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Region of Interest based Contrast Enhancement Techniques for CT Image

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***Abstract:** Medical images are used for decision making purpose by the physicians to recognize the disease by which the patient is suffering. Thus to lead the highly reliable results, it is mandatory that the image should be more qualitative and informative. In order to make an image more qualitative, the image enhancement technique is applied to it. Image enhancement is such a vast field and covers a large number of enhancing mechanisms under it. This study develops a medical image contrast enhancement technique by applying multi filters, curvelet transformation and un-sharp masking. For Multi Filtration, the Kuwahara filter and Gaussian filter is used in this. Along with this the ROI is applied to detect the infected areas or noise from the image. The implementation results show that the final enhanced image is quite qualitative in comparison to the initially input image in terms of Bit Error Rate, Mean Square Error, Standard Deviation, Peak Signal to Noise Ratio, Entropy, Contrast to Noise Ratio etc.*
***Keywords:** Image enhancement, Contrast Enhancement, Kuwahara Filter, Gaussian Filter, Curvelet Transform, Un-Sharp Masking.*

I. INTRODUCTION

Image enhancement is the part of the signal processing. The image processing can be of two types such as analog image processing and digital image processing [1].But the digital image processing is most preferable than the analog image processing because it has large variety of algorithms and techniques for implementation. Digital image processing also avoids the reformation of the signals at the time of processing. Digital image enhancement is used for improving the quality of the digital data by removing the unwanted and noisy contents from it. It is done to increase the quality of the image by increasing the sharpness of the image pixels and vision clarity of the image [2]. Digital image processing and enhancement is also done for extracting the information or meaningful data from the image. Digital image enhancement is a very vast field and it is quite complex also due to the usage of mathematical calculations. The process of image enhancements is initiated by an input image which is further processed by the computer by using some calculations and on the basis of these calculations the modifications are done in the image automatically [3]. The results obtained after enhancement can be displayed on the monitor or can also be kept for the purpose of future use. In order to increase the quality of the image various process are defined on the image [4]. Image quality is enhanced for the purpose of clear visibility of the image and the enhanced image can be used or more suitable for machine perception [5]. All of these features can only be enhanced by removing the noise from the signals or image. This study develops a medical image enhancement technique by using multi filters and curvelet transform technique.

II. PROBLEM FORMULATION

Each time when CT images are considered, they are contaminated by various types of noise like additive noise, salt-and-pepper noise and multiplicative noise. There are various filters available that helps in suppressing such kind of noise [6]. In the existing work, Gaussian filters, median filters and curvelet transformation techniques are used to suppress the noise and enhance the image. Gaussian filters are used to remove blur from the images whereas median filters are used to suppress salt-and-pepper noise. The curvelet transformation refers as a technique to characterize images at different scales and angles to eliminate multiplicative noise. However, median filter is not capable in preserving the edges of the image and reduced its quality. Considering this fact, there is a requirement of replacing the existing filter with the advanced filter that can preserve the edges while enhancing the contrast of the image.

III.PROPOSED WORK

From the survey, it has been concluded that existing work has used median filter for removal of noise from the image. However, median filter is not capable in preserving the edges of the image. Therefore, in the proposed work, median filter is replaced with the kuwahara filter algorithm. This algorithm is able to apply smoothing on the image while preserving the edges. The application of

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this algorithm can enhance the quality of image. Furthermore, ROI method based contrast enhancement technique has used to generate and extract the region based on the image contrast of the image. The primary objective of the work is to design a novel algorithm for extracting the affected region. The proposed work has the ability of retaining the actual quality of the image while enhancing its contrast.

