iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 **Issue:** III **Month of publication:** March 2024

DOI: https://doi.org/10.22214/ijraset.2024.59651

Crop Analyzer Using Deep Learning and Yolo

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Abstract: This paper presents an AI-driven crop analysis system using deep learning, integrated into a user-friendly web app built with Flask. Convolutional neural networks (CNNs) are used by the model, which was trained on a variety of crop photos, to accurately classify the crop images into categories such as healthy crops and different stages of disease. Crop health may be easily monitored by farmers and agronomists thanks to the user-friendly website. The system's practical applications, such as precision agriculture and disease management, hold promise for enhancing global food security by automating crop disease detection and minimizing losses.
Keywords: Agriculture, Crop disease analysis, Deep learning, Convolutional Neural Networks, Disease detection, Flask framework, Web application, Image classification.

I. INTRODUCTION

Crop diseases can seriously affect agricultural productivity, posing a serious threat to the world's food security. Traditional disease evaluation techniques, which rely on time-consuming physical inspections, frequently prove to be inefficient. In this study, we introduce a unique deep learning-based computational system for evaluating the health of crops. Our system has a user-friendly online interface designed to make submitting cropped photos for automated analysis straightforward.
Convolutional neural network (CNN) architecture that has been painstakingly trained and exposed to a broad dataset spanning a range of crop situations, from robustly healthy to various disease stages, forms the basis of our methodology. Underscoring the model's effectiveness is its amazing potential for precise classification, notably in identifying various disease phases and healthy crop conditions. The system's correctness and dependability have been confirmed through meticulous validation methods. Our study has far-reaching implications for the field of precision agriculture and the effective management of crop diseases. It has the potential to significantly advance efforts for global food security. Our approach attempts to reduce output losses by automating agricultural disease identification and monitoring.

II. LITERATURE REVIEW

Convolutional neural networks (CNNs), a type of deep learning, have demonstrated encouraging results in automating agricultural analysis in recent years. Large volumes of visual data can be processed by these models, which also reliably classify crop states and identify different illnesses. Prior to determining the disease class, it is essential to identify the crop species. Abdul Kadir in his research work has used color features like mean, standard deviation, skewness and kurtosis are made on the pixel values of the leaves. He has unified characteristics as indicated by the grey level co-occurrence matrix (GLCM). functions which identify the texture of an image. It generates a GLCM that produce statistical measures by calculating how frequently pairs of pixels with specific values and in a specified spatial relation occur in an image.[2] Pests and Diseases results in the destruction of crops or part of the plant, which lowers food output and causes food insecurity. Additionally, fewer people in many less developed nations are knowledgeable about diseases and pest management or control. Toxic pathogens, poor disease control, drastic climate changes are one of the key factors.[6]
The implementation of these AI models in web-based applications has been made easier by the use of frameworks such as Flask. Flask, known for its simplicity and flexibility, enables the development of user-friendly interfaces that empower farmers and agricultural experts to easily access and utilize these advanced technologies. While these advancements are promising, it is important to continue exploring and refining deep learning models and their integration into practical applications. Furthermore, a major area of ongoing research interest is comprehending the scalability, reliability, and practical implications of these systems.

A. Dataset Overview

The 'New Plant Diseases' dataset, created by SAMIR BHATTARAI and available on Kaggle, contains roughly 87,000 RGB photos that classify healthy and diseased crop leaves into 38 unique classifications. These photos have been properly organized, making them an invaluable resource for plant pathology and machine learning research.[1]

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
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B. Research and Discoveries

This dataset can be used by researchers to investigate plant disease detection and categorization. Machine learning and computer vision techniques can provide useful insights into early disease identification, assisting in proactive agricultural management practices.

III.PROPOSED METHODOLOGY

A. Utilizing the "New Plant Diseases Dataset" for Research

When it comes to furthering the field of crop disease identification, one useful tool is the "New Plant Diseases Dataset" [1], which can be accessed through Kaggle. This dataset is used as a starting point for research on the use of deep learning methods to the timely and accurate classification of plant diseases.

