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Biometric Fusion System based on IRIS and Fingerprint Recognition using GA along with ANN

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Abstract: ***In the authentic world applications, uni-modal biometric systems often face limitations because of appropriate feature, noise, size of data etc. Biometric system for identification and authentication provides automatic recognition of an individual based on certain unique features or characteristics possessed by that individual. Iris recognition is a biometric identification method that uses pattern recognition on the images of the iris of an individual. Fingerprint recognition is used for the verification of the authenticity of the person by the fingerprint. In the proposed work, we have two sections, first section is iris recognition and second section is fingerprint recognition. At the last, Parameters namely, FAR, FRR and Accuracy are used for the evaluation of the work. The work is being designed and developed on the basis of ANN (Artificial Neural Network), HCT (Hough Circular Transform), GA (Genetic Algorithm) and SIFT (Scale invariant feature transform) algorithms. Our investigational results suggest that the ANN method for the recognition at the decision level is the most excellent followed by the different techniques like Sum Rule, SVM, Clustering and KNN. The performance evaluation of proposed technique is reported in terms of FAR, FRR, and accuracy after doing comprehensive tests on the CASIA-Iris databases for iris and the FVC 2004 fingerprint database and we concluded the accuracy of proposed system is more than 96% with a better FAR and FRR value.***
Keywords: Biometric, Fingerprint recognition, HCT, ANN, SIFT, FAR, FRR and accuracy

I. INTRODUCTION

The biometric system is significantly a system of pattern recognition for recognizing a person on the basis of feature vector on the basis of behavioral or physiological characteristics that a human being has. On the basis of application context, the biometric system execution taken place in verification and the identification mode [1]. In the verification mode, the validation of system takes place following human being identity with the comparison of characteristics of biometric captured system with the biometric template being stored in the database [2]. The person claims an identity as per desired, generally, by means of PIN (Personal Identification number), smart card, login name and the system carry out the comparison one by one for determining whether the claim is true. In the identification mode, the system finds a person by means of searching the full template database for a match [3]. In this mode, the system executes one-to-many comparison for establishing person's identity. The identification fails if the subject is not registered in the database.

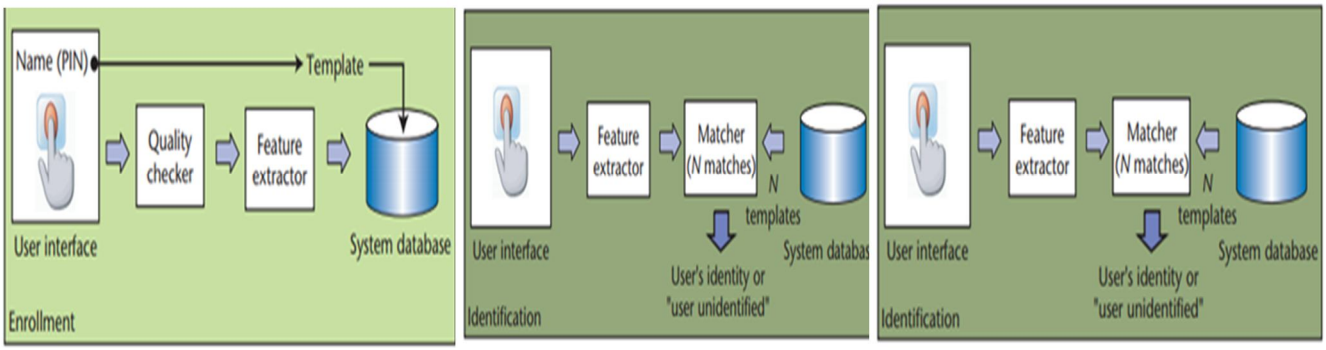

Figure 1: Enrollment, verification, and identification tasks

Above figure shows the enrollment, verification and identification of the tasks. The process of enrollment develops an association among the identity and the biometric characteristics [4]. In the verification task, the user being enrolled claims an identity and the authenticity of the system is being verified in the basis of the biometric feature. An identification mode finds an enrolled user on the basis of biometric a characteristic in which claim of an identity is not required [5].

