iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** VI **Month of publication:** June 2017

DOI:

www.ijraset.com

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Volume 5 Issue VI, June 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Hybrid Algorithm for Gray-Level Image Contrast Enhancement

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***Abstract**: Nowadays, images play important role in real world but sometimes when they are captured often due to bad weather, atmospheric conditions like fog or due to lower illumination or lightening etc. images are not clear. Image enhancement is a vast area of image processing with its application in different fields. Using this we improve the visual appearance of an image or modify attributes of an image to make it more suitable for a specific application. Improving Quality of those images is always a difficult, challenging, as well as an important task in image processing. This paper presents a novel hybrid method which uses combination of Differential Evolution i.e. DE and particle Swarm Optimization i.e. PSO for contrast enhancement. Experimental results show that the resulting images by the proposed method have good and natural contrasts compared with the resulting images by conventional methods. This comparison will be done on the basis of subjective and objective parameters. Subjective parameter is visual quality and objective parameters are Fitness function, Entropy value, Intensity/Average value, Detailed variance, Background Variance.*
Key Words— Image Enhancement, Image Contrast Enhancement, Differential Evolution, Image Enhancement, Particle Swarm Optimization, Fitness Function, Entropy value, Intensity/Average value, DV, BV.

I. INTRODUCTION

In today's world digital cameras are certainly the most used devices to capture images. They are everywhere, including mobile phones, personal digital assistants (PDAs - a.k.a. pocket computers or palmtop computers), robots, and surveillance and home security systems. There is no doubt that the quality of the images obtained by digital cameras, regardless of the context in which they are used, has improved significantly since early days. Need of these improvements are due to the higher processing capability of the systems they are built-in and memory availability. However, there are still a variety of problems which need to be tackled regarding the quality of the images obtained, including Contrast defects, Chromatic aberrations (hue distortion), Various sources of noises, Vignetting (i.e., a reduction of an image brightness or saturation at the edges compared to the image center, Geometrical distortions, Focus defects. Among these problems some are more dependent on the quality of the capturing devices used whereas others are related to the conditions in which the image was captured. When working on the latter, the time required to correct the problem on contrast is a big issue. This is because the methods developed to correct these problems can be applied to an image on a mobile phone with very low processing capability, or on a powerful computer. Moreover, in real-time applications, the efficiency of such methods is usually favored over the quality of the images obtained. A fast algorithm for generation of images with medium enhancement on image contrast is worth more than a slow algorithm with outstanding enhancement. With this in mind the work proposes a method based on DE and PSO algorithms. Although there has been a lot of research in the area of image enhancement for many years, there is still a lot of room for improvement concerning the quality of the enhanced image obtained and the time necessary to obtain it. Better image quality is a traditional need. It is an initial operation for almost all visions and image processing. The most significant outcome of image processing is contrast enhancement. Contrast is an important factor in any subjective evaluation of image quality. It is created by the difference in luminance reflected from two adjacent surfaces. Contrast is defined as the separation between the darkest and brightest areas of the image. Contrast enhancement improves the image quality, increase in contrast usually makes an image look vibrant while decrease in contrast makes image dull. Increasing the contrast makes light areas lighter and dark area in the frame becomes much darker.

This paper introduces a new hybrid algorithm which uses combination of Differential Evolution i.e. DE and particle Swarm Optimization i.e. PSO for contrast enhancement. DE represents an adaptive search process. This paper presents an attempt to demonstrate its adaptability and effectiveness for searching global solutions to enhance the contrast and details in a gray scale image. The task of DE is to adapt the parameters of transformation function by maximizing the objective fitness criterion and PSO is new candidate generation by updating velocity and location. This paper presents an attempt to demonstrate its adaptability and effectiveness for searching global solutions to enhance the contrast and details in a gray scale image. Objective and subjective evaluation of results obtained approves the superiority of our method over the other methods as it significantly enhances the contrast as compared to other algorithms. The

experimental results show that the proposed method has better performance than the existing methods.

