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Expression Recognition System for Images Processing Using Interval Type2 Fuzzy Modeling

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***Abstract:** face detection research confronts the full range of challenges found in general purpose, object class recognition. However, the class of faces also has very apparent regularities that are exploited by many heuristic or model-based methods or are readily "learned" in data-driven methods. One expects some regularity when defining classes in general, but they may not be so apparent. Finally, though faces have tremendous within-class variability, face detection remains a two class recognition problem (face versus non face). The system correctly classified expressions for each individual using only still images. It distinguishes 3 expressions (Happiness (HA), surprise, anger, and fear) precisely and identifies 1 other, Happiness by the Average Recognition Rate accuracy of 85.25%. Also many people made mistake identifying surprise from happiness. According to Carlo research Surprise is mis-recognized as happy. Following this information, Output membership functions are built and clearly depicted some expressions due to the mentioned facts. Experimental results demonstrate the superiority of the proposed method to existing ones.*

***Keywords:** Face Recognition, human-computer interaction. Interval Type2 Fuzzy, image processing, Recognition Rate.*

I.INTRODUCTION

In recent years, Face Recognition has become a very active area of research in recent years mainly due to increasing security demands and its potential commercial and law enforcement applications. The last decade has shown dramatic progress in this area, with emphasis on such applications as human-computer interaction (HCI), biometric analysis, content-based coding of images and videos, and surveillance. Although a trivial task for the human brain, face recognition has proved to be extremely difficult to imitate artificially, since although commonalities do exist between faces, they vary considerably in terms of age, skin, color and gender. The problem is further complicated by differing image qualities, facial expressions, facial furniture, background, and illumination conditions [1].This research a novel approach for face recognition that derives from an idea suggested by Hjelmås and Low. In their survey, they describe a preprocessing step that attempts to identify pixels associated with skin independently of face related features. This approach represents a dramatic reduction in

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computational requirements over previous methods

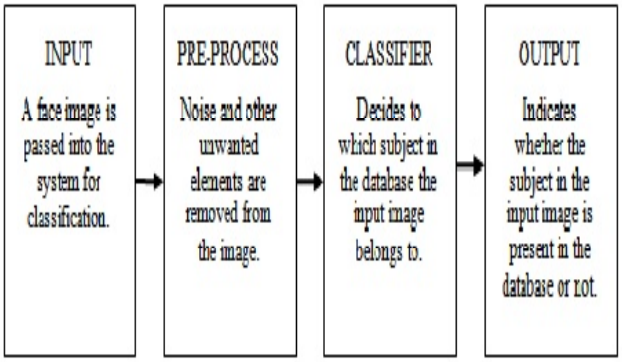

Fig.1. Generic representation of a face recognition system

Since skin color in humans varies by individual, research has revealed that intensity rather than chrominance is the main distinguishing characteristic. The recognition stage typically uses an intensity (grayscale) representation of the image compressed by the 2D-DCT for further processing [2]. This grayscale version contains intensity values for skin pixels. A block diagram of the proposed technique of the face recognition system is presented in Fig. 2. In the first stage, the 2D-DCT for each face image is computed, and feature vectors are formed from the discrete cosine transform (DCT) coefficients. The second stage uses a self-organizing map (SOM) with an unsupervised learning technique to classify vectors into groups to recognize if the subject in the input image is "present" or "not present" in the image database. If the subject is classified as present, the best match image found in the training database is displayed as the result, else the result displays that the subject is not found in the image database [3].In this research, we focus on image-based face recognition. Given a picture taken from a digital camera, we'd like to know if there is any person inside, where his/her face locates at, and who he/she is. Towards this goal, we generally separate the face recognition procedure into three steps: Face Detection, Feature Extraction, and Face Recognition [4]. Various approaches and protocols have been proposed to address image processing, and multiple standardization efforts are under way within the Internet Engineering Task Force, as well as academic and industrial research.

