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Melanoma Detection using Deep Learning Algorithms

Adithya B S[1] , Dr. Sankhya N Nayak[2], Amrutha V M[3] ,Gowri J Hiremath[4] , Rachana K P[5]
[1, 3, 4, 5]Research Scholar, [2]Associate Prof., Dept. of CS&E, JNNCE, Shimoga, India

Abstract: Melanoma is a type of skin cancer that arises from pigment-producing cells called melanocytes. These cells are responsible for the production of melanin, the pigment that gives skin, hair and eyes their color. Melanoma is considered more dangerous than other types of cancer because it can spread (metastasize) to other parts of the body. Key features of melanoma include the formation of abnormal or cancerous cells in the skin pigment. The main cause of melanoma is exposure to ultraviolet (UV) radiation from the sun or tanning beds. Most malignant tumours can be treated if diagnosed early. Therefore, early diagnosis of skin cancer is important to save the lives of patients. With today's technology, skin cancer can be diagnosed early and treated effectively. The traditional method of detecting melanoma relies on eye exams where dermatologists review biopsy results, which is time-consuming. These facilities are less available in rural areas where doctors are often available but dermatologists are not. This study was designed to develop a system that uses deep learning techniques to identify melanoma.

I. INTRODUCTION

Melanoma is a serious tumour that forms in melanocytes and creates significant problems for dermatologists due to its potential to spread and nuances in the skin. Early diagnosis is critical to improving survival, and computer vision screening offers promising solutions. This specification involves several important steps: collection of skin images, segmentation to separate the disease from surrounding tissue, extraction of characteristic features of the lesions, and classification based on these features. Segmentation or border detection is particularly important because it outlines the boundaries of the lesion so that it is easy to determine the truth. By using computer vision technologies such as imaging and machine learning, doctors can improve early detection and treatment of melanoma, which can save lives. A tongue-in-cheek sign to pay particular attention to is a change in the mole's face, especially a change in size, shape, color, or texture. Unlike normal moles, melanomas often show an asymmetric shape and irregular borders. It's also important that they showcase a variety of colors rather than just one shade of brown, or so they think.

The main purpose of this study is to predict the presence of melanoma using deep learning CNN to investigate various preliminary processes and changes in the CNN to achieve the accuracy of the benefits, or so they think.

Ms. Gaana M et al. (March 2019) [1] published “Diagnosis of skin cancer Melanoma using Machine Learning”. This work introduces some methodology and the techniques used in detecting the melanoma where data is the dermatoscopic images which are captured through a regular camera. The algorithm employed combines machine learning techniques with image processing for the detection of skin cancer. The SVM algorithm is used which was found to be most effective for detecting cancer due to its minimal disadvantages! The conclusion ss that the neural network technique is considered the best among the existing systems, by utilizing machine learning algorithms with minimal human intervention, the system can provide better and more reliable results, ultimately aiding in the early diagnosis of skin cancer!

GS Gopika Krishnan et al. (March 2023) [2] published, “Skin cancer detection using Machine Learning”. The dataset used in the research for skin cancer detection is from the ISIC (International Skin Image Collaboration) dataset. This dataset contains approximately 23,000 images of melanoma skin cancer. The algorithms used includes Back Propagation Algorithm for training multi-layer perceptron’s in Neural Networks; Support Vector Machine (SVM) for classifying data into different classes based on a decision boundary and Convolutional Neural Networks for image classification tasks.

The methodology involves three main phases. Phase 1 - Pre-processing where images are collected from the ISIC dataset and performing pre-processing tasks such as removing hair, glare, and shading to enhance the efficiency of identifying texture, color, size, and shape parameters; Phase 2 - Segmentation and Feature Extraction where Three segmentation methods (Otsu, Modified Otsu, and Watershed) were utilized to segment the images and extract features related to color, shape, size, and texture; and Phase 3 - Model Design and Training where the researchers designed and trained the model using the Back Propagation Algorithm, Support Vector Machine, and Convolutional Neural Networks.

The accuracy of the model in classifying malignant and benign skin cancer images was reported to be 85%. The accuracy of the classifier can be increased using methods like Data Augmentation, Feature Engineering, Hyperparameter Tuning, Regularization.