B. Data Acquisition and Preprocessing

Begin Get the dataset first, making sure it complies with licensing requirements and the right reference is made, from the Kaggle repository. Next, start a thorough data pretreatment step [Fig. 1]. Data cleaning includes scaling photographs to a uniform resolution, normalizing pixel values, and organizing data into organized directories.

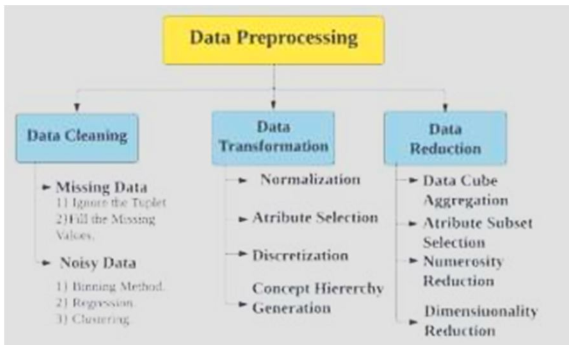

Fig. 1 Example of Data Preprocessing

C. Data Augmentation

Utilize data augmentation approaches [Fig. 2] to increase the dataset's diversity and enhance the generalization capacity of the deep learning model. Augmentation techniques like as rotation, flipping, cropping, and color adjustments can be applied methodically to expand the dataset and reduce the probability of overfitting.

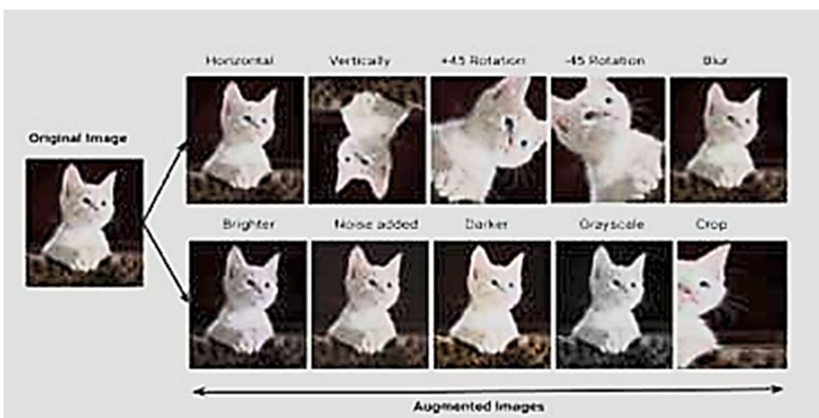

Fig. 2 Example of Data Augmentation [4]

D. Data Splitting and Cross-Validation

Divide the dataset strategically into separate training and testing subgroups, following the traditional 80/20 split ratio. Consider including cross-validation approaches as well, especially when dealing with restricted data resources, to thoroughly evaluate model performance.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
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E. Model Development

YOLO (You Only Look Once) is a real-time algorithm that divides an image into grid cells and predicts bounding boxes and class probabilities directly. It involves designing convolutional neural networks (CNNs) to process input images, integrating grid cell division, predicting bounding boxes, and optimizing loss functions for simultaneous object detection and classification. Considering the number and design of convolutional layers [Fig. 3], filter sizes, pooling layers, and fully connected layers must all be carefully chosen to complement the peculiarities/patterns of the dataset and the goals of the research.

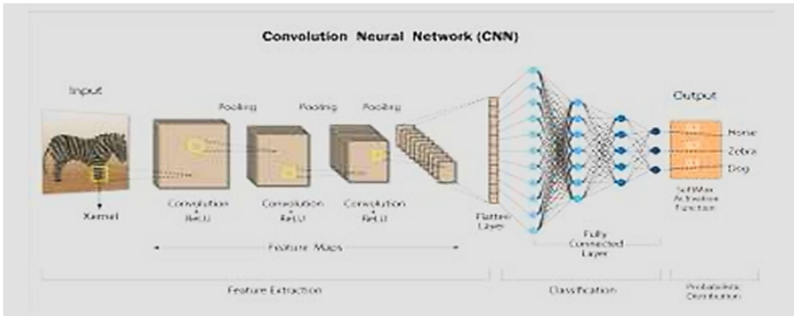


Fig. 3 Example of CNN Layers [4]

F. Model Training and Optimization

Execute the training phase with precision, specifying the optimization algorithm like 'ADAM' and loss function while defining key training parameters [Fig.4]. Monitor the convergence of the model and remain vigilant against overfitting, adjusting hyperparameters like epochs, batch size, etc as necessary.

