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FPGA Implementation of Adaptive Contrast Enhancement Architecture for Medical Image Processing

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Abstract: Contrast of any image is principally relying upon the sunshine intensity gift within the image. Conjointly this can indirectly associated with the standard of a picture. This can be as a result of is any image having low intensity level then it seems as dark image and a high intensity image seems to be terribly bright image. In each cases it's troublesome to work out the objects gift therein image. So, to form unhealthy quality image to sensible quality image distinction improvement techniques are ordinarily used. However the most drawback of these techniques is that the calculation of threshold worth. During this project we tend to propose and implement FPGA design for distinction improvement victimization accommodative threshold. The performance of the planned design is best than existing techniques in terms of each hardware utilizations and output image accuracy.
Keywords: Adaptive Threshold, Contrast Enhancement, FPGA Implementation, Gaussian Filter, Histogram Equation, Medical Image Processing.

I. INTRODUCTION

Now a day's life is incredibly quick. To take care of quick life human society is incredibly a lot of dependent to gadgets. Gadgets may be able to perform a group of predefined task quicker than traditional person. However to form quicker gadgets, the process unit should be able to method the input file. To make quicker process unit we will use quicker design. However which will not solve the full downside. as a result of the process speed additionally rely upon how briskly information will reach to the actual process unit. The causation of information is directly dependent to the speed of the bus design gift within the style. To design bus design isn't a simple task. As a result of the processor should take information from any input sensors which is able to activate by some incident on that and that we understand that the measure of such incident is way longer than the frequency is employed by the processor. So, once we connect the device to the processor then frequency match happens. to beat that sort of downside frequency conversion i.e. low frequency information to high frequency information at the input of processor and vise-versa within the output aspect of the processor. To make this specific frequency conversion and memory block in necessary. During this case the information is split into little block and store into the memory into one frequency. Once total information frame is hold on into the memory then the date may be red with completely different frequency than input. During this means we will build frequency conversion while not modifying or losing any information stream.

The basic method to obtain enhance image is histogram equalization (HE) [2]. Before to study the HE let us know about Histogram .it is a alternate form to represent an image. It can be range from '0'to 'L-1'where L is range of pixel valve for gray image it is 256.histogram is a simple plot of number of pixel with brightness value of pixel. It simply counts the pixel intensity value and pixel probability. In HE they are two approaches, global (GHE) and local or Adaptive histogram equalization (AHE).in GHE the histogram of entire image is considered. It is nothing but simple HE obtains of image. Hence it requires more hardware implementation with pore image quality. In AHE include two steps .first step is dividing the entire image into tiles and next step is applying HE for each tiles. Hence the obtain image quality is better than GHE. The AHE method [3] can give better image quality then GHE but main disadvantage of these method is blocking effect and noise amplification .when a same intensity value of pixel fall in two different tiles then AHE may remap them with two different intensity values this is called as Blocking effect hence output image is not smooth. The blocking effect can be seen at boundary of tiles. It also amplifies the noise present in an image. To resolve this problem the overlapping method is used but theses method is more complex. Contrast limited adaptive histogram equalization (CLAHE) [4] is a method use to enhance the local details of an image. Using this method solve noise amplification, the blocking effect of adaptive histogram equalization (AHE). Image is enhanced using two basic techniques they are spatial domain and frequency domain .in spatial method [5] it include point processing .which is nothing nut contrast stretching using linear method and

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also threshold method. Threshold method used to improve the dim images. The disadvantage of this method is the signal to noise ratio is increased. But this method can be used in medical image processing like CT scan, X-ray etc.

II. PROPOSED ENHANCEMENT ARCHITECTURE

The proposed architecture for contrast enhancement is shown in the Fig.1. The histogram is calculated from the input image. Depending upon the pattern of histogram the decision making block will decide that the contrast level of the input image i.e. high contrast or low contrast. This will used by linear starching block to stretch the contrast to acceptable label. The value is used by the Linear Stretching block is calculated by Adaptive Threshold block. Then the enhanced image pixel use mapped to a certain boundary by mapping block

