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Detection of Cancer in Cells based on Ratio of Nuclei and Cytoplasm Segmentation

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Abstract: ***The medical examination done in a living body by removing the tissue to detect the presence of disease is called Biopsy.Since,it involves invasive tissue removal from living body,it is more complicated and time consuming process.In such case,non-invasive in vivo virtual biopsy is preferred which involves automatic cell segmentation approach.Morphological image processing concepts are used in watershed transform to incorporate certain principles of convergence index filter to segment cells in vivo virtual biopsy of human skin.This paper provides various approaches to improve the results of skin cancer diagnosis using automated cell segmentation and identification of skin cancer at an initial stage.***
Indexterms: Biopsy,Automaticcellsegmentation,Watershed transform,convergence index filter

I. INTRODUCTION

In current scenario,cancer is a major health issue.Nowadays, most of the people die due to cancer.There are over 100 types of cancer which affect humans.cancer may occur due to usage of tobacco,improper diet,obesity and lack of physical work.The survival rate depends on start of treatment,location where cancer has occurred and type of cancer .Cancer tumor can spread easily into nearby tissues , these tumors will grow rapidly and can travel to far distances through blood to form new tumors.some tumors will grow back even they are removed from the body.Biopsy,laboratory tests,Imaging tests,Endoscopy,Genetic tests,Nuclear medicine scans are common diagnostic tests taken to confirm cancer.The prominent tool used for treating cancer is radiation therapy.The computed tomography(CT),Magnetic resonance imaging(MRI),ultrasound imaging are examples of some technologies for viewing internal biological structures in vivo.These instruments are expensive and can't view cellular and sub-cellular structures less than 10 nm.Early diagnosis is done by THG signals and type of treatment depends on level of malignancy.Eventhough many biopsy techniques are available for diagnosing skin cancer,histopatholy microscopic analysis is an effective technique to accurately diagnose skin cancer.

The screening tests are also used for diagnosis of cancer at an earliest stageIf a person is diagnosed with cancer, there is a increased risk of committing suicide in an initial stage.Even if the cancer is treated,there is less chance of making the people live longer or curing it.Vaccines like HPV helps in preventing certain types of cancer.Intake of nutrients like monounsaturated fat, polyunsaturated fat,omega-3 fatty acids,pytochemicals etc. would reduce the chance of getting cancer .The difference between manual and virtual biopsy is shown in fig (1).

A. Manual Biopsy and Virtual Biopsy

Biopsy is a examination done to detect the presence of a disease by removing tissue from a body which is tested under microscope by a pathologist.At times, false diagnosis would be made due to biopsy,tissue processing and artifacts which occurs due to operation errors.Besides , some clinical difficulties and side effects may occur which includes infection,pain,bleeding,scar formation and risk of cancer cellspreading.The techniques like biopsy,imaging cells and details of tissues under microscope are preferred to differentiate benign from malignant lesions non invasively.The drawback of biopsy medical examination has been eradicated by in vivo virtual biopy which voids remoing the tissues and also it reduces the cost and time involved in pathohistological processing.

Optical virtual biopsy which provides comprehensive non invasive total lesion scanning for improved clinical disease classification and therapeutic guidelines and possible way for continuous disease monitoring during and after treatment. Thermoregulation,protection,sensation and social communication are the significant functions provided by skin.In order to diagnose the skin conditions and disease accurately,histopathology microscopic analysis of the excised tissue is commonly used today.In dermatology,Pathological confirmation is done to diagnose the skin conditions and disease, rarely the same is done by naked eyes.The non invasive virtual biopsy tool is more appropriate and highly desired for early cancer diagnosis where as painful physical biopsy is avoided.The physical biopsy is not recommended for certain diseases like atopic dermatitis and vitiligo where as

