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Mango Leaf Disease Detection Using Deep Learning

Dr. Sapna B Kulkarni[1], J Keerthi[2]
[1]*Associate Professor,* [2]*Student, M Tech 4th Sem, Dept of CSE, RYMEC Ballari* VTU University, Belgaum

Abstract: ***Agriculture is one of the essential sectors for the survival of humankind. At the same time, digitalization touching across all the fields that became easier to handle various difficult tasks. Adapting technology as well as digitalization is very crucial for the field of agriculture to benefit the farmer as well as the consumer. Due to adopting technology and regular monitoring, one can able to identify the diseases at the very initial stages and those can be eradicated to obtain a better yield of the crop. Crops growth and yield are essential aspects that influence the field of agriculture as well as farmer economically, socially, and in every possible way. So, it is necessary to have close monitoring at various stages of crop growth to identify the diseases at right time. But humans naked may not be sufficient and sometimes it would be misleading scenarios arise. In this aspect, automatic recognition and classification of various diseases of a specific crop are necessary for accurate identification. This thought gave inspiration for the present proposed framework. The proposed framework is main concentrated on deep learning techniques using convolutional neural networks such as image classification and image recognition system. By using these system we can detect leaf diseases in various plants there are three different leaf diseases such as Anthracnose, Powdery Mildew, Red Rust of Mango has been identified in a dataset consisting of 1200 images of diseased and healthy mango leaves. The proposed CNN model achieves an accuracy of 93.67% for identifying the leaf diseases in mango plant thereby showing the feasibility of its usage in real time applications.***
Keywords: Deep Learning, CNN, Classification, Recognition

I. INTRODUCTION

Mango is national fruit of India also called as King of fruits. About 40% of mangoes production is produced by India and stands first in the various mango growing countries of the world. Amongst the fruit crops in India vital place gets occupied by mangoes and plays an essential role in the economy of the country. About 30% to 40% of the crop yield got infected by various diseases and due to unaided eye perception the mango leaf disease went undetected. The different diseases affecting mango leaves cannot get acknowledged by the farmers which cause less production of mango fruit. Different diseases cause different effects on mango crops. Some cause white patches and some cause black and all these patches seem over the surface of the leaf or early grown fruits as well while some other diseases cause white fungal powder on leaves and some affect the young leaves and shoots also. These patches begin in tiny form, but quickly they cover the entire region of the fruit or leaf, resulting in rotten leaves or rotten fruits. Such diseases are caused by pathogens like bacteria, virus, fungi, parasites etc, and even unfavourable environmental conditions. Disease in leaf affects the photosynthesis, transpiration, pollination, fertilization, germination, etc symptoms and the affected leaf area determine the type of disease.

All these different types of illnesses need to be discerned in the initial stages and should be managed before it grows more and causes a severe loss to the plant life. To get this detection done in the initial stage, farmers and agricultural scientists need to keep an eye continuously on the plant parts which is a sluggish process. For the advance detection of disease in the plants some technique is needed as the prior acclaim of disease is the first step in the detection and expansion of mango diseases. Conventional ways to identify diseases is time consuming and expensive as it needs the expertise, knowledge and continuous monitoring. Still it lacks correct recognition of disease because of the complex structure and pattern of the leaf. With the advent of computational methods in the field of image recognition and classification this problem can be solved with greater accuracy. By using technology one can detect diseases on a large scale. In the case of mango leaves; there are various types of diseases present like powdery mildew, anthracnose, red rust etc.

In the present work, a deep learning (DL) based model has been proposed for the classification of various mango leaf diseases (powdery mildew, anthracnose, red rust) at the initial stages. Accuracy, Recall, Precision and F-Score have been used to evaluate the model.

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II. RELATED WORKS

Sladojevic, S., et al. [1] concerned the generation of the new-age model for the identification of various diseases of 13 plant diseases out of the healthier plant leaf images. The deep learning architecture called Caffe was utilized for training the data. The results were obtained from the mentioned framework with a precision of 91percent to 98percent.

Fuentes, A., et al. [2] proposed a framework and can be applied in two stages. At first, the meta architecture of Faster R-CNN, R-FCN, and SSD will be combined to form a single meta-architecture. Lastly, certain methodologies such as VGG- 16, VGG-19, and ResNet-50 will be attached to extract the features from more depth and these models' efficiency was estimated. When compared to many other models, the proposed framework efficiency is better.