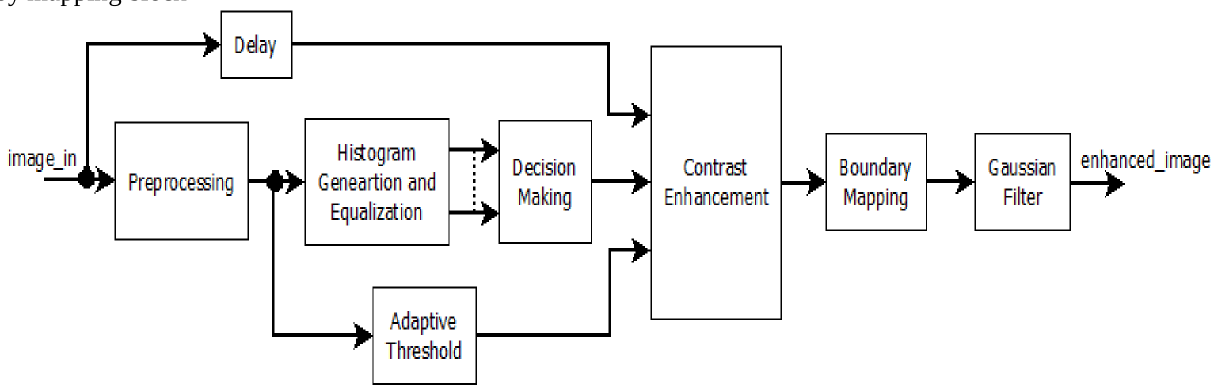


Fig 1 Proposed Model for contrast enhancement

A. Pre-Processing

The input image is resized 256*256 and the color image is converted by gray to simplify the hardware requirements.

B. Adaptive Threshold

This block is used to calculate threshold values used for proper enhancement. For different image this block adjust the threshold value for proper enhancement. So, it is named as Adaptive Threshold block. The equation of this block is given by equation (1) as

$$Adaptive\ Threshold\ (t_h) = \frac{\sum_{i=0}^{M-1}(x_i)^2}{8M^2} \qquad (1)$$

Where, X_i is the corresponding image pixel value
M is the total dimension of the input image (256x256)
The block diagram of adaptive threshold block is given in Fig.2 below.

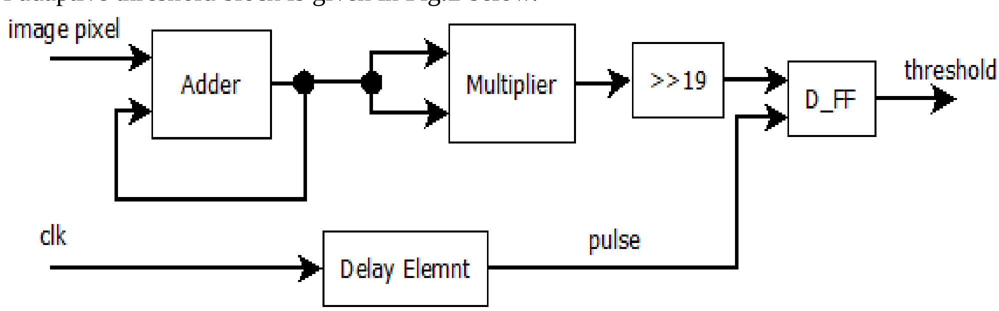


Fig 2 Proposed Thrshold Calculation Block

C. Histogram Generation And Equalization

The histogram will give the frequency of occurrence of each pixel. This will helps the system to understand the intensity level of the input image. To implement this block we use basic comparator and counter as shown in the Fig.2. In normal method we have to check the histogram of all pixel intensity range (i.e. 0 to 255). But this requires a large amount of hardware resources. To reduce the resource utilizations without affecting the output accuracy we consider only the pixel intensity range from first and last value upto 20 offset. Because most of the bad quality image histogram is higher in this range.