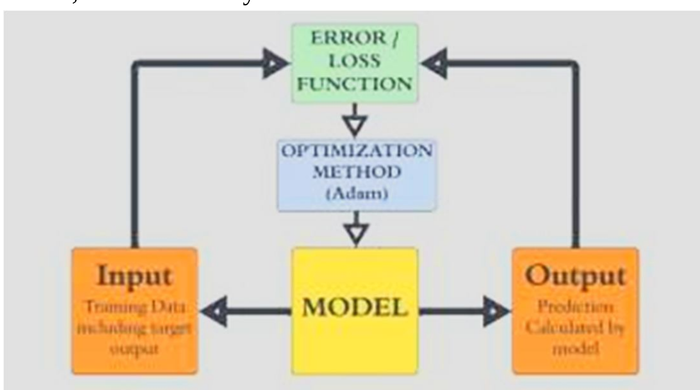


Fig. 4 Example of Training and Optimization

G. Model Evaluation and Metrics

Evaluate the trained model's performance rigorously using the designated testing dataset. Employ established evaluation metrics, including accuracy, precision, recall, and F1-score [Fig 4], to quantitatively assess the model's classification prowess. The construction of confusion matrices [Fig 5] affords valuable insights into classification outcomes.

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN} \text{ ------------ } (1)$$

$$\text{Precision} = \frac{TP}{TP+FP} \text{ ------------ } (2)$$

$$\text{Recall} = \frac{TP}{TP+FN} \text{ ------------ } (3)$$

$$\text{F1} = \frac{Precicion*Recall}{Precision+Recall} \text{ ------------ } (4)$$

Fig. 4 Example of Evaluation Metrices

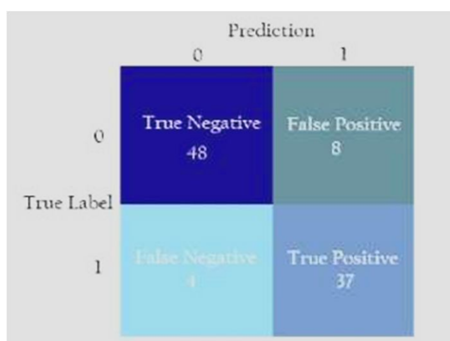
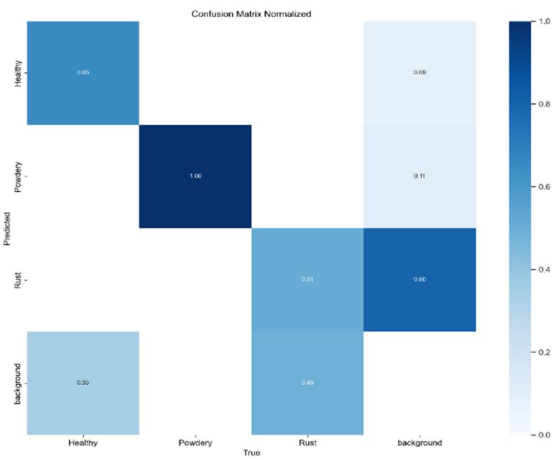
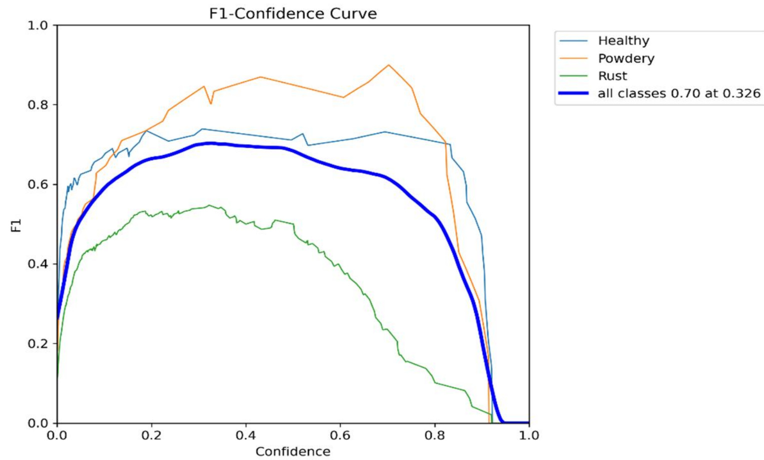


