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Compression of an Image and Performance over AWGN Channel by applying PSK along with DCT Transform

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Abstract: ***Transmission of multimedia, especially transmission of uncompressed image/video requires immense quantity of storage and high reliability. Analogues to this large transmission bandwidth required for transmission of uncompressed image/video information, over the network. In Wavelet transform image compression is one of the considerable characteristic. Some of the transform methods are used for image compression and gives sustainable reforms in the quality of image. This paper show round the influence of an image transmission via AWGN channel using PSK (Phase Shift Keying), QAM (Quadrature Amplitude Modulation) and also transmission of uncompressed image via AWGN channel. Most of the time less storage and time have required to compressed image. For the transmission of simple image & compressed image through AWGN channel, offered method is used to confer lesser BER (Bit Error Rate) and increase PSNR (Peak Signal to Noise Ratio) for different SNR (Signal to Noise Ratio) values. By plotting all the parameters we measure the performance and with the help of result it can be clear that the precision is maintain by the proposed scheme.***
Keywords: Signal to noise ratio, root mean square error, peak signal to noise ratio, phase shift keying, bit error rate.

I. INTRODUCTION

Using Communication channel image can be transfer from one place to another and for this PSK (Phase Shift Keying) is the optimal communication system. Therefore very important role played by the channel in communication system. Image can be affected by AWGN (Additive White Gaussian Noise) channel due to the presence of it into the communication channel and cannot be received by receiver[1]. While maintaining good quality of image, wavelet transform have been successful in providing high rate of compression[2].

A. What Is A Wavelet Transform?

Wavelets are functions defined over a finite interval and having an average value of zero. The basic idea of the wavelet transform is to represent any arbitrary function *(t)* as a superposition of a set of such wavelets or basis functions. These basis functions or baby wavelets are obtained from a single prototype wavelet called the mother wavelet, by dilations or contractions (scaling) and translations (shifts). The Discrete Wavelet Transform of a finite length signal *x(n)* having *N* components, for example, is expressed by an *N* x *N* matrix.

Wavelets are mathematical functions that were developed by scientists working in several different fields for the purpose of sorting data by frequency. Translated data can then be sorted at a resolution which matches its scale. Studying data at different levels allows for the development of a more complete picture. Both small features and large features are discernable because they are studied separately. Unlike the Discrete Cosine Transform, the wavelet transform is not Fourier-based and therefore wavelets do a better job of handling discontinuities in data.

B. Discrete Cosine Transform

DCT widely used in Signal Processing and a part of lossy compression [3]. As compare to Wavelet DCT give more fruitful results and yielded higher quality image. At moderate bit rates, DCT based JPEG coders perform very well[4]. Image quality degrades at higher compression ratio due to block based DCT scheme.

II. PHASE SHIFT KEY (PSK) SYSTEM

PSK is a digital modulation technique defined as the process of shifting the phase of the carrier signal between two levels, depending on whether 1 or 0 is to be transmitted.

$$v_{c1} = V_c cos\omega_c t$$
$$v_{c2} = -V_c cos\omega_c t$$

In other words, PSK system, change in phase of the sinusoidal carrier to indicate the information or data[5]. In this system, if we pass the input binary (0) then the phase of sinusoidal will shift by 180 degree. Phase shift represent the change in state of information.

III. AWGN CHANNEL

An AWGN channel is a additive white Gaussian noise to the signal that passes through it. Additive Gaussian, the standard model of amplifier , independent of the signal intensity and independent at each pixel[6]. An AWGN channel is typically described by quantities such as Signal-to-Noise ratio (SNR) per sample and this is the actual input parameter to the AWGN function[1].