II. LITERATURE REVIEW

A. N. M. Kwok et al [1]

focused on histogram equalization method to produce images with enhanced contrast. They have presented methods for contrast enhancement of an image. It is clarified that sometimes there is a frequent appearance of artifacts (observational errors which can't be measured) from the linear histogram equalization process which causes uncomfortable viewing especially in homogenous regions. To resolve this, pixel intensities in the original image histogram is matched to a smooth version of itself and than a continuous histogram is developed such that the information contained in the image can be better visualized by using the complete intensity range and then these pixel intensities in discrete manner, are perturbed as a solution to artifact problem. These image intensities are then distributed over the available range and an increased image contrast is achieved. Satisfactory results are obtained from the experiments conducted on a set of outdoor colored scenery images and the effectiveness of performance of the introduced approach is verified.

B. H. Yang et al [2]

introduced a novel colored image contrast enhancement method called Co-occurrence histogram equalization (COHE), which equalizes color components by using co-occurrence histogram. They applied this here on the RGB color space but dependent COHE perhaps result in hue changes and artifacts. For a color space channel, enhancement should be achieved by the spatial-adjacent of gray-levels. Gray-level co-occurrence histogram making the use of the conditional probability of a given gray-level is equalized in independent manner. But dependent COHE excels hue changes and artifacts. The results ascertained from the experiments show that this method can enhance the RGB i.e. Colored images with low contrast very effectively.

C. Pei-Chen Wu et al [3]

Focused on traditional histogram equalization (HE) method for improving the contrast of the image but it usually causes the unnatural look and visual artifacts of the processed image. They introduced a new histogram equalization method, which is composed of an automatic histogram separation and intensity transformation modules. In this method firstly the original histogram is automatically divided into several sub-histograms by using histogram separation and then the generated sub-histograms are equalized by the intensity transformation module to ascertain accurate contrast enhancement. Results ascertained from the experiments demonstrate the superiority of the proposed method, it not only keeps the shape characteristics of the original histogram but also enhance the contrast of image very effectively. It has produced the images with best quality, which have been demonstrated using qualitative evaluation, PSNR, and AMBE metrics compared to many other methods.

D. Z. Zhou et al [4]

Introduced a new example based (ExDS) contrast enhancement algorithm which enhances the contrast by learning the distance features between sub-histograms of the example image from the histogram of the example image and then used to stretch the sub-histograms of the target image. It is so simple and effective that it can also be extended for real time contrast enhancement and correction in old film restoration also. Results of conducted experiments reveal that this algorithm has superiority over the classical histogram equalization algorithm and its variants. They produce visually more natural looking outputs and they can enhance the image contrast effectively and due to the example based learning process, the output images appear more natural than the outputs of traditional histogram equalization based methods.

E. S. Chitra et al [5]

introduced a new approach for restoring the images degraded by haze. Sometimes image frames are spoiled by atmosphere full of haze which is a process due to which light is dispersed from the particles in the air. Haze leads to contrast loss and blurring of far off object images. Dehazed image is restored by technique based on the human illustration representation. This uses a cost function based on human visual model to estimate air light map. It uses Artificial Bee Colony optimization (ABC) or Particle Swarm Optimization (PSO) for estimating air light map. Results have revealed that the performance of ABC is better than PSO in dehazing.

F. U. Salamah et al [6]

have introduced image enhancement method so as to make possible the readability of malaria parasite in the low quality of thick blood image. Malaria is one of the diseases that lead to many deaths in many areas. For its diagnosis Parasite readings from thick blood smear

Volume 5 Issue VI, June 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

microscopic images are done so, high-quality image is needed that is easily readable so that we can confirm the existence of parasites but images which are produced are blurred, have unclear boundaries, and the low contrast between the object and the background. In this method we perform contrast enhancement using Dark Stretching and Contrast Limited Adaptive Histogram Equalization (CLAHE) and edge correction using Unsharp Masking Filtering (UMF). The experimental results demonstrate that the introduced method has improved image entropy in comparison to other methods as the value of MSE and PSNR have improved which proves that the introduced approach can produce images that contain more information than the other methods So, it can successfully improve readability of parasite inthe low quality of thick blood smear microscopic images.