The biometric solution provides high identification level management security operations with different benefits over conventional means. The behavioral and physiological traits are defined below [6]:

A. Physiological Traits

Generally, the factors considered are fingerprints, face, IRIS, finger vein patterns, hand and DNA.

B. Behavioral Traits

Usually, the recognized factors are keystroke dynamics, signature and gaits. Traits like, voice has accurate and unique identification methods.

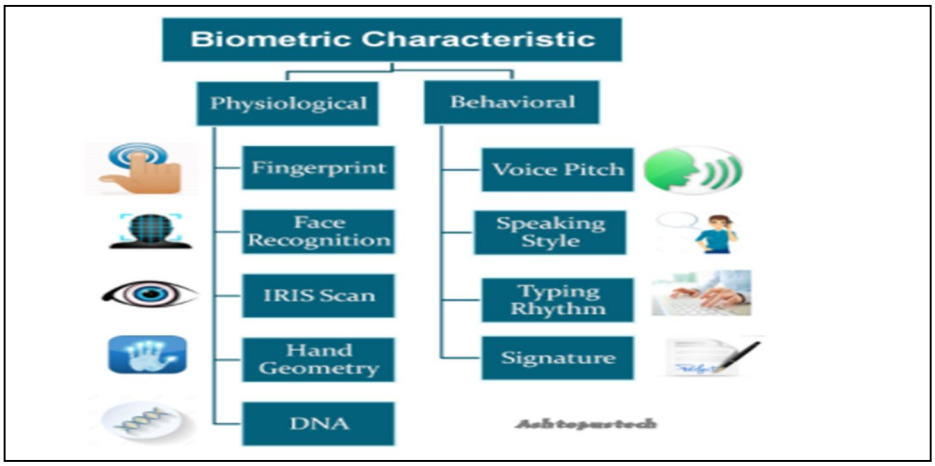

Figure 2: Biometric Traits

In these days, biometric fusion system is frequently used on the basis of iris and fingerprint recognition but there is a problem occurred during the classification part due to the existing feature extraction techniques. The major causes of the problem in biometric fusion system are the extraction of best and appropriate feature sets from the iris and fingerprint images. To minimize these types of problems from biometric fusion system, there are many options available but SIFT (Scale Invariant Feature Transform) with GA (genetic algorithm) is best. In the proposed work, SIFT is used to extract the features from the iris images and minutia feature is used for fingerprint images. There are another problem occurs in the classification of biometric fusion system, if the feature sets are not optimized then the possibility of error rate is more, so, to overcome the error rate from the biometric fusion system, the optimization is a need with a novel objective function. To optimize the extracted feature sets genetic algorithm has been used that eliminates the unwanted feature sets to increase the accuracy of the proposed work. In the proposed work, an effective biometric fusion system based on iris and fingerprint recognition using genetic algorithm along with the artificial neural network as a classifier has been presented. ANN (Artificial Neural Network) is used as a classifier to train the both recognition system to achieve better efficiency on the basis of score level matching techniques.

II. MATERIALS AND METHODS

In the proposed work, HCT (Hough Circular Transform) is used to figure out the centre and radius coordinates of the pupil and iris regions. SIFT descriptor is used for extracting the features from Iris image and the Minutia feature is used for finger print extraction, GA is used to optimize the extracted features by using objective functions. ANN is used to classify the uploaded image.

A. HCT (Hough Circular Transform)

The Hough transform is a general computer vision algorithm that could be utilized for determining the simple geometric objects parameters, like lines and circles, employed in an image [16]. The circular Hough transform is employed to figure out the centre and radius coordinates of the pupil and iris regions. An automatic segmentation algorithm is dependent on the circular Hough transform is employed by Wildes. Hough transform can be used to detect the geometric Shape parameters that can be written in the form of lines, circles, parabolic and hyperbolic. Circular Hough transform can be used to discover known Image radius. Circle equation can be written as

$$s^2 = (x-b)^2 + (y-a)^2$$

In which r2 is taken as the circle radius and 'b' with 'a' are the coordinates of centre. In the form of parameters, the equation points for circle can be written as follows:

$$y = b + r\cos\theta$$

$$x = a + r\cos\theta$$

By drawing a given circle to calculate transform, edge radius of each point in the image takes place. For each point, circumference of a circle is drawn by coordinates 1. It is to increase the draw for each round is like creating an integrated array. With a circle peak represents joint array (Hough space). Circle detection transformation needs to know the radius. Because we do not know the exact radius of the pupil or iris, radius must be calculated for a range of conversion. Each radius testing, storage location and maximum values with a radius of the peak indicates the most likely radius and center coordinates. Above figure shows the segmented iris using hough circular transform method.

