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Histogram based QR Code Authentication using Medical Images

Sujatha C. N[1], Rakesh Kuchana[2]
[1, 2]*ECE, SNIST, Ghatkesar, Hyderabad*

Abstract: ***Medical images require proper attention during the information embedding since the information which is to be embedded should not disturb the image quality. The remedy for the distortion caused by embedding data into medical images can be overcome by using lossless data hiding techniques. QR Code are consisting of relevant medical information that can be retrieved easily. In the present, information security become vital asset at the communication services, thereby concealing of information become a dilemma. For this issue, we employ a method known as Steganography in which the data is concealed in a medium like text, image etc., and appears to be normal, without affecting the quality of the hidden medium. Watermarking enables the protection of data format which is embedded with other data format and provides ownership access to the end user in unrecognizable format. Both steganography and watermarking techniques employ greater security to the information which can be embedded within a data format of any type.***

Keywords: Watermarking, DICOM, LSB, Steganography, MSE, PSNR, Authentication, Encryption, Decryption, Histogram

I. INTRODUCTION

With the availability of the Internet, the information security has become the major concern. Cryptography is the technique which involves encryption and decryption of data to keep the message in unidentifiable format for the security. It can be implemented using a technique known as steganography using QR Code image. Steganography is the process of invisible communication which is used for various data formats such as audio, video, image. In this paper, we use QR Code image to embed the medical information and QR Code is embedded into medical image using Watermarking [7] [11] and [12].

A **QR code** is a 2-D barcode which was devised in year 1994 for the automobile factory in Japan. Applications consisting of tracking a product, detection of items, marketing purposes etc.

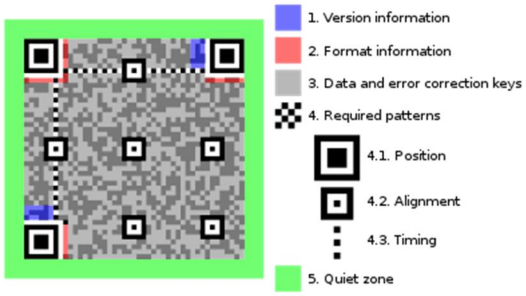

Fig. 1 Image for QR code

Figure 1 consists of a QR code including black squares aligned in a square grid format on white background. Information can be accessed by the end user by scanning QR Code image using QR Code Scanner. The QR Code image is embedded into the respective medical image to create final watermarked image or stego image. Steganography involves the method in which information is embedded in existing medium, although the quality of medium doesn't affect while embedding information in unidentifiable way. A digital watermark is a marker embedded in various data formats such as audio, video or image. It is used to verify the copyright ownership access of any data format. Watermarking is used to confirm the authenticity of the data or signal, in order to show the identity of its owners. Image Histogram is a graphical representation of image in statistical format to visualise the image pixels distribution in sequential intervals of unique size [2] and [9].

Medical Modality is the process of analysing the human body using various image scanning procedures for specific body parts or body areas. Doctors suggest the most appropriate modality for the patient in order to supervise the health status of the patient. In this paper, we used MRI (Magnetic Resonance Imaging) medical images to embed the necessary medical data using LSB Watermarking [4] [5] [9] and [1].

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II. LITERATURE SURVEY

Amin Motahari and Malek Adjouadi, have proposed a new propaganda for information modulation in 2-D barcodes, in which its efficiency can be estimated by specific methods of modulation of barcode. In this, OFDM modulation along with DPSK is used over adjacent frequency domain elements [10].

Stefan C. Katzenbeisser proposed that the area of cover image should be greater than that of area of message image, so the data could be hidden in cover image without any issue. After the completion of embedding process, particular region of cover image gets altered, but remaining region of the cover image remains unaltered [1].

Akshara Gaikwad proposed a method in order to hide QR Code images into colour images via QR codes luminance. After embedding QR codes into the colour images, the image luminance is decreased [13].

Zain proposed a scheme of LSB on ultrasound medical images, where the original image can be recovered completely using SHA-256 hash code, to calculate for the selected ROI in embedding process. Further, the LSBs of RONI are to be embedded with the hash code. The drawback involved is that the reversibility of the scheme depends on the original RONI pixels value before embedding were 0s, whereas, the scheme is not reversible for nonzero values [3].