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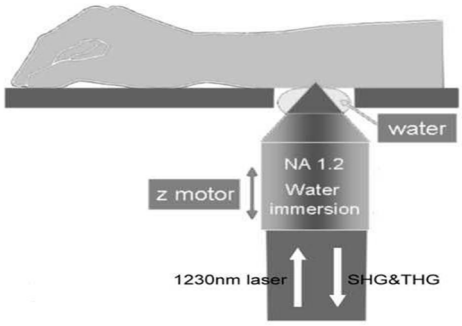
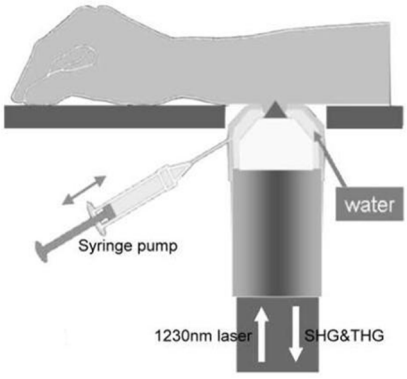
virtual biopsy is used to assist in diagnosing and screening the skin conditions . The various non-invasive imaging techniques like dermoscopy,ultrasound,opticalcoherence tomography,Reflection confocal microscopy ,two-photon fluorescence microscope and second harmonic generation microscopy have been developed and in use for in vivo human skin diagnosis.

(a)



(b)



(c)

Fig. 1: *(*a)manual biopsy (b) In vivo virtual biopsy of skin with an NA 1.2 water immersion objective. (c) In vivo virtual biopsy of skin with a syringe-pump objective

II. CELL SEGMENTATION ALGORITHMS

A. Watershed Transform

Watersheds are one of the classics in the field of topography. A drop of water falling on one side of this line flows down until it reaches the Atlantic Ocean, whereas a drop falling on the other side flows down to the Pacific Ocean [2]-[3]. Now, in the field of image processing and more particularly in Mathematical Morphology (MM), grayscale pictures are often considered as topographic image. It means that topographic representation of a given image the numerical value (i.e., the gray tone) of each pixel stands for the elevation at that particular position. This type of representation is highly useful, since it first allows one to better appreciate the

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effect of a given transformation on the image under study [5]. It is also more accurate and behaves well in all the particular pixel configurations where many algorithms produce incorrect results [16]. Furthermore, the present algorithm is very general: its adaptation to any kind of underlying grid is straightforward, and it can be fairly easily extended to n-dimensional images and even to graphs [6]. Mainly watershed transform is used in nuclei segmentation. It may be combined with marker controlled strategy which identifies regional minima. By using watershed transform we can avoid photo damage and produce over segmentation.

B. Marker controlled strategy

Marker controlled watershed transform provides good results if we identify background locations and foreground objects.The procedure for marker controlled strategy is given below:

1) Ssegmentation function is computed which is an image whose dark regions are objects which we are trying to segment
2) Foreground markers are computed which are connected blobs of pixels with in each of the objects.
3) Background markers are computed which are pixels and they are not part of any object.
4) Segmentation function should be modified to have minima at the foreground and background marker locations.
5) The watershed transform should be computed for modified segmentation function

C. Convergence index filter

Convergence index filter set is the convergence degree of a gradient vector which is calculated from the angle (k,l) with respect to reference direction i.Edege detection is one of the major problem in image processing where edge gives important clues for image recognition and image understanding.Edge detection have proposed many methods,most of them are based on magnitude of spatial differences because considerable intensity differences could be expected at the boundary between object and its background.Some objects are found to have very weak contrast to their backgrounds like abnormal opacities on X-ray images where boundaries of cancerous tumor are not clear.An effective method to identify vague boundaries are required since characteristics of tumor boundaries are very useful in discriminating between benign and malignant tumors. The discrete convolution method of high pass mask and statistical differencing is used to perform edgse enhancement.Discrete convolution method depends on the magnitude of spatial differences in which edge christening effects are not enough if contrasts are not strong.The proposed filter to gradient vector fileds and not to intensity images.The distribution of orientation of gradient vector regarding pixel of interest is evaluated.The size and shape are changed according to the distribution of gradient vector in the neighborhood of pixel of interest.It is possible to enhance indistinct boundaries which is also effective in detection of rounded convex regions in an image irrespective of their contrast to background.

