasser H. Sweilam, Doaa M. Shawky	BREAST CANCER	Pixel temperature, MRF-based probable texture feature,	Neural network classifier, Hough transformation , Median filter, Canny edge detector, Gaussian smoothing filter, Gray-Level Co-occurrence Matrices (GLCM),	Success rate is 96.51%, Sensitivity Is 79.7%, Specificity Is 98.25%	In this paper they have used thermal images to detect breast cancer. The aim of this study is to develop an efficient system to detect breast cancer by using image processing techniques. The proposed system extracts the characteristic features of the breast from the region of interest that is segmented using a novel approach from the thermal input image. Then the image is classified based on these features to normal or abnormal using a neural network classifier.
Breast Cancer Detection from Histopathological Images Using Deep Learning	Naresh Khuriwal, Nidhi Mishra	BREAST CANCER	DATASET- MIAS Database, FEATURES- Catchment basins, watershed ridge lines	convolutional neural network, Watershed Segmentation, Colour based segmentation, Adaptive Mean Filters, median filter and histogram	Accuracy 98%	This paper is divided in three parts: first they have collected a dataset and applied a pre-processing algorithm for scaled and filtered data then they have split the dataset for training and testing purposes and generated some graphs for visualization data. In
Image Processing for Early Diagnosis of Breast Cancer Using Infrared Images	Pragati Kapoor, Dr. S.V.A.V. Prasad	BREAST CANCER	Heat patterns- skewness, temperature variation and kurtosis	Edge detection, Canny edge detector, Gaussian function and Hough transform	This paper only proposes the model and how we can detect breast cancer.	Infrared thermal imaging or thermography is a promising screening tool as it is able to warn women of breast cancer ten years in advance. The approach outlined includes the following steps: 1) Edge Detection to extract the boundaries of the breasts. 2) Hough transforms to extract the lower breast boundaries. 3) Classify each segmented pixel into a certain number of clusters. 4) Diagnose the breast diseases based on asymmetric analysing of the pixels in every cluster.

Research on the Detection Method of Breast Cancer Deep Convolutional Neural Network Based on Computer Aid	Mengfan Li	BREAST CANCER	Dataset- breast cancer image data set, BCDR-F03	Convolutional neural network, image median filtering, histogram equalization, support vector machine, KNN, Random Forest.	Accuracy- 89%	This study is mainly based on the design of deep learning algorithm for tumour benign and malignant classification based on three-dimensional breast ultrasound data, and focuses on the impact of adjusting the convolutional neural network structure to integrate multiple information on classification performance. Combining the characteristics of different information and the flexibility of using the CNN model, it is proved that the use of convolutional neural network for multi-information fusion is an effective fusion method, which eliminates the steps of artificially designing fusion methods and improves classification efficiency and accuracy
Segmentation of Breast Using Ultrasound Image for Detection Breast Cancer	Uswatun Khasana, Riyanto Sigit, Heny Yuniarti	BREAST CANCER	FEATURES- size, location, type of lump in the breast	watershed transform algorithm, thresholding binaries, median high boost filter.	Accuracy- 88.65%	In this research, a segmentation method is proposed to be used to detect an object in the area where the ultrasound test results are drawn using the Watershed Transform algorithm method.
Automatically Early Detection of Skin Cancer: Study Based on Nueral Netwok Classification	Ho Tak Lau, Adel Al-Jumaily	SKIN CANCER	The image databases are collected from Sydney Melanoma Diagnostic Centre in Royal Prince Alfred Hospital and internet website	Back-propagation neural network, support vector machine, Karhunen-Loève (KL) transform histogram equalization, median filter, segmentation, Wavelet decomposition Auto-associative neural network (AANN)	BNN accuracy- 89.9% AANN Accuracy- 80.8%	In this paper, an automatically skin cancer classification system is developed and the relationship of skin cancer image across different type of neural network are studied with different types of pre-processing. The collected images are feed into the system, and across different image processing procedure to enhance the image properties. Then the normal skin is removed from the skin affected area and the cancer cell is left in the image. Recognition accuracy of the 3- layers back-propagation neural network classifier is 89.9% and auto-associative neural network is 80.8%

