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"Blood Analysis Using Image Processing"

Anuj Pujari[1], Shivanjali Mohite[2], Utkarsh Walekar[3], Satyajeet More[4], Yogesh Handge[5]
[1, 2, 3, 4]*Student,* [5]*Professor, Department of Computer Engineering, SCTR's Pune Institute of Computer Technology, Pune, India*

Abstract: ***The human blood is a health indicator; it delivers necessary substances such as oxygen and substance that provides nourishment is necessary. Hence, segmentation of blood cells and identification of blood type is very important. The human blood consists of the RBCs, WBCs, Platelets and Plasma. Presently, lab technician tests blood groups manually and they use a device called Hemacytometer and microscope to count blood cells. But this method is extremely time consuming, monotonous and leads to the inaccurate results due to human errors. To overcome the problems regarding time, accuracy and cost, a method is proposed based on processing of images acquired from laboratory. The image processing techniques such as Segmentation, Morphological operations and Circular Hough Transform will test with some samples. In healthcare, blood testing is observed to be as one of the most significant medical examination tests. In pathology labs, different types of blood cells are counted to diagnose the diseases patient. By counting RBCs (Red Blood Cells) in images of blood cells can play a very great role in detection as well as to follow the treatment process of number of diseases such as anaemia, leukaemia etc. Counting and examination of blood cells manually by microscope is tedious, time intense and entails a lot of technical expertise. Hence arises a need to come across for automated blood cell detection and counting system that can facilitate physician for diagnosing diseases in fast and efficient way. According to present studies, the RBCs are classified in four types of abnormality, namely elliptocytes, echinocytes, tear drop cells and macrocytes. In this paper, technique has been introduced to count the RBCs automatically. In proposed work, images are classified based on colour, texture and morphology. Process of counting of cells is done into three parts: image processing including texture feature extraction using morphology, thresholding segmentation and counting of cells using Hough transformation.***

I. INTRODUCTION

Malaria is a deadly disease and the recent survey by the World Health Organization (WHO) has estimated that malaria causes over 200 million cases of fever annually.

The diagnosis of the disease requires powerful and expensive tools unavailable for the poorest countries of the world, where often the disease is endemic. Microscopic malaria diagnosis is, by far, considered to be the most effective diagnostic method, but it is highly time-consuming and labor intensive. The accuracy of the system solely depends on the expertise of the microscopist. Other techniques widely involved in Malaria diagnosis are Rapid Diagnostic Tests (RDTs) and Polymerase Chain Reaction (PCR) tests. However, the accuracy of these tests depends on the extent of infection with sensitivity directly proportional to the level of infection.

Various automated malaria related diagnostic studies are described in. Recognizing the potential of mobile technology and internet to revolutionize the access to information throughout the developing countries like India and Africa as well as developed nations, the work reported in this paper exposes a reliable automated Android based diagnostic platform, without expert intervention for the effective treatment and eradication of the deadly disease, which can be deployed in all the Android based mobile phones and tablets. Blood grouping tells us what type of blood a person has.

Everyone may have different 2 blood groups. These differences in human blood groups are because of the presence or absence antigens and antibodies on the surface of blood cells. Individuals have different combinations of antigens and antibodies and therefore have different blood groups. According to ABO and Rh blood grouping systems there are 8 different blood groups: A Rh+, A Rh-, B Rh+, B Rh-, AB Rh+, AB Rh-, O Rh+ and O Rh-. The complete blood count (CBC) evaluates the health of person and detects the disorders like anemia, infection and leukemia. CBC is very important in medical diagnosis. RBCs, WBCs, platelets, plasma these are constituents of human blood. The complete blood count involves counting of these four types of cells. The count of these cells determines the ability of an organism to resist a particular infection and capability of the body system. The normal count of these cells is different for men, women, and children, etc. change due to ingress of any foreign object or micro-organism can lead to any sort of infections.