A. LSB Steganography

Least significant bit (LSB) is a spatial domain technique for data hiding in any medium like image. It is the 8th bit of the byte for an image, is altered in accordance with the message bit. Grayscale images has 8 bits, whereas coloured image has 24 bits to visualize RGB model. The spatial domain techniques would modify the pixel bit values of the image in order to hide the information secretly. The secret bits are written directly to the pixel bytes of the cover image. In LSB bit-plane substitution, the 8th bit of input data is replaced with the hidden data bits based on the number of bit-plane substitutions, the input data LSB bits are modified [5] [6] [8] and [12].

III. PROPOSED METHODOLOGY

We had created information embedded QR Code images using Python programming in Python IDLE software. Medical image has to undergo grayscale conversion. The QR Code image is concealed into the medical image by LSB bit-plane Steganography at specific bit-plane range (1-8). After performing LSB Steganography, we obtain watermarked image or stego image as output. Next the watermarked image is decrypted with the selected bit-plane to obtain the recovered QR Code. Next the watermarked image is added with noise and the QR Code is extracted from noisy-watermarked image to compare the noise-free QR Code and noisy QR Code. The flowcharts for encryption and decryption of medical images are shown below.

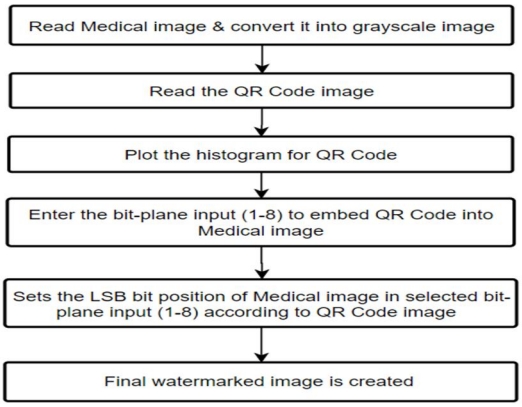

Fig. 2 Encryption flowchart

Figure 2 shows the embedding or encryption flowchart. The steps involved in embedding are given below.

1) The Medical image (Cover image) and the QR Code image (Message image) must be of same size (say 256 x 256 pixels) or the two images must be resized to proper pixels format.
2) Here, the histogram of message image is plotted.
3) Enter bit-plane input (1-8) to embed QR Code into Medical image.
4) The LSB bit positions of the medical image are set using bitset function in selected bit-plane input (1-8) according to the QR Code image, so as to embed the QR Code into Medical image.
5) Finally, watermarked image is formed which is also known as Stego image.

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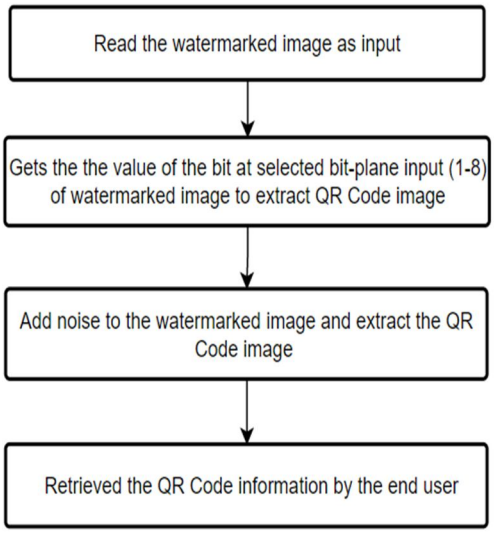

Fig. 3 Decryption flowchart

Figure 3 shows the extraction or decryption flowchart. The steps involved in extraction are given below.

a) Watermarked image is given as input image.
b) The watermarked image is decrypted with the bit-plane input (1-8) entered by the user (1-8) using bitget function.
c) Extract the QR Code from the obtained watermarked image output.
d) Add noise to the watermarked image & retrieve the QR Code, which is noisy.
e) Compare the recovered QR Code images extracted from watermarked image and noisy-watermarked image using evaluation metrics.

The following performance metrics are used in this work to estimate the efficiency.

MSE is the square of difference in error between medical and watermarked image or stego image. It can be measured using the following equation given as

$$MSE = [\sum ((I - J)^2)] / N$$

Where, I indicates the Cover image

J indicates the Watermarked image

PSNR is the logarithmic ratio of square of maximum pixel value to the MSE between medical and watermarked image, which is computed in decibel (dB) form.

$$PSNR=10*\log[(\text{maximum pixel value})^2/MSE]$$

NOTE: Since we are converting a normal image into grayscale image (Cover image & Message image) for the LSB Watermarking, maximum pixel value = 255.