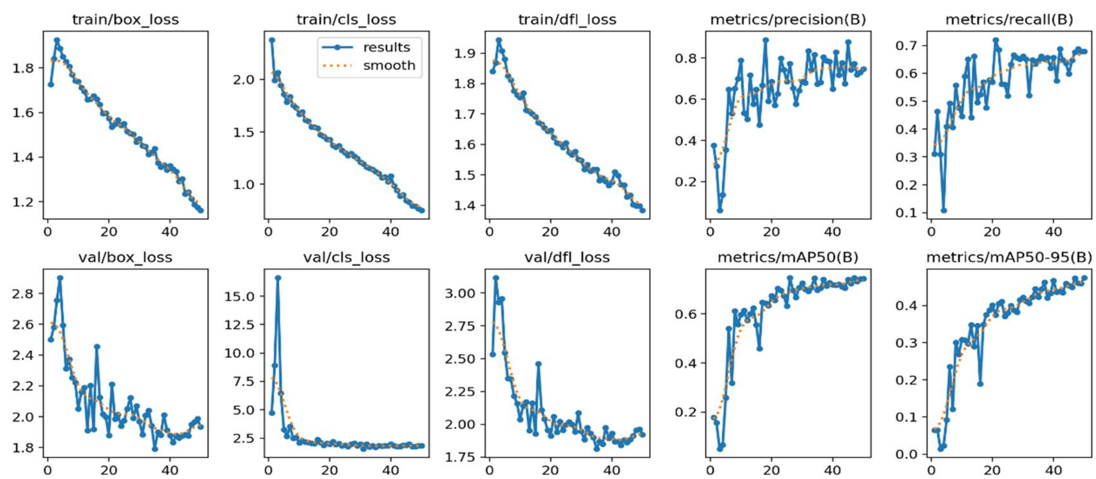
Fig. 5 Example of Confusion Matrix

H. Results





i. Confusion Matrix (Normalized): ii. F1 Curve (Graph):



iii. Loss-Precision-Recall (Graph) of Training and Validation:

I. Model Deployment

In instances where deployment is vital, utilization of a robust web framework such as Flask to facilitate model deployment [Fig. 6]. Provide an intuitive user interface so that people may engage with the model and provide photographs for real-time disease classification.

Fig. 6 Example of Model Deployment

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J. Website UI and Features

Currently our website is in prototype phase, so we haven't yet did work on UI part much, but here are some features of our website, firstly on main page we have a simple banner and below it we have 'choose a file' option where we can choose a file from our local system [Fig. 7]. Secondly, we have a predict button beside the that option, which will run the prediction on the input image given, at back-end. After predicting the image, it will show the results whether it is diseased or healthy [Fig. 8]. Also, there will be 2 more options View Doc and Download Doc [Fig. 8]. After clicking the 'Download Doc' button it will open a window, where to save it. [Fig. 9]. After clicking the 'View Doc' button it will open a new window in browser, where it will open the corresponding Doc which contents the information about the Disease [Fig. 10].

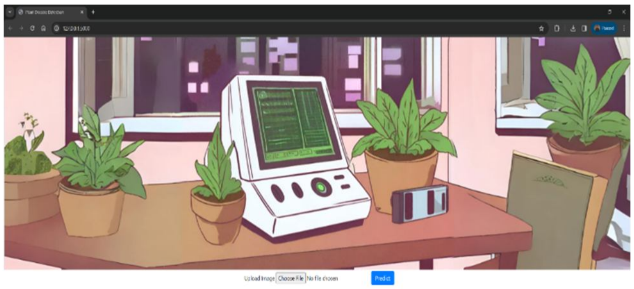

Fig. 7 Main Page (Before Predicting)