IV. PROBLEM FOMULATION

A. *Bit Error Rate (BER)*

The bit error rate or bit error ratio (BER) is the number of bit errors divided by the total number of transferred bits during a studied time interval. The bit error rate of BPSK in AWGN can be calculated as BER= Error/ total number of bit

B. *Mean Square Error (MSE)*

Mean square error is a criterion for an estimator: the choice is the one that minimizes the sum of squared errors due to bias and due to variance. The average of the square of the difference between the desired response and the actual system output. As a loss function, MSE is called squared error loss. MSE measures the average of the square of the "error. The MSE is the second moment (about the origin) of the error, and thus incorporates both the variance of the estimator and its bias. For an unbiased estimator, the MSE is the variance. In an analogy to standard deviation, taking the square root of MSE yields the root mean squared error or RMSE. This has the same units as the quantity being estimated. For an unbiased estimator, the RMSE is the square root of the variance, known as the standard error.

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}\|I(i,j) - K(i,j)\|^2$$

$$RMSE = sqrt(mse)$$

Where m x n is the image size and I(i,j) is the input image and K(i,j) is the retrieved image.

C. *Peak Signal-To-Noise Ratio(PSNR)*

It is the ratio between the maximum possible power of a signal and the power of corrupting noise .Because many signals have a very wide dynamic range, PSNR is usually expressed in terms of the logarithmic decibel scale. The PSNR is most commonly used as a measure of quality of reconstruction in image compression etc. It is most easily defined via the mean squared error (MSE) which for two m×n monochrome images I and K where one of the images is considered noisy.

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

Or

$$PSNR = 20.log_{10}\left(\frac{MAX_I}{\sqrt{MSE}}\right)$$

Or

$$PSNR = 20 * log10\left(\frac{255}{rmse}\right)$$

Here, MAXi is the maximum possible pixel value of the image. When the pixels are represented using 8 bits per sample, this is 255. More generally, when samples are represented using linear PCM with B bits per sample, MAXI is 2B-1.Typical values for the PSNR in Lossy image and video compression are between 30 and 50 dB, where higher is better. PSNR is computed by measuring the pixel difference between the original image and compressed image. Values for PSNR range between infinity for identical images, to 0 for images that have no commonality. PSNR decreases as the compression ratio increases for an image.

D. Signal-To-Noise Ratio (SNR)

It is the ratio of bit energy to noise power spectral density, $(\frac{E_b}{N_o})$ is set to 10 dB. From this value, the signal to noise ratio can be determined. Or we can say that Signal-to-noise ratio is a term for the power ratio between a signal (meaningful information) and the background noise [7].

$$SNR = \frac{P_s}{P_n}$$

where Ps is average signal power and Pn is average noise power.