III. REVIEW OF BACKEND

A. *Proposed System Model*

Proposed System Model work as, an original image is taken and firstly base algorithm is applied to it and than proposed i.e. hybrid algorithm is applied. The performance of this method is evaluated on the basis of subjective and objective parameters. Subjective parameters are visual quality and objective parameters are Fitness Function, Entropy value, Intensity/Average value, DV i.e. Detailed variance, BV i.e. Background variance. Methodology to be followed is as follows:

1) Input Image: Firstly, we take an original gray-level image .

2) Applying Base Algorithm: After taking an original image, the base algorithm is applied to it. performance metrics used are both subjective and objective parameters. Subjective parameters are visual quality and objective parameters are Fitness function, Entropy value, Intensity/Average value, Detailed variance, Background Variance. This model is used for enhancing contrast in the Gray-Scale input image.

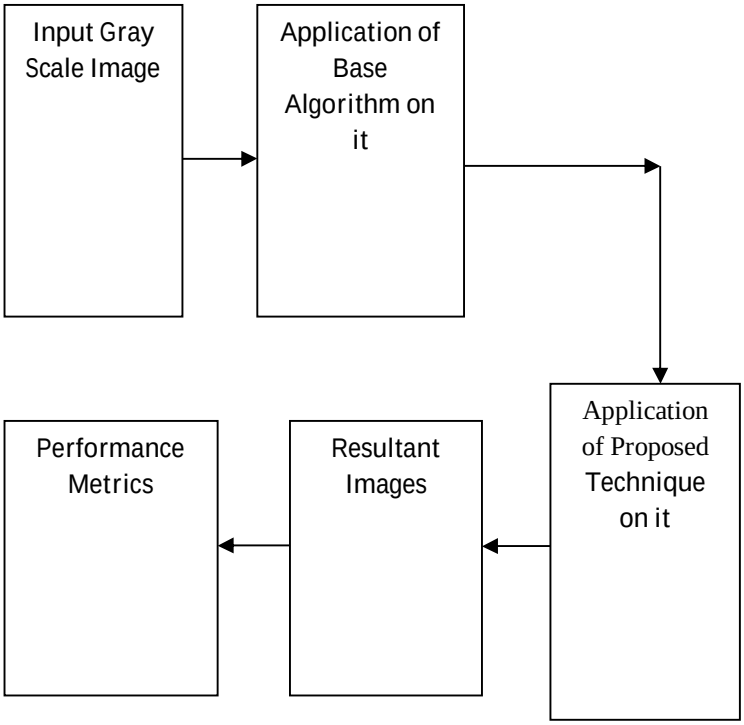

Fig. 3.1. Proposed System Model

3) Resultant Image: After applying this proposed technique we will get the resultant image.

4) Performance Metric: After getting images, performance matrics i.e. Fitness Function, Entropy value, Intensity/Average value, DV i.e. Detailed variance, BV i.e. Background variance are calculated.

B. *Proposed System Algorithm*

The work done in this paper proposes an Hybrid DE (Differential Evolution Algorithm) which is the combination of DE and PSO

(Particle Swarm Optimization) in which DE is used for the task of adapting the parameter of transformation function by maximizing the objective fitness criteria i.e. to yield the best solution that has maximum fitness value and for better results PSO is used for New candidate generation which consist of two steps updation of Velocity and updation of location.