II. LITERATURE REVIEW

1) A Novel Method to Count the Red Blood Cells in Thin Blood

The paper proposes a method that eliminates the need for traditional segmentation procedures used to separate cells in microscopic images. Instead, it directly detects and locates red blood cells in the image. Unlike many existing methods, this approach does not require extensive image pre-processing to correct for non-uniform illumination in the images. This simplifies the overall process. The method leverages knowledge about the structure of red blood cells and the brightness variations resulting from Giemsa staining, which is commonly used in preparing thin blood film samples. The ultimate goal of this work is to support the development of an automated malaria parasite detection system. Identifying and counting RBCs is a crucial step in assessing parasitemia, which is essential in diagnosing and monitoring malaria infections. This approach appears to offer a more efficient and direct method for RBC detection in Giemsa-stained thin blood film images, reducing the need for complex image processing steps. It may contribute to the development of more accurate and automated systems for malaria diagnosis and research.

2) Analysis of Infected Blood Cell image using Morphological Operators

This work presents a system designed for the detection and classification of malaria parasites in images of Giemsa-stained blood slides, with the purpose of assessing the parasitemia in the blood. The system employs an automatic thresholding technique based on a morphological approach to detect malaria parasites in the images. It introduces a more accurate method for segmenting cell images compared to the traditional watershed-based algorithm. This improved segmentation involves the use of grey scale granulometries with different types of disk-shaped structuring elements. Hemispherical elements enhance the roundness and compactness of red blood cells, while flat elements help separate overlapping cells. These methods take into account the unique structure of red blood cells, which sets them apart from existing watershed-based algorithms. The system includes two distinct classification methods: one based on morphological operators and another based on the similarity of color histograms. The framework's functionality is demonstrated through a practical example, and its performance is validated by comparing its results to those of expert human analysts who assessed multiple images. This system aims to improve the accuracy and efficiency of malaria parasite detection and classification in Giemsa-stained blood slide images.

3) Disease Detection by Using Image Processing

This text discusses a novel approach for analyzing both malaria and dengue fever using digital image processing techniques. The system is based on the Annular Ring Ratio Method, implemented in MATLAB. It can detect various blood components, including Red Blood Cells (RBCs), White Blood Cells (WBCs), and parasites within infected RBCs. This method aids in the diagnosis of malaria. Dengue fever is a viral disease that is a significant problem in many developing countries, such as India. The primary goal here is to detect and count platelets, a crucial parameter for diagnosing Dengue Hemorrhagic Fever. This approach reduces the need for labor-intensive, time-consuming, and costly manual procedures. The solution employs digital image processing techniques, including segmentation and morphological operations, to analyze microscopic images of blood smears. These techniques are used to estimate platelet counts, which can help diagnose dengue fever infection. Unlike manual methods that typically require expert lab technicians and traditional microscopes, this approach involves a digital camera attached to a regular magnifying microscope, which is then connected to a computer. The use of advanced cameras and digital processing is presented as a cost-efficient alternative. The system aims to improve the accuracy and efficiency of both malaria and dengue fever diagnosis by automating the process and reducing the reliance on manual labor, ultimately making it more accessible, especially in primary health care centers.

4) Parasite Detection and Identification for Automated Thin Blood film Malaria Diagnosis

This paper focuses on the automated detection and identification of malaria parasites in images of Giemsa-stained thin blood film specimens. The Giemsa stain used in this context not only highlights the malaria parasites but also white blood cells, platelets, and artifacts. The paper presents a comprehensive framework to extract these stained structures, determine whether they are malaria parasites, and identify the specific species and life-cycle stages of the parasites. The primary goal is to detect and identify malaria parasites within the stained blood film images. The identification of parasite species and life-cycle stages is treated as a multi-class classification problem. The paper explores three different classification schemes to achieve this. The paper empirically demonstrates that the tasks of detection, species identification, and life-cycle stage identification can be performed jointly. This approach streamlines the process of identifying and classifying parasites in the images. The paper also introduces a binary parasite detector, which can identify the presence of parasites even at very low parasitemia levels, such as 0.1%, without producing false detections. This is a significant achievement for accurate and sensitive parasite detection.