Arivazhagan, S. and Ligi, S. V. [3] proposed a framework based on automated deep learning for the recognition and classification of various diseases in mango plants. The dataset utilized for this framework consists of 1200 images which include both diseased and healthy leaves of mango. The accuracy obtained from the proposed framework is 96.67%.

Oppenheim, D. and Shani G. [4] proposed a framework based on convolutional neural network architecture for the recognition and classification of various diseases in mango plants. The dataset 6 utilized for this framework consists of 2465 mango images.

Barbedo, J. G. A. [5] investigated and identified the pros and cons through various factors that affect the model and efficiency of deep learning neural networks which are used for the recognition as well as the classification of various plant diseases. The investigation carried out on the literature as well as the experiments carried out with the image database consists of 50000 images of various plant diseases.

III. PROPOSED METHOD

A Deep Learning based model is designed for proposed framework and for this study; three commonly found diseases are considered viz. Anthracnose, Red rust and Powdery Mildew. Data is collected from various resources, there are around 1098 images of 4 classes i.e Healthy, Anthracnose, Red rust and Powdery Mildew. Figure shows some images of collected dataset.

(a) Healthy leaf

(b) Anthracnose

(c) Powdery Mildew

(d) Red rust

Fig. Showing the Samples of Images of Mango Leaves in collected Dataset

Steps of Dataset Collection and Preparation

The main phases of our entire dataset preparation procedure are as follows:

1) Conducting background study on prevalent diseases that affect mango trees.
2) Selecting the mango orchards for data collection in consultation with the agricultural experts.
3) Physically capturing the images of healthy and diseased mango leaves from the trees. We consider seven diseases in total.
4) Validating the images of the dataset. This step includes:

a) Labelling the images manually by human experts.
b) Resizing the images to standard shape.
c) Cleaning the images from background noise.

After data collection of images we move onto Image Processing

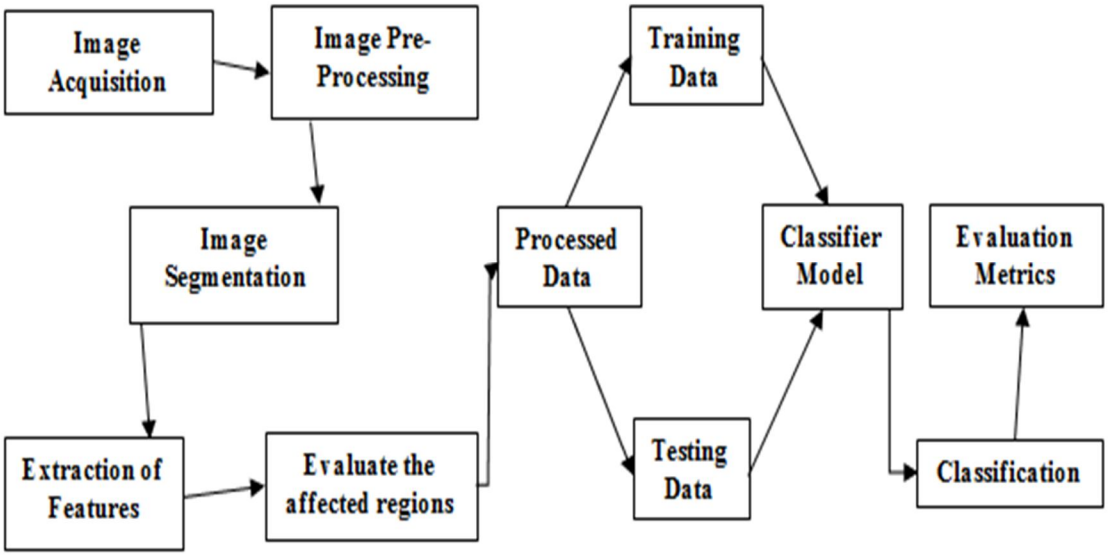

Figure 2. Flow Chart of the Machine Learning and DL Methodology

A series of steps need to be carefully followed for the process need to be followed in a disciplined manner.

Step-1: Image Acquisition for dataset creation: This step involves exploring various data sources from where data can be extracted for training the model and further how the test image input is to be provided.

Step-2: Image Pre-processing and background removal: This is most important phase, as it involves the quality assurance of the data. In the image pre-processing phase image is processed to desired color format, resized to desired size and images are denoised.

Step-3: Image Segmentation to obtain infected region: Region of interest that is the infected part of the leaf is identified. This is again one of the most crucial step, as entire analysis is dependent on the infected region identified by the process of segmentation.

Step-4: Extraction of Features from images: On the basis of obtained region of interest which is the infected part of the leaf various image features like standard deviation, mean of red, blue and green channels, the entropy of image is extracted.