Set NP, F, and CR parameters of the DE
Set G_{max} and gen=1
Initialize a population of size NP of D dimensional target vectors
Evaluate fitness values of each individual vector of the population using eq.(5)
Set best = best solution with maximum fitness value
while gen ≤ Gmax do do
for each target vector x_i i=1 to NP do do
Generate enhanced image using eq. (4) for x_i
Evaluate fitness value using eq. (5) for x_i
if Fitness(x_i) > Fitness(best) then
best = x_i
end if
Randomly select index of three different individuals such that $r_1 \neq r_2 \neq r_3 \neq i$
The mutation operation produces donor vector
$v_i = x_{r1} + F.(x_{r2} - x_{r3})$
The crossover operation produces trail vector u_i
Using target x_i and donor v_i Vectors
for each parameter j = 1 to D do do
if rand ≤ CR then u_{ij}-v_{ij} then
$u_{ij} = v_{ij}$
else
$u_{ij} = x_{ij}$
end if
end for

The selection operation produces new target Vector x_i as follows
if Fitness(u_i) > Fitness(x_i) then
$x_i = u_i$
else
New candidate generation using PSO notation
Update Velocity
Update Location
end if
end for
gen = gen + 1
end while

IV. EXPERIMENTAL RESULTS

In this experiment result we discuss about the improvement in contrast. A Hybrid DE method is proposed for enhancement of contrast in an image. The effectiveness of this approach has been justified with four standard and real images of both gray scale. We work on the gray scale images.

The performance of our method is tested with four images by using performance metrics like Fitness function, Entropy value, Intensity/Average value, Detailed variance, Background Variance. This method gives better results. This method yields results as shown in fig.

Volume 5 Issue VI, June 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Original Image Base Image Proposed Image

Fig. 4.1

Original Image Base Image Proposed Image

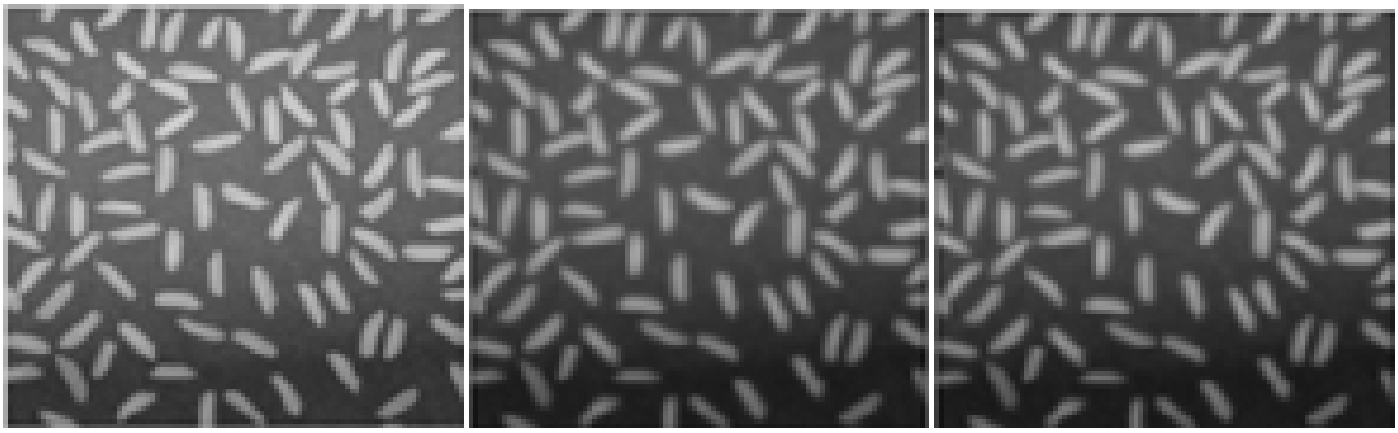

Fig. 4.2

Fig. 4 Snapshots of work 4.1, 4.2 of pout.tif, rice.png, respectively.

This figure describes as, we have taken two images as input, i.e. pout.tif, rice.png respectively and applied both algorithms ie. Base (DE) and proposed (Hybrid DE). We have got the enhanced image in terms of contrast.

