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Offline Signature Recognition Using PCA-FFNN Method and Adaptive Variance Reduction and Invariant Moment Feature Extraction

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Abstract: ***Although offline handwritten signature recognition has been frequently researched, it nevertheless calls for an improvement of popularity rate. Most of present techniques attention on feature extraction (FE) to improve their performance. In this analyze, we put in force Offline Signature attention utilizing principal component analysis (PCA) and Feed Forward Neural network (FFNN) method. We extract signature features using histogram of Orientation (HOG) and Seven Invariant Moments. The proposed system works in three parts. First Pre-processing: where resizing, binarization, noise reduction is done to make signatures all set for FE consequently, the variance discount technique is utilized to normalize offline handwritten signatures in means of an adaptive dilation operator. Then the range of signatures is analyzed in conditions of coefficient of variant (CV). The optimal CV is obtained and used to be a threshold limit value for the acceptable variance reduction. Within the experimental outcome, we extended signature recognition accuracy in conditions of attention expense up to 95.8%with database of SigWiComp2011 (48 signatures of 12 persons).***

Keywords—Signature Recognition, PCA, FFNN, Invariant Moment, HOG, AVR

I. INTRODUCTION

Biometrics is a fast developing technology in recent years mainly due to increasing need for authentication and access control. Signature recognition plays vital role in this field. Numerous procedures had been proposed for the signature recognition and colossal successes have been completed

The classification was leading to a vector of independent measure that could be when compared with other vectors within the database. An effective signature recognition approach must be in a position to care for variants of the face pictures in poses, illumination and expression. The variations between the pictures of the same face because of illumination and poses are continually better than photo variation because of face identification. This makes FC enormous challenge. In this paper PCA namely Eigen based method is used as a FE and recently many advanced work has been implemented for recognition of signature. In this work original size of images is taken without preprocessing like Image size normalization, equalization, and filtering, back ground removal signature two issues. What features are use to represent a face and other one to classifying a new picture? To classify a face different classifiers are used. Bayesian classifier, Euclidean distance, nearest neighbor classifier and ANN. NNs have been proficient to participate in difficult capabilities in more than a few fields of application together with pattern recognition, identification, classification, speech, and manage methods. The NN-situated attention methods are observed to be notably promising, in view that the NNs can without difficulty put in force the mapping from the feature house of face pictures to the facial features space. NN has the capacity to learn how one can do duties established on the info given for training or initial experience called adaptive studying. An ANN can create its own institution or illustration of the expertise it receives throughout studying. In this paper we suggest cascade neural for recognizing faces and the results are when put next with FFNN.[1].

A. Principal Component Analysis (PCA)

Its sometimes called Karhunen-Loeve process is without doubts one of the recognized approaches for function choice and dimension reduction. Realization of human faces utilizing PCA was first executed with the aid of Turk and Pentland and reconstruction of human faces was accomplished with the aid of Kirby and service. The realization process, known as Eigen face approach defines a characteristic space which reduces the dimensionality of the real knowledge space. This reduced information area is used for attention. But bad discriminating power inside the class and gigantic computation are the good recognized common issues in PCA process.[2]

B. Histogram of Oriented Gradients (HOG).

HOG points are proposed by using Dalal and Triggs. They involve first computing the gradient information at every pixel inside a particular grid zone (either Cartesian or Polar). Next, HOG orientations in that zone are computed. While calculating gradient orientation histogram, we apply a normalization to allow for rotational differences of the strokes within the grid zone. Surely, after finding the gradient orientation at each factor, we discover the dominant gradient orientation and characterize it on the primary bin of the histogram. Without this normalization, a rotation of the strokes in a zone would communicate to a circular shift in the HOG histogram; lowering the match between the original and matched histograms.[3].

II. LITERATURE SURVEY

[4] The proposed way is founded on the hypothesis; reducing the inconsistency of signatures leads to boost up the recognition rate. For that reason, the variance reduction method is utilized to normalize offline handwritten signatures by way of an adaptive dilation operator. Then the variety of signatures is analyzed in terms of coefficient of version (CV). The optimal CV is obtained and used to be a threshold limit value for the acceptable variance reduction. Based on 5,739 signature samples with 140 classes, the experimental results show that the adaptive variance reduction procedure helps improve the recognition rate when evaluated to the usual schemes without adaptive variance discount, including HOG and PHOG tactics.

