iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** V **Month of publication:** May 2020

DOI: http://doi.org/10.22214/ijraset.2020.5028

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue V May 2020- Available at www.ijraset.com

Malaria Parasite Detection using Deep Learning

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Abstract: ***Malaria may be a life-threatening disease caused by parasites that are transmitted to people through the bites of infected mosquitoes. An Early detection of malaria is very crucial for ensuring the proper diagnosis and increasing chances of cure. By considering the seriousness and also the number of fatalities claimed by this malaria disease, it's rational to simply accept potential small implementation errors introduced by an automatic system. Automation could be a process within which the diagnosis process will enable accurate diagnosis of the disease and hence holds the promise of delivering reliable health and care to resource-scarce areas.***

I. INTRODUCTION

Malaria could be a widespread disease that has claimed voluminous lives everywhere the planet. in step with the planet Health Organization, approximately 438,000 deaths result from 219 million infections in 2017. Endemic regions with widespread disease which include Africa and South-East Asia and other countries..

In these and other parts of the planet where malaria mortality is critical, necessary resources like reliable prevention, healthcare, and hygiene are removed from adequate .

In most cases, the sole available method of malaria diagnosis is manual examination of the microscopic slide . so as to supply reliable diagnosis, extensive experience and training are required.

Unfortunately, such specialized human resources are fairly often limited in rural areas where malaria contains a marked predominance. Also, manual microscopy is subjective and suffers from a scarcity of standardization. This problem is further intensify by the big size of microscopic images, which require a lengthy scanning.

The automation of the diagnosis process will ensure accurate diagnosis results of the disease and hence holds the promise of delivering reliable health and care to resource scarce areas of the country or city. Hence, rural areas stricken by lack of specialized infrastructure and trained manpower can benefit greatly from automated diagnosis process which helps many other areas. Early detection of malaria is incredibly essential for ensuring proper diagnosis and also the increasing chances of cure. it's in mind and also the number of fatalities claimed by this disease, it's rational to simply accept potential small implementation and also the errors introduced by an automatic system.

An automatic system consists of the many streamlined image processing techniques for initial filtering and segmentation and suite of pattern recognition and/or machine learning algorithms, which are very helpful and directed toward robustly recognizing infected cells in an exceedingly light of the microscopic image. A computer-assisted system as a call network could also be paramount to faster and reliable diagnosis.

It can help and supply a benchmark and best way of measuring the degree of infection of the disease.

The automation of the diagnosis process will ensure accurate diagnosis results of the disease and hence holds the promise of delivering reliable health and care to resource scarce areas of the country or city. Hence, rural areas stricken by lack of specialized infrastructure and trained manpower can benefit greatly from automated diagnosis process which helps many other areas.

A. Overview

The current technique of malaria detection in laboratories can be automated using a deep learning based CNN model that would require input as the image of the blood smear. It would be better if malaria can be detected faster than conventional methods with high accuracy using CNN based deep learning models which would require images of blood smears and the model can be trained against them to find spatial local correlation between nearby pixels of the image to extract features corresponding to malaria parasites. For images, a very important source of data lies within the spatial local correlation among the neighboring pixels/voxels. Convolutional Neural Networks (CNN), a category of DL models, are designed to take advantage of this information through the mechanisms of local receptive fields, shared weights and pooling. The promising performance of CNNs is in the course of the supply of an enormous amount of annotated data. With scarcity for annotated medical imagery, Transfer Learning which is TL, methods are used where the pre-trained learning models are fine-tuned on the information or used as feature finders to aid in visual recognition tasks.

B. Problem Statement

Currently there's no efficient technique present which may effectively detect the presence of Plasmodium vivax in patient during a computationally smaller time.

The available techniques are manual and takes lots of your time to provide the results. it'd are far better if a digital computerized technique of detection of Plasmodium vivax existed.

The objective of this project is to automate the method of diagnosis of malaria with high accuracy and minimal error using convolutional neural networks based deep learning model, which is able to help in delivering reliable health care to resource-scarce areas.

An automatic system that works on its own consists of streamlined image processing techniques for initial filtering and segmentation and suite of pattern recognition and/or machine learning algorithms directed towards robustly recognizing infected cells during a light or whole slide microscopic image.