Table I: comparison between results of base & proposed image

	IMAGE	FITNESS FUNCTION	ENTROPY VALUE	INTENSITY/AVERAGE VALUE	DETAILED VARIANCE	BACKGROUND VARIANCE
BASE ALGORITHM	pout.tif	1.3545	6.5509	564.0708	0.0139	0.0024
	rice.png	1.493	6.9524	586.7086	0.0243	0.0011
PROPOSED ALGORITHM	pout.tif	1.3966	6.8957	570.7354	0.0154	0.0026
	rice.png	1.495	6.9845	584.0741	0.0259	0.0012

Volume 5 Issue VI, June 2017
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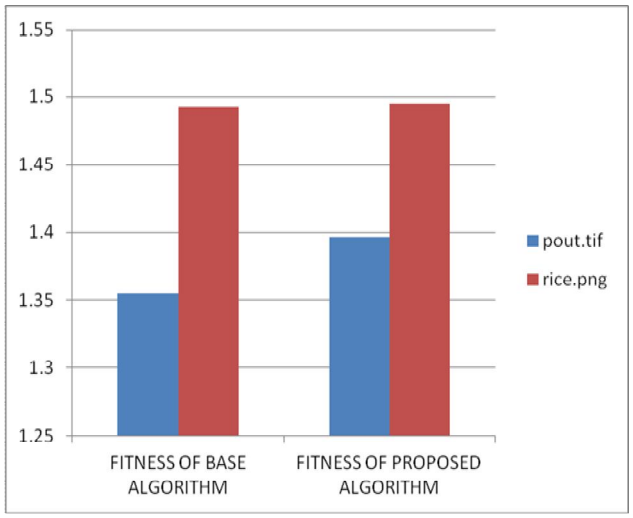
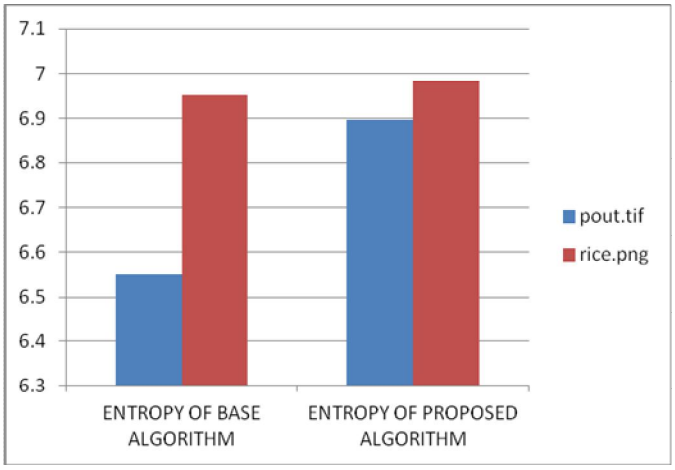
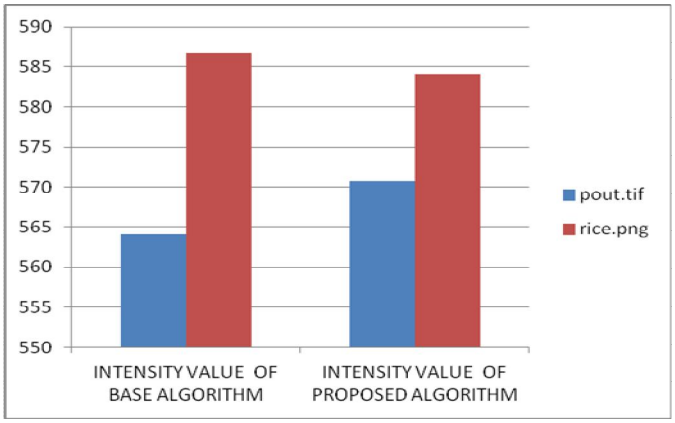
In this table, we show the comparison between base image, proposed image. Fitness function, Entropy value, Intensity/Average value, Detailed variance, Background Variance are also given in this table.