Similarity Index or Correlation expresses the similarity or relation between the medical and watermarked image.

$$SI = \frac{E[(I - m_I)(J - m_J)]}{\sigma_I * \sigma_J}$$

where, I indicates the Cover Image, J indicates the Watermarked Image, m_I indicates the Mean value of I, m_J indicates the Mean value of J, σ_I indicates the Standard deviation value of I, σ_J indicates the Standard deviation value of J

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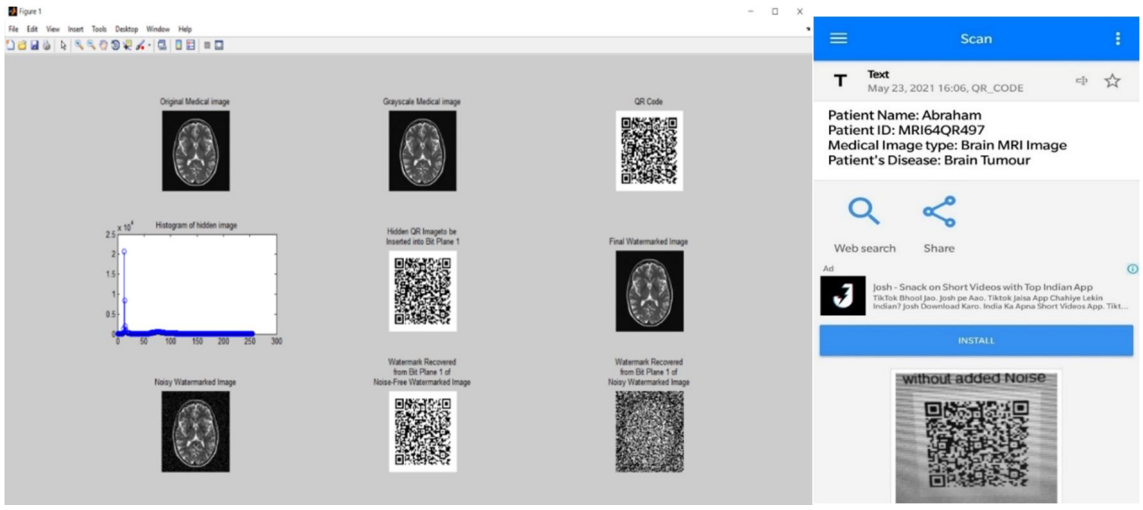
IV. RESULTS & DISCUSSION

This work has been implemented in MATLAB R2013a. The following results depict the LSB Watermarking for various medical images consisting of MRI images of Brain, Lungs and Neck. The extracted watermarked image is finally decrypted by the end user, in order to retrieve QR Code information. The information in QR Code image can be retrieved by using QR Code Scanner in mobile phone.

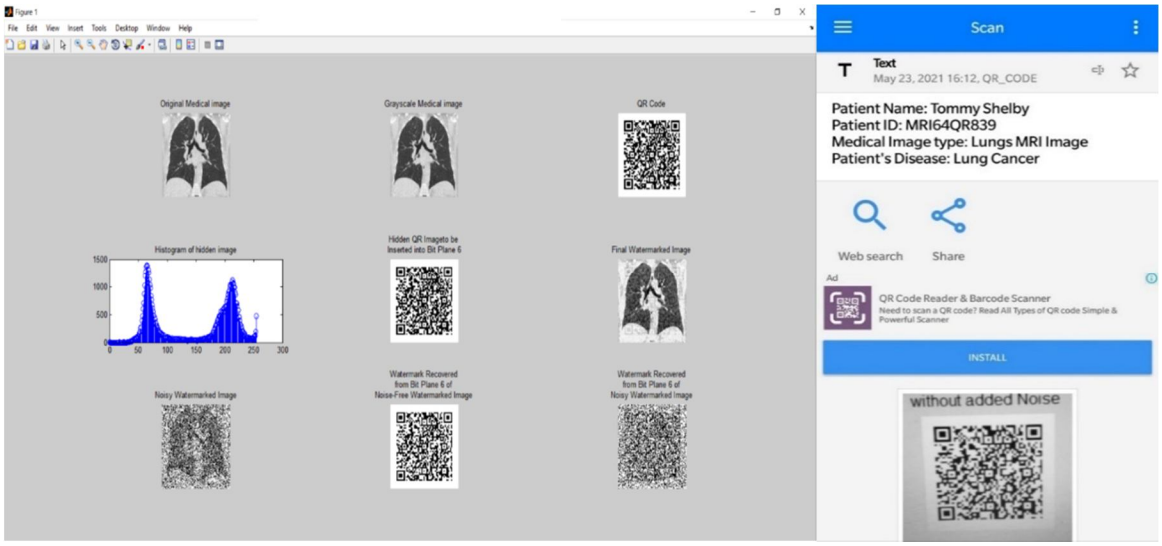


(a) (b)

Fig. 4 (a)Brain MRI watermarking using LSB scheme with Gaussian noise (b) Message found from retrieved QR code

Figure 4(a) shows the watermarking of Brain image using LSB plane = 1 by introducing Gaussian noise with mean and variance values as (0, 0.01).