V. EXPERIMENTAL RESULT

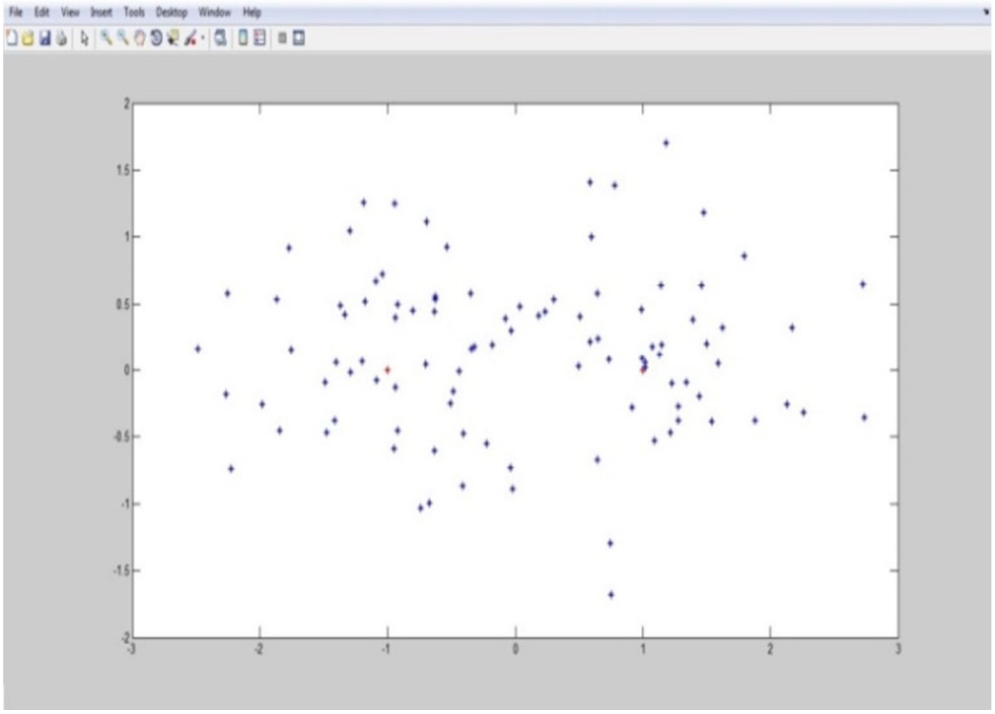


Fig.1: Original image goes through AWGN channel

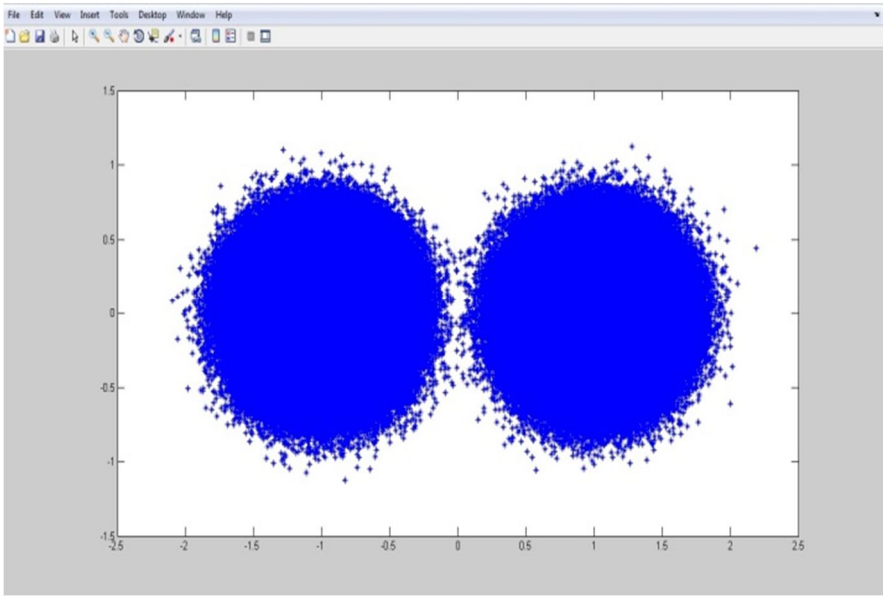
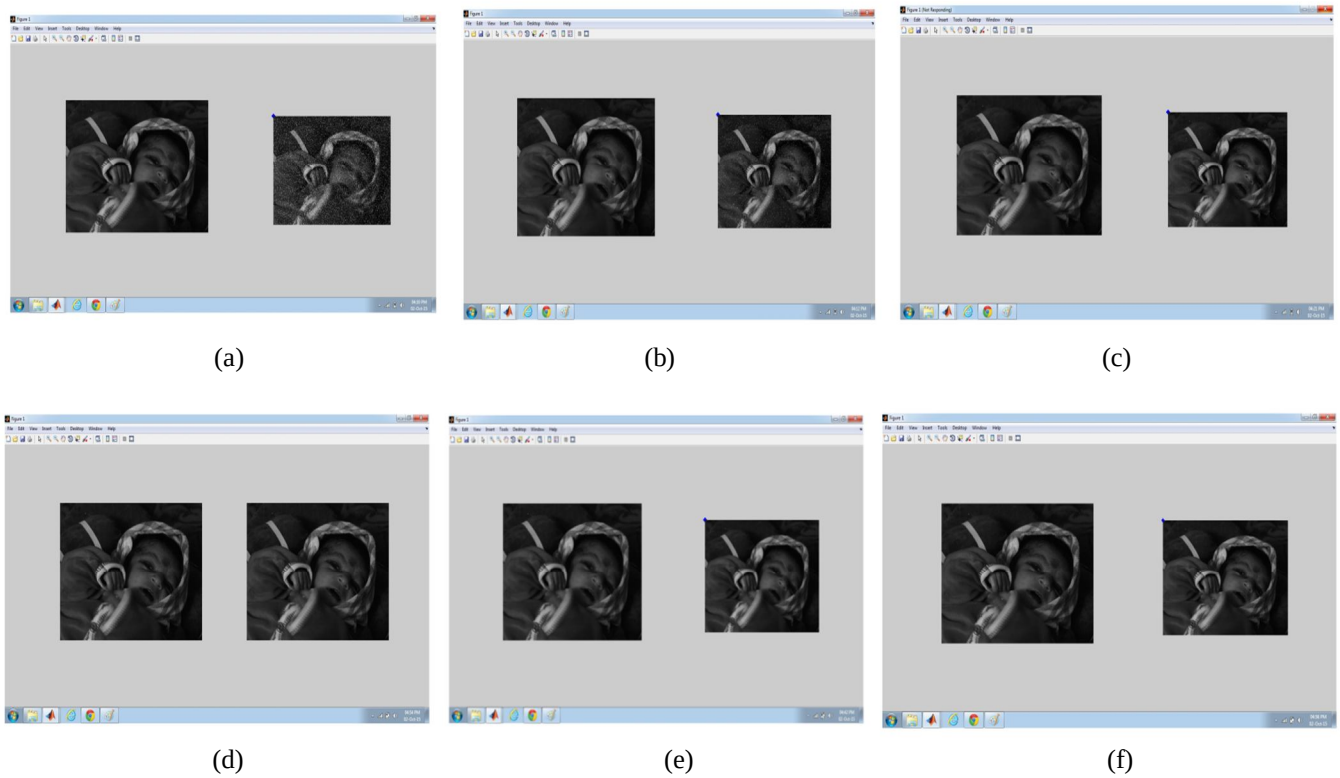