Graph 1: Comparison of Fitness function of base & proposed algorithm



Graph2: Comparison of Entropy values of base & proposed algorithm



Graph 3: Comparison of Intensity/Average values of base & proposed algorithm

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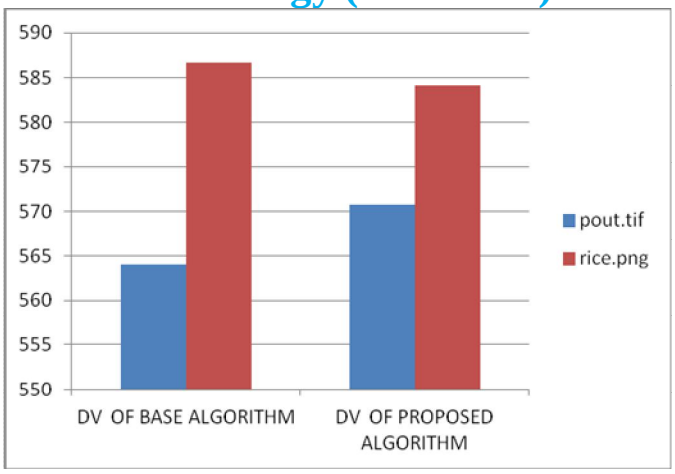
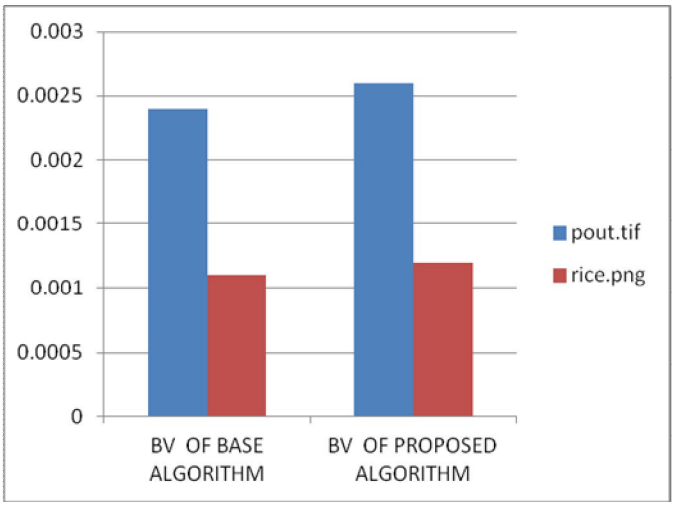


Graph 4: Comparison of Detailed Variance of base & proposed algorithm



Graph 5: Comparison of Background Variance of base & proposed algorithm

V. CONCLUSIONS

In this chapter, a variety of papers which addressed various methodologies of image contrast enhancement were reviewed. Although none of the papers quoted above were tested on large number of images, many of them do discuss features which might be useful for future development. different research approaches to the problem are discussed. The proposed conceptual prototype will make use many of the features that have been highlighted in this literature survey. Experiments done on two images and some of the results of them are shown below. Hybrid algorithm enhances the contrast while preserving its brightness also. It produces much natural looking image. This proposed algorithm is able to overcome the drawbacks of previous traditional methods. This algorithm is able to get good contrasted image which increases the brightness of the low contrasted images. This algorithm is tested on different type of images. Results are compared with results of base algorithm. As we know that a good enhanced image contains:

A. Fitness Function
B. Increase the overall intensity of edges
C. Increases entropy measure in the Image
D. Increase in DV & BV

Table 1 contains description of input images such as Fitness function, Entropy value, Intensity/Average value, Detailed variance, Background Variance. Overall performance achieved visually better results than other methods. The experimental results shows that the Contrast is increased as compared to previous one.

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ISSN: 2321-9653
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VI. FUTURE SCOPE

A. In hybrid algorithm main focus was on contrast but many other improvements are also needed to be done eg. brightness, denoising, deblurring etc.

B. Speed can be made better and more increased. Future work can be extended and modified to work with color images instead of limited application in gray level -based algorithms.

