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Face Recognition with the Help of Genetic Algorithm

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Abstract: ***As on date, biometric applications are rapidly replacing the PIN for recognition of individuals and individual's confidential transactions. The biometric identification comprises of finger print, iris match and face recognition. Although, a two year child can distinctively recognize his near and dear one; for the computer, it had not been easy. Even today, methods are being refined to correctly identify a human face with varied expressions and under different disguise. After the first semi-automated face recognition system of early 1960s, many advances have taken place to significantly fortify the face recognition system. In the current paper, the author have utilized open source data base to establish face recognition with the help of Genetic algorithm. The metric has been the accuracy over 98% with zero false recognition.***
Key Words: Bio-metric, genetic algorithm, Haar

I. INTRODUCTION

A biometric is a unique, measurable characteristic of a human being that can be used to automatically recognize an individual or verify an individual's identity. Biometrics can measure both physiological and behavioral characteristics.

A. The physiological biometrics is based on measurements and data derived from direct measurement of a part of the human body and they are

1) Finger-scan
2) Facial Recognition
3) Iris-scan
4) Retina-scan
5) Hand-scan

B. Whereas, behavioral biometrics is based on measurements and data derived from an action and they are Voice-scan , Signature-scan & Keystroke-scan.

The face recognition requires no physical interaction on behalf of the user. It is accurate and allows for high enrolment and verification rates. It can use existing hardware infrastructure, existing cameras and image capture Devices with no problems. There are many benefits of a Facial Recognition Systems. One of the big benefits of using facial biometric systems in an organization is that one need not worry about time fraud. It will be impossible for buddy punching to occur, since everyone has to go through face scanning biometrics devices to clock in. A face biometrics system offers better security since, not only an employee can be tracked but any visitors can be added to the system and tracked throughout the area too. Anyone that is not in the system will not be granted access. A face recognition system has added advantage of automation, easy integration and high success rate. In its worst performance, it may deny access to an authorized person but would never allow an un-authorized person.

C. In Facial recognition there are two types of comparisons

1) *Verification*: The system compares the given individual with who they say they are and gives a yes or no decision.
2) *Identification:* The system compares the given individual to all the other individuals in the database and gives a ranked list of matches. All identification or authentication technologies operate using the following four stages:-
3) *Capture:* A physical or behavioral sample is captured by the system during Enrollment and also in identification or verification process.
4) *Extraction:* Unique data is extracted from the sample and a template is created.
5) *Comparison:* The template is then compared with a new sample.

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6) Match/non-match: The system decides if the features extracted from the new Samples are a match or a non match.

D. The implementation of face recognition technology includes the following five stages: Image acquisition, Image processing, Distinctive characteristic location, Template creation & Template matching

After the facial image has been captured by a camera or a video system, the image is processed to retain only characteristic features in grey scale. Further, the detected face is localized and normalization process may be required to bring the dimensions of the live facial sample in alignment with the one on the template. The enrolment templates are normally created from a multiplicity of processed facial images whose sizes can vary from less than 100 bytes to over 3KB. Facial recognition software is based on the ability to first recognize faces through landmarks as nodal points. There are approximately 80 nodal points on a human face like, distance between the eyes, width of the nose, depth of the eye socket, cheekbones, jaw line and chin.

E. Open Source Databases for Face Recognition

There are 60 known open source face recognition databases are available to academicians and researchers. The different databases deal with different facial conditions to suit the researcher's requirement of a set of conditions. For example, The AR database of Ohio State University contains over 4,000 colour images of 126 people's faces (70 men and 56 women). The images are frontal view faces depicting different facial expressions, illumination conditions, and add-ons like sunglasses and scarves. The pictures were taken under strictly controlled conditions. There were no restrictions placed on clothes, glasses, make-up or hair style. The JAFFE database contains 213 images of 7 facial expressions (6 basic facial expressions + 1 neutral) depicting 10 Japanese female models. Each image has been rated on 1 of 6 emotion adjectives. In another database, IIIT-Delhi Disguise Version 1 Face Database, dataset contains 681 images of 75 subjects with different kinds of disguise variations. Version 1 of the dataset consists of images captured in the visible spectrum. There is a further subset of this called the IIITD In and Beyond Visible Spectrum Disguise database, which includes both visible and thermal versions of the images.

II. METHODOLOGY

Given an image that consists of many objects our goal is to detect human faces, extract these faces and identify each face using a database of known humans. So, our algorithm is divided to three main steps:-

A. Face detection

The proposed algorithm depends heavily on the Genetic Algorithm (GA) in this step.