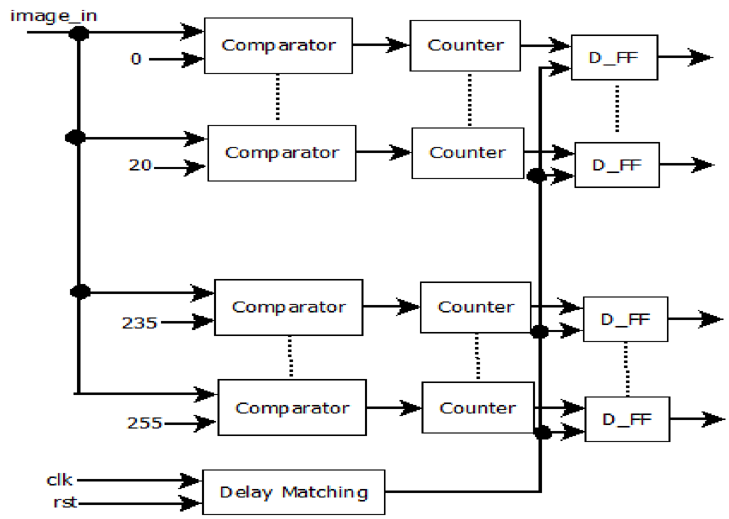
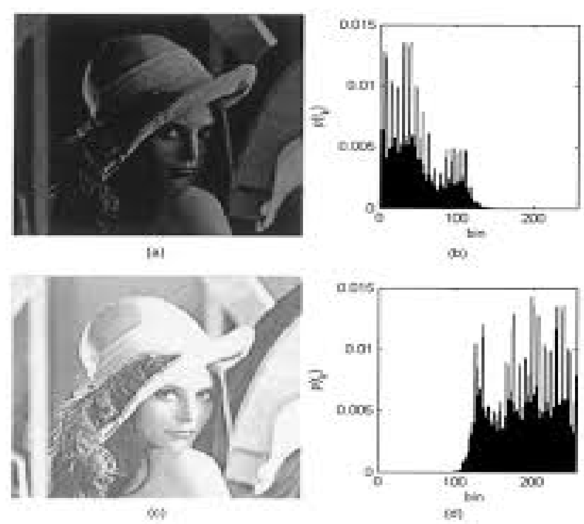


Fig 3 Proposed Histogram generation and equalization

D. Decision making

Deending upon histogram values, decision is made for the contrast of the input image. If the contrast is shifted '0'value then the image having low contrast. Similarly, if the contrast is shifted towards '255' then it having high contrast. The contrast decision is shown in Fig. 4.



E. Contrast Enhancement

To enhance the contrast of the image we use linear contrast stretching technique [12]. The equation for linear stretching is

$$output\ image\ pixel = input\ image\ pixel \pm \gamma \qquad (2)$$

Where, γ ⟶ constant, depend upon the level of enhancement

F. Boundary Mapping

After linear stretchy there are high possibilities of getting pixel values outside of the considerable range. The boundary mapping block is used to map all pixel values into corresponding boundary for proper display purpose. In the proposed method we consider the gray pixel which can vary from 0 to 255 so the equation for boundary mapping function is

$$mapped\ pixel\ value = \begin{cases} \text{input pixel} \ ; \text{if} & 0 > input\ pixel < 255 \\ 255 \ ; \text{if} & \text{input pixel} > 255 \\ 0 \ ; \text{if} & \text{input pixel} < 0 \end{cases} \qquad (3)$$

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G. Gaussian Filter

After mapping the enhanced image into fixed boundary using equation (3), many of high frequency component appears in an image is considered as Noise. To remove that high frequency component from the enhanced image .Gaussian filters is used. For good clarity we use 3X3 Gaussian mask [12], which is given below

$$output\ image\ pixel = \frac{1}{16}\begin{bmatrix}1 & 2 & 1\\ 2 & 4 & 2\\ 1 & 2 & 1\end{bmatrix} * \begin{bmatrix}a & b & c\\ d & e & f\\ g & h & i\end{bmatrix} \quad (4)$$

Where, ‘a’ to ‘i’ are the 3x3 sub-matrix of the corresponding image

III. FPGA IMPLEMENTATIONS

In this chapter we discuss the implementation results on hardware. For this implementation we use ATLYS FPGA Board (xc6slx45-2csg324). The simulink model (software) for proposed architecture is shown in Fig 5.