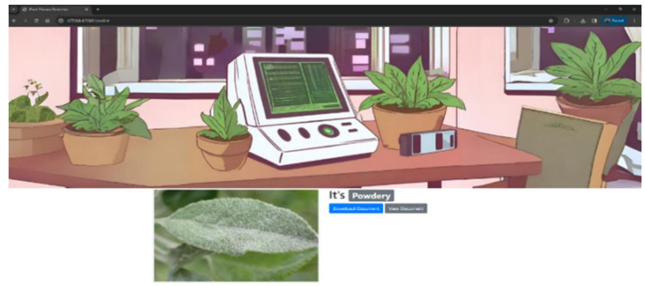

Fig. 8 After Predicting

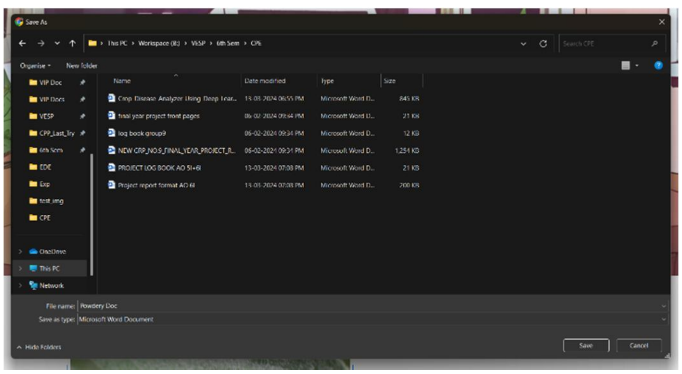

Fig. 9 After Clicking on Download Doc

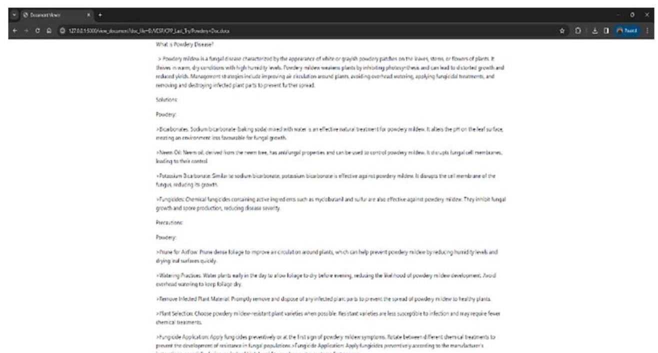

Fig. 10 After Clicking on View Doc

K. Advantages

1) This AI is so future proof that we only have to upload new and different crops for keeping update to date.
2) This AI predicts the crops health while the Crop is in production period so that our farmers will be able to regain the health back to its normal condition
3) Fast crop disease detection of real-time images.

L. Disadvantages/Limitations

1) Farmers would have to go to the fields for capturing the photos.
2) Farmers would require to have Laptops to get analysis of the Crops Health.
3) The proposed system can only detect the disease if it is present on the leaf and not other parts of the crop such as stem and fruits

M. Future Improvements

1) In future we will build a drone / RC Car to drive this AI model to click live images from the farm to have a great consistency.
2) Create an App for communicating with real time farming experts to have a ONE-TO-ONE CHAT and also "MONITOR HEALTH".
3) In upcoming times, we will add different Crops and Abroad crops so that this AI will be used by abroad consumers.

N. Future Scope:

In this era of Developing India, Farming is a considered to play a huge role in India. Many of the different crops and grains are being exported out of India to different Aboard countries. Producing a large quantity of crops with same consistence and Quality is mostly required. With increasing population of India, demand of food supply is increasing day by day. Keeping this all things we decided to build this AI Model to help our farmer friends to have a great and healthy yield of crops.

IV. CONCLUSION

This research uses deep learning methods and the Kaggle "New Plant Diseases Dataset" to develop an effective custom CNN model for crop disease identification. Thanks to data augmentation, the model displays exceptional performance measures, including accuracy, precision, recall, and F1-score. The model's simple Flask deployment underscores its potential for real-world use. This study provides a solid basis for future improvements in crop management and global food security.

V. ACKNOWLEDGMENT

We like to convey our gratitude to our mentors for their invaluable guidance. We appreciate the Kaggle community sharing of datasets. Important resources were provided by Vivekanand Education Society's Polytechnic. Finally, also Mr Prashant Kamble who is a Director of CM Electronics for guiding us as our Industrial Mentor We would want to express my sincere gratitude to farmers and stakeholders for their support of our work. This study is evidence of academic cooperation and of our common commitment to finding solutions to agricultural problems.