Yinhao Wu, Bin Chen et al. (July 2022) [3] published "Skin cancer classification on deep learning: a systematic review". Here Derm7pt Dataset, BCN20000 Dataset and ISIC Dataset are used. The procedure involves collecting of several skin legion images from Derm7pt , BCN20000 and ISIC datasets. Next deep learning algorithms, such as Convolutional Neural Networks (CNNs) like ResNet, MobileNet, and SqueezeNet are applied to automatically learn features from the images; and classify different types of skin lesions. Transfer learning methods, including fine-tuning and data augmentation, are utilized to enhance model performance. Techniques like ensemble learning, attention mechanisms, and knowledge distillation are employed to optimize model efficiency and accuracy. The models are trained and evaluated on the datasets to measure their classification performance, with reported accuracies ranging from 0.9209 to 0.934, on specific datasets. The study concludes by highlighting the importance of addressing challenges like data imbalance, model robustness, and efficiency; and suggests future research directions to improve skin cancer classification algorithms.

Chandran Kaushik Viknesh, Palanisamy Nirmal Kumar et al. (2023) [4] proposed "Detection and Classification of Melanoma skin cancer using Image Processing Techniques". This study suggests two methods for detecting melanoma skin cancer using image data: one based on convolutional neural networks (CNNs) and another utilizing support vector machines (SVMs with a default RBF kernel. CNNs like AlexNet, LeNet, and VGG-16 are employed for the first method, while SVMs are utilized in the second. Both methods go through data preprocessing, segmentation, feature extraction, and classification stages. The results suggest high accuracy rates for both CNN and SVM models in diagnosing melanoma. Also, the study explores the practical implementation of CNN models in web and mobile applications through Django and Android Studio, suggesting real-world deployment potential. Model interpretability is addressed utilizing Grad-CAM techniques to enhance transparency and reliability in predictions. Overall, the research offers a comprehensive approach to early melanoma detection, leveraging advanced image processing, artificial intelligence, and machine learning!

Dheiver Santos (2022) [5] hath proposed "Melanoma Skin Cancer Detection using Deep Learning". This study utilized a dataset of 2357 images from the International Skin Imaging Association (ISIC), focusing on melanomas and moles. Various AI algorithms, including artificial neural networks (ANN), with image processing are employed in a three-phase model: data collection and augmentation, model development, and prediction. Imaging tests aid in lesion localization and cancer staging. The proposed neural network is trained using Adam optimization with a learning rate of 2e-4; 100 epochs; dropout optimization of 0.5; and a batch size of 32. The object is to classify cancer images from the ISIC database. Deep learning' with different layers achieved a test dataset classification accuracy of 89%. This research highlights the potential o AI techniques in analyzing' medical images for skin cancer diagnosis, contributing' to advancements in computer science research in this domain."

Mario Fernando Jojoa Acosta et al. (2021) [6] recently released a study titled, "Melanoma diagnosis using deep learning techniques on dermatoscopic images." The research team introduces an automatic classification method for cutaneous lesions in digital dermatoscopic images, aimed at identifying the presence of melanoma. The method is divided into two main stages.

1) *Stage 1:* Utilizing Mask R-CNN, they crop a bounding box around the skin lesion in the input image to highlight regions of interest (ROIs) that might contain a skin lesion. This initial stage focuses on isolating the lesion for further examination. The *model's training, validation, and testing are performed using the ISIC 2017 dataset*
2) *Stage 2:* Cropped images recognized as skin lesions in Stage 1 are then subjected to classification using a ResNet152 classifier. This classifier categorizes lesions into "benign" or "malignant," with "malignant" indicating melanoma lesions and "benign" for non-melanoma lesions. The ResNet152 model integrates feature extraction layers (convolution layers) and a fully connected network for classification. The performance evaluation includes metrics like specificity, sensitivity, accuracy, and balanced accuracy.