II.RELETED WORK

Face and facial expression recognition have attracted much attention though they have been studied for more than 20 years by psychophysicists, neuroscientists, and engineers. Many research demonstrations and commercial applications have been developed from these efforts. A first step of any face processing system is detecting the locations in images where faces are present. However, face detection from a single image is a challenging task because of variability in scale, location, orientation (upright, rotated), and pose (frontal, profile). Facial expression, occlusion, and lighting conditions also change the overall appearance of faces. We now give a definition of face detection: Given an arbitrary image, the goal of face detection is to determine whether or not there are any faces in the image and, if present, return the image location and extent of each face. The challenges associated with face detection can be attributed to the following factors. Pose [5]. The images of a face vary due to the relative camera-face pose (frontal, 45 degree, profile, upside down), and some facial features such as an eye or the nose may become partially or wholly occluded. Presence or absence of structural components. Facial features such as beards, mustaches, and glasses may or may not be present and there is a great deal of variability among these components including shape, color, and size [6]. Facial expression. The appearance of faces are directly affected by a person's facial expression. Occlusion. Faces may be partially occluded by other objects. In an image with a group of people, some faces may partially occlude other faces. Image orientation. Face images directly vary for different rotations about the camera's optical axis [7].Imaging conditions When the image is formed, factors such as lighting (spectra, source distribution and intensity) and camera characteristics (sensor response, lenses) affect the appearance of a face. Face detection also provides interesting challenges to the underlying pattern classification and learning techniques. When a raw or filtered image is considered as input to a pattern classifier, the dimension of the feature space is extremely large (i.e., the number of pixels in normalized training images). The classes of face and non face images are decidedly characterized by multimodal distribution functions and effective decision boundaries are likely to be nonlinear in the image space. To be effective, either classifiers must be able to extrapolate from a modest number of training samples or be efficient when dealing with a very large number of these high-

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dimensional training samples [12]. With an aim to give a comprehensive and critical survey of current face detection methods, comparisons are often difficult. We indicate those methods that have been evaluated with a publicly available test set. It can be assumed that a unique data set was used if we do not indicate the name of the test set detect faces in different poses since it is challenging to enumerate all possible cases. On the other hand, heuristics about faces work well in detecting frontal faces in uncluttered scenes. Yang and Huang used a hierarchical knowledge-based method to detect faces [13]. Their system consists of three levels of rules. At the highest level, all possible face candidates are found by scanning a window over the input image and applying a set of rules at each location. The rules at a higher level are general descriptions of what a face looks like while the rules at lower levels rely on details of facial features. A multi resolution hierarchy of images is created by averaging and sub sampling, and an example is shown Examples of the coded rules used to locate face candidates in the lowest resolution include: “the center

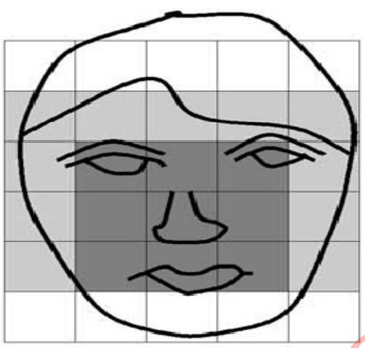

Fig.2. a typical face used in knowledge-based top-down methods:

a localization method to segment a face from a cluttered background for face identification .It uses an edge map (Canny detector) and heuristics to remove and group edges so that only the ones on the face contour are preserved. An ellipse is then fit to the boundary between the head region and the background. This algorithm achieves 80 percent accuracy on a database of 48 images with cluttered backgrounds. Instead of using edges, Chetverikov and Lerch presented a simple face detection method using blobs and streaks (linear sequences of similarly oriented edges) [14]. Their face model consists of two dark blobs and three light blobs to represent eyes, cheekbones, and nose. The model uses streaks to represent the outlines of the faces, eyebrows, and lips. Two triangular configurations are utilized to encode the spatial relationship among the blobs. A low resolution Laplacian image is generated to facilitate blob detection. Next, the image is scanned to find specific triangular occurrences as candidates. [15].They used a cascade correlation neural network [5] for supervised classification of textures and a Kohonen self-organizing feature map to form clusters for different texture classes. To infer the presence of a face from the texture labels, they suggest using votes of the occurrence of hair and skin textures. However, only the result of texture classification is reported, not face localization or detection. Dai and Nakano also applied SGLD model to face detection [7]. Color information is also incorporated with the face-texture model.

Back grounds. Hence, face detection re each confronts the full range of challenges found in general purpose, object class recognition. However, the class of faces also has very apparent regularities that are exploited by many heuristic or model-based methods or are readily “learned” in data-driven methods. One expects some regularity when defining classes in general, but they may not be so apparent. Finally, though faces have tremendous within-class variability, face detection remains a two class recognition problem (face versus non face).