D. Image thresholding

The method which converts grayscale image to binary image where pixels are assigned with two levels which are below or above the threshold value.Image threshold operation is very effective in providing several methods for finding the optimal threshold value for an image.

E. Histogram Shape Based

Histogram based image is the very simplest and frequently used image segmentation techniques.It selects gray levels for grouping pixels into regions.The histogram will provide gray level of the background and the object.Background is represented by largest peak and object is represented by next largest peak.Threshold takes the pixel which are present on the object and set it to one and sets the rest to zero.

F. Entropy Based

This approach is based on the process of dividing digital image so that different objects can be located.Color infor mation would be very useful to obtain accurate segmentation compared to gray level images.

G .Spatial Methods

In Spatial segmentationregion based approach depends on homogeneity of certain spatially localized feature like texture, position and intensity.

H. Clustering Methods

Cluster analysis help to divide image data set into clusters or numberof disjoint groups.

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I. Spectral Clustering

Spectral clustering gives the flexibility to define how pairs of data points are same or not.In this method there are infinite number of ways to group points.

J. K Means Clustering

This algorithm is used to partition interest area from the background.The image that is to be segmented are represented as set of points in 3D data space.

K. Sliding Band Filter

Microscopy image analysis of cell culture is used for experimental research in cell biology.In most of the cases,the use of various fluorescence dies or proteins is to enable the multivariate images which has information on various aspects of each cell.Manually, images can be analysed but it is time consuming,human error will occur and need frequent repetitions to validate the results.since, there are lot of drawbacks automatic cell analysis tool was developed to identify each cell individually and to extract relevant cell characteristics.The SBF filter depends on gradient convergence and not on intensity which can detectlow contrast cell information otherwise it would be lost in the background noise.

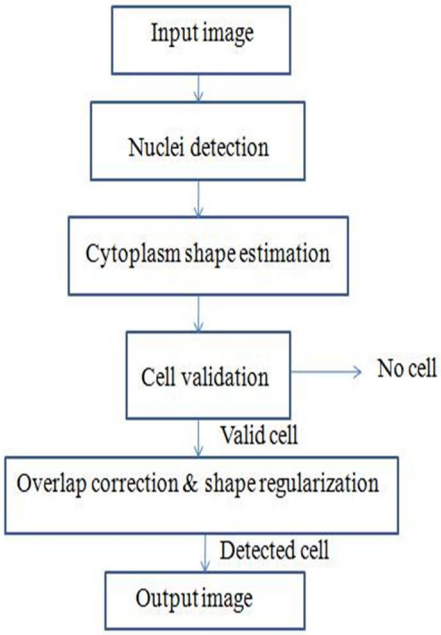

Fig: 2 Cell detection method

SBF filter has certain advantages where some one can easily set up the parameters even though they don't have knowledge about the underlying image processing details and it has simple observable image characteristics like shape ansd size.In order to apply SBF filter to multivariate images, gradient convergence centre of the cell nuclei and cytoplasm image should be same.

The errors caused by noise in the images are avoided by use of nuclei approach restricts the final shape and limiting unlikely shape estimation deviations which is in contrast to the state of the art methods like active contours detection information to guide the cytoplasm shape segmentation.

The detection criterion has been proposed which evaluates the nuclei and cytoplasm convergence cell estimation center and cell detection removal which does not meet a minimum convergence level.

Therefore , nuclei detection errors do not imply final cell detection.in order to limit the allowed cell shape and cell overlap in final cell detection,there are two correction steps.

First,overlap is corrected by irregular cytoplasm shapes which greatly overlap with other cells that were incorrectly estimated.Second,cell shapes are regularized so that strong discontinuities are eliminated.