II. PRELIMINARY INVESTIGATION

A. Current System

The Current system which is used for malaria detection uses manual techniques for the detection of plasmodium parasite in blood of the patient like Rapid Diagnostic Test (RAD), Polymerase Chain Reaction (PCR), which is time consuming process they take about 15 to 30 minutes for detecting the presence of disease in a single patient.

B. Limitation Of Current System

1) Manually testing for presence of disease is a bit inefficient and time-consuming process.
2) A single patient's sample may take up to 30 minutes to detect the disease which may cause a lot of problem when there are a large number of samples to be tested.

C. System Analysis And Requirement Specification

The main objective of SRS (Software Analysis Requirement Specification) document is to explain the external behavior of the web site. It defines the operations, performance and interfaces and quality assurance requirement of the web site. The entire software requirements for the system are captured by the SRS (Software Analysis Requirement Specification).

III. PROPOSED SYSTEM

A. The Proposal

The proposed solution to the given problem is to develop a CNN based deep learning model and train it using the provided dataset so as to achieve the highest accuracy possible. The input to the model will be an image of the blood smear. The model will then use various different image processing techniques for basic filtering and segmentation and suite of pattern recognition and/or machine learning (ML) algorithms directed toward robustly recognizing infected cells in a light or whole slide microscopic image. The output in the final layer would be a number indicating the probability percentage of malaria parasite in the image. This would be translated by the classifier layer of the model and the final output will then be displayed to the user. We aim to use early stopping techniques and dropouts to control overfitting as well as applying random transformations to the input image during the training phase would allow the model to even detect the hidden features. We are using a variant of the VGG16 architecture adapted to suit our needs, containing an array of convolution layers, each layer followed by a batch normalization as well as max pooling 2*2 layer.

B. Benefits Of The Proposed System

The current system had a lot of challenges that are overcome by this system:

1) *Efficient Detection of Disease:* The machine learning algorithm will more efficiently classify the image.
2) *Time Efficient:* The automated system will generate the result more quickly as compare to the manual detection.
3) *Availability:* The model can be deployed over cloud so that it can be accessible from remote areas.

C. Feasibility Study

A feasibility study is an analysis of how successfully a system can be implemented, accounting for factors that affect it such as economic, technical and operational factors to determine its potential positive and negative outcomes before investing a considerable amount of time and money into it.

1) *Technical:* Our project consists of CNN model which can be merged with a website which is a light weight software which is supported by most of the browsers and operating system. For proper functioning of system high speed internet connectivity is required.
2) *Operational:* The main motto of our system is to provide a platform where medical practitioners can upload the blood samples and can detect the presence of malaria. The system is able to do that accurately and efficiently making the system operationally feasible.

IV. IMPLEMENTATION

Our Convolution Neural Networks based Deep Learning model uses a variant of VGGNet-16 architecture adapted to suit the dataset. This model is trained using a labelled dataset containing images of blood smears (blood cells) of both categories – parasitic and non-parasitic.