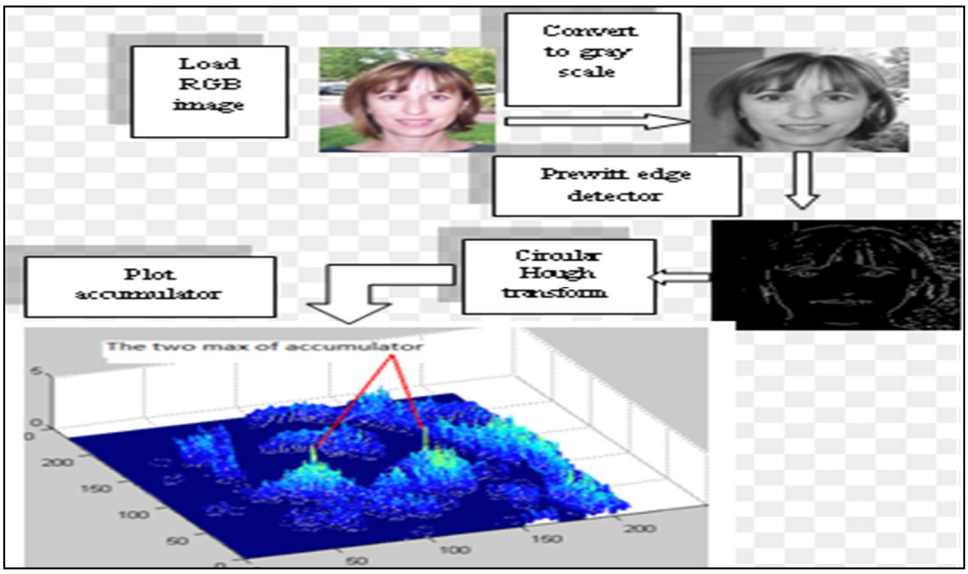

Figure 3: Iris localization general overview

B. SIFT (Scale Invariant Feature Transform)

The algorithm was proposed by David Lowe [10] that has the capacity to distinguish and depict neighborhood picture elements successfully. Following stages are involved for the execution of the SIFT algorithm:

1) Scale-space local extreme a detection
2) Accurate Key-point Localization
3) Orientation assignment
4) Key-point descriptor
5) Trimming of false matches

C. GA (Genetic Algorithm)

According to Goldberg et al., 1989, GA (Genetic Algorithm) is basically utilized in the applications where the search space is large. The advantage of a Genetic Algorithm is that the procedure is fully automatic and avoids local minima. The major components of Genetic Algorithm are named as crossover, mutation, and a fitness function. The crossover operations are utilized for generating a novel chromosome from parents sets while the mutation operators add variation. The fitness function executes a chromosome dependent on the criteria already defined. An improved fitness value of a chromosome increases its survival chance. The population is a chromosomes collection. A novel population is carried out by utilizing standard genetic operations like single-point crossover, mutation, and selection operator.