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III. PROPOSED METHODS

The nuclei segmentation and cytoplasm segmentation are the proposed methods.Watershed transform is used for the computation of nuclei segmentation.Segmented cytoplasm is obtained by local filter.Atlast,evaluated nc ratio is obtained.The above mentioned two methods are explained below in detail.

A. Nuclei Segmentation

Gradient watershed transform with marker controlled strategy is used to perform nuclei segmentation.Accurate segmented nuclei blob detection were used by shape descriptors.

The regional minima which was used for nuclei segmentation is identified by watershed transnsform.The input image should be converted to gradient map before performing nuclei segmentation.Application of direct watershed transform on gradient map results in over segmentation.In order to get rid of this,nuclei initialization is done using marker controlled strategy.

B. Cytoplasm Segmentation

A convergence index filter is used based on valid nuclei for cytoplasm segmentation since it considers gradient vectors instead of intensity of images.Low contrast and noisy miocroscopy images also use convergence index filter.This filter makes unwanted preprocessing for enhancing contrast and removing irregular noise in biomedical images which also preserves the information needed for clinical diagnosis

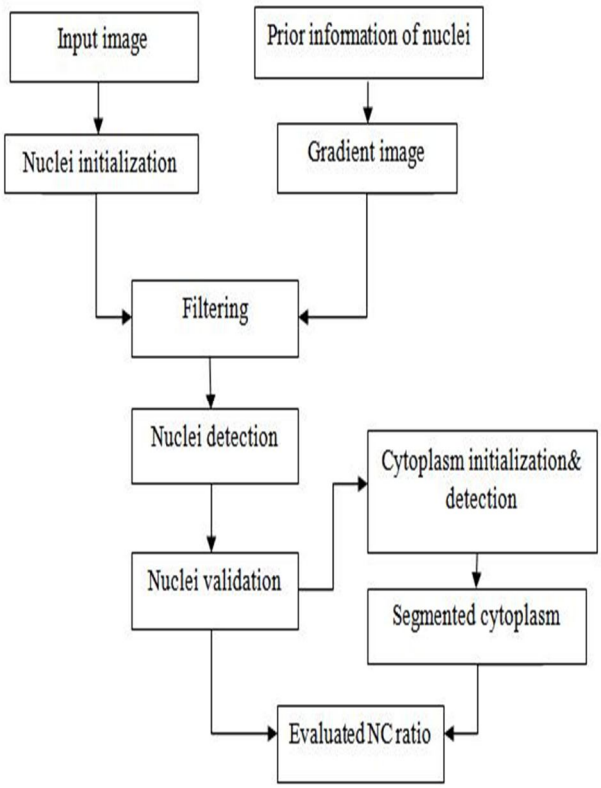

Fig: 3.Flowchart of proposed method

C. Nuclei Detection and Validation

The watersheds of the filtered gradient map are calculated by watershed transform to obtain segmented nuclei from original skin cell images.Shapes are considered to assure whether nuclei have been accurately segmented.Shape descriptors are used in applications like pattern recognition,computer vision and microscopy imaging analysis where undesired objects are excluded.The proposed algorithm is applied for skin cell image shown in fig 4.The image consists of either valid cells or invalid cells.Usually ,cell has circular or elliptical structure and shape descriptors removes invalid cells.