The team explores data augmentation techniques and fine-tuning hyperparameters to address data imbalances and enhance classification performance. The top-performing model, eVida M6, achieves an overall accuracy of 90.4%, showcasing superior performance compared to models in the ISIC 2017 challenge. The study emphasizes that automated ROI extraction significantly improves the classifier's performance, highlighting the importance of meticulous data augmentation and hyperparameter optimization to mitigate imbalances and strengthen the model's robustness. This work represents a significant advancement in automatic melanoma diagnosis from dermatoscopic images, demonstrating enhancements in cutting-edge methodologies.

"Aishwarya A et al. (2022) [7] Conducted Research on "Detection of Skin Cancer Based on Image Processing using Machine Learning"

In this research conducted by Aishwarya A et al. in 2022, the work focused on "Detection of Skin Cancer Based on Image Processing using Machine Learning." The methodology includes gathering melanoma skin cancer images from the ISIC dataset, and then doing some pre-processing to help with the accurate identification of cancerous areas, you know. They used a Convolutional Neural Network (CNN) for skin lesion segmentation, extracting features for classification as melanoma or non-melanoma, you see. The research managed to reach an accuracy rate of 93% using the Convolutional Neural Network model for skin lesion segmentation and classification in dermoscopy images, which is pretty good if you ask me. The high accuracy rate really shows how effective the methodology is in precisely identifying and distinguishing between melanoma and non-melanoma areas in the input images. By utilizing machine learning and image processing techniques, the methodology aims to automate and improve the accuracy of skin cancer detection, focusing on spotting malignant melanoma early for better patient outcomes, you get it.

"Meenakshi M M et al. (2019) [8] discussion about "Melanoma Skin Cancer Detection using Image Processing and Machine Learning", this particular model incorporates three phases which consists of data collection and augmentation, designing model and finally prediction. Phase 1 containing the collection of datasets, in this phase the images are collected from ISIC dataset (International Skin Imaging Collaboration). This particular phase also contains preprocessing of images including hair removal, glare removal and shading removal. Phase 2 is comprised of the segmentation and feature extraction methods, segmentation is explored using three methods a. Otsu segmentation method b. Modified Otsu segmentation method c. water shed segmentation method. Phase 3 entails designing the model and training. The model was trained for the Back Propagation Algorithm (Neural Networks), SVM (Support Vector Machine), and CNN (Convolutional Neural Networks) on the dataset that was collected in the phase1, the model after training was tested for accurate output. The paper achieved an accuracy range of 75%-85% in detecting melanoma, by leveraging the capabilities of CNN and SVM, the paper demonstrated the effectiveness of machine learning techniques in automating the process of dermatological disease recognition and achieving a high accuracy rate."

Mohammadreza Hajiarbabi et al.(2023)[9] proposed that "Skin Cancer Detection using Multi-Scale Deep Learning and Transfer Learning". This methodology includes preprocessing images to remove noise, applying image augmentation for data diversity, utilizing transfer learning with a pre-trained CNN from ImageNet, fine-tuning the network for melanoma detection, focusing on central image features, combining results for classification, and achieving high accuracy rates in skin cancer detection. The methodology employed in the study involved training three different convolutional neural networks (CNNs) using images with varying degrees of cropping (50% and 75%) and resizing. Transfer learning was utilized to enhance the detection rate by combining the outputs of the three networks through global average pooling. A fully connected layer with two outputs was then created to classify the images as melanoma or non-melanoma. The study also focused on image augmentation techniques to increase the number of training images and improve the quality of the dataset. Overall, the multi-scale structure implemented in the research demonstrated improved accuracy in skin cancer detection compared to traditional methods.

Algorithms used are Generative Adversarial Network (GAN) for generating new data samples,MobileNetV2 which has CNN with 53 layers for melanoma detection,Multi-scale structure used to capture different levels of detail and features that enhance the model's ability to differentiate between melanoma and non-melanoma skin lesions. The study achieved an overall accuracy of 94.42% in detecting skin cancer, with a recall of 88.5% and precision of 91.75%. Additionally, the area under the curve (AUC) was reported as 0.94, indicating the effectiveness of the proposed method in accurately identifying melanoma lesions. To increase accuracy, consider optimizing hyperparameters like learning rate and batch size, implementing data augmentation techniques to enhance the diversity of the training set, and fine-tuning the model architecture using transfer learning with pre-trained networks for improved feature extraction and classification performance.