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Early Detection of Skin Cancer Using Deep Learning Architectures: Resnet-101 and Inception-v3	Ahmet DEMİR and Feyza YILMAZ, Onur Köse	SKIN CANCER	Dataset- ISIC-Archive FEATURES- lesions' geometry, color, and tissue features	ResNet-101 and Inception-v3	accuracy rate of 84.09% is get in ResNet-101, and accuracy rate of 87.42% is get in Inception-v3	In this study, they showed that two different deep learning methods can be used to diagnose skin cancer with high accuracy rates. According to the results, accuracy value obtained in Resnet-101 model is 84.09%, and accuracy value obtained in Inception-v3 model is 87.42%. The results show that the classification performance with Inception-v3 model is better than the classification performance with ResNet-101 model
Effect of Color Enhancement on Early Detection of Skin Cancer using Convolutional Neural Network	Agung W. Setiawan	SKIN CANCER	DATASET- ISIC archive 2019	CLAHE, MSRCR, CNN	Accuracy- 85%	In this study, there is no hand-crafted of image processing technique except color image enhancement using CLAHE and MSRCR. Using these approaches, it is expected that the results of this study can examine the role of image enhancement using CLAHE and MSRCR in the early detection of skin cancer using CNN.
Skin Cancer Detection using Machine Learning Techniques	Vidya M, Dr. Maya V Karki	SKIN CANCER	DATASET- International Skin Imaging Collaboration (ISIC)	GLCM, HOG, Geodesic Active Contour (GAC), ABCD scoring method, SVM, KNN and Naïve Bayes classifier, median filtering, bottom hat filtering,	Accuracy- SVM- 97.8% KNN- Sensitivity- 86.2% Specificity- 85% Naïve Bayes- 76%	In this paper, hybrid feature extraction has been used to classify skin lesion either as benign or melanoma. Automatic detection of skin lesion with ABCD rule, GLCM and HOG for feature extraction and classification using machine learning techniques. GAC method was proposed for segmentation of the skin lesion. For color, symmetry and diameter of skin lesion ABCD rule, texture of skin lesion GLCM and shape, edge of skin lesion HOG was proposed for feature extraction. Different machine learning techniques such as SVM, KNN and Naïve Bayes was proposed to address the classification.

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Skin Disease detection based on different Segmentation Techniques	Kyamelia Roy, Sheli Sinha Chaudhuri, Sanjana Ghosh, Swarna Kamal Dutta, Proggya Chakraborty Rudradeep Sarkar	SKIN DISEASE	Edge detection, clusters	adaptive thresholding, edge detection, K-means, clustering morphology-based image segmentation, deblurring, noise reduction	In case of chicken pox adaptive thresholding is the best method. For eczema k-means clustering is the best method. Morphology based segmentation is the best method for detecting psoriasis.	In this paper, they performed four segmentation techniques on certain skin diseases namely- eczema, psoriasis, chicken pox and ringworm, intending to be informative regarding the detailed information relative to the images. The proposed method improves the segmentation using OpenCV with the help of python in separating the image on the basis of edge detection or region detection. For the four different disease images, four segmentation techniques are used and the resultant images are produced on the basis of Signal to Noise Ratio. The segmentation techniques show promising results differently for the four categories of diseases
Brain Tumor Detection using Deep Learning and Image Processing	Aryan Methil	BRAIN TUMOUR	The experimental study was carried on a dataset with different tumour shapes, sizes, textures, and locations. DATASET "no_tumor" in the original dataset on Kaggle.	Convolutional neural network (CNN)	Accuracy of 97.94% training recall of 98.55 % and validation recall of 99.73%.	Convolutional Neural Network (CNN) was employed for the task of classification. Detection of brain tumours from various brain images by first carrying out different image pre-processing methods ie. Histogram equalization and opening which was followed by a convolutional neural network.
Image Analysis for MRI Based Brain Tumor Detection and Feature Extraction Using Biologically Inspired BWT and SVM	Nilesh Bhaskarrao Bahadure,Arun Kumar Ray,and Har Pal Thethi	BRAIN TUMOUR	Magnetic resonance (MR) image dataset	Berkeley wavelet transformation (BWT) and support vector machine (SVM)	96.51% accuracy	This paper has a combination of biologically inspired Berkeley wavelet transformation (BWT) and SVM extracted information from the segmented tumour region and classify healthy and infected tumour tissues for a large database of medical images. **Concludes that the proposed method is suitable to integrate clinical decision support systems for primary screening and diagnosis by the radiologists or clinical experts.**