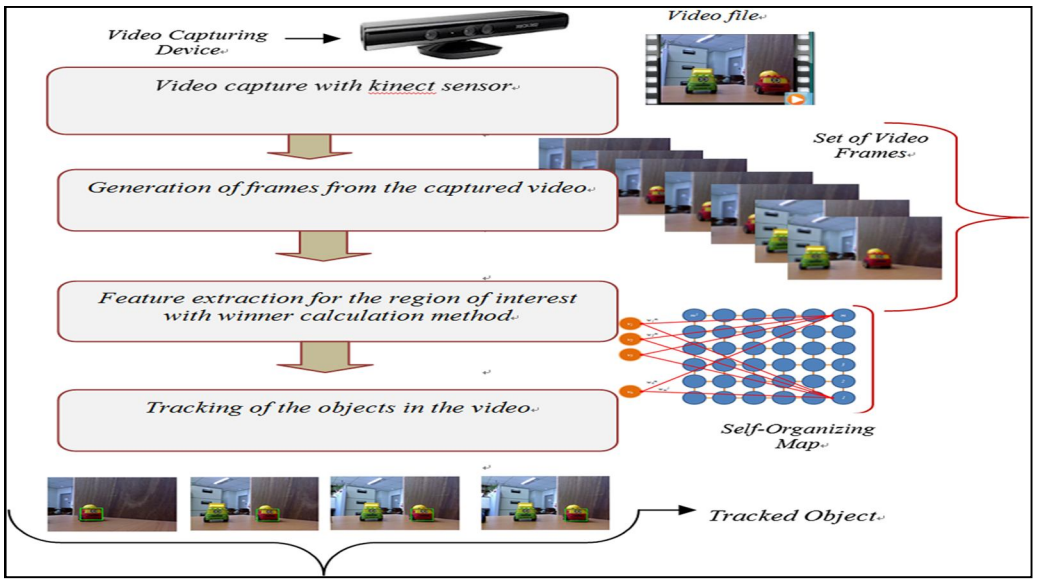

Figure 4: SIFT descriptor extraction

D. Steps of Genetic Algorithm

Step 1: To initialize random population having chromosomes.
Step 2: To calculate fitness function in the population.
Step 3: To develop novel population with individuals.
Step 4: To select parent chromosomes for best fitness function.
Step 5: To perform crossover to have copy of parents.
Step 6: To perform mutation to mutate novel off springs.
Step 7: To place novel offspring in the population.
Step 8: To repeat the steps to get a satisfied solution.
Step 9: Stop

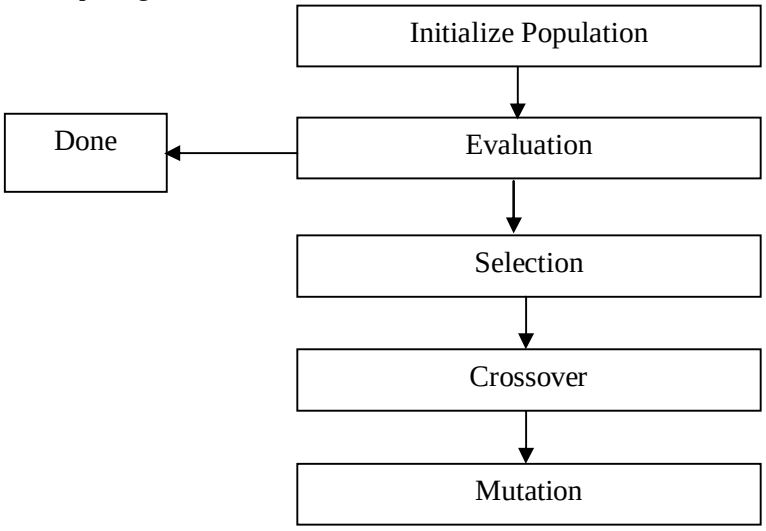

Figure 5: Genetic Algorithm Flowchart

E. ANN (Artificial Neural Network)

Neural network consists of a series of layers: The first layer has a connection from the network input. Respectively successive layer has a connection from the preceding layer. The last layer produces the network's output. Neural network can be used for any kind of input to output mapping. A neural network with one hidden layer and sufficient neurons in the hidden layer can be suitable for any finite input-output mapping problem. Figure below represents the model of neural network in which there is one input layer, one hidden layer in which 10 neurons are taken and at the end one output is observed.