Step-5: Evaluate and identification of the affected region: By comparing the extracted region of interests & features which are extracted from the image, an efficient model is derived.

Step-6: Processed Dataset creation: The data which are processed in previous stages are processed and extracted and converted to a csv file format and stored. This stored data is further utilized for analysis purpose.

Step-7: Training Data Extraction: Randomly the data in csv file is split. The 70% of the split data is used for training the proposed model.

Step-8: Testing Data Extraction: Randomly the data in csv file is split. The 30% of the split data is used for training the proposed model.

Step-9: Classification: Test data has labels such as: Late Blight, Early Blight, and Healthy, based on which classification is performed.

Step-10: Evaluation of proposed model: Depending on the obtained results from the classifier model, the evaluation metrics such as precision, recall, F1-score, and accuracy will be obtained.

DL is the subset of machine learning (ML) that emulates the functioning of the human brain in coursing data and producing patterns for use in decision making. It is a broader and more advanced part of ML methods. It is also called deep neural learning or deep neural networks. DL technique uses various layers consisting of nonlinear units. Every layer utilizes the output of the previous layer and considers it as its input.

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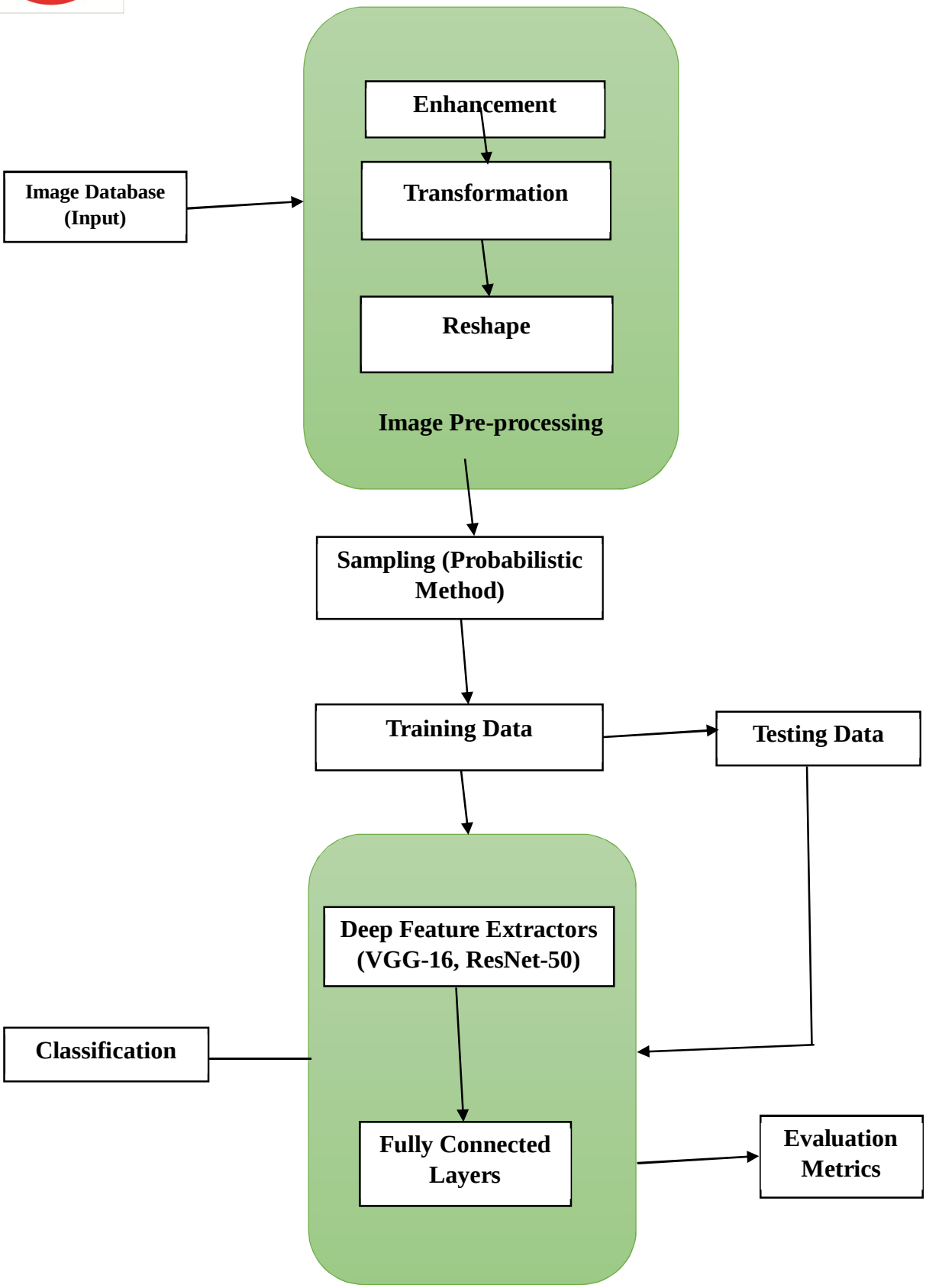