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A Survey on Brain Tumor Detection Using Image Processing Techniques	Luxit Kapoor	BRAIN TUMOR	CT scans, X-Ray and MRI datasets, Image Processing, Segmentation, Filtering Techniques, Tumor Detection	Fuzzy C Means, K Means and Level Set Techniques Region Based, Threshold Based Segmentation	In Threshold Based Segmentation Cannot be used for images with poor contrast or images with a lot of background and foreground artifacts, in Region Based Noise may lead to undesired artifacts in final result, in fuzzy sets Sample selection and establishing fuzzy sets may be tedious	This paper surveys the various techniques that are part of Medical image Processing and are prominently used in discovering brain tumors from MRI Images. At first the various methods that are currently used in medical image processing were extensively studied. This involved studying the available research. Based on that research this papers was written listing the various techniques in use. A brief description of each technique is also provided. Also of all the various steps involved in the process of detecting tumors, Segmentation is the most significant and propitious.
Image Processing Techniques for Brain Tumor Detection: A Review	Vipin Y. Borole1, Sunil S. Nimbhore2, Dr. Seema S. Kawthekar	BRAIN TUMOR	MRI Image dataset	Median Filtering for Noise Removal, Various De-noising Filters,	MRI Image provides better results than CT, Ultrasound, and X-ray.	In this paper, Digital Image Processing Techniques are important for brain tumor detection by MRI images. The
				4Edge DetectionActiv e contour method Watersheds Method Threshold method Seed region growing Marker based Watershed		preprocessing techniques include different methods like Filtering, Contrast enhancement, Edge detection is used for image smoothing. The preprocessed images are used for post processing operations like; threshold, histogram, segmentation and morphological, which is used to enhance the images.
Brain tumor detection based on multi-paramet er MRI image analysis	Rajeev Ratan A, Sanjay Sharma B, S. K. Sharma C	BRAIN TUMOR	MRI Dataset , Brain tumor, Magnetic resonance Imaging (MRI), Image segmentation, watershed segmentation, MATLAB.	2D & 3D MRI Data and MATLAB	Total approximate volume of tumor of data set 1 comes out to be 4075.65 mm3 (4.07565 cm3), Total approximate volume of tumor of data set 2 comes out to be 1072.60 mm3 (1.0726 cm3).	This paper proves that methods aimed at general purpose segmentation tools in medical imaging can be used for automatic segmentation of brain tumors. The quality of the segmentation was similar to manual segmentation and will speed up segmentation in operative imaging.