Jean Daglier et al. (2021) [10] proposed "Melanoma skin cancer detection using deep learning and classical machine learning methods: a combination", where data were collected from ISIC. Firstly, complete the preprocessing of the dermoscopic images. Hair identification from dermoscopic images is performed using the two-dimensional derivative of the Gaussian (DOG). Then use a threshold to separate the hair from the background. The Otsu method was used. The purpose of the segmentation process is to determine the boundaries of organisms. Pixel classification is done using hierarchical clustering, which are interrelated pixels that are not hair or skin. This technique has been further developed by investigating different epilation methods such as Morphological Geodesic Active Shaping (MorphGAC) and Edgeless Morphological Active Shaping (MorphACWE). After the skin is removed, low-level features are extracted by three visual methods: texture (SIFT, HOG) definition, color (color name (CN), color SIFT) features, and other features describing the lesion area (convexity, circularity, Irregularity index) are extracted and benign and It was used to identify malignant lesions.

Train the SVM classifier for the training process. KNN classifier was used to find the K nearest neighbours of the diagnosis. The experiments were performed by training a large dataset of 512 lesion images. The proposed CNN architecture takes as input all images of size 124 × 124 pixels, which need to be preprocessed before training the model. CNN architecture consists of 9 layers. After the features are extracted by the convolution process and down sampled by the pooling process, they are mapped across all layers with the SoftMax activation function. The final output of the network is the result of whether the disease is malignant or benign. An accuracy of 57.3% was achieved using the KNN classifier. However, due to its efficiency and adaptability, SVM classifier outperforms KNN with 71.8% accuracy. The CNN model achieved 85.5% accuracy.

Neema et al (2020) [11] published a study on "Skin disease/cancer diagnosis using deep learning" focusing on skin disease/cancer using dermoscopic images from a deep CNN architecture. The approach here has two stages; The first phase involves data collection, preprocessing, and training/testing the model. Dermoscopic criteria such as asymmetry and color assessment were taken into account and data included ISIC 2018 Competition, HAM10000, Benign etc. Malignant and PH2. The data is split 8:2 (0 for benign, 1 for malignant) for training and testing and before being associated with image rescaling and labeling. The second phase includes immediate operations and GUI visualization of the results. The deep CNN model can classify melanoma types into benign or malignant classes. In this study, the model was used less and approximately 70% accuracy was achieved. Future extension of this work involves improving the prediction accuracy by measuring the parameters and restructuring the network into different classes to detect different skin classes. The proposed method is an effective tool that facilitates timely and accurate diagnosis of diseases. The system also features an integrated user interface and user interface GUI form.

Gajjala Sravya et al. (2023) [12] Skin images were processed using CNN for subtraction and SVM for classification. Combining CNN and SVM models aims to leverage the power of both algorithms to improve the accuracy of melanoma detection.

CNN is used to extract characteristics of skin lesions such as size, color, texture, and melanoma size. A support vector machine was used as the product to classify skin lesions as benign or malignant based on the extracted features. The CNN and SVM model combination combines the features of CNN's learning ability with the decision-making quality of SVM to improve classification accuracy. The accuracy of the combined CNN and SVM model for melanoma detection was reported to be 90%. By combining CNN and SVM, the model achieves greater accuracy than using CNN alone, demonstrating the effectiveness of the combination.

This study concluded that combining CNN and SVM algorithms in the search function effectively increased the accuracy of identifying skin diseases, including melanoma. The proposed model provides a unified method for binary classification using CNN and SVM, enabling more accurate and reliable early detection of cancer cells. This study demonstrates the successful application and high accuracy of CNN and SVM in melanoma detection and demonstrates the potential of the combination of traditional deep learning and learning techniques for examining medical images.

II. COMPARISON AMONG MODELS

We compared the work based on metrics, algorithms used and the accuracy on several datasets used by the authors. The work is summarized as shown in Table 1.

