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Image Quality Assessment for Multi Exposure Fused Images

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Abstract: ***Multi-exposure picture combination (MEF) is viewed as a successful quality improvement procedure generally received in buyer gadgets. In this paper, we do a subjective client study to assess the nature of pictures created by various MEF calculations. No single MEF algorithm produces the best quality for all images. Motivated by the lack of appropriate objective models, we propose a novel target picture quality appraisal (IQA) calculation for MEF images based on the principle of the structural similarity index (SSIM) approach to find quality maps of the test images. Our experimental results on the images shows that the proposed model gave good results based on quality map, MSE and PSNR values.***
Keywords: ***Multi-exposure picture combination (MEF), image quality assessment, structural similarity, Quality maps***

I. INTRODUCTION

The main aim of our project is to estimate the quality of the fused images produced by using different algorithms. MEF takes a series of pictures with various introduction levels as inputs combines and yield a picture that is more enlightening and perceptually engaging than any of the information pictures [1],[2]. By using MEF the difference between the high dynamic range and low dynamic range pictures taken from the natural digital cameras is reduced.

MEF has been a dynamic research subject pulled in an expanding measure in recent years. As we have many MEF algorithms it is difficult to analysis the performance of all algorithms, by which we can know the best algorithm for next research. Since the human visual framework (HVS) is the extreme collector in many applications, subjective assessment is a clear and dependable way to deal with assess the nature of melded pictures Albeit costly furthermore, tedious a complete subjective client examine has a few advantages. To start with, it gives valuable information to study human practices in assessing saw quality of intertwined pictures. Second, it supplies a test set to assess what's more, analyze the relative execution of established and best in class MEF calculations. Third, it is valuable to approve what's more, think about the execution of existing target picture quality appraisal (IQA) models in foreseeing the perceptual nature of intertwined pictures. This will thusly give bits of knowledge on potential approaches to enhance them.

In this work, we intend to handle the issue of perceptual quality appraisal of MEF pictures. We manufacture one of the main databases committed to subjective assessment of MEF pictures. The database contains 17 source groupings with numerous presentation levels (≥ 3) and the melded pictures produced by 8 traditional and cutting edge MEF calculations. In view of the database, we complete a subjective client study to assess and think about the nature of the melded pictures. We watch extensive assention between human subjects, and not a solitary MEF calculation creates the best quality for all test pictures. All the more vitally, we locate that current target quality models for general picture combination are extremely restricted in foreseeing seen nature of MEF pictures. This persuades us to build up a novel target IQA display for MEF pictures. Our model is roused by the basic comparability (SSIM) file whose logic is that the HVS is exceedingly adjusted for removing auxiliary data from characteristic scenes. To think about the structures of various patches from various exposures, patches from various exposures.

II. LITERATURE SURVEY

The issue of MEF can be for the most part detailed as

$$\mathbf{Y}(i) = K\_k{=}1\ \mathbf{W}k(i)\mathbf{X}k(i),$$

where K is the quantity of multi-introduction input pictures in the source grouping, Xk(i) and Wk(i) speak to the luminance esteem (or the coefficient adequacy in the change area) what's more, the weight at the i-th pixel in the k-th presentation picture, individually. Y means the intertwined picture. The weight figure Wk(i) is regularly spatially versatile and bears data as to relative auxiliary detail and perceptual significance at various introduction levels. Contingent upon the particular models for basic data and perceptual significance, MEF calculations vary in the calculation of Wk A noteworthy number of MEF calculations have been proposed, going from straight forward weighted averaging to complex strategies in light of cutting edge factual picture models. Nearby and

worldwide vitality weighting methodologies are the most straightforward ones, which utilize the nearby or worldwide vitality in the picture to decide Wk.