[5] This paper discusses the offline signature recognition procedure in which aspects are extracted making use of DWT and PCA and the unreal neural network (ANN) is used for the realization of signature. ANN is used to appreciate whether a signature is original or fraud. The consumer furnish the scanned picture of signature for computer database, modifies there excellent through IP.

[6] The proposed process, founded on the enter signal from the MEMS (Micro Electro Mechanical system) accelerometer sensors measure the acceleration corresponding to tilt, shock & vibrate It is reliably and accurate detect. Here, the lean movement knowledge produced via the human topics and transmitted to the AVR microcontroller i.e. ATmega32A. The sign sequence and template matching algorithm developed to recognize the gesture in a sequence.

[7] For a given data base the features are extracted using PCA. The feature set is split into training and checking out knowledge. The training data is used to prepare cascade neural network (CASNN). Testing knowledge is used for efficiency of the method. This paper uses UMIST face information base. The performance is when compared with extra popular FFNN. The results got show the efficacy of the proposed CASNN centered classifier as compared to the FFNN classifier.

[8] Regional histogram points like HOG and histogram of LBP. SVMs are then used for classification of these two different approaches. It reported an EER of 15.41% in accomplished forgery experiment.

III. PROPOSED METHODOLOGY

In picture or picture representation one is concerned with the characterization of the amount that each picture-aspect (likewise known as pixel) indicates.

This process contains the next steps: (i) Pre Processing (ii) feature Extraction (iii) Classification

A. Pre-Processing

The real signature picture as specify in Fig 2 is bought by way of scanning signature of the person, which is additional pre-processed to make signature typical and in a position for characteristic extraction. In the pre-processing stage image is first resized the image with 250X 300 resolution for better visibility shown in Fig 3. Then binarized to make feature extraction simpler.The binary image of the signature contains just 0's and 1's. Where 0's indicates signature boundary and 1's indicates blank white area as indicated in Fig 4. Apply DWT on binary image then decompose into four bands: LL, LH, HL and HH for noise reduction. The enhanced signature image is reduced its variation through the means of an adaptive dilation operator; i.e. the size of structuring element increases from 3×3 to 5×5, 7×7, …, n×n. Therefore, the variability of signatures is estimated the optimal threshold value as a stopping criteria for the variability reduction. An image variation can be produced using CV as defined by (1).

$$CV = \frac{\sigma}{\mu} \quad (1)$$

Where σ and μ defined as standard deviation and mean of an image.

Mean- It is the average of all pixel values$Q(i,j)$, M x N are rows and columns of an image.

$$\mu = \sum_{i=1}^{M} \sum_{j=1}^{N} \frac{Q(i,j)}{M \times N}$$

Standard Deviation- It calculates the mean value deviation.

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$$\sigma = \sqrt{\sum_{i=1}^{M}\sum_{j=1}^{N}\frac{(|Q(i,j)| - \mu)^2}{M \times N}}$$

The proposed algorithm can be described as follows:
Step1. Consider the scanned image with 250X300 image resolution.
Step2. Enhanced image using DWT then apply AVR on this image shown in Fig 5
Step 3: the CV of thickness of the enhanced image in Step 2 is calculated by (1).
Step 4: if the CV of Step 3 reach to the optimal threshold value, the algorithm breaks the operation. Otherwise, go to Step 2.

B. Feature Extraction (FE)

In this phase, HOG, which is used for shape FE by using the giving out of greatness gradients or edge directions. This method consists of three steps: (i) the thickened signature line image is separated into small connected regions called cells; (ii) each cell is computed the HOG coefficients; and (iii) the HOG features are constructed by concatenating all HOG coefficients. These features can be improved by normalization technique. This technique is employed to standardize HOG coefficients of each cell with its nearest neighbor which has 4- histogram to form one block feature. Second feature is scale invariant moment, Calculate moment (p,q) of an image f(x,y) of size M*N is defined using this equation:

$$m_{p,q} = \sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f(x,y)\, x^p y^q$$

where *p* is the order of *x* and *q* is the order of *y*
A significant moment is essentially the equal because the moments simply described except that the values of x and y used in the formulas are displaced by way of the mean values

$$\gamma_{p,q} = \sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f(x,y)\,(x - x_{avg})^p (y - y_{avg})^q$$