Table-1: Comparison Among Models

Reference	Dataset	Tools used	Machine Learning Algorithms Used	Evaluation Metrics	Outcomes of Outperformed Algorithms
Ms. Gaana et al. [1] 2019	PH2D database	Python 2.7	CNN, SVM, K means algorithm, Hybrid genetic algorithm	accuracy, precision and recall	----
GS Gopika Krishnan et al. [2] 2023	ISIC dataset	. -----	CNN, SVM, Neural Networks with the Back Propagation Algorithm	accuracy, precision, recall, F1 score	Accuracy=85%

Yinhao Wu, Bin Chen et al.[3] 2022	Derm7pt dataset , BCN20000 dataset ,HAM 10000 dataset, MED-NODE dataset ,PH 2 Dataset, ISIC Dataset. .	----	CNN, SVM, XGBoost, decision tree	Accuracy, Sensitivity, Area Under the Curve (AUC), Balanced Multiclass Accuracy, Classification Accuracy	CNN accuracy=73.7%-92.9% SVM accuracy=89%
Chandran Kaushik Viknesh et al. [4] 2023	673 Images train and tested from ISIC	--	ANN, SVM, ABCD	Accuracy, Precision and Recall	Acuuracy ANN=92%,SVM=94%
Dheiver Santos [5] 2022	2357 images of various oncologic malignancies and malignancies developed by the International Skin Imaging Association (ISIC)	---	AN, CNN	Accuracy	Accuracy=89%
Mario Fernando Jojoa Acosta et al. [6] 2021	ISIC Archive, PH2 database	Mask RCNN,Resnet152, -	Mask RCNN (Mak and Region based convolutional neural network)	Specificity,sensitivity,accuracy	Accuracy(0.904) sensitivity(0.820) ,specificity(0.925)
Aishwarya A et al. [7] 2022	ISIC dataset	Python 3.9.7	CNN, SVM, K-NN, GLCM (gray level co-occurrence matrix)	Accuracy, precision, recall and F1-score,area under the curve, confusion matrix	The research achieved an accuracy rate of 93% using the Convolutional Neural Network model
Meenakshi M M et al. [8] 2019	ISIC dataset	----	Convolutional Neural network(CNN), Support vector machines , k-nearest neighbor , back propagation algorithm	Accuracy, precision , recall	The accurate output.The paper achieved an accuracy range of 75%-85% in detecting melanoma

Mohammadreza Hajiarbabi et al. [9] 2023	ISIC 2020 dataset	---	CNN(Convolutional Neural Network)	Accuracy,recall,precision, area under the curve	.Achieved an overall accuracy of 94.42% in detecting skin cancer, with a recall of 88.5% and precision of 91.75%.
Jinen Daghrir [10] 2021	public dataset which is collected from the ISIC	----	Jupyter notebook,Matplotlib,Seaborn,OpenCV,Scikit-learn	ROC Curve, Area Under the Curve	Accuracy of KNN=57.3%, SVM=71.8%, CNN=85.5%
Neema M et al. [11] 2020	International Skin Imaging Collaboration (ISIC) 2018 Challenge, HAM10000	Softmax	Deep CNN	Accuracy, sensitivity, specificity, precision, and F1 score, receiver operating characteristic curve (AUC-ROC)	Accuracy obtained is around 70%
Gajjala Sravya et al. [3] 2023	Medical imaging data format DICOM	TensorFlow, Keras.	Convolutional Neural Networks and Support Vector Machine.	Accuracy, Loss.	CNN model alone reported an accuracy of 82%, integrated CNN and SVM model achieved an accuracy of 90%

III. CONCLUSION

This project focuses on predicting skin cancer and classifying skin lesions such as nevus, melanoma or seborrheic keratosis. System-wide, from data collection and prioritization to training models, validation and testing, attention to detail and ability to develop effective screening tool. Convolutional neural networks will be used as a classification system and the system will be trained to recognize features and classify dermoscopic images. The study included many researchers working in melanoma research. His research papers include CNN, backpropagation algorithm, support vector machine algorithm, K nearest neighbor algorithm, deep CNN and other algorithms. Among the above algorithms, the CNN algorithm appears to have high accuracy and can process many data sets. Integrating deep learning into treatment for melanoma detection could help detect the disease earlier and reduce mortality.