Overall, the paper presents a robust framework for automating the detection and identification of malaria parasites in stained blood film images, addressing the challenges of multi-class classification and achieving high sensitivity at low parasitemia levels.

5) Real Time Blood Image Processing Application for Malaria Diagnosis using Mobile Phones

This paper presents a mobile phone Android application designed for the fast and reliable analysis of blood images and malaria diagnosis using Giemsa-stained thin blood film images. The application is built upon the innovative Annular Ring Ratio Method, which has previously been implemented, tested, and validated in MATLAB. The paper introduces an Android application that allows users to perform blood image analysis and malaria diagnosis using their mobile phones. This offers convenience and accessibility for healthcare workers in various settings. The core methodology for detecting and diagnosing malaria is the Annular Ring Ratio Method. This method is already established and has been proven effective in MATLAB. It enables the identification of various blood components, including Red Blood Cells (RBCs), White Blood Cells (WBCs), and malaria parasites within infected RBCs. The application goes beyond merely detecting parasites; it also recognizes different life stages of the parasites. This comprehensive approach provides a more detailed assessment of the infection. In addition to detecting parasites and their life stages, the application calculates parasitemia. Parasitemia is a critical measure that indicates the extent of the infection within the blood, which is important for diagnosis and treatment decisions. Overall, this paper describes a mobile application that leverages the Annular Ring Ratio Method for the automated analysis of Giemsa-stained blood film images, offering a practical and efficient solution for malaria diagnosis and assessment.

6) Red Blood Cell Classification using image Processing and CNN

This paper addresses the crucial task of analyzing blood samples in the medical field, with a particular focus on classifying red blood cells (RBCs) to diagnose various diseases. Traditionally, this process has been carried out manually using microscopes, which is time-consuming and prone to human error. Health conditions can alter the shape, texture, and size of RBCs, making automated analysis valuable. The proposed method utilizes image processing techniques and convolutional neural networks (CNNs) to classify RBCs. This automated approach aims to provide more efficient and accurate results compared to manual analysis. The algorithm extracts feature from segmented cell images to facilitate the classification process. These features likely include information about cell shape, texture, and size. The system is designed to classify RBCs into nine different types, allowing for the differentiation of various health conditions or abnormalities. In summary, the paper presents an automated approach for classifying RBCs using image processing and CNNs, with a focus on accuracy and efficiency. Such a system has the potential to save lives by aiding in the diagnosis of various health conditions associated with abnormal RBCs.

7) Computer Aided System for Red Blood Cell Classification in Blood Smear Image

This paper addresses the crucial task of identifying and counting red blood cells (RBCs) for the diagnosis of blood-related diseases like malaria and anemia. The conventional method for this procedure involves manual inspection by a pathologist under a light microscope. However, manual examination is labor-intensive, subjective, and can lead to variations in RBC identification and counting. The paper introduces a computer-aided system to automate the detection and identification of RBCs in blood smear images. This system aims to improve the efficiency and consistency of the process. The process begins by extracting RBC regions from the background using a global threshold method applied to the green channel of the color image. This step helps isolate RBCs from other elements in the image. Noise and holes within the RBCs are removed using morphological filters and connected component labeling. This step improves the quality of the RBC segmentation. Information about the RBCs is extracted based on their geometric properties. This information likely includes details about size, shape, and other relevant features. An Artificial Neural Network (ANN) classifier is used to classify RBCs as normal or abnormal based on the extracted information. This classification helps in identifying potential health issues. The proposed method has been tested on blood cell images and is demonstrated to be a reliable and effective system for distinguishing between normal and abnormal RBCs.