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Automatic Lung Cancer Prediction from Chest X-ray Images Using the Deep Learning Approach	Worawate Ausawalaithong, Sanparith Marukatat, Arjaree Thirach, Theerawit Wilaiprasitporn	Lung Cancer	JSRT (Japanese Society of Radiological Technology) dataset, ChestX-ray14 Dataset	Data preparation, CNN architecture and transfer learning, Loss and Optimizer, Class Activation Mappings (CAMs)	**ChestX-ray14:** Accuracy 84.02% Specificity 85.34% Sensitivity 82.71% **JSRT** Accuracy 65.51 ± 7.67% Specificity 80.95 ± 20.59% Sensitivity 45.67 ± 21.36% **ChestX-ray14 and JSRT** Accuracy 74.43 ± 6.01% Specificity 74.96 ± 9.85% Sensitivity 74.68 ± 15.33%	This paper explored the performance of a densely connected neural network in detecting lung cancer from chest x-ray scans. Because the dataset was too small to train the deep convolutional neural network, a way for training it with a very small dataset was proposed. As a result, the mean accuracy and sensitivity were higher, but the mean specificity was lower, and the standard deviation was lower. The region used to categorise photos was depicted using CAMs in Model C, displaying relatively accurate lung cancer spots, while some were not due to the overfit problem. The CAMs from the Retrained Model B, on the other hand, were significantly worse. Therefore, it can be concluded that the proposed method can solve the problem of a small dataset.
Deep Learning Algorithm for Classification and Prediction of Lung Cancer using CT Scan Images	Diksha Mhaske, Kannan Rajeswari, Ruchita Tekade	Lung Cancer	Lung Image Database Consortium image collection (LIDC-IDRI) consists of lung cancer screening thoracic CT scans. 1018 helical thoracic CT scans of 1010 different patients.	Deep Learning, Convolutional Neural Network, Recurrent Neural Network and Long Short Term Memory.	Accuracy 97%	In this paper they proposed a hybrid CNN-LSTM model for lung cancer detection. It starts with accepting CT images then pre-processed and segmented. At last classification is done by using CNN-LSTM algorithm. The main aim of this paper is to improve the accuracy of the prediction systems which they achieved by the accuracy of 97%.

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Lung Cancer Detection and Classification Using Deep Learning	Ruchita Tekade, Prof. Dr. K. Rajeshwari	Lung Cancer	Lung Image Database Consortium and Image Database Resource Initiative (LIDC-IDRI), Data Science Bowl 2017, LUNA 16	Deep Learning Architectures , CNN, Image Processing, Computer Tomography (CT), U-Net, 3D Multipath VGG like network	**Accuracy** 95.66%, **Loss** 0.09 **Dice coefficient** 90% **Log loss** 38%	The aim of this paper is to improve efficiency of lung nodule detection and malignancy level prediction using lung CT scan images. The lung CT scan images from LUNA 16 and Data Science Bowl 2017 are used and labels from all three datasets are used. Segmentation of lung nodules is done over Data Science Bowl 2017 dataset. The predictions from both the approaches are combined and test set is predicted over all the models. Here, the Artificial Neural Networks plays very important role in better analysing the dataset, extracting features and classification. They used mainly two architectures where U-Net architecture is used for segmentation of lung nodules from lung CT scan images and proposed 3D multipath VGG-like architecture for classifying lung nodules and predict malignancy level. This is mainly useful for predicting the patient whether have the cancer in next two years or not.

III. DATASETS

Datasets that different authors have used for different diseases are as follows-

1) *Breast Cancer:* MIAS Database, breast cancer image data set, BCDR-F03
2) *Skin Cancer:* Databases are collected from Sydney Melanoma Diagnostic Centre in Royal Prince Alfred Hospital and internet website, ISIC-Archive 2019.
3) *Brain Tumour:* No_tumor, Magnetic resonance imaging (MRI)
4) *Lung Cancer:* JSRT (Japanese Society of Radiological Technology) dataset consists of Chest X-ray 14 Dataset, Lung Image Database Consortium image collection (LIDC-IDRI) consists of lung cancer screening thoracic CT scans (1018 helical thoracic CT scans of 1010 different patients) and Data Science Bowl 2017, LUNA 16.

IV. SYSTEM ANALYSIS

A. *Methodology*

1) *Input Layer:* The dataset is provided to the input layer, which consists of thermal infrared, ultrasound, MRI, X-ray, CT scan, and Histopathological images of patients in DICOM format, which should be converted into jpg format.

a) *Pre-processing:* After taking the input image to the model, we will pre-process the image by applying different pre-processing techniques such as Segmentation, image resizing, conversion into a grayscale image, etc., to remove noise. These images are further converted to a grayscale image.

b) *Feature Extraction:* Once the image pre-processing is done, the model will extract features from the images by using different feature extraction techniques such as Adaptive median filters, Gaussian Smoothing filters, hough transformation, canny edge detectors, HOG, etc.