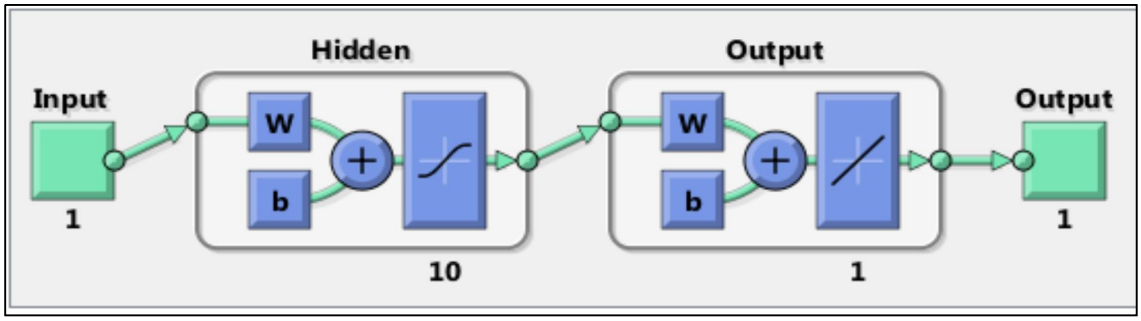

Figure 6: Neural network layer

F. Simulation Model

To verify the efficiency and accuracy of proposed biometric fusion system based on iris and fingerprint recognition using genetic algorithm along with the artificial neural network; we perform several experiments with this procedure on several images. In proposed biometric fusion system, there are several steps will use to recognize the accurate result from the testing images. The methodology of proposed work is given below:

Step 1: Design and develop a proper GUI for the proposed biometric fusion system.

Step 2: Upload the iris and fingerprint images for Training and Testing of proposed biometric fusion system.

Step 3: Apply pre-processing on uploaded images in both section.

Step 4: Develop a code for the iris localization and segmentation from the pre-processed iris images in training as well as testing section and same procedure is applied for fingerprint image with the thinning technique.

Step 5: Apply SIFT for the feature extraction from the segmented iris and minutia for the feature extraction from the fingerprint.

Step 6: Initialized Genetic Algorithm to optimize features and remove the unwanted feature sets using the objective function.

Step 7: Apply artificial neural network on optimized data to train the database and train the data using following steps: Select optimized feature as an input of artificial neural network for training and testing data. Compute the total categories which are generated by the training of optimized data using artificial neural network.

Step 8: After that in the classification section we classify the test data according to the trained artificial neural network structure.

Step 9: In the both recognition panel we create a test matching number and on the basis of the matching number in the fusion part we check the recognition result.

Step 10: At last of module, we calculate the performance parameters of proposed biometric fusion system like FAR, FRR and Accuracy.

III. SIMULATION RESULTS

This section explains the results obtained after the simulation of the proposed work. The parameters considered for the calculation of the performance are FAR, FRR and accuracy.

Table 1: FAR, FRR AND Accuracy

S. No.	FAR (False Acceptance Rate)	FRR (False Rejection Rate)	Accuracy
1	0.653693	0.642798	95.728314
2	0.682546	0.632578	97.966232
3	0.641478	0.653251	93.678999
4	0.668792	0.665471	96.956552
5	0.639985	0.635478	97.932233
6	0.670378	0.640124	98.032547

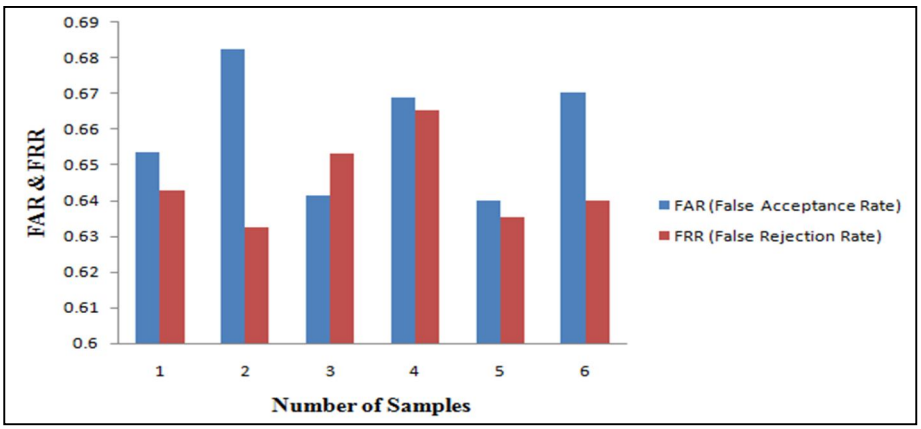

Figure 7: FAR & FRR of the proposed work

The above figure represents the FAR and FRR of the proposed work. Blue lines represent the FAR values obtained for the proposed work and red lines represent the FRR value. The above figure shows that the FAR value is more than the FRR value. FAR measure the efficiency of the system at a rate in which unauthorized users is verified on a particular system. FRR is the instance of a security system failing to verify or identify an authorized person. The average value of FAR and FRR for 6 samples are 0.659478 and 0.64495 respectively.