8) Automated P.Falciparum Detection System for post-treatment malaria Diagnosis using Modified Annular ring Ratio Method

This paper addresses the challenge of detecting and differentiating gametocytes of the malaria parasite Plasmodium falciparum in thin blood film images. Gametocytes of P. falciparum are known for their high resistance to antimalarial drugs and can still be present in the blood after successful malaria treatment. The paper introduces a modified version of the Annular Ring Ratio method, which is designed to locate and distinguish gametocytes of the P. falciparum species in thin blood film images. This method is particularly useful for post-treatment malaria diagnosis. The method efficiently detects gametocytes, which can be challenging due

to their resistance to antimalarial drugs and the need for accurate post-treatment monitoring. In addition to detecting gametocytes, the method identifies the presence of White Blood Cells (WBCs) in the image, which is essential for a comprehensive analysis of the blood sample. The method is designed to exclude artifacts and non-infected cells from the analysis, ensuring a more accurate assessment of gametocyte presence. The method relies on information related to the structure, color, and geometry of the cells. It doesn't require segmentation or non-illumination correction techniques that are commonly used in cell detection.

Sr No.	Reference	Domain	Parameter study	Description
1.	WHO	Healthcare	Antimalarial drug efficacy and drug resistance	Effective treatment of malaria is the cornerstone of malaria control, and appropriate selection of first- and second-line antimalarial medicines for country programmers is based entirely on the efficacy of the medicines against the malaria parasite. Monitoring the therapeutic efficacy of antimalarial medicines is therefore a fundamental component of treatment strategies.
2.	Anna Rosanas-Urgell, Dania Mueller , Inoni Betuela, Céline Barnadas, Jonah Iga, Peter A Zimmerman, Hernando A del Portillo , Peter Siba, Ivo Mueller and Ingrid Felger	Healthcare	Comparison of diagnostic methods for the detection and quantification of the four sympatric Plasmodium species in field samples from Papua New Guinea	Accurate diagnosis of *Plasmodium* infections is essential for malaria morbidity and mortality reduction in tropical areas.
3.	S. Kareem, R.C.S. Morling, I. Kale	Image Processing, Healthcare	Count of Red Blood cells, White blood cells as well as their location in Giemsa stained thin blood film images.	This paper describes a novel idea to identify the total number of red blood cells (RBCs) as well as their location in a Giemsa stained thin blood film image. This work is being undertaken as a part of developing an automated malaria parasite detection system by scanning a photograph of thin blood film in order to evaluate the parasitemia of the blood. Not only will this method eliminates the segmentation procedures that are normally used to segment the cells in the microscopic image, but also avoids any image pre-processing to deal with non uniform illumination prior to cell detection..
4.	S. Kareem, I. Kale, R.C.S. Morling	Image Processing, Healthcare	Automated Malaria Parasite Detection in Thin Blood: A Hybrid Illumination and Color Constancy Insensitive, Morphological Approach	In this paper, we propose a novel method to identify the presence of malaria parasites in blood image. Malaria is deadly infection disease affecting red blood cell in human body due to the plasmodium effect. In 2015, there is an estimated death toll of 438,000 patients out of the total 214 million malaria cases reported worldwide. Automated evaluation process can decreases the time needed for diagnosis of the disease. Thus building an accurate automatic system for detecting the malaria cases beneficial and has huge medical value in medical field.