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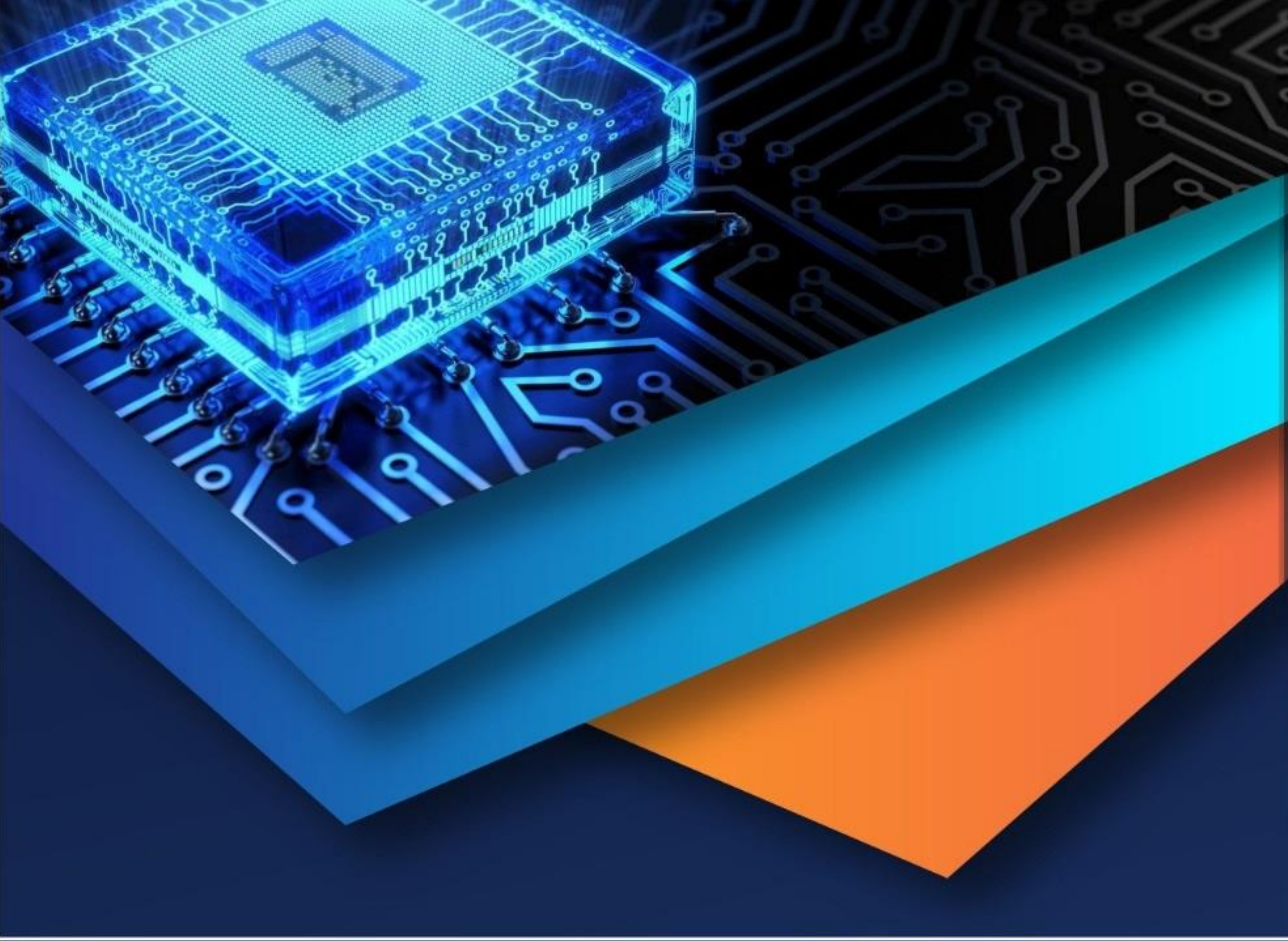

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