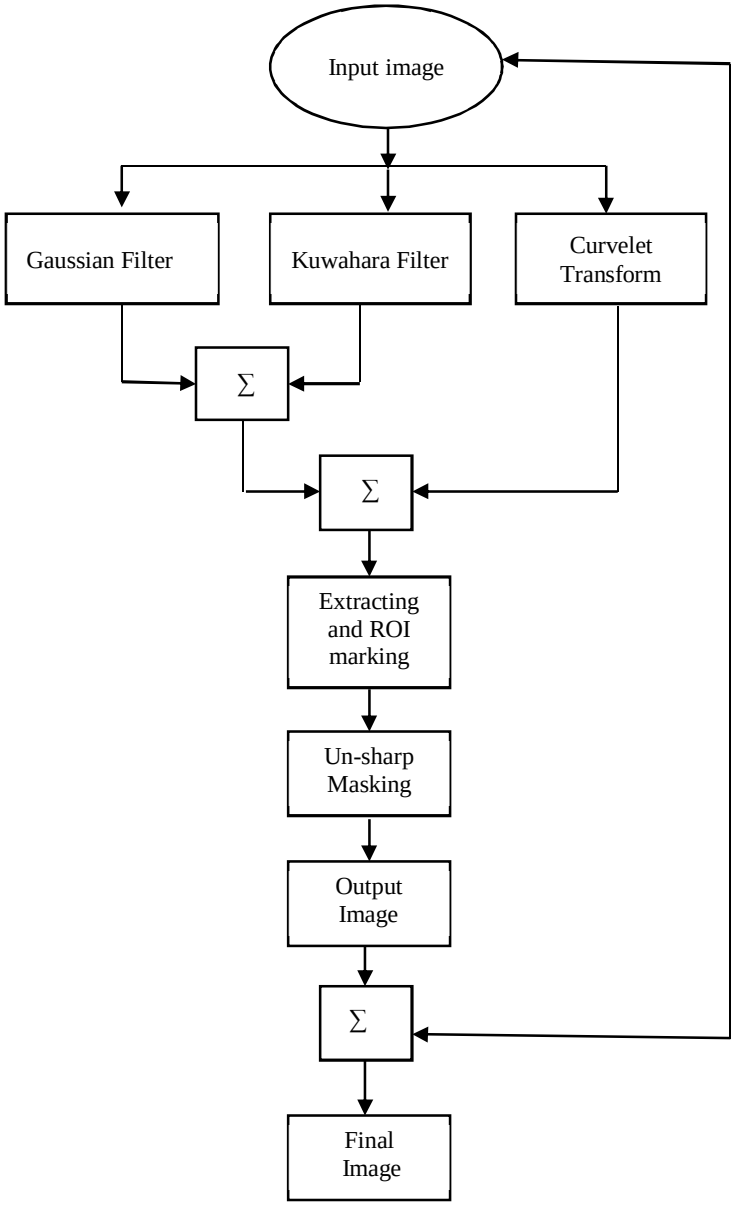


Fig. 1 Framework of Proposed Work

A. The Step Wise Procedure of Proposed work is Defined as Follows

1) Start

2) First step in proposed work is to select the input image from available dataset of image. In proposed work, three different images are used for this purpose. Out of these three images one is of Lena and two are medical images. When user runs the proposed work, the system empowers the user to select the image for input to the system.

3) In this step, the input image is enhanced by applying multiple filters i.e. Gaussian filter, Kuwahara filter and curvelet transformation. The Kuwahara filter is applied to reduce the adaptive noise from the image. The Kuwahara filter is a non- linear

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filter that divides the image into four sub blocks and evaluates the mean of these blocks. The block division is shown as follows:



Fig. 2Block Division of Kuwahara Filter [12]

The Gaussian filter is used for enhancing the blur image. It falls in the category of low pass filters. It uses the following Gaussian function for this purpose

$$G(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{x^2}{2\sigma^2}} \dots\dots\dots (1)$$

Where σ is used for standard deviation.

The Curvelet Transform is a multi scale transformation technique that is used to handle the curve discontinuities in image.

4) The images generated after applying filters and curvelet transformation is preceded further for processing.

5) In final observed image, the extraction and detection is applied. In extraction, the high contrast region on the basis of region of interest (ROI) is extracted from the final combined filtered image. The ROI is selected on the basis of infected areas in the image.

6) Apply un-sharp masking technique. This is applied to enhance the quality and contrast of the image.

7) The observed image is added with the initially used input image in order to generate the final enhanced image.

IV. RESULTS

Input images: This section represents the input images that are used for simulating the proposed work. There are total three types of images are considered in this and two of them are medical images i.e. the image of Sheep Logan and Liver and one is of Lena. The table 1 represents the results that are obtained after implementing the proposed image contrast enhancement technique in MATLAB.

TABLE I SIMULATION RESULTS

Output Images	Description
  (a)Lena (b)Sheep-Logan	As defined in methodology, the first step for proposed mechanism is to select an input mage. Thus for this purpose, three different images are considered in this work. The image shown in figure 3(a) depicts the input image 1 (Lena). The figure 3(b) depicts the sample image of Sheep-Logan and 3(c) shows the sample of Human Liver that is obtained after doing CT Scan. These are the most common sample images used for simulation purpose.