IQA models for different picture combination applications, orderly and far reaching assessment and correlation of these models have been to a great extent lacking. To approve the execution of goal IQA models, subjective client study is essential. To et and Franken [4] analyzed the perceptual nature of multi-scale picture combination plans, where just evening outside scenes and exceptionally straightforward combination techniques were incorporated into the review. Petrovi' c [6] detailed subjective evaluation comes about for multi-sensor picture combination calculations. Notwithstanding, the quantity of info pictures was constrained to 2 and most test pictures were monochrome ethereal pictures. Besides, best in class picture combination calculations are absent from the trial. To show the viability of their combination calculation, Tune et al. [5] directed two gatherings of matched examination tests through both on location and Web stages, where the subjective trial comes about just incorporate couple of illustrations.

A. Objective User Study

In this paper for objective study we use PSNR(peak signal to noise ratio) and MSE(mean squared error) to estimate the quality of the images. the mean squared error or mean squared deviation measures the averages of the squares of the errors or deviations i .e the difference between estimator and what is estimated. The difference occurs because of randomness it measures the quality of the viewer. It is a non-negative value the value closer to the zero are better.

$$\mathbf{MSE} = \frac{1}{n}\sum_{i=1}^{n}(\hat{Y}_i - Y_i)^2$$

PSNR(peak signal to noise ratio) : It can be defined as the ratio of power of the signal to the power that corrupting noise which affects the fidelity of the receiver. It is commonly used to measure of reconstruction of the compression codec. It is usally expressed in the logarithamic decibel scale. It is an approximation to the human perception of reconstruction quality. Although the high PSNR represents reconstruction of high quality.

$$PSNR = 10 \cdot \log_{10}\left(\frac{MAX_I^2}{MSE}\right)$$

B. Subjective Quality Assessment of MEF Images

1) *Image Database and Subjective User Study:* Seventeen brilliant common source picture groupings are chosen to cover assorted picture content including indoor and open air sees, regular landscapes, and man-made designs. All source picture arrangements are appeared in Fig. 1 and recorded in Table I. Every one of them contain no less than 3 input pictures speak to underexposed, overexposed, and in the middle of cases. For representation reason, in Fig. 1, we select the best quality intertwined picture as far as subjective assessments to speak to each source grouping.

Three MEF calculations are chosen, for example, 1) Mertens07 [1], 2) Li12 [2], and 3) Raman09 [3]. These calculations are secured different sorts of MEF strategies as far as philosophy and conduct. In all cases, default parameter settings are received without tuning for better quality. Three MEF calculations are chosen, for example, 1) Mertens07 [1], 2) Li12 [2], and 3) Raman09 [3]. These calculations are secured a various sorts of MEF strategies as far as approach and conduct. In all cases, default parameter settings are received without tuning for better quality. In the long run, a sum of 136 intertwined pictures are produced, which are isolated into 17 picture sets of 8 pictures every, where the pictures in a similar set are made from a similar source arrangement. An illustration is appeared, which incorporates a source succession at three introduction levels and eight melded pictures Take note of that diverse MEF calculations create significantly extraordinary combined pictures as far as perceptual appearance and quality. Along these lines, quality evaluation of combined pictures is alluring to pick the one with the best quality.

The subjective testing condition was setup as a typical indoor office workspace of conventional brightening level, with no reflecting roof dividers and floor. All pictures are shown on a LCD screen at a determination of 2560 × 1600 pixel with Truecolor (32bit) at 60Hz. The screen was adjusted as per the suggestions A modified MATLAB figure window was utilized to render the pictures on the screen. Amid the test, every one of the 8 melded pictures from a similar set are appeared to the subject in the meantime on one PC screen at genuine pixel determination yet in arbitrary spatial request. The review embraced a multi-boost quality scoring system without demonstrating the reference succession. A sum of 25 credulous onlookers, including 15 male and 10 female subjects matured in the vicinity of 22 and 30, took an interest in the subjective analysis. The subjects are permitted to move their positions to

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get nearer or facilitate far from the screen for better perception. Every single subject rating were recorded with pen and paper amid the review. To limit the impact of visual weariness, the length of a session was restricted to a most extreme of 30 minutes.

Fig. 1. Input source image sequences contained in the database. Each image sequence is represented by one image, which is a fused image of the sequence that has the best quality in the subjective test.