A. Technique Used

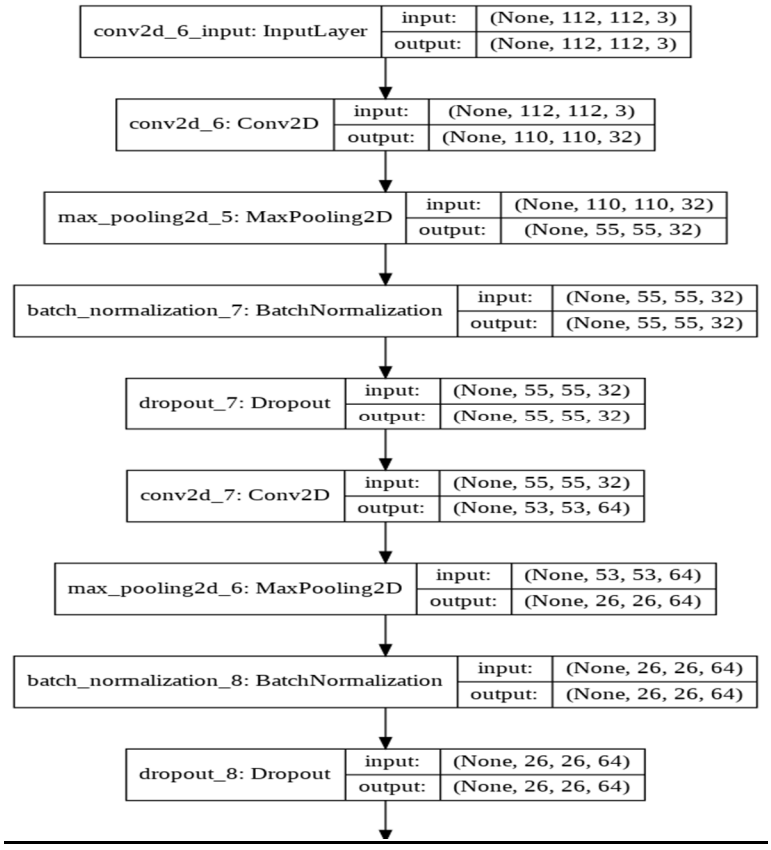
1) *Deep Learning:* Deep learning is an artificial intelligence (AI) or man-made intelligence function that imitates the workings of the human brain in processing data and creating patterns to be used in deciding and learning. Deep learning may be a subset of machine learning in AI (AI) that has networks capable of learning unsupervised from data that's unstructured or unlabelled. Also referred to as deep neural learning which is also called deep neural network
2) *Convolution Neural Networks:* We used convolutional neural networks because it's the flexibility to automatically extract features and learn filters. In preceding machine learning solutions, property or we can say that features had to be manually programmed in, as an example, size, colour, the morphology of the cells. By using the convolutional neural networks (CNN), it will greatly boost up prediction time while mirroring the accuracy of therapist/doctors.

B. Deep Learning Model

The model, when trained for 12 epochs with early stopping mechanism, gives a validation accuracy of around 94-95%. Early stopping helps prevent the overfitting of the model.

We used various pre-trained model for practice and research purposes like VGGnet, GoogleNet.