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(c)Liver

Fig. 3 Sample Input Images



Fig. 4 Original Image

The figure 4 delineates the input image which is selected for further processing.

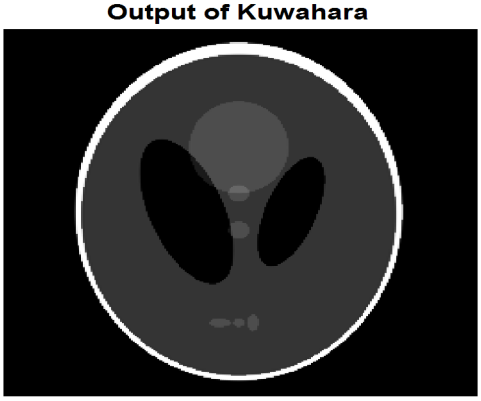


Fig. 5 Kuwahara Filtered Image

After entering the image to the system the multi filtration process is applied to it. The image in figure 5 represents the filtered image that is obtained after applying the kuwahara filter to the input image.

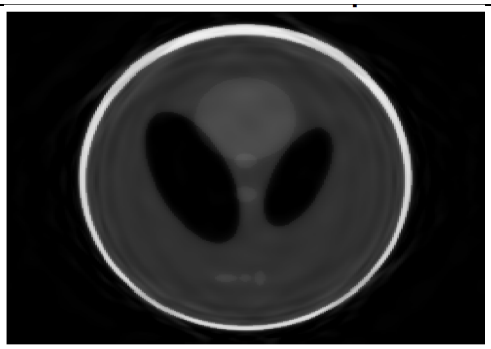
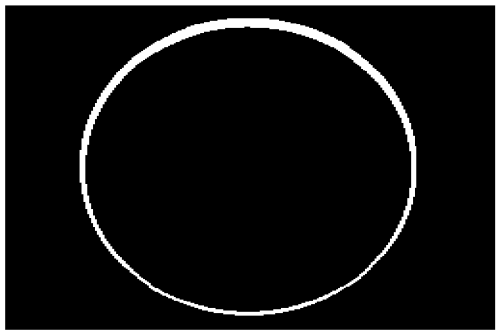


Fig. 6 Gaussian Filtered Image

The figure 6 represents the filtered image which is observed after applying the Gaussian filter to the initially input image.

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 Fig. 7 Combined Filtered Image (Kuwahara and Gaussian)	After applying two different filtration mechanisms, two different filtered images are obtained. Figure 7 presents the combined filtered image that is obtained after combining both the filtered images as shown in figure 5 and 6.
 Fig. 8 Curvelet Based image	The image in figure 8 delineates the output image of curvelet transformation. The curvelet transformation is applied to preserve the curves of the image.
 Fig. 9 Combined Output Image	After applying the curvelet transformation, the final filtered image and transformed image is used to obtain a combined output image. The image in figure 9 depicts the combined output image(Kuwahara filter, Gaussian filter and curvelet transformation).
 Fig. 10 ROI detected Image	After obtaining a single output image, the region of interest is detected from it. The ROI is selected on the basis of the two different parameters one is high contrast and another is effected region. The figure 10 shows the image with selected ROI.

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Fig. 11 Sharpened Image

After selecting the ROI, the un-sharp masking technique is applied to preserve the contrast of the images so that the quality of image can be enhanced. Figure 11 shows the sharpened image on the basis of selected ROI.



Fig. 12 Final Enhanced Image

After performing all the procedure defined in methodology section, a final enhanced image is obtained as shown in figure 12. The final image is enhanced image with the perspective of quality, contrast etc.

TABLE III PERFORMANCE PARAMETERS

S No.	Parameters	Value
1.	CNR (Contrast to Noise ratio)	25.1307
2.	STD (Standard Deviation)	0.5851
3.	Entropy	2.0576
4.	MSE (mean Square Error)	98.7561
5.	BER(Bit Error Rate)	0.03548
6.	PSNR (Peak Signal to Noise Ratio)	28.1852
7.	SNR (Signal to Noise Ratio)	0.46521

The performance of the proposed work is evaluated and reflected in table 2 in terms of different performance parameters i.e. CNR, STD, Entropy, MSE, BER, PSNR, and SNR. The CNR of proposed work is 25.1307, STD is 0.5851, Entropy is 2.0576, MSE is 98.7561, BER is 0.0355, PSNR is 28.1852 and SNR is 0.4652. These facts prove the efficiency of the proposed work in respective terms.