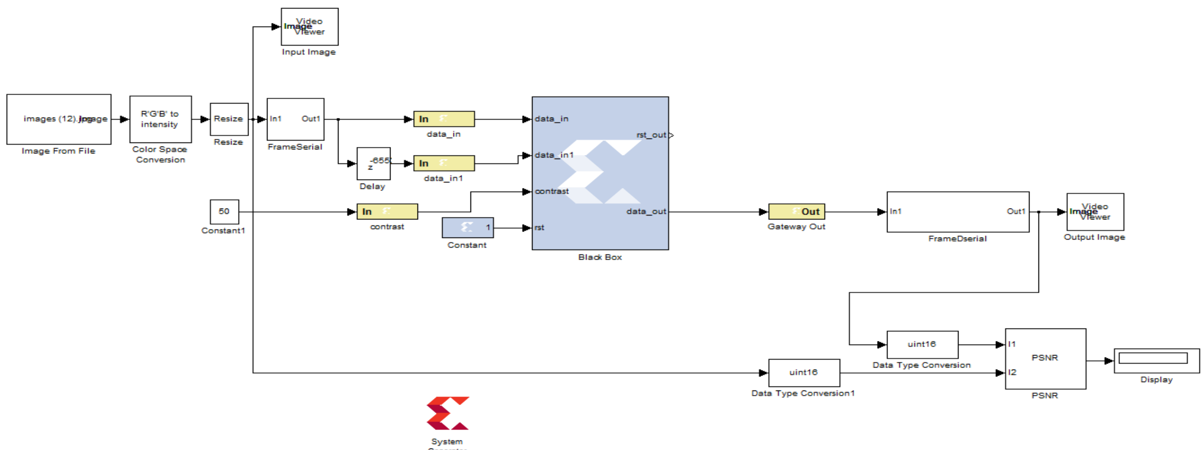


Fig 5 Simulink software for Contrast Enhancement

The simulink model (hardware) for proposed architecture is shown in Fig 6 which is generated from the software model.

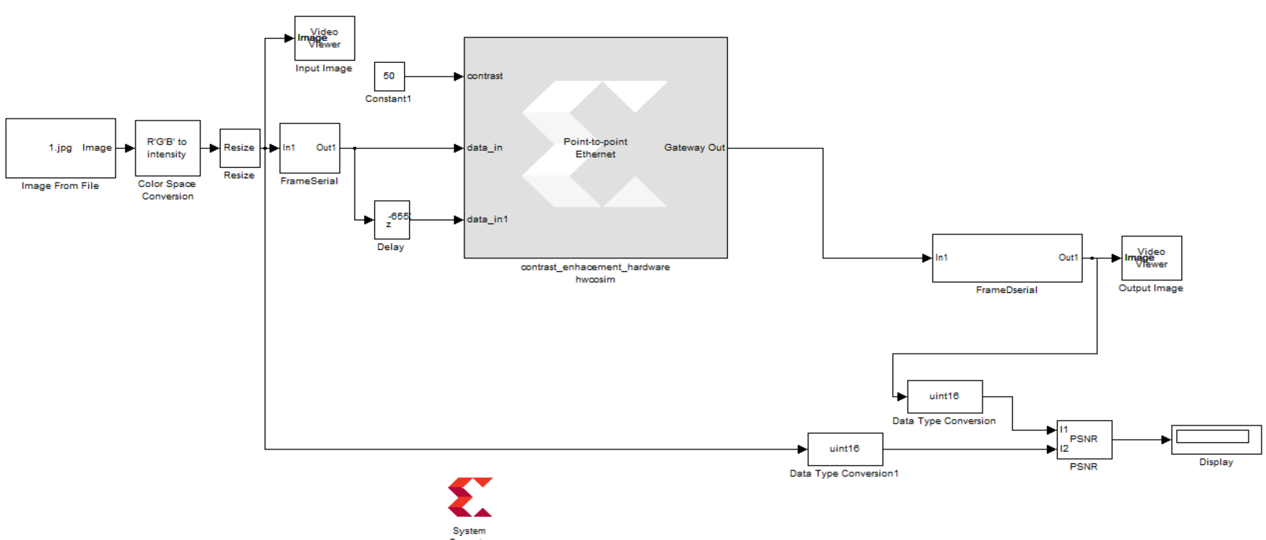


Fig 6 Simulink hardware for Contrast Enhancement

The images of the proposed architecture is generated at output for contrast enhancement applications is shown in Fig 6