Sr No.	Reference	Domain	Parameter study	Description
5.	S. Kareem, I. Kale, R.C.S. Morling	Image Processing, Healthcare	Development of a fully automated malaria diagnostic tool that employs thin blood films	This reference might provide insights into the development of a fully automated malaria diagnostic tool that employs thin blood films. The paper could describe advancements in image processing and automation for healthcare applications.
6.	S.Kareem, I Kale, R.C.S Morling	Healthcare	Malaria,parasite Plasmodium falciparum	The gametocytes of the malaria parasite Plasmodium falciparum are highly resistant to antimalarial drugs. Its presence in the blood can be detected even after a successful malaria treatment. This paper explains a modified Annular Ring Ratio method which successfully locates and differentiates gametocytes of P. falciparum species in thin blood film images. The method can be used as an efficient tool for gametocyte detection for post-treatment malaria diagnosis. It also identifies the presence of any White Blood Cells (WBCs) in the image, and discards other artifacts and non infected cells. It utilizes the information based on structure, color and geometry of the cells and does not require any segmentation or non-illumination correction techniques that are commonly used for cell detection..
7.	C. Di Ruberto, Andrew G. Dempster, S. Khan, and B. Jarra	Image processing	Analysis of infected blood cell images using morphological operators	Paper describes a system for detecting and classifying malaria parasites in images of Giemsa stained blood slides in order to evaluate the parasitaemia of the blood. The first aim of our system is to detect the parasites by means of an automatic thresholding based on a morphological approach. A major requirement of the whole system is an efficient method to segment cell images. So the paper also introduces a morphological approach to cell image segmentation, that is, more accurate than the classical watershed-based algorithm. We have applied grey scale granulometries based on opening with disk-shaped elements, flat and hemispherical. We have used a hemispherical disk-shaped structuring element to enhance the roundness and the compactness of the red cells improving the accuracy of the classical watershed algorithm, while we have used a disk-shaped flat structuring element to separate overlapping cells.

Sr No.	Reference	Domain	Parameter study	Description
8.	K.N.R.M.Rao.	Image processing	Mathematical Morphology	This paper describes a fast and reliable mobile phone Android application platform for blood image analysis and malaria diagnosis from Giemsa stained thin blood film images. The application is based on novel Annular Ring Ratio Method which is already implemented, tested and validated in MATLAB. The method detects the blood components such as the Red Blood Cells (RBCs), White Blood Cells (WBCs), and identifies the parasites in the infected RBCs.
9.	Boray Tek, Andrew G. Dempster, Izzet Kale	Computer vision , Image processing	Computer Vision for microscopy diagnosis of malaria	This paper reviews computer vision and image analysis studies aiming at automated diagnosis or screening of malaria infection in microscope images of thin blood film smears. Existing works interpret the diagnosis problem differently or propose partial solutions to the problem. A critique of these works is furnished. In addition, a general pattern recognition framework to perform diagnosis, which includes image acquisition, pre-processing, segmentation, and pattern classification components, is described.
10.	J.N. George, S.H. Woolf, G.E. Raskob	Healthcare	Idiopathic Thrombocytopenic Purpura	Idiopathic Thrombocytopenic Purpura known as primary immune thrombocytopenic purpura) is a hematologic disorder for which appropriate diagnostic and treatment strategies are uncertain. In 1994, the American Society of Hematology (ASH) established a panel to produce explicitly developed practice guidelines for the diagnosis and management of ITP. "Explicitly developed," evidencebased practice guidelines, which are being issued increasingly by medical specialty societies, combine a critical appraisal of scientific evidence with practice recommendations that state clearly to what extent the guidelines are based either on published scientific evidence or opinion (eg, clinical experience).I4 More details about the clinical practice guideline movement are provided elsewhere.'

III. CONCLUSION

There are different machine learning and deep learning algorithms employed by researchers for segmentation of blood cell components and disease detection considering microscopic analysis. There is a scope of improvement in terms of different performance evaluation parameters. Different bio-inspired optimization algorithms can be used for improvement. Explainable AI can analyze the features of AI implemented system and will make the system more trusted and commercially suitable. Blood cell analysis assumes a crucial job in location and expectation of various issues and maladies identified with the person.

There are distinctive neurotic strategies for the equivalent by and by, which ends up being exorbitant and furthermore requires a long understanding of the location. Image processing and computer vision strategies are produced for the investigation of blood cells and the discovery of maladies. The microscopic blood cell analysis framework has various stages of being specific, pre-processing, segmentation, feature extraction, classifier, and illness identification. Pre-processing comprises improving the gained picture quality and commotion expulsion. This incorporates Gray-scale conversion, thresholding, filtering, histogram stretching, morphological operations. Preprocessed image is portioned to get the locale of interest for further processing. Here WBC and RBC, and platelets are isolated.