Figure 4(b) shows the retrieved QR Code output of Brain which is obtained by scanning the QR Code using QR Code Scanner in mobile phone.



(a) (b)

Fig. 5 (a) Lungs MRI watermarking using LSB scheme with Salt & Pepper noise (b) Message found from retrieved QR code

Figure 5(a) shows the watermarking of Lungs image using LSB plane = 6 by introducing Salt & Pepper noise with density value as 0.6.

Figure 5(b) shows the retrieved QR Code output of Lungs which is obtained by scanning the QR Code using QR Code Scanner in mobile phone.

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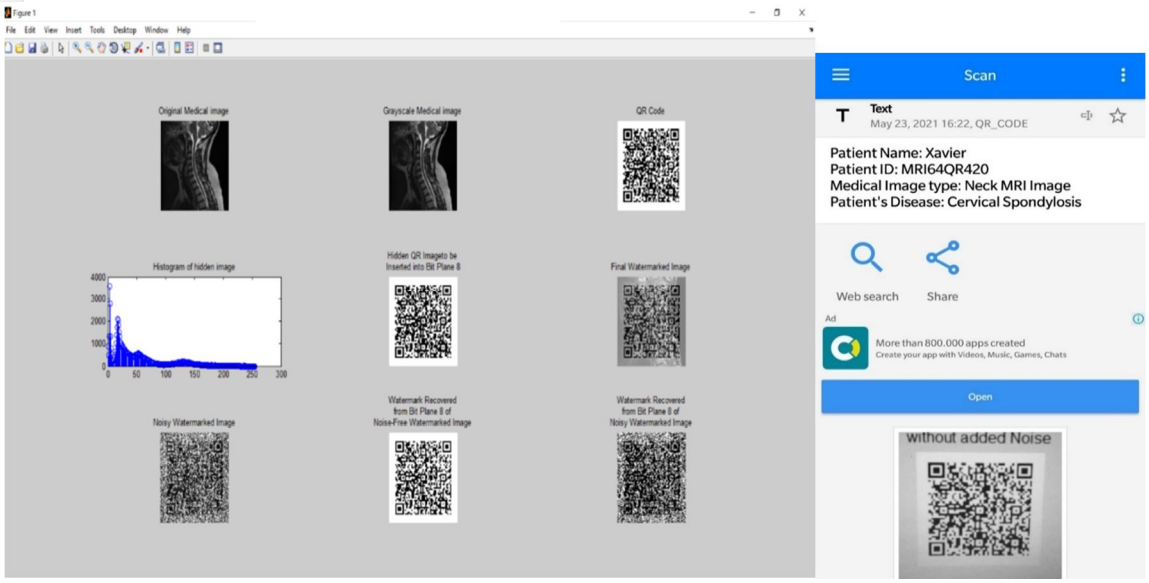

(a) (b)

Fig. 6 (a) Neck MRI watermarking using LSB scheme with Speckle noise (b) Message found from retrieved QR code

Figure 6(a) shows the watermarking of Neck image using LSB plane = 8 by introducing Speckle noise with density value as 0.6. Figure 6(b) shows the retrieved QR Code output of Neck which is obtained by scanning the QR Code using QR Code Scanner in mobile phone.

The tabular values of MSE, PSNR and Correlation for the various medical images of Brain, Lungs and Neck by introducing various noises at LSB are displayed in Table I.

Table I. Performance metrics of algorithm for various MRI images

Medical Image	Evaluation Metrics	Medical & Watermarked image	QR Code & Recovered Watermark image	Recovered Watermark & Noisy-Recovered Watermark image		
				Gaussian Noise (0, 0.01)	Salt & Pepper Noise (0.2)	Speckle Noise (0.4)
BRAIN	**MSE**	0.1514	-	106.0139	17.7468	90.6250
	PSNR	56.3291	-	27.8771	35.6396	28.5583
	Correlation	0.9999	0.9478	-0.0395	0.7764	-0.0073
LUNGS	**MSE**	0.1567	-	83.5629	17.6261	69.6137
	PSNR	56.1794	-	28.9106	35.6692	29.7038
	Correlation	0.9999	0.9425	0.0121	0.7778	0.0469
NECK	**MSE**	0.1552	-	103.4614	17.4316	96.2670
	PSNR	56.2198	-	27.9830	35.7174	28.2960
	Correlation	0.9998	0.9440	-0.0230	0.7765	0.0087

V. CONCLUSION

QR Code image is concealed within the medical image to store relevant medical data in unrecognizable form using LSB Steganography technique.