Where $x_{avg} = \frac{m_{10}}{m_{00}}$ and $y_{avg} = \frac{m_{01}}{m_{00}}$

The normalized instants $\gamma_{p,q}$ are the same as the central moments except that they are all divided by an appropriate power of m_{00}

$$\gamma_{p,q} = \frac{\gamma_{p,q}}{m_{00}^{\frac{p+q}{2}+1}}$$

Seven invariant moments are linear combinations of the middle moments and here is how defined seven moments are:

$I1 = \gamma_{20} + \gamma_{02}$
$I2 = (\gamma_{20} - \gamma_{02})\text{^}2 + 4\times\gamma_{11}$
$I3 = (\gamma_{30} - 3\times\gamma_{12})\text{^}2 + (\gamma_{03} - 3\times\gamma_{21})\text{^}2$
$I4 = (\gamma_{30} + \gamma_{12})\text{^}2 + (\gamma_{03} + \gamma_{21})\text{^}2$
$I5 = (\gamma_{30} - 3\times\gamma_{12})\times(\gamma_{30} + \gamma_{12})\times((\gamma_{30} + \gamma_{12})\text{^}2 - 3\times(\gamma_{21} + \gamma_{03})\text{^}2) + (3\times\gamma_{21} - \gamma_{03})\times(\gamma_{21} + \gamma_{03})\times(3\times(\gamma_{30} + \gamma_{12})\text{^}2 - (\gamma_{30} + \gamma_{12})\text{^}2)$
$I6 = (\gamma_{20} - \gamma_{02})\times((\gamma_{30} + \gamma_{12})\text{^}2 - (\gamma_{21} + \gamma_{03})\text{^}2) + 4\times(\gamma_{30} + \gamma_{12})\times(\gamma_{21} + \gamma_{03})$
$I7 = (3\times\gamma_{21} - \gamma_{03})\times(\gamma_{30} + \gamma_{12})\times((\gamma_{30} + \gamma_{12})\text{^}2 - 3\times(\gamma_{21} + \gamma_{03})\text{^}2) + (\gamma_{03} - 3\times\gamma_{21})\times(\gamma_{21} + \gamma_{03})\times(3\times(\gamma_{30} + \gamma_{12})\text{^}2 - (\gamma_{30} + \gamma_{12})\text{^}2)$

C. Recognition and Classification

PCA technique is utilized for signature recognition. The rationale behind PCA is to minimize the hugged dimensionality of the data area to the littler average dimensionality of the element house (self reliant variables), which are expected to explain the information economically. It is realized that the unbiased variable is in charge to the same amount of deviation or error as the needy variable. A picture of size M x M can be represented as a point in a M2 dimensional space. Given a signature image I(x, y), be 2D M through cluster of (eight bit) intensity worth. N coaching portraits are represented with the aid of I1, I2,… ., IM and each picture Ii is represented to as a vector Fi. At the moment the normal signature vector is figured utilizing the accompanying comparison.

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$$\varphi = \frac{1}{N}\sum_{i=1}^{N} Fi$$

Here, φ is the average signature vector. Now the deviation is estimated from the mean (average) signature vector for every image. The equation will be as follows:

$$\emptyset i = Fi - \varphi$$

$$A=[\emptyset 1, \emptyset 2 \ldots \emptyset N]$$

Here, $\emptyset i$ is the deviation vector for ith image. A is the set of deviation vector of N images. We can examine the covariance utilizing A vector as

$$D=AA^T$$

Here D is an *M2xM2* matrix and A is an *M2xN* matrix. In order of matrix AA^T, we are learning the matrix A^TA. Regard as A is an *M2xN* matrix; hence A^TA is an *NxN* matrix. If we compute the Eigenvectors of this matrix, it would go back *N* Eigenvectors, every of size *Nx1*, let's call these Eigenvectors v_i. The greatest N Eigenvectors can be finding with the aid of under equation

$$\mu_i=Av_i$$

Each signature in the preparation set (short the mean), $\emptyset i$ can be spoken to as a straight gathering of Eigenvectors μi.

$$\emptyset i = \sum_{k=1}^{j} \omega k \mu_k$$

These weights can be considered as

$$\omega_k=\mu_i^T \emptyset i$$

Every normalized training image is characterized on this basis as a vector

$$\omega_i=\omega_{1,}\omega_{2\ldots..}\omega_j$$

1) Processing of signature consists of two main stages: Training stage & Testing stage