C. Modification of algorithm can produce better results for the image.

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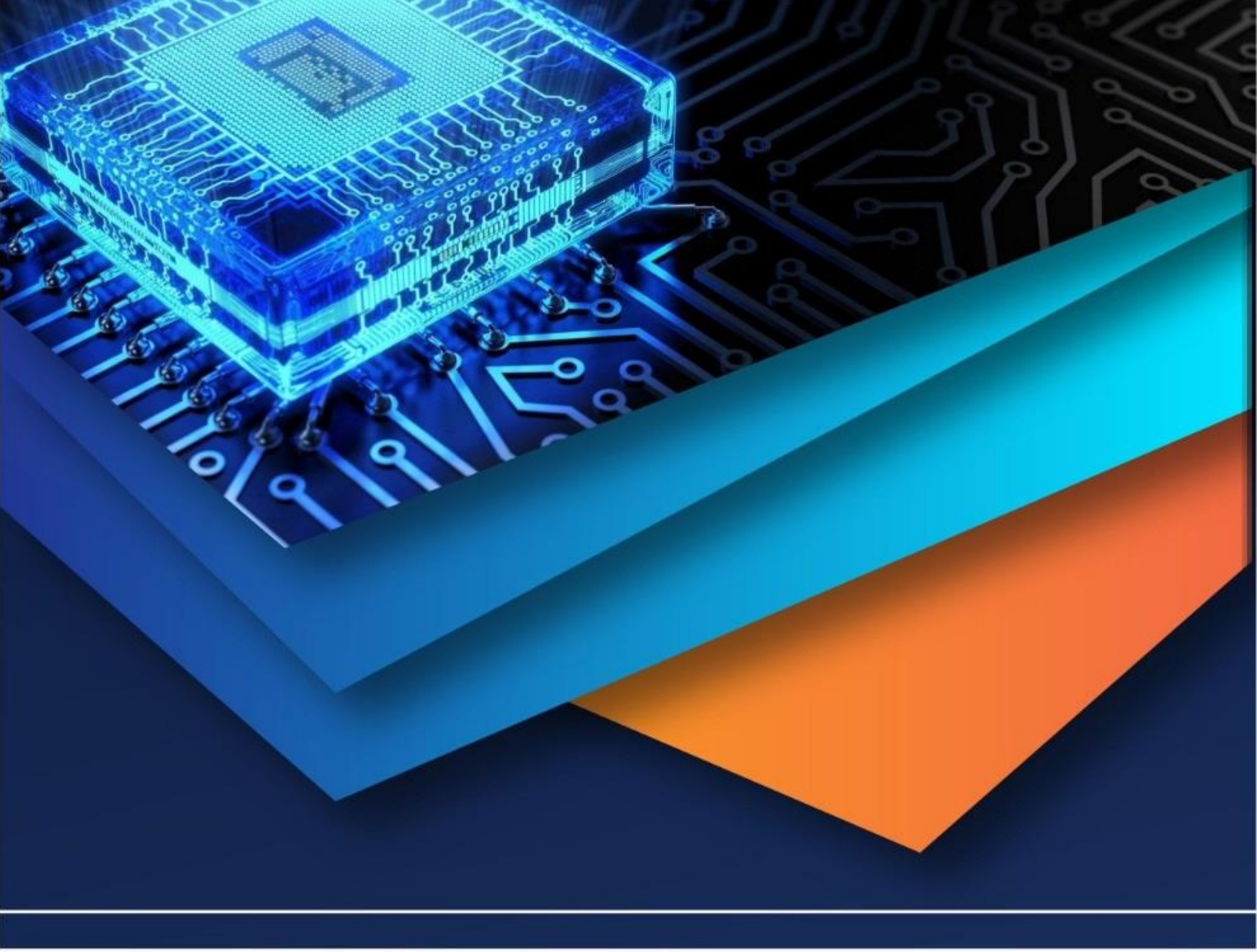

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