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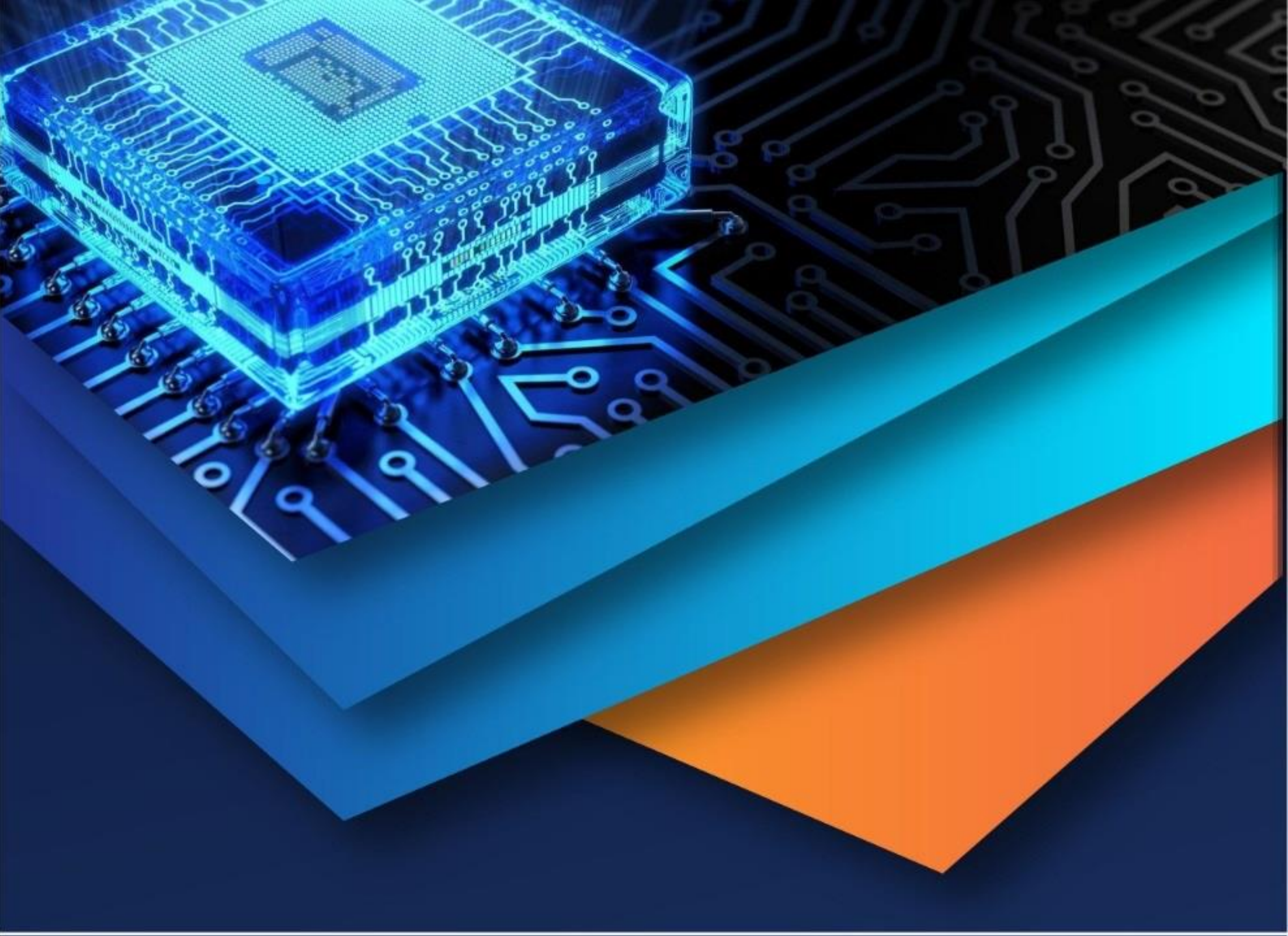

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