In the paper, we have visualized various medical watermarked images which are obtained from different number of LSB bit-plane substitutions and computed the MSE, PSNR and Correlation values for every watermarked image. By comparing the results of different Stego images, we have found that if the number of LSB Bit Substitutions is higher, the Stego image quality will be less and it will no longer look like the original Medical MRI image.

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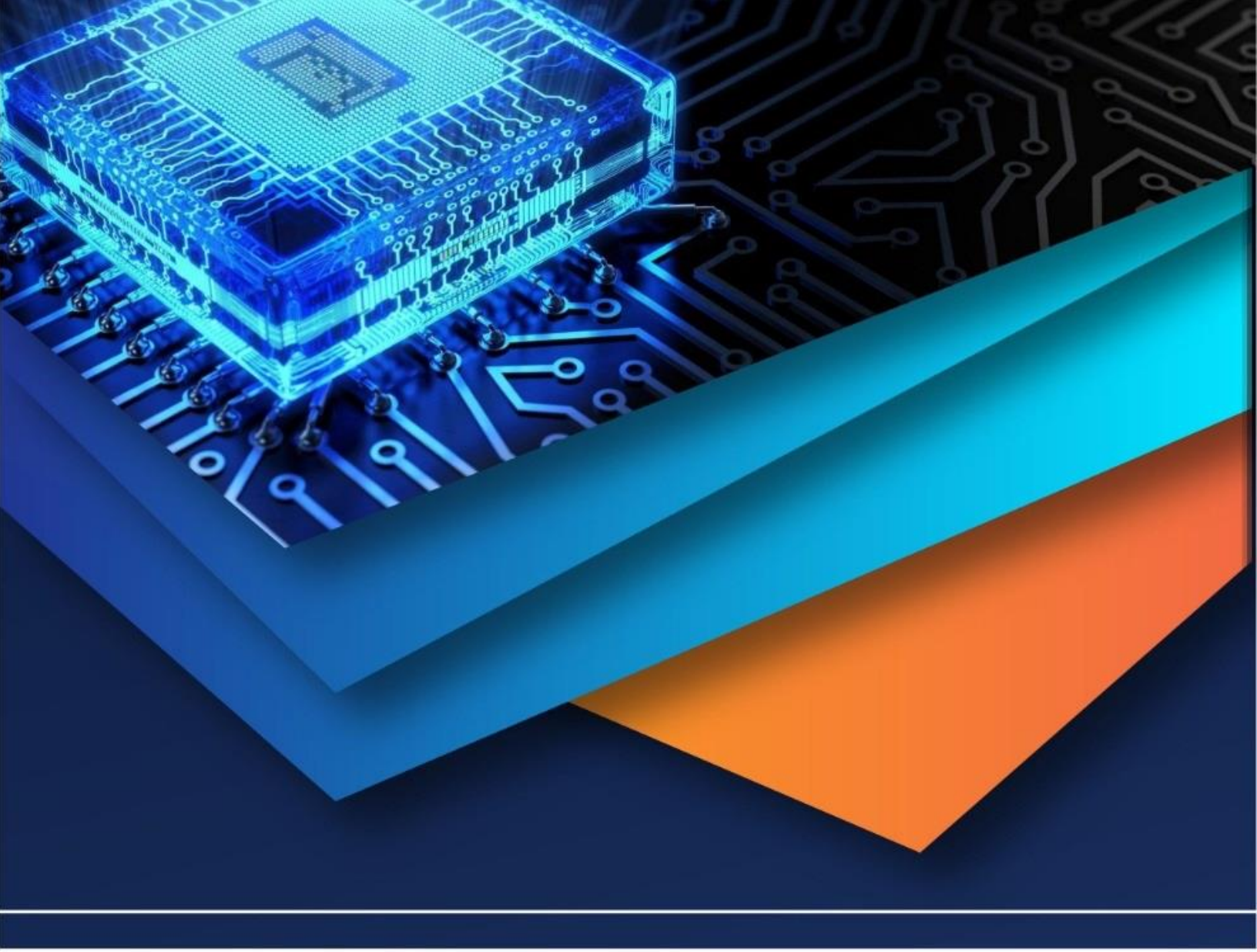

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