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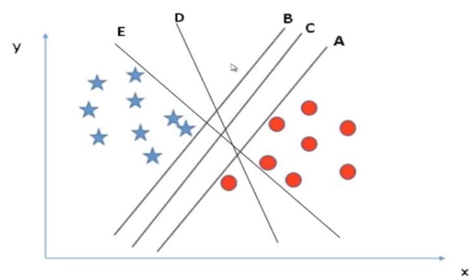
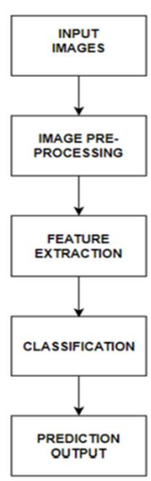
c) *Classification:* Now the image is ready for training and classification. The model will be trained with the help of deep learning algorithms such as CNN. It will do this classification with the help of some classification algorithms such as CNN, SVM, or Random Forest. CNN or Convolutional Neural Network is another sort of Artificial Neural Network or ANN used in image recognition and processing designed to process pixel data. CNN also has learnable parameters like neural networks, i.e., weights, biases, etc. A convolutional layer in CNN converts segmented pictures to feature maps. This is accomplished by convolution, which is defined as the sum of the dot products of two functions after one has been shifted and reversed. The segmented input images are filtered using a kernel filter, and the feature maps are generated from the convolved output. A-Max Pooling Layer is utilized in feature map downsampling by taking the maximum value from a tiny window length map. The CNN -LSTM's LSTM layer is the last one. The main goal of the LSTM network is to map the features retrieved from the preceding layer to their correct classification. The softmax activation function is used to sort the retrieved characteristics into categories. Random forest is a classification algorithm that is supervised that is commonly used to solve regression and classification tasks. It creates decision trees from various samples, using the majority of votes for classifications and the averaging for prediction. The bagging approach in Random Forest generates various training set from sample data sets with substitution, and the outcome is based on the majority of votes, which is then used to improve the overall result by combining learning models. In simple words, random forest combines multiple decision trees to produce much more reliable and accurate results based on Averaging and Majority Voting for regression and classification, respectively. Support Vector Machine (SVM) is a supervised type of ML algorithm used to solve issues like classification and regression. It transforms the data using a method known as the kernel trick and then calculates an optimum boundary between the potential outputs based on these transformations. The input space is converted into a featured space where the data points are divided by a hyperplane.



Hyper Plane C has a sufficient margin on the left as well as the right side, which makes it more robust for the new data points that might appear in the future. The output is generated by the activation function using a sigmoid kernel.

2) *Output:* After predicting whether the image is infected or not, our model will fetch the result for the user. The final outcome is given as a class or label, such as normal or malignant.

B. *Flow Of The Proposed System*



The deep learning model starts with taking the input image in the model. After taking the input image to the model, we will pre-process that image by applying different pre-processing techniques such as Segmentation, image resizing, conversion into a grayscale image, etc. Once the image pre-processing is done, the model will extract features from the images by using different feature extraction techniques such as Adaptive median filters, Gaussian Smoothing filters, Hough transformation, canny edge detectors, HOG, etc. Now the image is ready for training and classification. The model will be trained with the help of deep learning algorithms such as CNN. It will do this classification with the help of some classification algorithms such as CNN, SVM, or Random Forest. After predicting whether the image is infected or not, our model will give the result to the user.

C. Result

Several models are proposed for detecting Breast Cancer, Skin Disease, and Brain Tumor. The best accuracy achieved for the detection of Breast Cancer is about 96.51% with a sensitivity of 79.7% and Specificity 98.25%, then for Skin Disease using SVM is about 97.8%, and for Brain Tumor, it's the accuracy of 97.94% with training recall of 98.55 % and validation recall of 99.73%.

V. CONCLUSION

Preventing is always preferable to cure. If we find out the deadly diseases at the early stages, then they can be cured beforehand without worrying about severities and complexities. For this, we have selected four different types of diseases, which are Breast Cancer, Lung Cancer, Skin Cancer, and Brain Tumour. We have gone through numerous papers on deep learning to find out different algorithms and methods for the same. After extensive research, it is found that most of them are using CNN, Adaptive median filters, Canny edge detection, and Segmentation for the detection and classification of the diseases.