In the examination of the proposed strategy, 48 signatures of 12 persons are utilized to prepare the system; furthermore some skilled forgeries are introduced in the training dataset. For the awareness system, FFNN is designed and implemented utilising MATLAB 12a with NN Toolbox. There are numerous algorithms that may be used to create NN, but the FFNN is chosen as its miles simplest to enforce, whilst retaining performance of the network. NN consists of simple computational elements called neurons, which are linked with weights. It mainly includes 3 layers: the input layer, hidden layer and the output layer. The primary layer takes the inputs whilst last one producing the outputs. The middle (hidden) layer has no connection with the external world, and hence is called hidden layers. In the exploration of proposed system, the number of units in the hidden layer is 30 and the total number of units, must reach the following rule: $h \geq (p-1) / (n+2)$ Where p is the quantity of preparing cases, n is the quantity of inputs in the system.

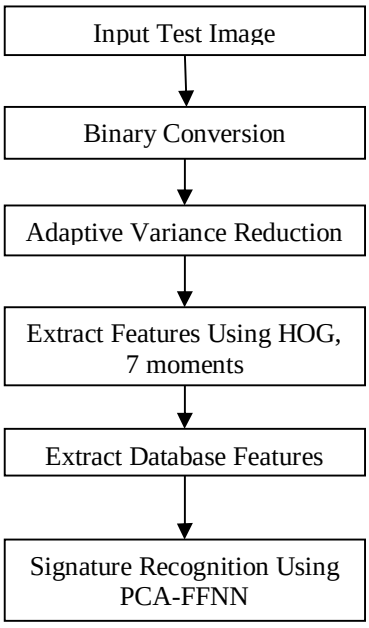

Fig1. Proposed System Block Diagram

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I. READ ORIGINAL IMAGE

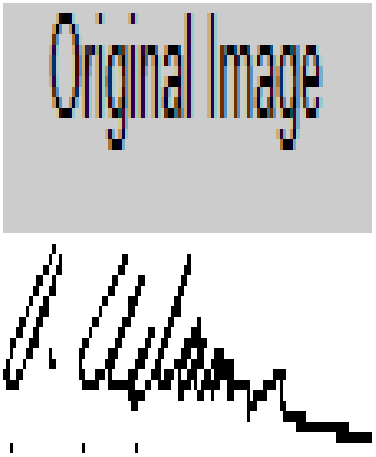

Fig 2. Show Test Image

2) Resize Image

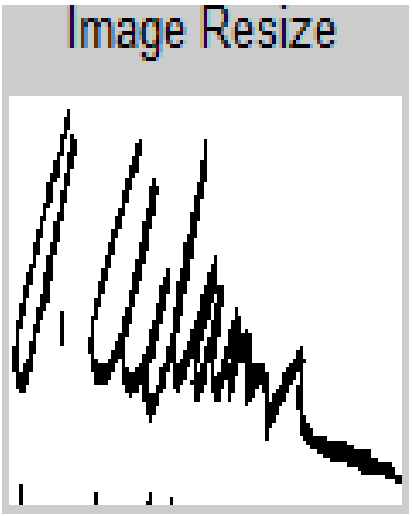

Fig 3. Show Resized Image

3) Binary Image

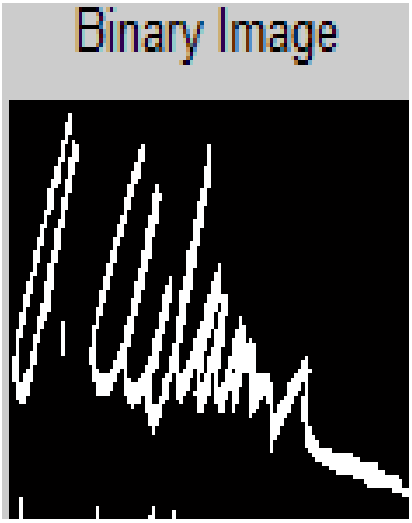

Fig 4. Show Binary Image

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4) Thickened Image

Fig 5. Show Thick Line Image

5) Signature Matching

Fig 6. Signature Matched

In the final experiment, an input image is equivalent to matched image from a database. It explains the genuiness of the signature.

II. COMPARATIVE RESULTS

A. Matlab

It is an information evaluation and visualization tool which has been designed with robust help for matrices and matrix operations. Along with this, Matlab has excellent graphics capabilities, and its own powerful programming language. One of the explanations that Matlab has ended up such predominant software is through the use of sets of Matlab packages designed to support a special challenge. These units of packages are referred to as toolboxes, and the special toolbox of interest to us is the IP toolbox.