TABLE I
INFORMATION ABOUT SOURCE INPUT IMAGE SEQUENCES

Source sequence	Size	Image courtesy
House	340 × 512 × 4	Tom Mertens
Light house	340 × 512 × 3	HDRsoft
Chinese garden	340 × 512 × 3	Bartlomiej Okonek
Madison capitol	384 × 512 × 30	Chaman Singh Verma
Tower	512 × 341 × 3	Jacques Joffre
Balloons	339 × 512 × 9	Erik Reinhard
Kluki	341 × 512 × 3	Bartlomiej Okonek
Cave	384 × 512 × 4	Bartlomiej Okonek
Belgium house	384 × 512 × 9	Dani Lischinski
Landscape	341 × 512 × 3	HDRsoft
Office	340 × 512 × 6	MATLAB
Venice	341 × 512 × 3	HDRsoft
Lamp1	384 × 512 × 15	Martin Čadík
Memorial	512 × 381 × 16	Paul Debevec
Lamp2	342 × 512 × 6	HDR projects
Farmhouse	341 × 512 × 3	HDR projects
Candle	364 × 512 × 10	HDR projects

(a1) Under Exposure (a2) Normal Exposure (a3) Over Exposure

(1)Mertens07 (2)Raman09 (3)Li12

III. EXISTING METHOD

Gone back to 1984, Burt [2] initially utilized Laplacian pyramid decay for binocular picture combination. Later in 1994, Burt and Kolczynski connected this deterioration to MEF, where they chose the nearby vitality of pyramid coefficients and the relationship between's pyramids inside the area to register Wk. Laplacian pyramid ends up being a viable plan in picture combination to dodge unnatural appearance and undesirable antiquities presented by combination in the spatial area . Goshtasby parceled each source picture into a few non-covering squares and chose the piece with the most elevated entropy to build the intertwined picture. Due to the non-covering allotment, the technique unavoidably experiences blocking curios. Mertens et al. [1] embraced legitimate difference, high immersion and well introduction as quality measures to manage the combination procedure in a multi determination form. Utilizing a similar weighting guide to control the combination in the spatial space, the strategy has a tendency to present

simulated edges and shading mutilations in the melded picture. Reciprocal channel is utilized as a part of [6] to figure edge data, which is consequently utilized to process the weights. This strategy puts no limitations on worldwide luminance consistency and regularly delivers dim appearance of the melded picture. Melody et al. firstly evaluated the underlying picture by augmenting the visual difference and scene slope, and incorporated the intertwined picture by smothering inversions in picture inclinations. Practically speaking, this strategy tends to create shading immersed pictures. Zhang and Cham built perceivability and consistency measures from angle data and utilized them as the weighting elements. The reception of slope heading empowers the strategy to meld a source arrangement caught in a dynamic scene that has moving articles. A comparative angle based MEF technique is proposed in [2]. In view of [1], Li et al. [3] improved the points of interest of a given melded picture .

Utilizing the database, we test the execution of 4 existing target IQA models for picture combination. Since the source successions in the database comprise of no less than 3 input pictures, models that can just work with the instance of 2 info pictures are avoided from the correlation. For the reason for reasonableness, all models are tried utilizing their default parameter settings. Take note of that to acquire a sensible outcome, we take the outright estimation of the target score in . Three usage of the calculation in were proposed and the one with the best execution is accounted for here. Tables II and III abridge the assessment comes about, which is to some degree frustrating on the grounds that cutting edge IQA models try not to appear to give sufficient forecasts of saw nature of intertwined pictures. Indeed, even the models with the best execution, for example, mertens[1] and Li[2] techniques, are just respectably associated with subjective scores. The above test outcomes likewise give some valuable bits of knowledge concerning general methodologies utilized as a part of IQA models. To begin with, models in view of entropy calculations of pixel force values and change coefficients have poor connection with perceptual quality. The reason might -be that the nature of melded pictures is profoundly content ward also, just entropy of picture power/coefficient histogram is lacking in catching the perceptual contortions presented by MEF forms. Second, nearby structure-safeguarding based models, for example, SSIM and angle based methodologies connected in spatial or change space , give the most promising outcomes up until now. Be that as it may, they are frequently unsuccessful in catching the debasements of luminance consistency over the picture space. This recommends more precise goal IQA models might be created by accomplishing a decent adjust between surveying nearby structure protection and assessing huge scale luminance consistency.