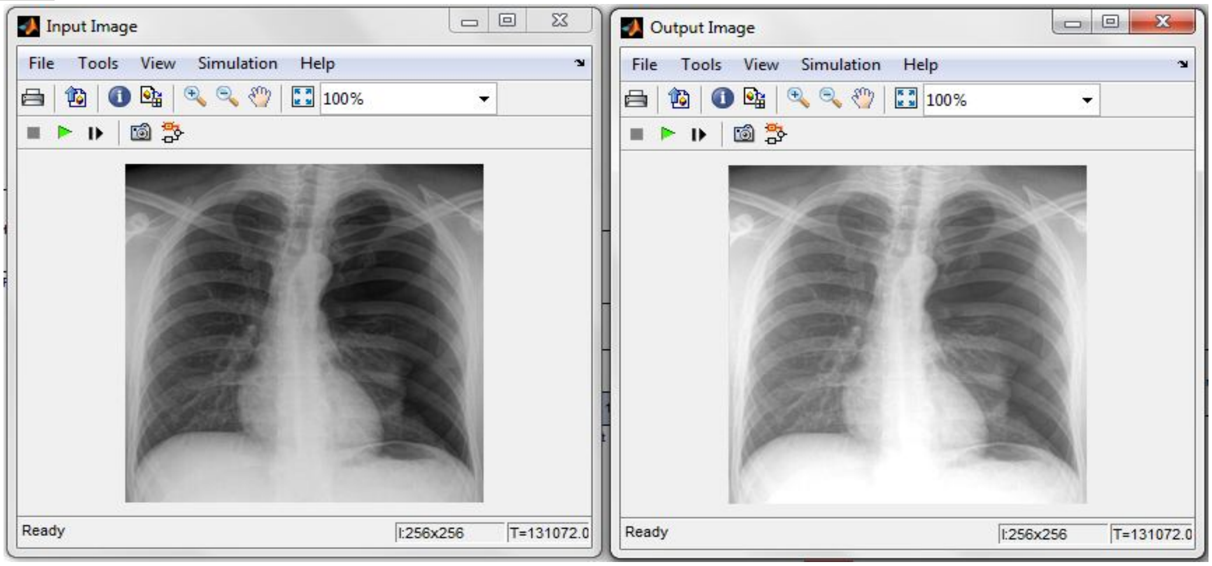
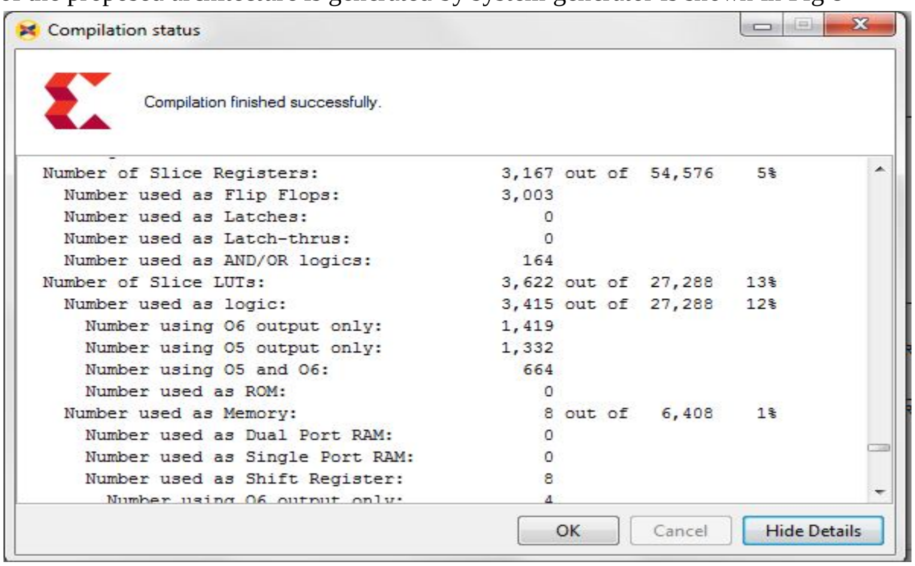


Fig 7 Image input and output

The device utilizations of the proposed architecture is generated by system generator is shown in Fig 8



IV. COMPARISONS WITH EXISTING TECHNIQUES

In this chapter we compare the proposed technique with existing techniques is given in the table 1 below

Table 1 Comparisons with existing techniques

Parameters	Pratik and Nitin [11]	Hanumantharaju et al, [10]	Burak Unal et al., [9]	Proposed Method
Slice Registers	3206	1867	440	1705
Fully Used FF-Pairs	2809	4096	4766	1177
Total	6015	5963	5206	2882

V. CONCLUSION

In this paper, an algorithm that is suitable for implementation on FPGA Spartan 6 board for image enhancement. In VLSI the area is very important when it comes to implementation point of view. The proposed method start with Acquire input image .Then the converting color image to gray image. The Histogram is generated for the gray image. The Decision unit helps to know the contrast of original image. If low contrast then the contrast of an image is increased. Hence the quality of an image is improved.