B. Facial feature extraction

An effective method to extract facial features like eyes, nose and mouth depending on their locations with respect to the face region is developed.

C. Similar face identification or image searching

The goal of this step is to scan the database of known faces to find the most similar faces to the faces extracted from the test image in the first step. The proposed method starts with a piece of code named facedetect.cpp [1]. It detects all faces within a given image via Haar classifier cascades and draws rectangles around them, as shown in figure -1.

Figure-1: Face extraction from the image

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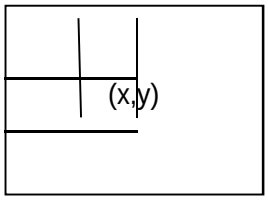
Haar-like feature classifier cascades are composed of multiple classifiers, or conditions, that are used to distinguish unique objects (i.e., face, eye, etc.) from anything that is not that object [2][3]. Classifiers are a set of values representing sums of pixel brightness on a region-by-region basis. These specifically structured regions are called Haar-like features. Haar-like feature classifiers are created using the integral image which is an intermediate image representation that allows the features used by the detector to be computed very quickly. Rectangle features can be computed very rapidly using the integral image. The integral image at location *x, y* contains the sum of the pixels above and to the left of *x, y* inclusive, as shown in the below given figure. Each pixel in the integral image represents the change in brightness of the corresponding pixel in the original image by finding the sum of the derivatives of the pixels above and to the left of the original:-



$$(x,y) = \sum i(x', y')$$
$$x' \le x, \quad y' \le y$$

Where, *ii* (*x* , *y*) is the integral image and *i* (*x* , *y*) is the original image.

A. Genetic Algorithm (GA)

The genetic algorithm uses the medical terms like chromosome, gene etc to explain the rational of coding. The algorithm (pseudo code) of the simple GA illustrates the main steps that should be performed to produce the required solution and is given below [4]:-

Initialization [population];
Evaluation [population];
Generation: =0;
-do
Selected-parents: = selection [population];
Created-offspring: =recombination
[Selected-parents];
Mutation [created-offspring];
Population: =created-offspring;
Evaluation [population];
Generation: =geaeration+1;
UNTIL stop-criterion;

B. Population

A population consists of n individuals where N is chosen by the designer of the GAs. Every individual has a chromosome which consists of L genes. The chromosome is often referred to as the genotype of an individual. The following notation will be used to describe the chromosome of individual number "i"

Where 1<=i<=N:
Chromosome I = gene1 gene 2….gene j…..gene L
When a binary encoding has been used every gene
1<=J<=L Є {0,1}.
As an example assume L=6, then a chromosome can look like:
Chromosome I =110101

C. Initialization

Initialize the genes of all individuals randomly with 0's and 1's (assuming a binary encoding for simplicity). These individuals are the starting points in the search space for the simple GA. [5][6][7][8]

D. Evaluation

Calculate the fitness of each individual by decoding each chromosome and applying the fitness function to each chromosome and

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applying the fitness function to each decode individuals. The decoding creates a phenotype based on a genotype.

E. Selection

Select a specific individual from the population to be the parents that will be used to create new individuals. There are many methods to choose those parents. The most popular is the roulette wheel selection (RWS) which select the individuals with higher fitness with a higher probability ("selection of the fitter individuals"). In this research we choose the parents that have specific fitness.

F. Recombination

Individuals from the set selected-parents are mated at random and each pair created offspring using 1-point crossover or 2-point crossover.

G. Mutation

Mutation is a random change of one or more genes. Every chromosome is simply scanned gene by gene and with a mutation rate Pm a gene is changed/swapped, i.e. 0→ 1 and 1→ 0 the probability for a mutation is usually kept small, i.e. Pm = 1/L such that we can expect one mutated gene per chromosome.

H. Stop Criterion

A simple and easy to implement stopping criterion is to stop the simple GAs if no improvement of the best solution has been made for a (large) predefined number of generations, where one generation is one turn through the do-until loop in algorithm.