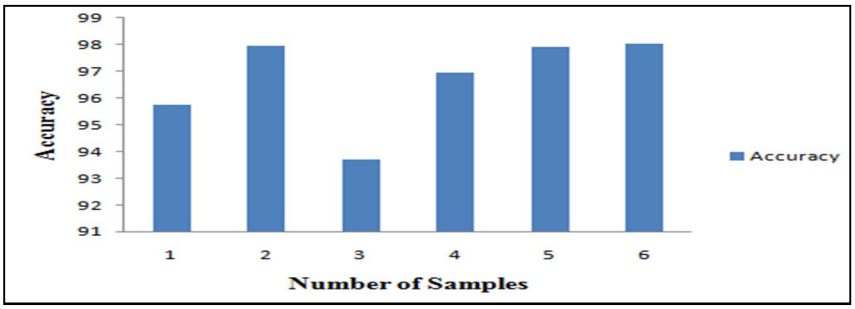

Figure 8: Accuracy of the proposed work

The above figure represents the accuracy of the proposed work. X-axis represents the number of samples and y axis represents the Accuracy. The average value of accuracy obtained for the proposed work is 96.7158.

A. Comparison of Proposed Work with the Existing Work

In this section, the comparison of proposed work with the existing one is taken place on the basis of parameters.

Table 2: Comparison of proposed and existing work (Accuracy)

Accuracy (%)	
Proposed Work	Existing Work
96.71	79.64

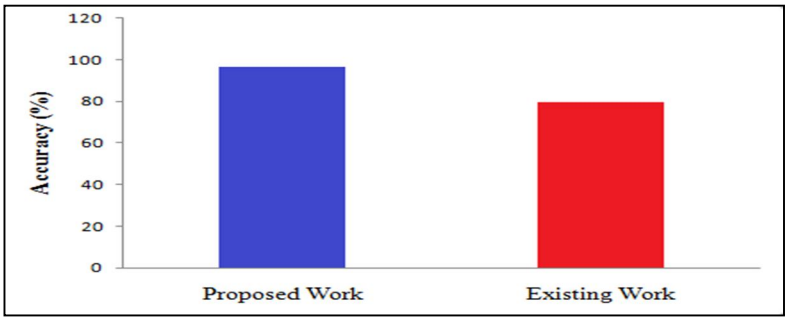

Figure 9: Comparison graph of proposed and existed Accuracy

Above figure shows the comparison graph of accuracy parameter for existed and proposed work. Red bar line indicates the value of existing work and blue bar line indicates the average value of accuracy for the proposed work. The average value of proposed work is 96.71% whereas for existing, it is 76.64 %.Thus it is concluded that proposed work perform well than existing work.

IV. CONCLUSION

In the proposed work, iris recognition is done by using Hough Circular Transform (HCT), Scale Invariant Feature Transform (SIFT) using Artificial neural network (ANN) and Canny Edge detection technique. In the Iris recognition, biometric parameters have been calculated like FAR, FRR and Accuracy by using Iris pattern. Iris recognition is used to identify the individual person and their identity. HCT is used to for segmenting the pre-processed image. SIFT technique is used to find feature of the uploaded Iris image. Training panel is used for one time simulation whereas testing panel simulates multiple times. Training and Testing is done for matching the biometric parameters like if parameters are matched than the image gets recognized otherwise not-recognized. Pre-processing is done for resizing, Binarization and for color conversion of the loaded image. Similarly, for thumb print feature extraction is done by using Minutia feature extractor and optimization has been performed by using Genetic algorithm (GA). Also, training and testing is performed same as the IRIS and performance parameters are calculated, weather the image is recognized or not. The average value of FAR and FRR for 6 samples are 0.659478 and 0.64495 while Accuracy Rate is 96.71. At last, comparison of proposed work with existing work is provided and it is concluded that proposed work perform well than existing work with an improved accuracy by 26.18%. In the future, we can use optimization technique for feature optimization like ABC, PSO, ACO and BCO. Feature optimization gives the best optimal feature set. It gives best fitness results than the SIFT which is being applied in the proposed work.