Fig.2: Image at the time of compression



(a) (b) (c)

(d) (e) (f)

Fig. (a) original image without AWGN channel and noisy image, (b) more noisy image, (c) (d) (e) are images where noise remove at each level and (f) shows image after compression.

A. Graph between BER and SNR

For an image performance of BER of PSK modulation over AWGN channel. In the below graph, it has been observed that BER decreases with increase in the value of SNR. To calculate the bit error rate through Additive White Gaussian Noise (AWGN) channel. Basically, the performance was determined in term of bit error rate (BER) and signal to noise ratio (SNR) to noise power density ratio ($\frac{E_b}{N_o}$).

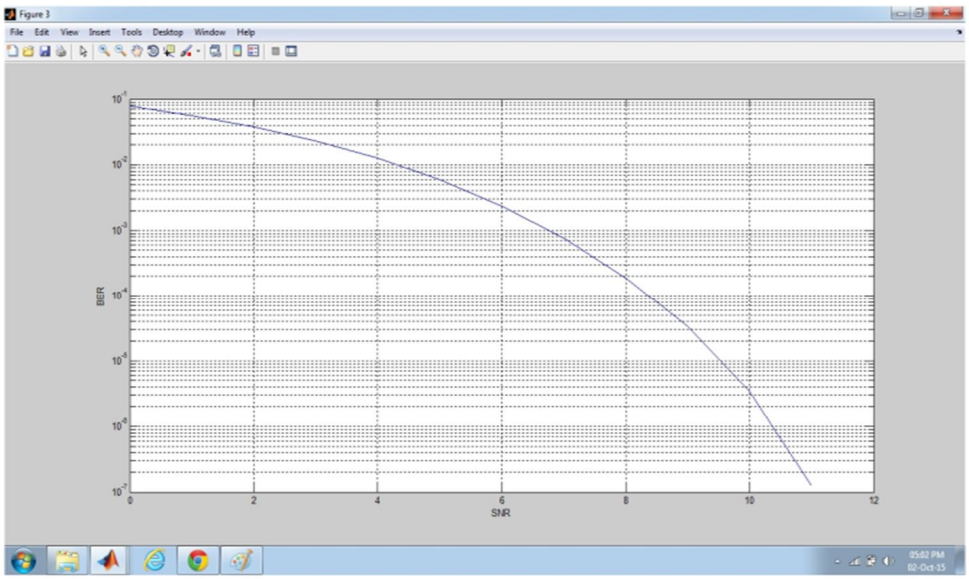


Fig. 3: BER vs. SNR

B. Graph between RMSE and SNR

For an image performance of RMSE of PSK modulation over AWGN channel. In the below graph, it has been observed that RMSE decreases with increase in the value of SNR.