1) *Architecture Of The Model*



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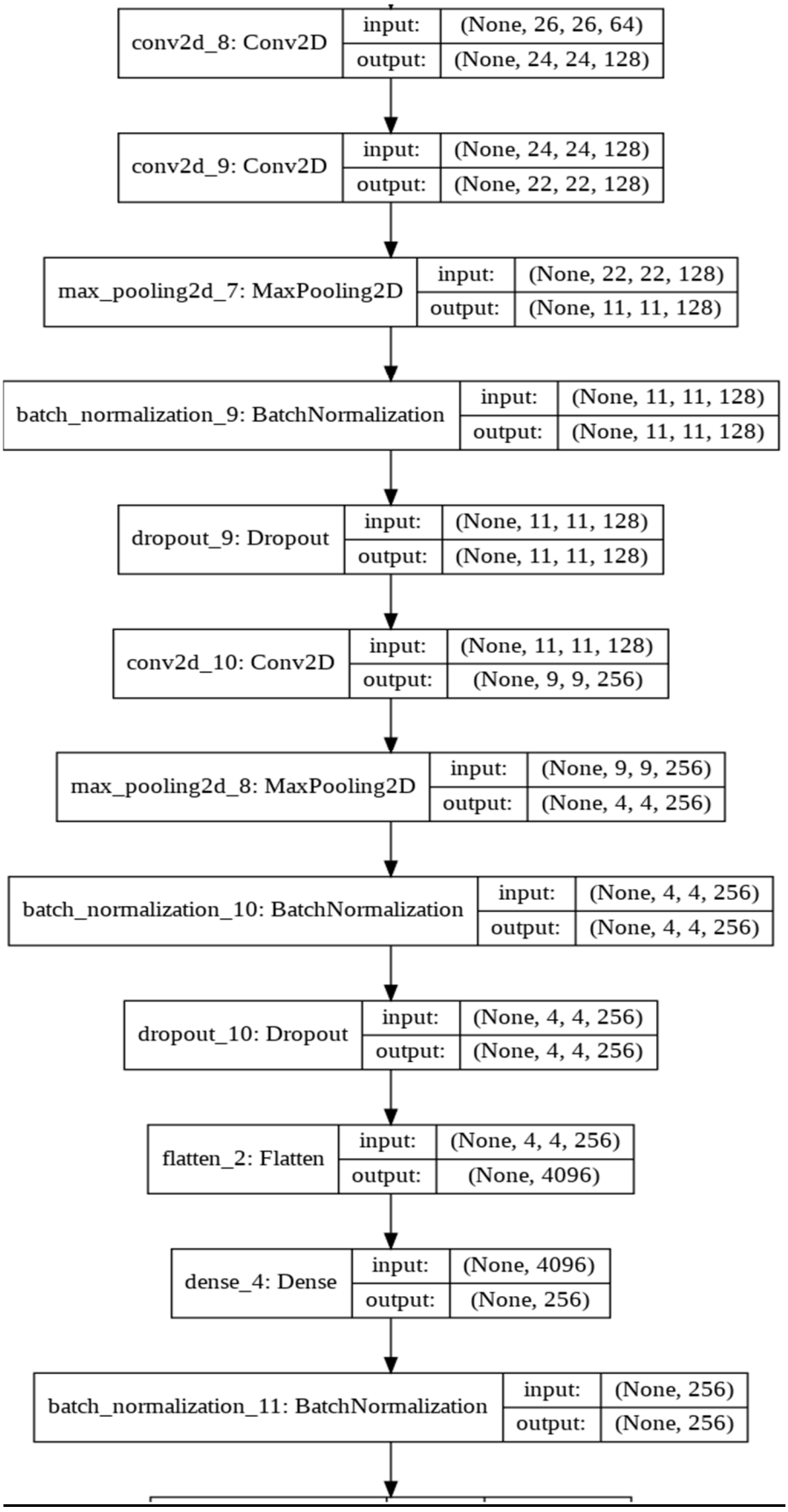
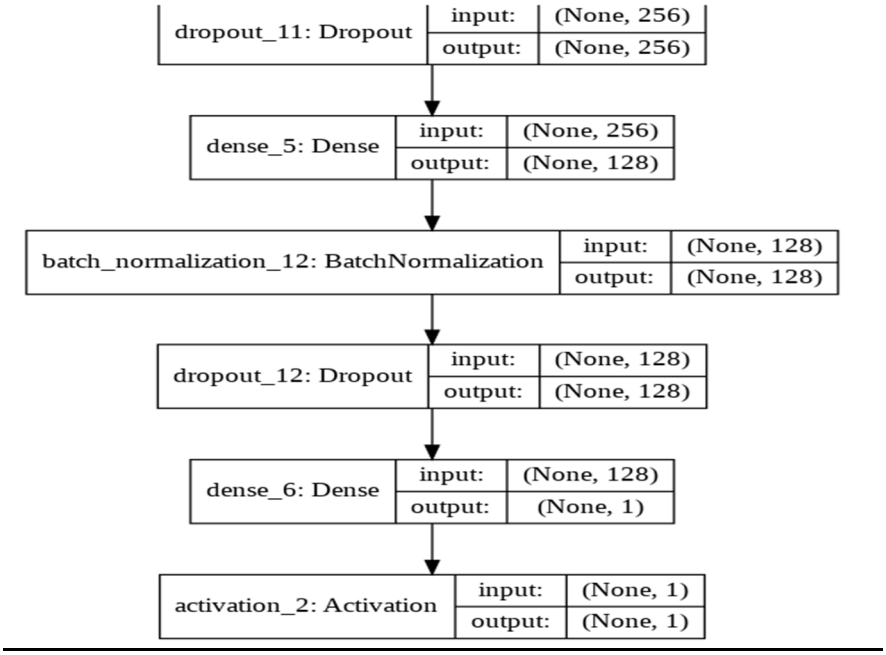
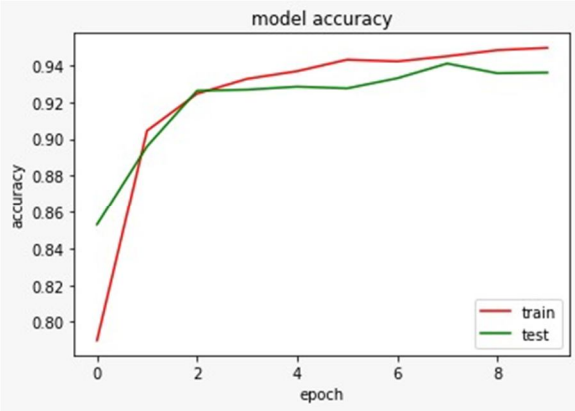
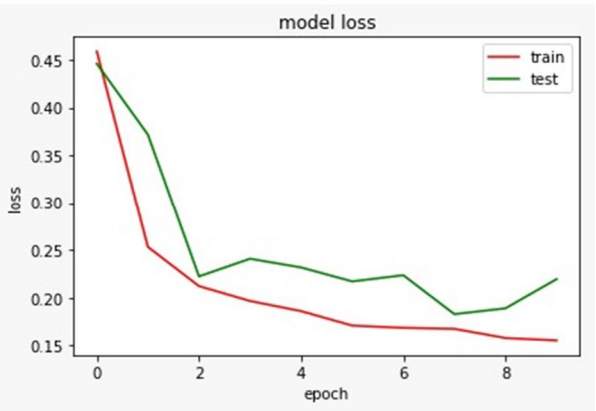