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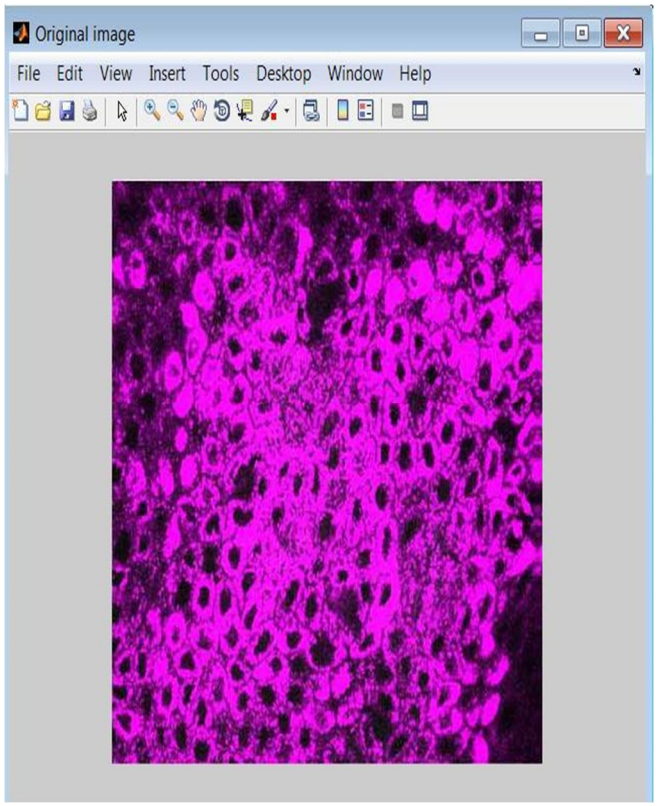
D. NC Ratio Evaluation

Nucleus size and cell size indicates certain diseases.usually the value of NC ratio is higher in cancer affected cells compared to normal cells.NC ratio also indicates the maturity of a cell since cell matures the size of its nucleus decreases. From this ratio, developing stages of certain skin diseases can be identified.Thus, any diseases can be detected at earlier stage.

IV. SIMULATION

A. Nuclei and Cytoplasm Segmentation

The input image is normal skin cell image which is converted to gradient map.Boundary of the nucleus is identified which would be compared with original image.From this, valid nuclei regions are identified followed by nuclei and cytoplasm segmentation using convergence index filter.Thus, the result of nuclei segmentation is shown in fig 6.



Cell index	Cell area	Nuclear area	Cytoplasmic area	NC ratio	Position row	Position column
1	193	54	139	0.3855	13	400
2	294	60	234	0.2564	50	354
3	183	56	127	0.4409	55	381
4	173	60	112	0.5446	62	361
5	220	61	165	0.3333	76	355
6	166	55	120	0.3833	76	378
7	283	46	231	0.2251	89	421
8	172	52	120	0.4333	92	341
9	212	58	144	0.4722	92	308
10	216	49	167	0.2934	101	255
11	159	51	108	0.4722	100	203
12	431	61	370	0.1649	117	189
13	163	46	117	0.3932	107	377
14	251	66	185	0.3568	113	310
15	200	53	147	0.3505	117	140
16	168	50	118	0.4237	118	53
17	184	51	133	0.3835	120	338
18	189	49	140	0.3500	122	123
19	207	62	145	0.4276	124	77
20	212	66	146	0.4521	126	279
: :	: :	: :	: :	: :	: :	: :
Total	8354	2214	6140	15.2794	-	-
Average	214.2051	56.7692	157.4359	0.3918	-	-

Fig:4 Skin Cell image

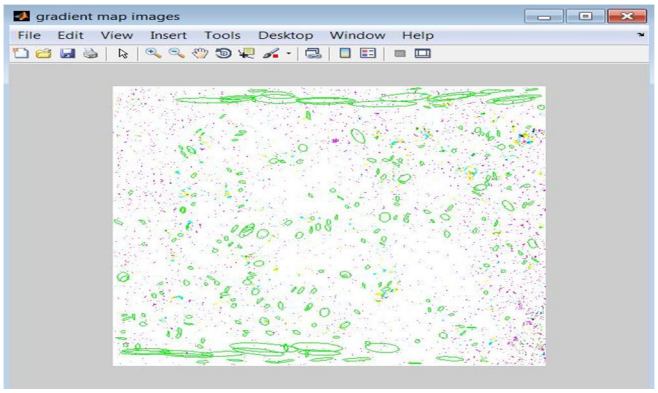


Fig:5 Gradient map image

In fig 4,The blue mark indicates valid nuclei and remaining shows unwanted nuclei.