IV. PROPOSED METHOD

Taking after the general development of SSIM , we first look at how the data in the multi-introduction picture grouping is safeguarded in the intertwined picture at each spatial area. Coordinate utilization of the SSIM calculation , be that as it may, is inconceivable, which requires a single quality reference picture. The most effective method to work with numerous information pictures in MEF is a noteworthy test here. The best method to know the quality of an image is to divide any image area into three components there are luminence, contrast and

Structure components of that image.

$$\begin{aligned}\mathbf{x}_k &= \|\mathbf{x}_k - \mu_{\mathbf{x}_k}\| \cdot \frac{\mathbf{x}_k - \mu_{\mathbf{x}_k}}{\|\mathbf{x}_k - \mu_{\mathbf{x}_k}\|} + \mu_{\mathbf{x}_k} \\ &= \|\tilde{\mathbf{x}}_k\| \cdot \frac{\tilde{\mathbf{x}}_k}{\|\tilde{\mathbf{x}}_k\|} + \mu_{\mathbf{x}_k} \\ &= c_k \cdot \mathbf{s}_k + l_k,\end{aligned}$$

It is difficult to keep the luminance constant directly in all images so, we exclude it for comparison. Under the realisticity constraint the area of the image having the high constrast is viewed better.The equation for contrast is

$$\hat{c} = \max_{\{1 \le k \le K\}} c_k = \max_{\{1 \le k \le K\}} \|\tilde{\mathbf{x}}_k\|.$$

Differentfromcontrast,the structuresof neighborhood imagepatches are meant by unit-length vectors sk for $1 \le k \le K$, each of which focuses to an alternate course in the vector space. The coveted structure of the combined picture fix relates to another bearing in a similar vector space that best speaks to the structures of all source picture patches. A straightforward model to represent this relationship is given by

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$$\bar{\mathbf{s}} = \frac{\sum_{k=1}^{K} w(\tilde{\mathbf{x}}_k)\,\mathbf{s}_k}{\sum_{k=1}^{K} w(\tilde{\mathbf{x}}_k)} \quad \text{and} \quad \hat{\mathbf{s}} = \frac{\bar{\mathbf{s}}}{\|\bar{\mathbf{s}}\|},$$

where w(·) is a weighting capacity that decides the commitment of each source picture fix in the structure of the combined picture fix. Naturally, the commitment ought to increment with the quality of the picture fix. A direct approach that acclimates with such instinct is to utilize a power weighting capacity given by

$$w(\tilde{}\ \mathbf{xk}) = \lrcorner\ \tilde{}\ \mathbf{xk} \lrcorner\ \mathbf{p},$$

If P=1 corresponds to length-weighted direction average,P=2 corresponds to energy-weighted direction average,and P=∞corresponds to picking the direction corresponding to the area which has the vector length large ampng all areas. Therefore, we define a structure consistency measure between a set of vectors based on the degree of direction agreement between them. In particular, we compute

$$R(\{\tilde{\mathbf{x}}_k\}) = \frac{\|\sum_{k=1}^{K} \tilde{\mathbf{x}}_k\|}{\sum_{k=1}^{K} \|\tilde{\mathbf{x}}_k\|}.$$