2) Accuracy of the Model: In our first attempt we used VGGnet model which gave accuracy of 93.85% under ideal conditions.

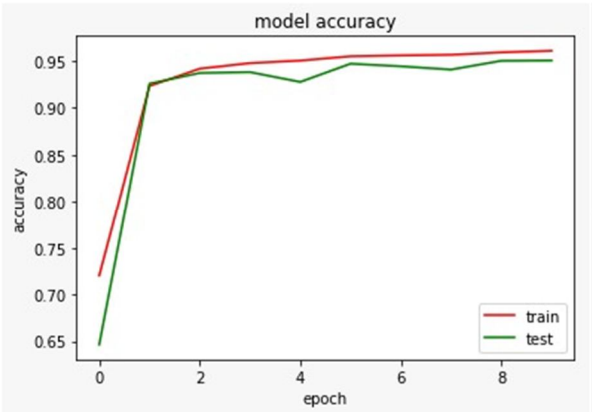


(Fig. 1) Accuracy vs. Epoch VGGNet

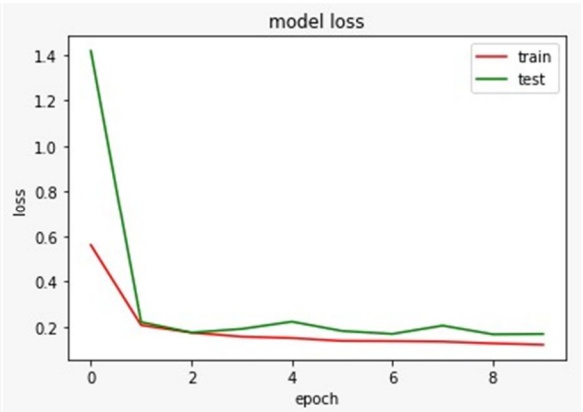


(Fig. 2) Loss vs. Epoch VGGNet

In second attempt after adding some random transformations to images, increasing number of epochs to 12, adding early stopping to prevent overfitting and using learning rate reduction the final accuracy obtainedwas 95.035%.



(Fig. 3) Accuracy vs. Epoch VGGNet



(Fig. 4) Loss vs. Epoch VGGNet

C. Tools Used

1) *Tensorflow:* TensorFlow is an open source and end-to-end platform for machine learning developed by the Google. It is a flexible and very coprehensive ecosystem of libraries, tools and community resources that lets researchers push the state-of-the-art in ML that is machine learning and developers could easily build and deploy ML powered applications.
2) *KERAS:* Keras is an open source library for neural-network which is written in Python language. It is capable of running on top of Microsoft Cognitive Toolkit, TensorFlow and PlaidML. It is designed to enable fast experimentation with deep neural networks (DNN), it focuses on being very user-friendly, extensible, and modular.
3) *Google Colab:* GoogleColab is a platform provided by Google that uses high performance servers and processors that is provided by Google for the purpose of training ML & DL i.e. machine learning and deep learning models.

D. Using The Model

The model can be saved as the tensorflow ".hd5 file ". This can then be deployed on any expert system that supports loading of tensor flow models.

V. CONCLUSION

This project will help medical practitioners to automate the process of detection of malaria parasites in a given blood sample and help to detect the presence of malaria parasite in a patient's blood sample more efficiently and faster which will save a lot of time and reduce the possibility of false malaria detection which was a possibility in manual technique.