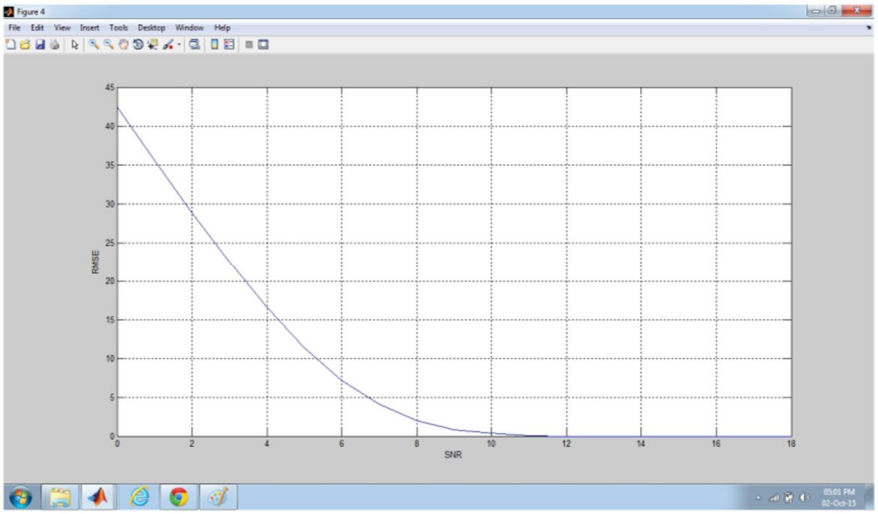


Fig. 4: RMSE vs. SNR

C. Graph between PSNR and SNR

For an image performance of PSNR of PSK modulation over AWGN channel. In the below graph, it has been observed that BER increases with increase in the value of SNR.

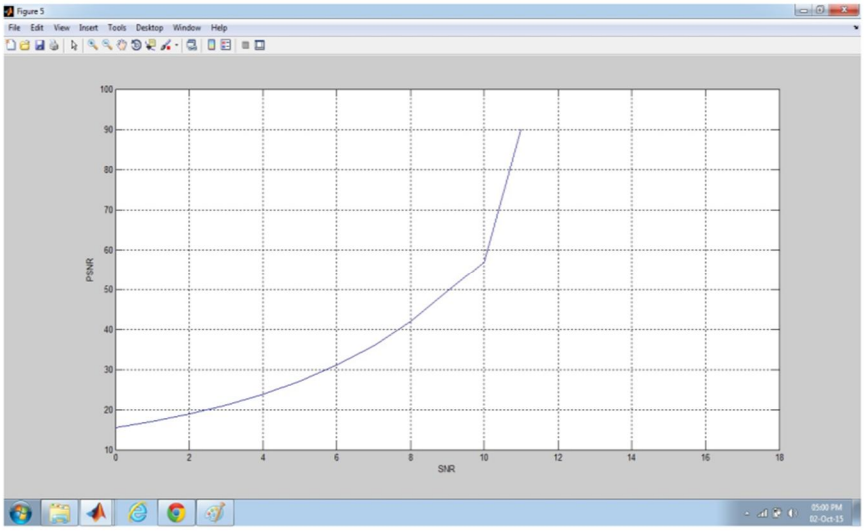


Fig. 5: PSNR vs. SNR

VI. CONCLUSION

In this paper we conclude that, basically the performance was determined in term of bit error rate (BER) and signal to noise ratio (SNR) through AWGN channel having increase in the value of SNR with decrease in the value of BER. Second the performance was determined in term of root mean square error (RMSE) and signal to noise ratio (SNR) through AWGN channel have increase in SNR value with decrease in the value of RMSE. Third the performance was determined between peak signals to noise ratio (PSNR) and signal to noise ratio (SNR) through AWGN channel it has been observed that with increase in the value of PSNR, SNR value also increases.