III. PROPOSED MODEL

In this section we will describe the techniques we have adopted for the face recognition as shown in Figure-2:-

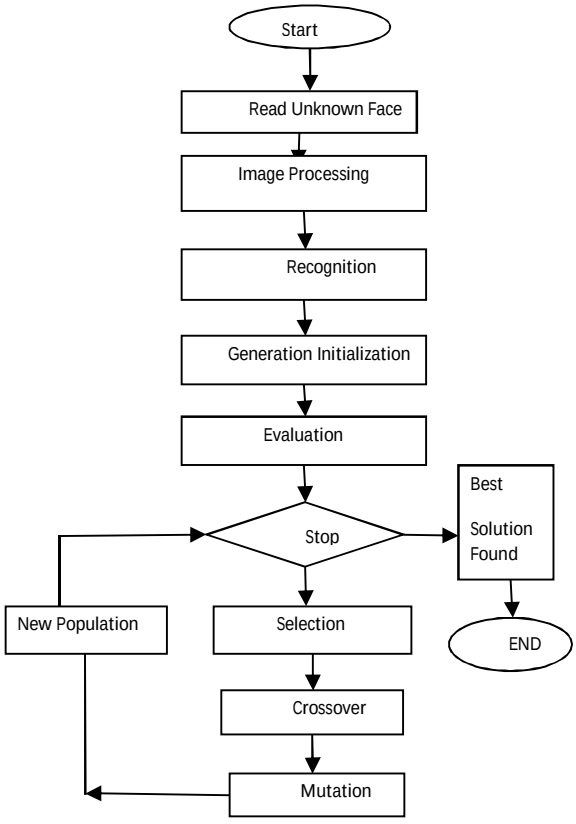

Figure-2: Circle Life of Genetic algorithm

A. The proposed model consists of two parts

1) Process the image before recognize: Image processing is done through several procedural steps. A procedure takes the

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unknown image, returns it without empty rows and columns in an array b, then another procedure isolates the unknown image in array b from points if found, return the result in array c, the next procedure takes array c and extract the corner feature of the unknown image and saves the result in four 3*3 arrays, the last procedure in this group translate the features of the image which is stored in four 3*3 arrays into one vector called "kyc". Finally this vector is used in the search operations to calculate fitness

2) *Recognition:* Recognition represents the genetic algorithm operations such as reproduction, crossover, mutation and replacement. This can be discussed as follows

a) *Initialize:* An initial population is created of 50 individuals. Each individual length is 36 genes with random selection. And the algorithm flow chart is given as under:-

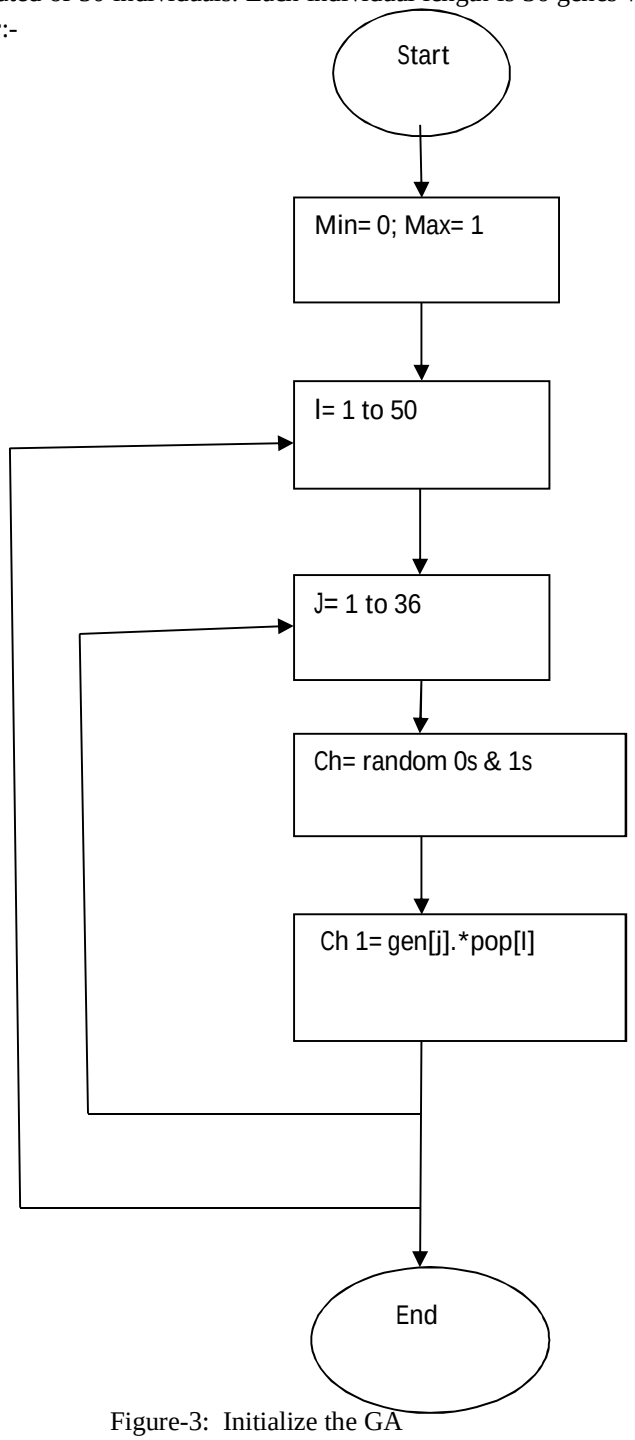

Figure-3: Initialize the GA

b) *Evaluate:* The fitness of each individuals in the population is calculated according to the differences between them and the