Performance	Average MSE	Average Incorrect Classification (%)	Average Correct Classification (%)
Proposed System	0.0476	4.2	95.8
Base System	0.1309	14.58	85.41

TABLE1. COMPARISON BETWEEN PROPOSED AND BASE SYSTEM

Performance	FPR	FNR	TPR	TNR
Proposed System	95.7%	4%	96.0%	4.3%
Base System	91.3%	20%	80%	8.7%

TABLE2. ERROR RATE COMPARISON BETWEEN PROPOSED AND BASE SYSTEM

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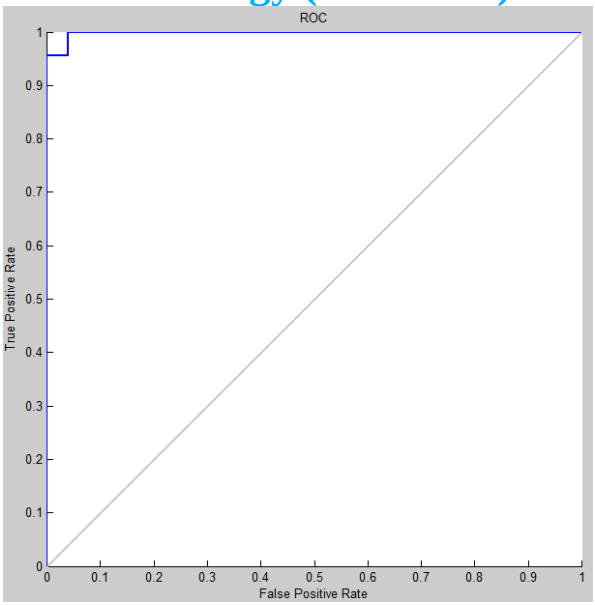


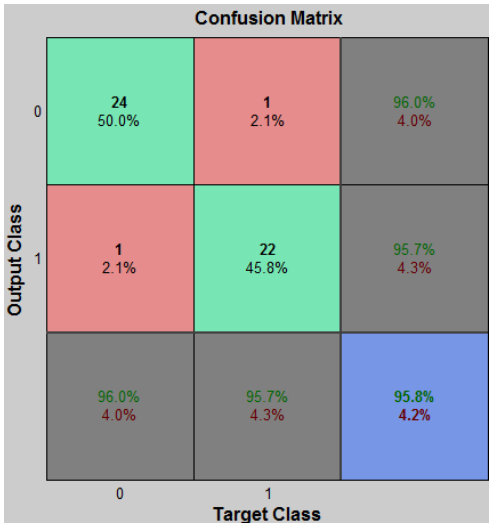
Graph1. Show ROC of the System

In this graph, we showed the genuiness of the signature in the form of TPR line and it reached up to 95.83% for correct classification and 4.16% for incorrect classification.

1) *True positive (TP):* The percentage of total number of genuine images taken as genuine, closer to 1 is better.
2) *True negative (TN):* The percentage of total number of genuine images taken as forged, closer to 1 is better.
3) *False positive (FP):* The percentage of forged images taken as genuine, closer to 0 is better.
4) *False negative (FN):* the percentage of forged images taken as forged, closer to 0 is better.

TP=24	FN=1
FP=1	TN=22

TABLE3. CONFUSION MATRIX OF PROPOSED SYSTEM



Graph2. Show average Confusion Matrix of Proposed System

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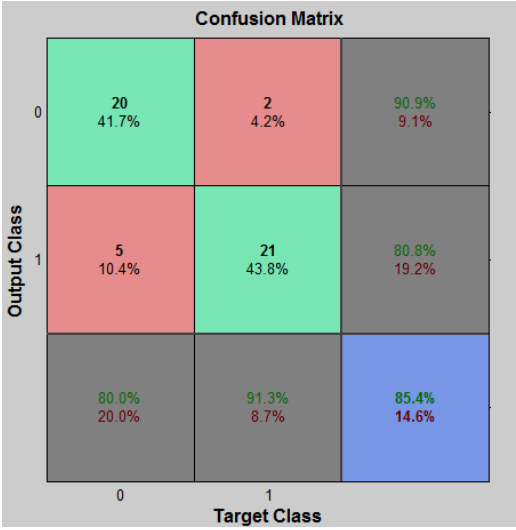

Graph3. Show average Confusion Matrix of Base System

III. CONCLUSION

Offline signature recognition is an imperative biometric technique and has wide applications. On this paper, we put into outcomes Offline Signature recognition making use of PCA and FFNN process. The proposed system has used HOG and Seven invariant moment's technique for feature extraction and FFNN as classifier to classify the signature. It has been observed that the features extracted using HOG, along with central moment are found to be efficient for signature recognition. We achieved the accuracy rate is 95.8% for enrollment of 12 persons. Future work of this work includes the analyses of the new features of signature image and combining those with the feature vectors used in this work to obtain better accuracy than the correctness of the their works.