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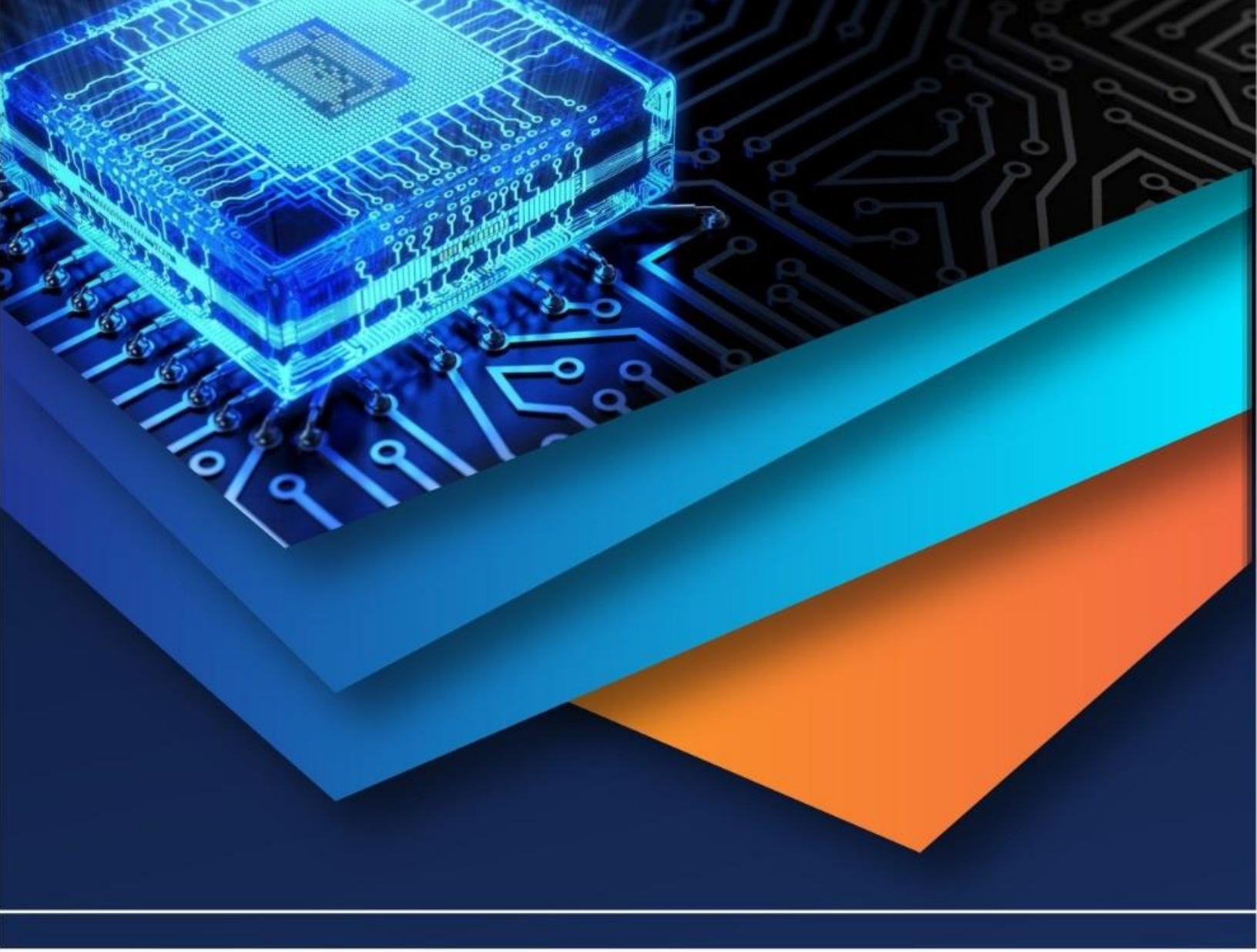

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