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B. Evaluated NC Ratio

The result which are placed on the table is for segmented normal cells.The normal cell nc ratio is less compared to cancer affected cells.The nc values supports medical pathologist to diagnose the intensity of the disease which also helps to identify the disease at the earliest.

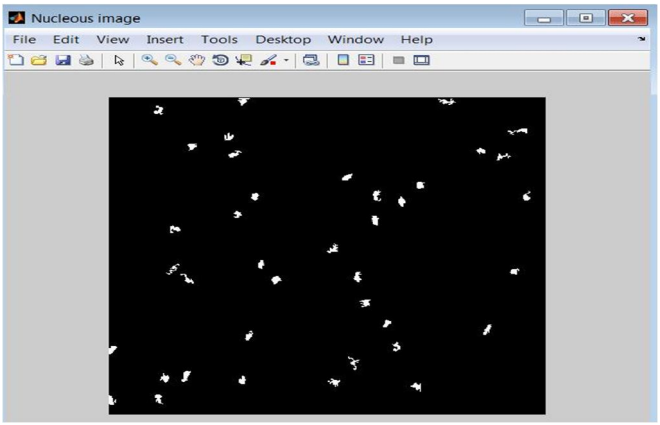

Fig:6 Cell identification

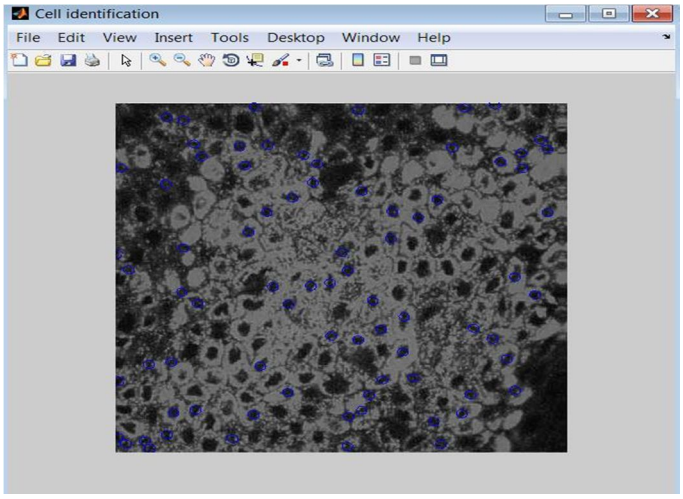

Fig:7 Segmented nuclei

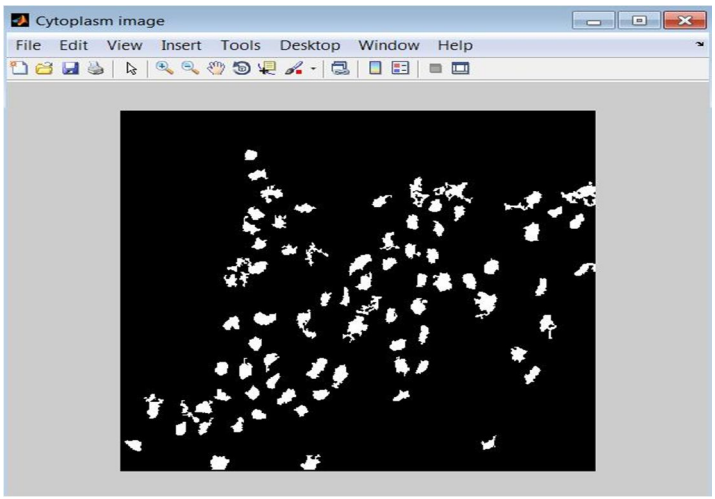

Fig :8 Segmented Cytoplasm

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V. CONCLUSION AND FUTURE WORK

This paper presents a method to find NC ratio for normal skin cell image where the value of NC ratio in cancer affected cells are large compared to normal one.The different stages of disease and its severity can be identified by NC ratio and it is also used to find different skin diseases like skin aging and affected skin due to the usage of cosmetic products.Computer integrated surgery uses cellsegmentation which provides less time consumption and high speed.In future,cell segmentation method will provide more precision , accuracy ,computational speed of segmentation and also reduce the amount of over segmentation.