Fig 3. The flowchart of the proposed model

Performance Evaluation:

The performance of the model will be analyzed on the basis various parameters derived from its confusion matrix represented as under Table

Actual Results			
Predicted result		LOW	HIGH
	LOW	True Positive	False Positive
	HIGH	False Negative	True Negative

True Positive (TP): These are the correctly predicted positive values which mean that the value of the actual class is yes and the value of predicted class is also yes.

True Negative (TN): These are the correctly predicted negative values which means that the value of actual class is no and the value of predicted class is also no.

False Positive (FP): When the actual class is no but the predicted class is yes.

False Negative (FN): When the actual class is yes but the predicted class is no.

Accuracy - Accuracy is the most intuitive performance measure and it is simply a ratio of correctly predicted observation to the total observations.

Precision - Precision is the ratio of correctly predicted positive observations to the total predicted positive observations.

Recall - Recall is the ratio of correctly predicted positive observations to the all observations in actual class.

F1 Score - F1 Score is the weighted average of Precision and Recall. Therefore, this score takes both false positives and false negatives in observations.

These performance measures can be calculated as shown below

Parameter	Formula
Accuracy	(TP + TN) / (Total Cases)
Recall	TP / (TP + FN)
Precision	TP / (TP + FP)
F1 Score	(2 * Recall * Precision)/(Recall + Precision)

IV. RESULT

In the proposed study, a dataset of 1090 images is collected Dataset consists of 4 classes i.e. Normal, Anthracnose, Red rust and Powdery mildew. Argumentation is performed on the collected dataset to increase the number of images for model training and testing. Then splitting of data dataset has been performed to train and test the dataset. 80% of data has been used to train the model and the rest 20% of images have been used to test the model. A CNN based has been developed to classify the images. The otsu algorithm was utilized for the binary image segmentation and infected region identification this was done with the help of preparing an image mask. The Gray Level Co-occurrence Matrix is the main tool that implements the concepts learned from extracted features, utilized for feature extraction, & multi-class support vector machine methodology was utilized for the classification of mango leaves.

The model has been trained with epochs equal to 40 and the batch size of 35. The test accuracy of 90.36% is attained. The training and Validation accuracy graph and the Training and Validation loss graph as shown below

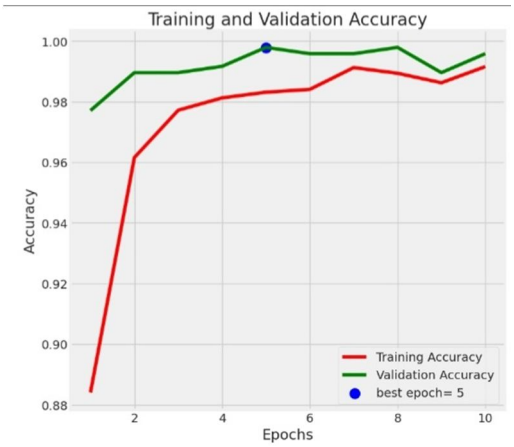

Fig 4. Shows the Training and Validation of the Model

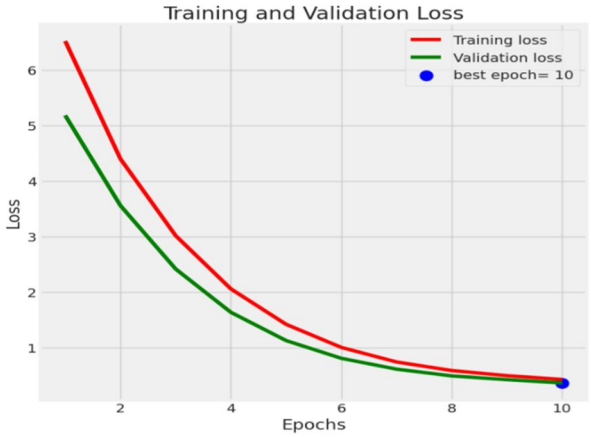

Fig 4.1 Shows the Training and Validation Loss for the model

V. CONCLUSION

Mango is one of the most cultivated fruit crops in India. So, it is important to protect it and detect the various diseases in the initial stages. For that, a model based on deep learning approach called CNN is proposed for the identification of 3 different plant leaf diseases, detection and recognition systems. This approach utilized a maximum set of layers to identify the diseases of four classes. The findings of this research indicate that disease identification from image with the convolution neural network architectures is a strong technique for high precision identification of mango disease. Therefore, this study shows that deep learning neural network provides a strong channel for in-field disease detection using convolution neural networks using an image dataset, and is a powerful technique for high precision mango disease identification.