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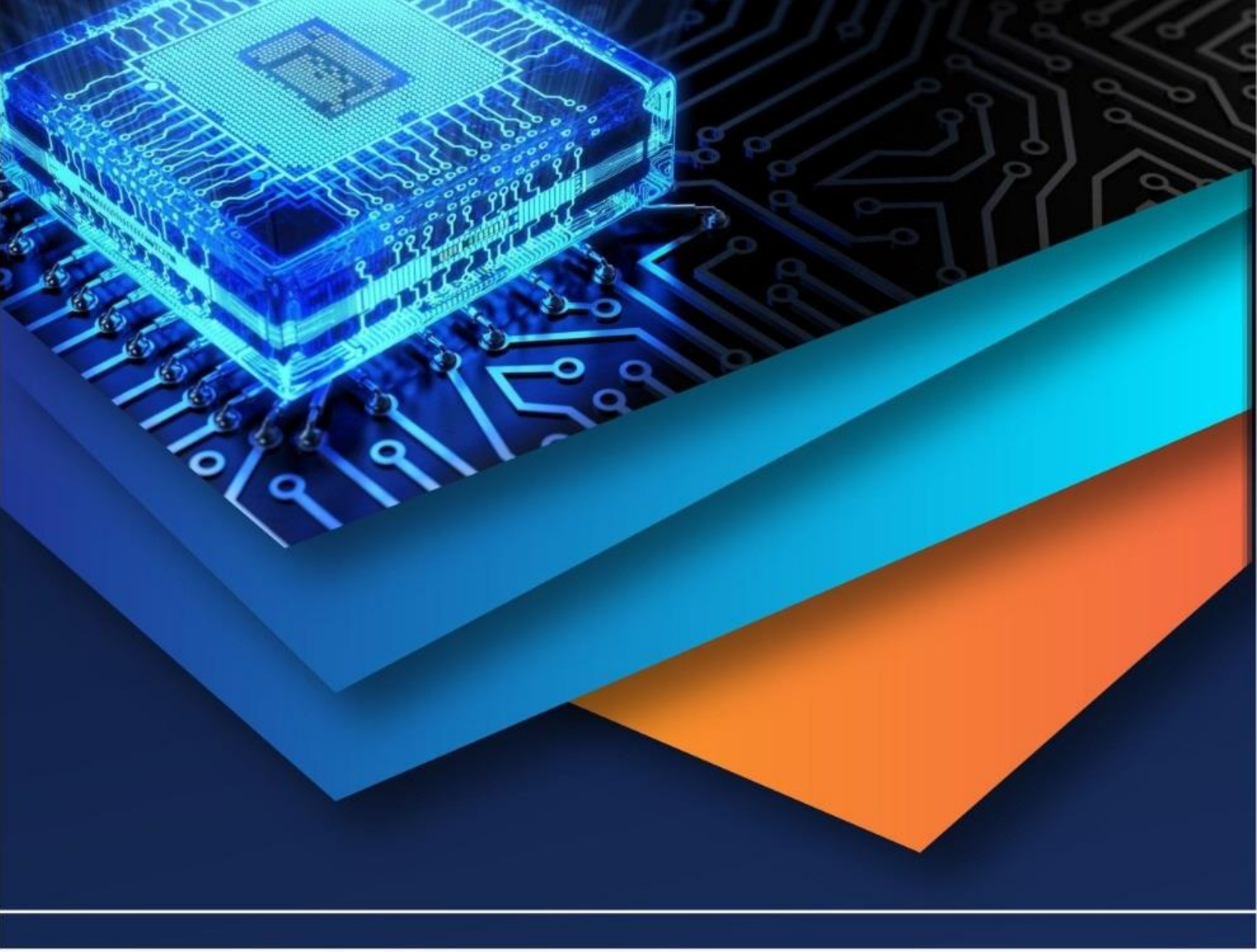

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