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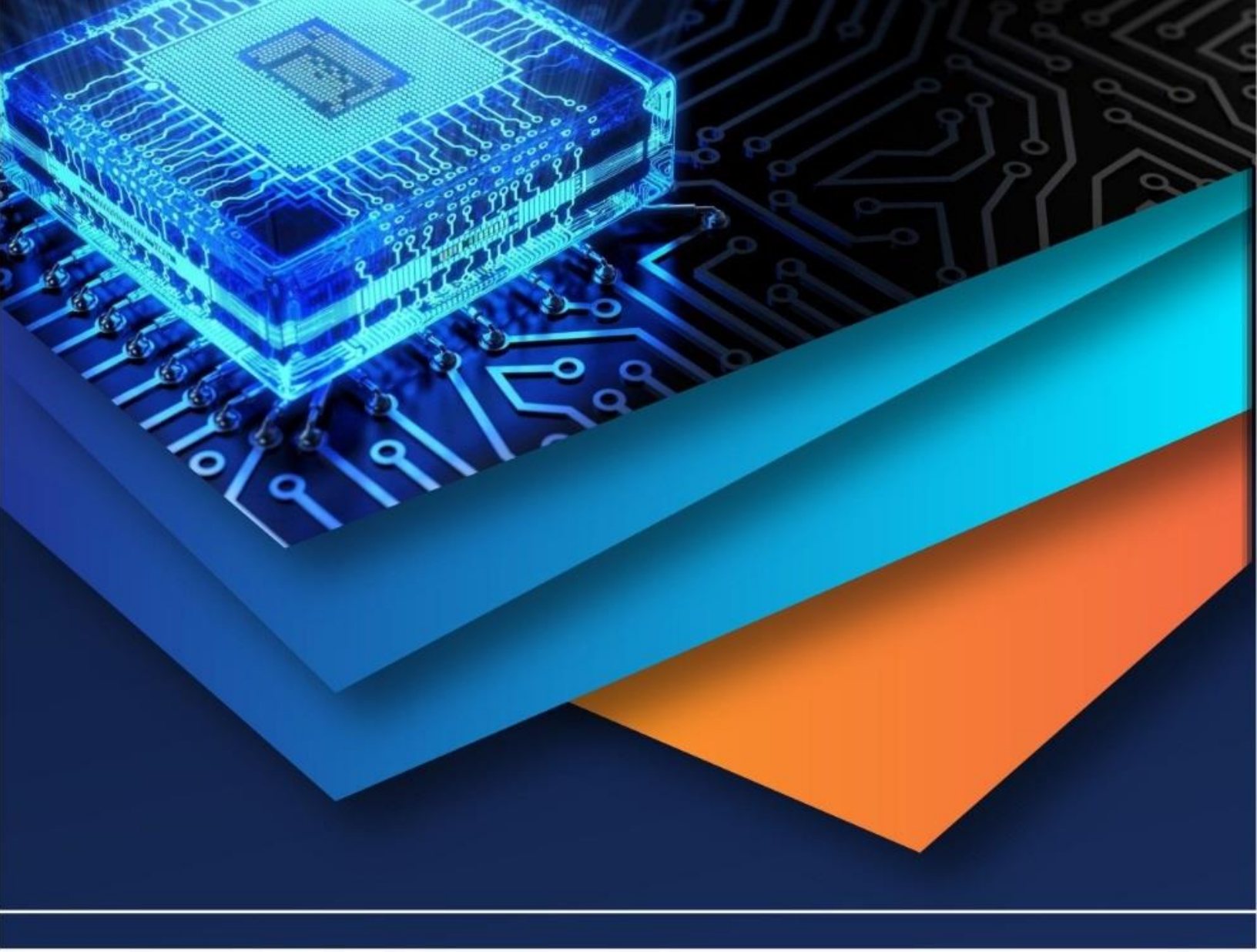

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