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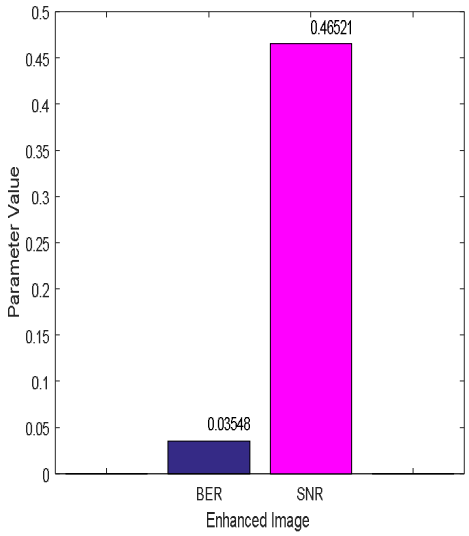


Fig. 13 BER and SNR

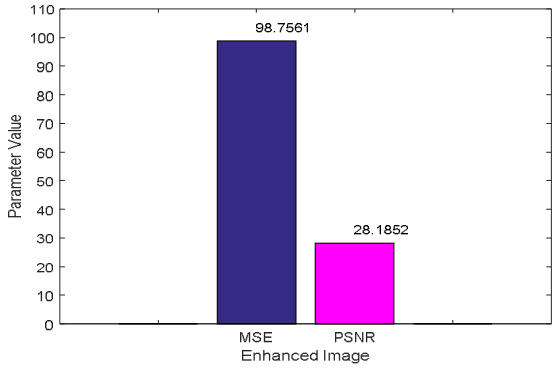


Fig. 14 MSE and PSNR

The graph shown in figure 13 depicts the BER and SNR that is observed in proposed work. The BER of the proposed work is 0.03548, and the evaluated SNR is 0.46521.

The MSE and PSNR of proposed work are presented in figure 14. The MSE of proposed work is 98.7561 and the PSNR is 28.1852.

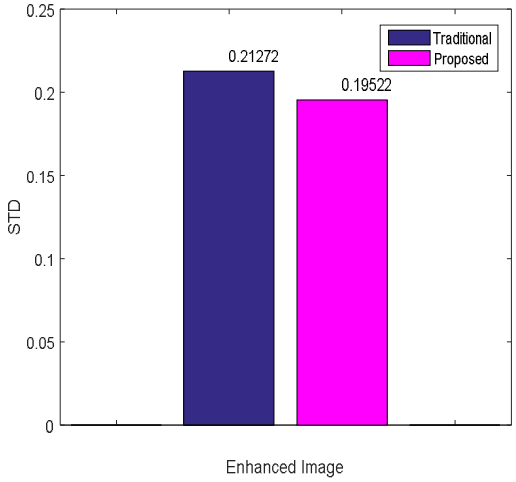


Fig. 15 Comparison of STD

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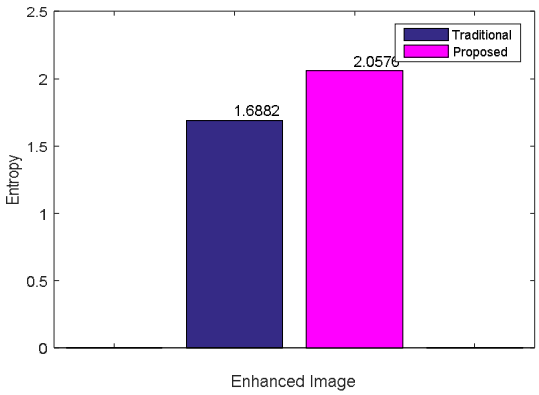


Fig. 16 Comparison of Entropy

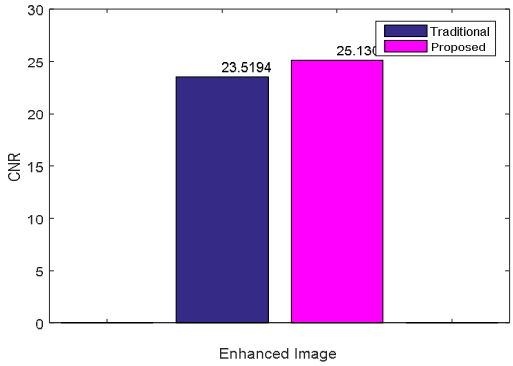


Fig. 17 Comparison of CNR

The comparison of proposed and traditional work is shown in figure 15, 16 and 17. The comparison analysis is done on the basis of the standard deviation (STD), Entropy and Contrast to Noise Ratio (CNR) respectively. From the graphs it is concluded that the proposed work outperforms traditional work in respective terms.