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vector "kyc".

c) *Choice parents*: From the population, 16 individuals are randomly selected to be the parents and have fitness ranging between 15 and 20.

d) *Cross2x:* The 2-point crossover (2x) is performed on the parents to create new individuals, and the flowchart for the algorithm is given as under:-

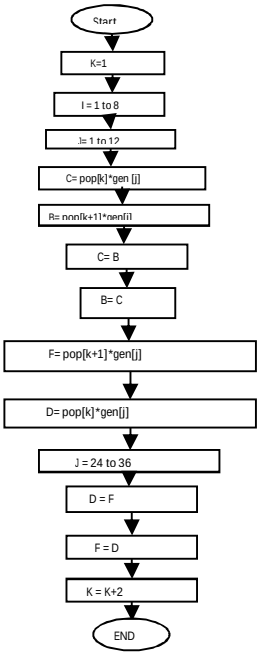

Figure-4. Flow Chart for the Algorithm

e) *Mutation:* When new individuals are created by cross2x procedure and 15 genes are randomly changed from it, the mutation algorithm is given below:-

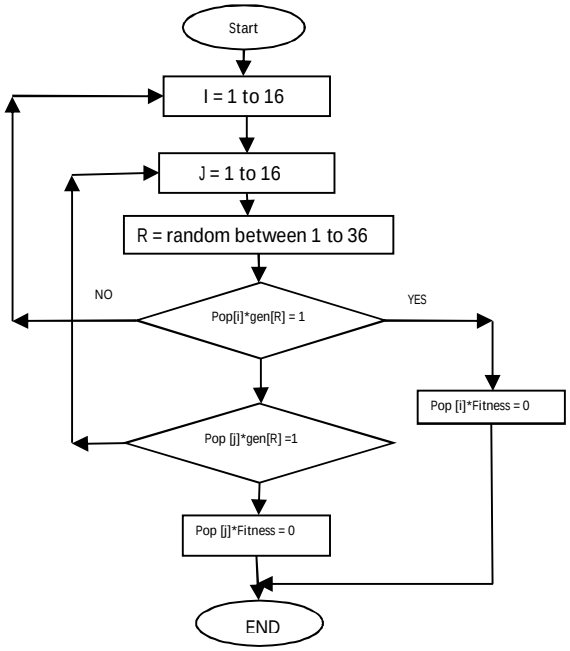

Figure-5: Perform 2 point crossover on the parents

f) *Replacement:* The five elements are randomly chosen from the population. The worst one is selected and then is replaced with a

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new individual. The algorithm flow chart is given as under:-

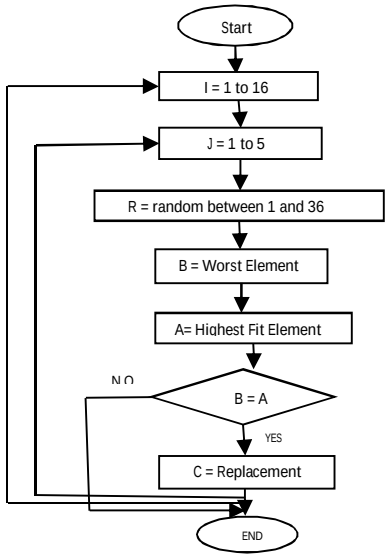

Figure-6: Replacement of worst performer

g) Checkstop: Stop the algorithm when the best solution is found or when fitness is less than 3 or when the generation number is more than 500.

IV. RESULT AND PERFORMANCE ANALYSIS OF GA

The three standard databases, viz, JAFFE, IIIT-D and the CMU Multi-PIE Face Database were examined for templates. The CMU database contains more than 750,000 images of 337 people. The subjects were photographed under 15 view points and 19 illumination conditions. They displayed a range of facial expressions. There are some high-resolution frontal images. Because of all these reasons, CMU database was chosen for template matching. The results were obtained for different angle view point, different illumination condition and accuracy of recognition. The below given table explains the results:-

Image condition	Number of Images	Face recognized	False Recognition
Front Axial Image	20	19	0
15^0 off axial Image	5	4	0
30^0 off axial Image	10	9	0
Low light	10	8	0
Medium light	10	10	0
Studio Light	10	10	0

Table-1: Results

The experiment sample size was 65 and the mean accuracy was above 95%. Each result was delivered within ≤0.5 second with zero

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false recognition.