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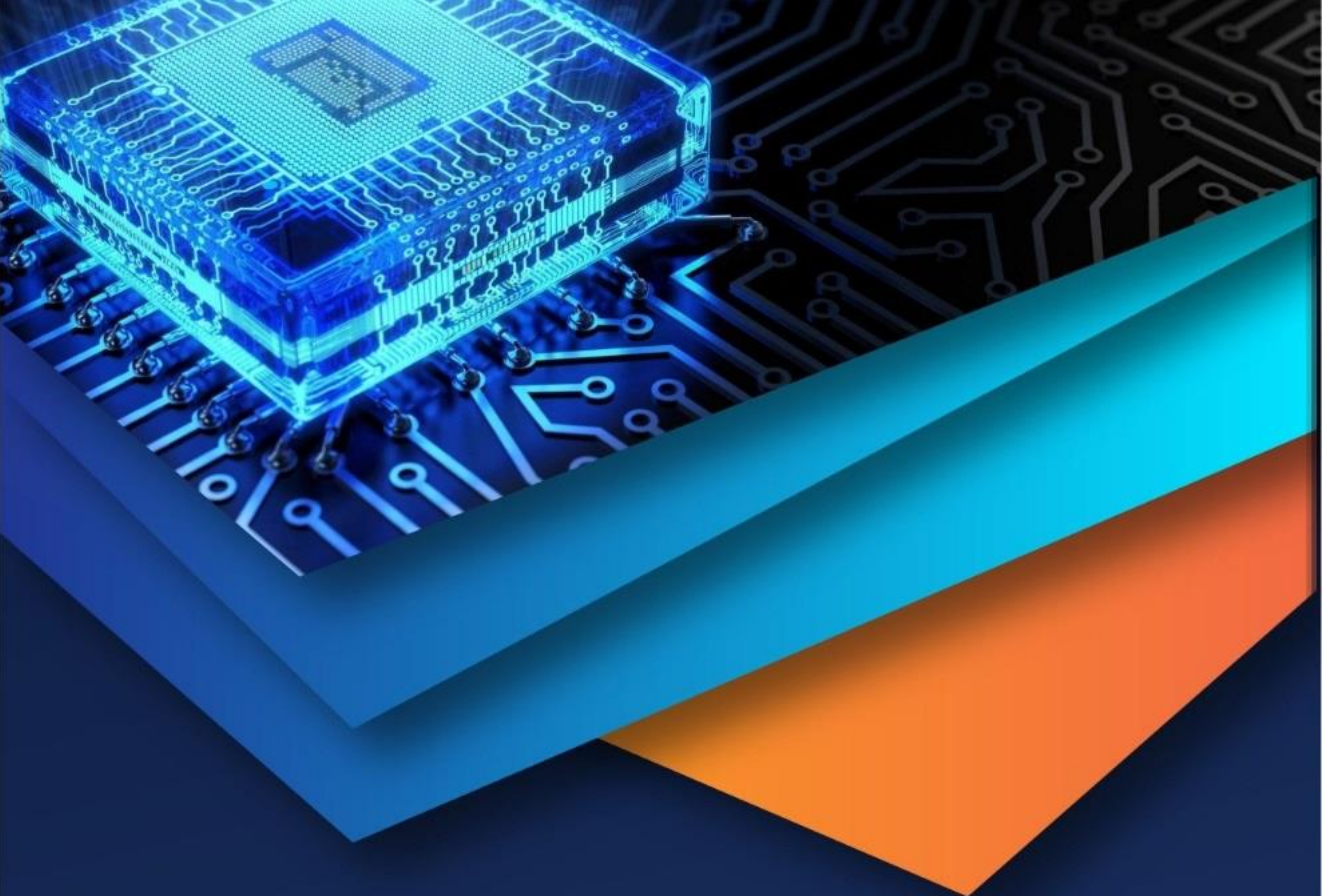

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