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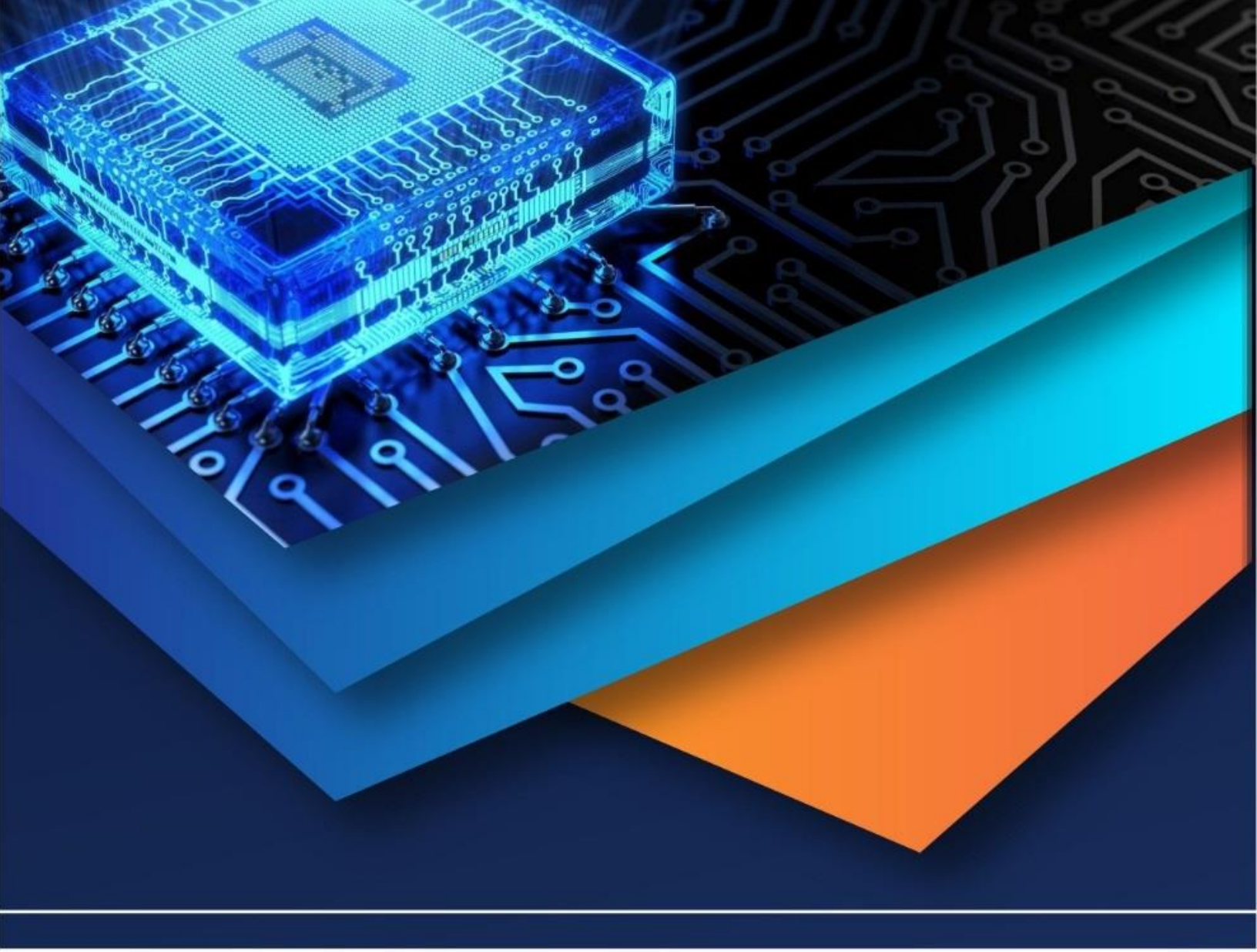

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