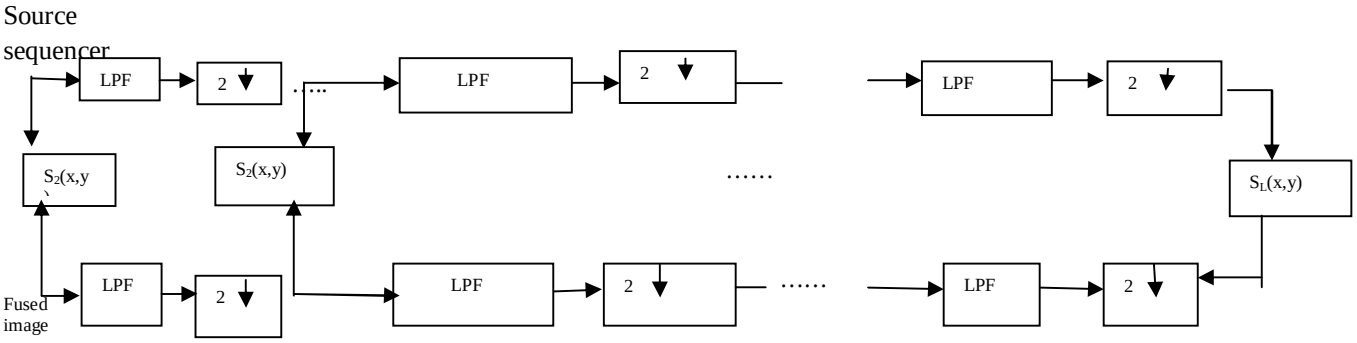
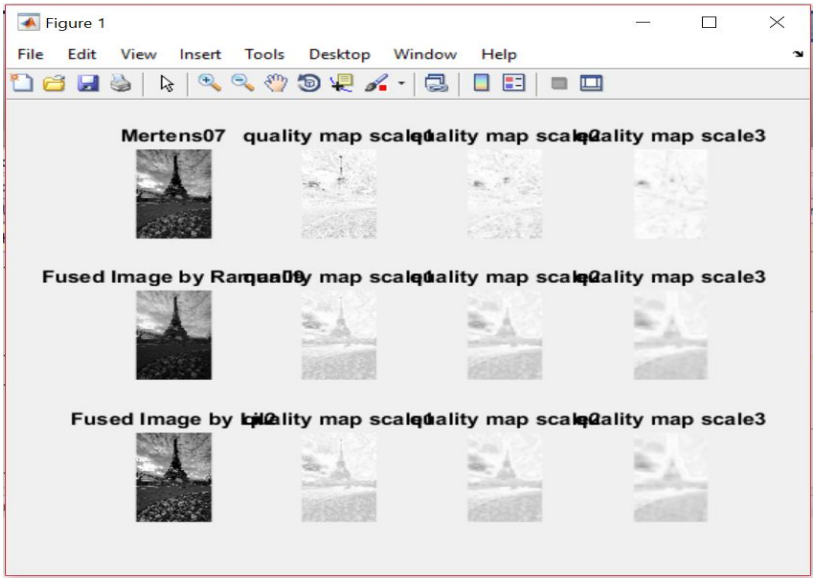


Fig. Diagram of multi-scale structure comparison. LPF: low-pass filtering; 2 ↓: downsampling by a factor of 2.

V. SIMULATION RESULTS



A. Objective Results

Mse Performance Evaluation Of The Proposed Model Against 3 Existing Models

Images	Mertens07	Ramon09	Li12
Towers	2.9692	2.0661	5.1236
Balloons	23.8240	67.4541	30.7948
Beligum	19.0639	70.6028	27.7977

Table III

Psnr performance evaluation of the proposed model against 3 existing models

Images	Mertens07	Raman09	Lil2
Towers	99.9422	103.5687	94.4868
Balloons	79.1183	68.7108	76.5518
Belgium	81.3473	68.2546	77.5757

VI. CONCLUSION

In this paper we can know the quality of MEF images and can be assessed. In this we first build a image database for MEF IQA which are created by different MEF algorithms.The Existing method doesnot provide all the quality consraints for fused images.
Now our proposed mehod which is based on multi scale SSIM principle and a novel measure of stuctural patch consistency.In this proposed method the local stucture is preserved at fine scale and captures the luminance consistency at coarser scales.Our model overcomes the drawbacks of all existing models of image fusion.
In future researchSecond, most existing target quality models, including the proposed one, work with the luminance componentonly.Proper accountingfor shading mutilations have incredible possibilities to enhance the execution of the target quality model . Third, all source arrangements that constitute the subjective database are almost static, however the regular scenes we experience by and by are frequently rapid and contain moving articles . It is valuable to sum up the proposed model to represent dynamic scenes. Fourth, how to coordinate the quality model into buyer hardware to catch top notch melded picture progressively is another testing issue yet to be investigated.