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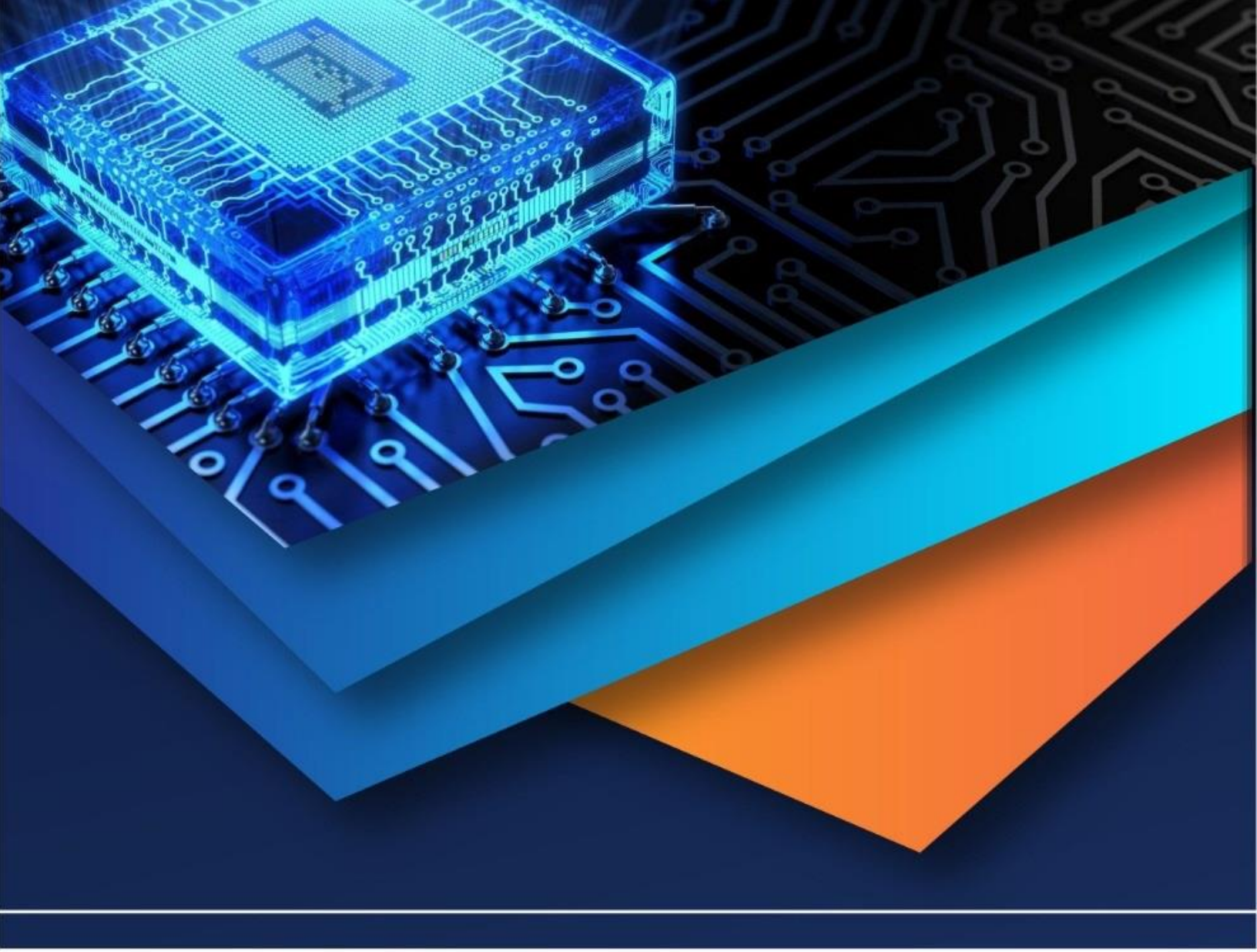

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