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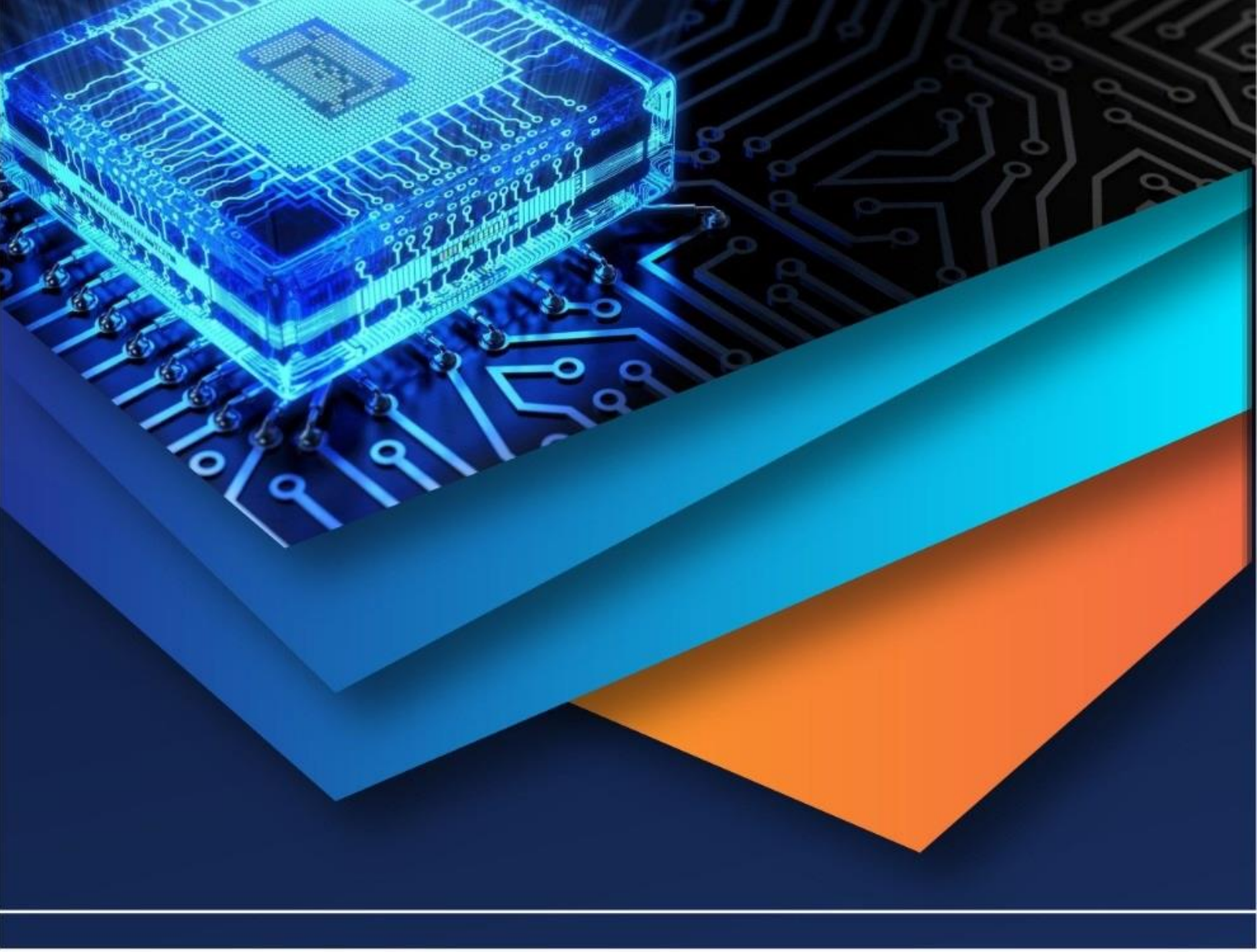

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