V. CONCLUSION

The image enhancement is done to increase the quality of the image. This study concludes that the filtration, transformation and masking has great impact in order to enhance an image. The multi filtration technique is applied in this work to medical image. Along with this, the curvelet transform and un-sharp masking technique is also used. This is done to increase the efficiency of decision making process on the basis of the medical images.

In future more amendments can be done to enhance the efficiency for extracting the Region Of interest (ROI). Thus advanced ROI extraction techniques can be applied in future.

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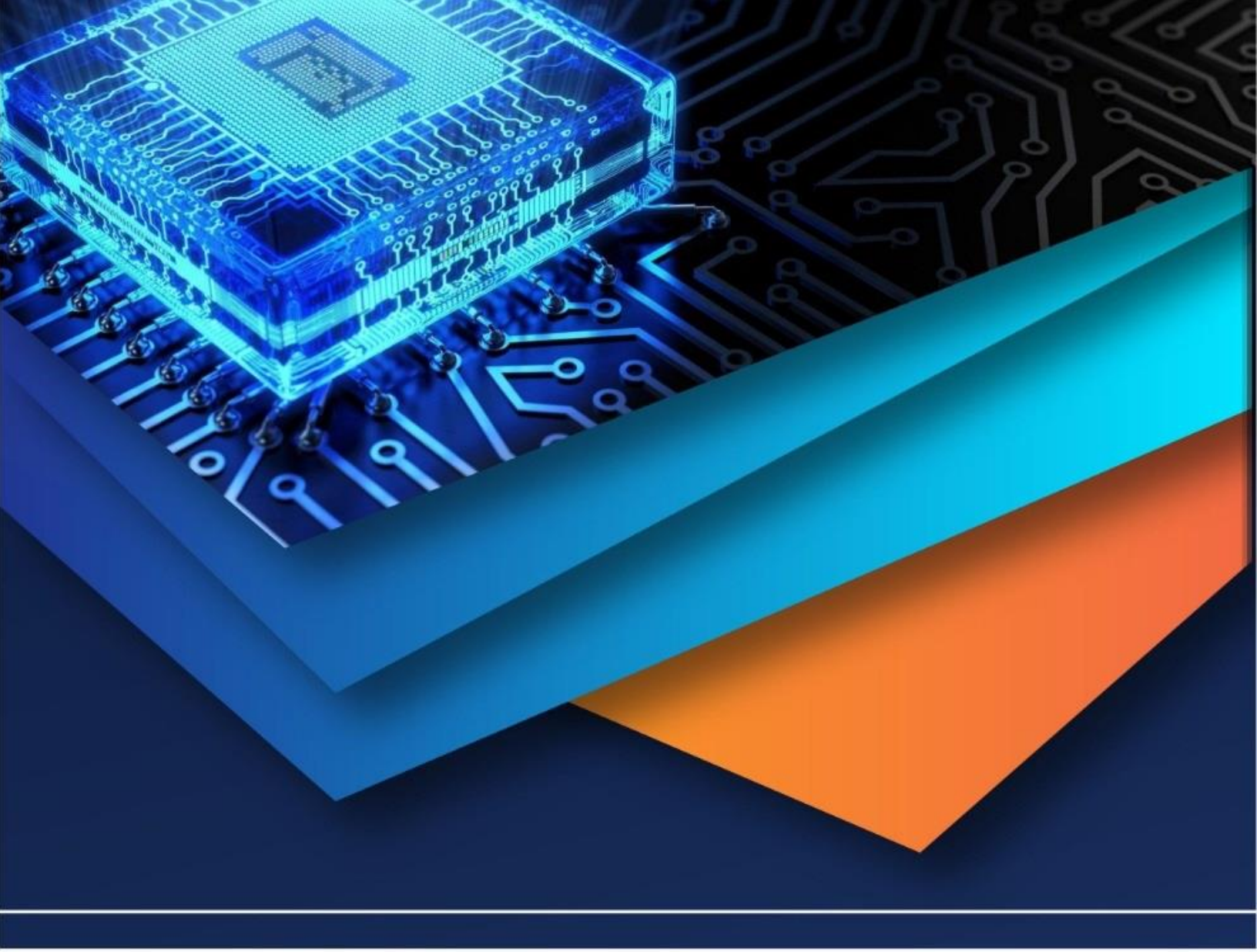
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