V. CONCLUSION

In this paper, a new method of face recognition was shown which is unambiguous, accurate and fast. It can be used in face recognition systems such as video surveillance, human computer interfaces, image database management and smart home applications. The proposed algorithm has been tested using a database of faces and the results showed that it is able to recognize a variety of different faces in spite of different facial angles and different illumination conditions.

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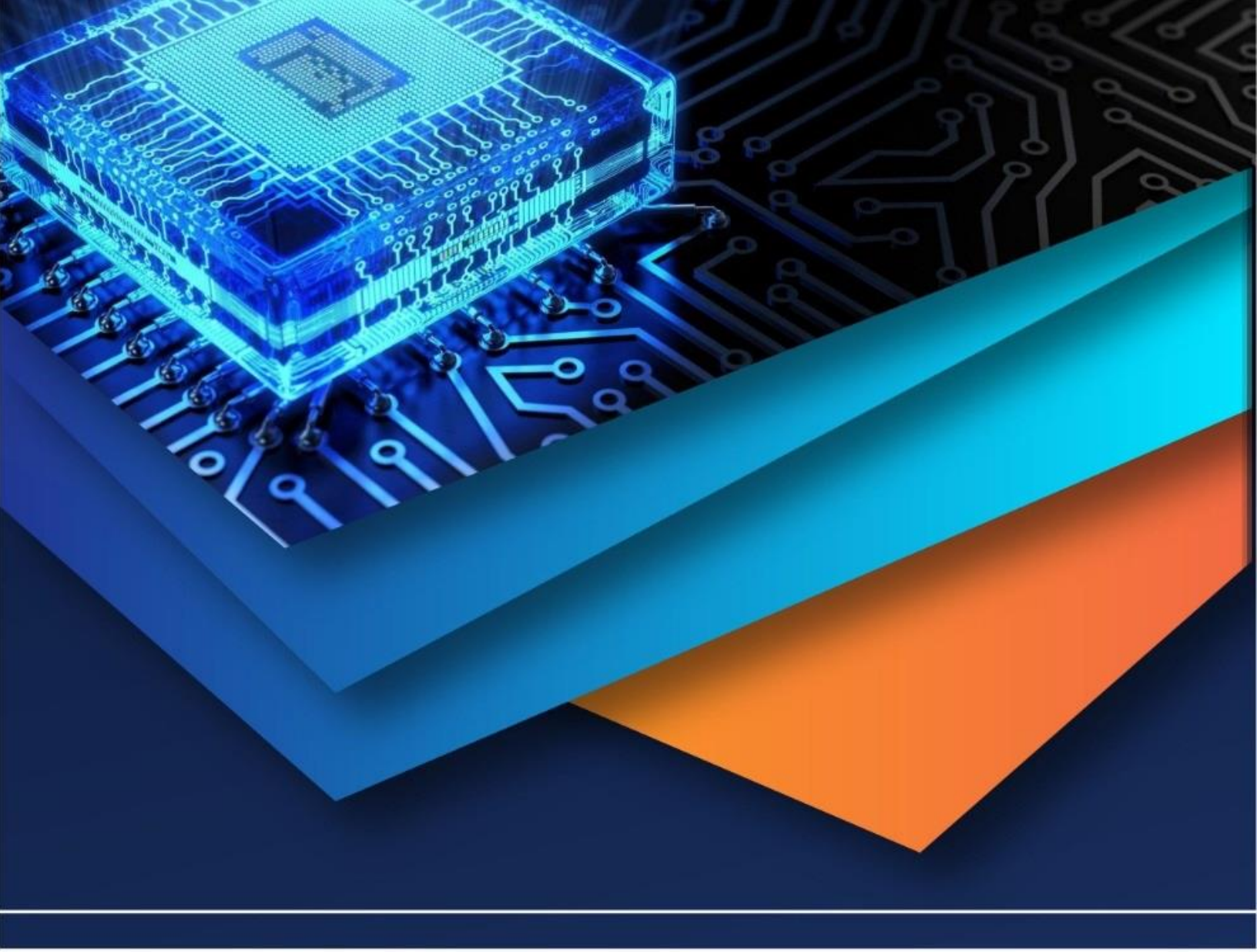

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