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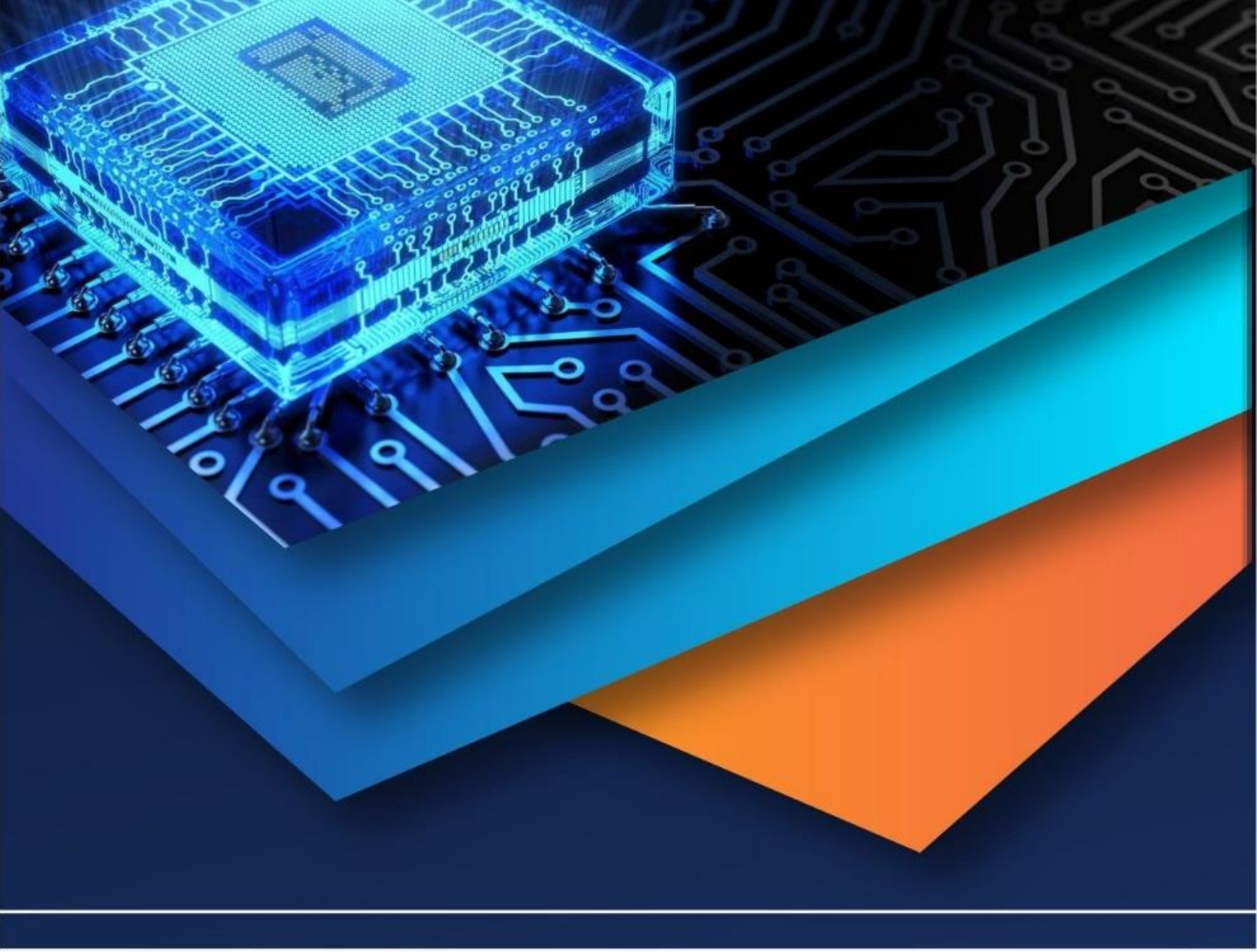

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