A. Limitation Of The Work

1) The model which we designed is not 100 percent accurate i.e. there could be a possibility that the result produced is inaccurate.
2) If random samples are given as input there can be a change in accuracy.
3) Due to the internet requirement of system the results may take some time to display if the internet speed is slow.

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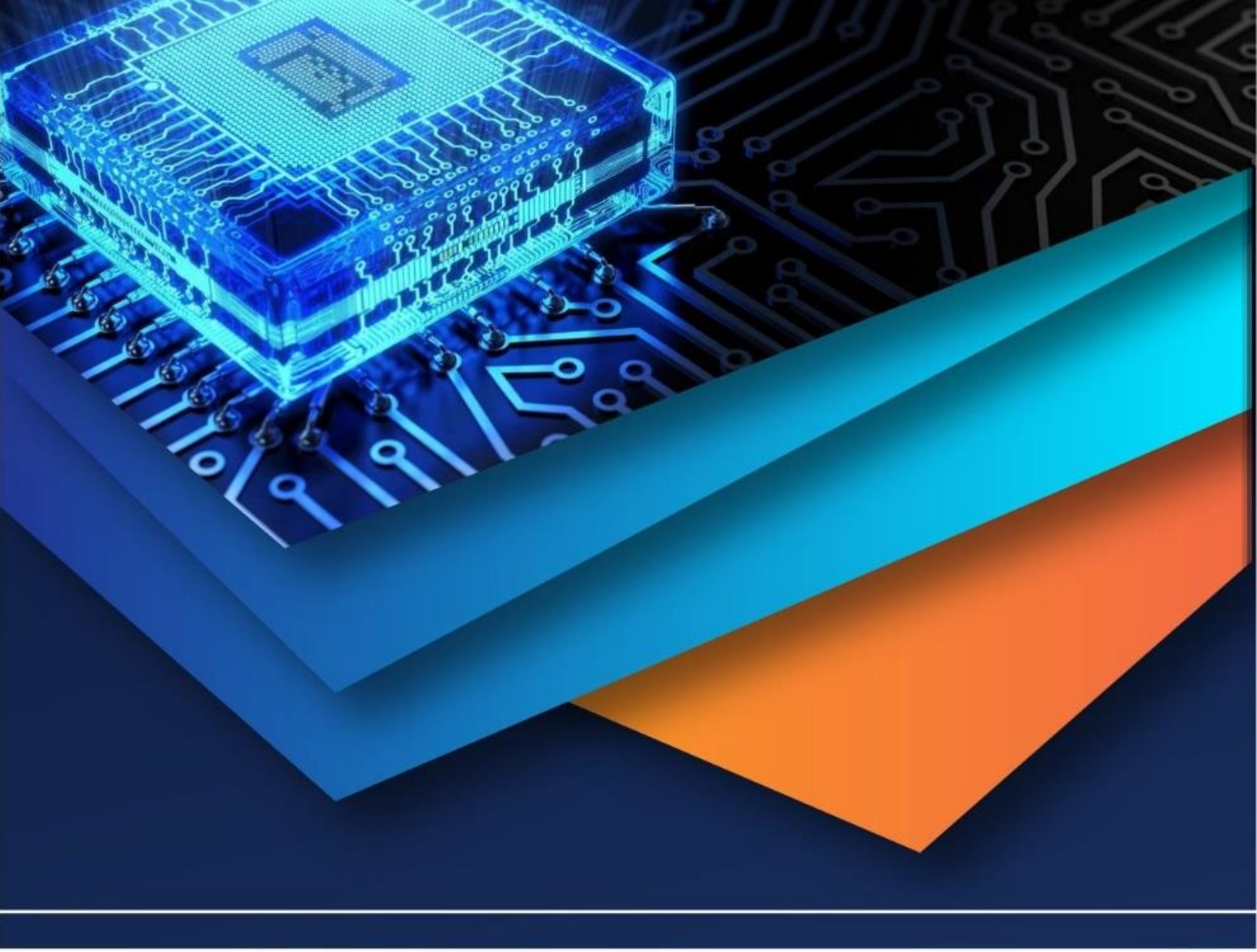

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