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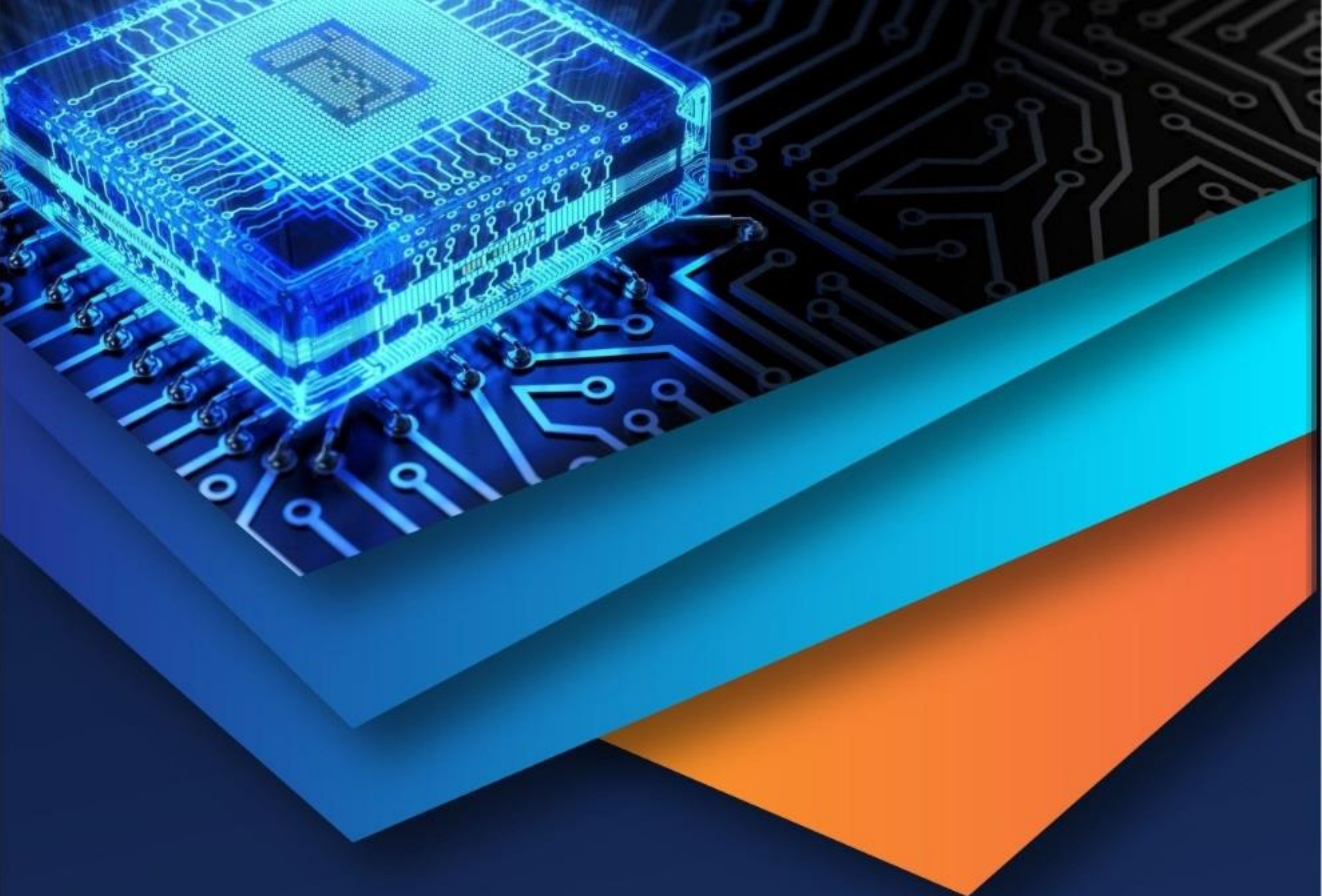

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