III. PURPOSE OF RESEARCH

Research and Application Challenges

Accuracy may need to be sacrificed for for speed. The scope of the considered techniques in evaluation is also important. In this survey, we discuss at least four different forms of the face detection problem[5,8]:

1.Localization in which there is a single face and the goal is to provide a suitable estimate of position;
2.scale to be used as input for face recognition.
3.In a cluttered monochrome scene, detect all faces.
4.In color images, detect (localize) all faces.
5.In a video sequence, detect and localize all faces.
6.. lighting conditions,
7. orientation, pose, and partial occlusion,
8. facial expression, and
9. presence of glasses, facial hair, and a variety of hair styles.

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IV. EXPERIMENT and IMPLEMENTATION

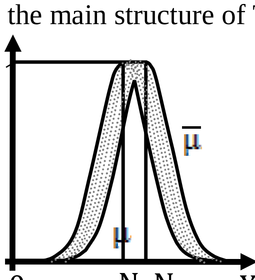
The simulation parameters that we used along with those of and (the random scenarios). This research reviewed most conventional face recognition techniques. Interval Type-2 Fuzzy Logic (IT2FL) has gained a great demand in many engineering applications. Fuzzy Logic (FL) technology enables the use of engineering experience and experimental results in designing an expert system capable of handling uncertain or fuzzy quantities. This paper presents a design of IT2FL for PCA-ICA based face recognition system. Firstly, the principles of IT2FL theory will be briefly presented. Secondly, the employment of the IT2FL techniques in a PCA-ICA based face recognition system will be outlined. The concept of IT2FL can be extended for application to different human expression recognition. Uncertainty is an inherent part of intelligent systems used in real-world applications. Type-1 fuzzy sets used in conventional fuzzy systems cannot fully handle the uncertainties present in intelligent systems. Type-2 fuzzy sets that are used in Type-2 fuzzy systems can handle such uncertainties in a better way because they provide us more parameters. This paper deals with the design of PCA-ICA based face recognition system using interval Type-2 fuzzy logic. The IT2FL is found more effective than the conventional face recognition systems. Aimed to this requirement, most pattern recognition techniques have been widely studied to realize the qualitatively or quantitatively recognition of gas mixtures, such as statistical techniques, Artificial Neural Networks and fuzzy systems [1-3]. This paper proposes a PCA-ICA signal preprocessing and fuzzy neural network based electronic nose algorithm, to quantitatively recognize the alcohol concentrations under interferences of gasoline and smokes.

V. PROPOSED ALGORITHM

STEP 1. Get the edge map image (edge (I,j)) from RGB image using sobel operator.
STEP 2. For each pixel (I,j),get the corresponding H and S values.
STEP 3. if (colorhistogram(H,S)>skinthresold) and(edge(I,j)<edgethresold) then skin(I,j)=1 i.e. (I,j) is a skin pixel , else skin(I,j)=0 i.e. (I,j) is a non-skin pixel.
STEP 4. Find the different regions in the image by implementing connectivity analysis using 8-connected neighborhood.
STEP 5. Find height,width and centroid for each region and percentage of skin in each region
STEP 6. For each region, if (height/width) or (width/height) is within the range (goldenration±tolerance) and (percentage of skin>percentage of threshold) then the region is a face, else it is not face.

Interval Type-2 Fuzzy Logic (IT2FL)

Fuzzy Logic Systems (FLS) are known as the universal- approximates and have various applications in identification and control designs. A Type-1 fuzzy system consists of four major parts: fuzzifier, rule base, inference engine and defuzzifier. A Type-2 fuzzy system has a similar structure, but one of the major differences can be seen in the rule base part, where a Type-2 rule base has antecedents and consequents using Type-2 Fuzzy Sets (T2FS). In a T2FS, we consider a Gaussian function with a known standard deviation, while the mean (m) varies between m_1 and m_2. Therefore, a uniform weighting is assumed to represent a footprint of uncertainty as shaded in Fig.4.5. Because of using such a uniform weighting, we name the T2FS as an Interval Type-2 Fuzzy Set (IT2FS). Utilizing a rule base which consists of IT2FSs, the output of the inference engine will also be a IT2FS and hence we need a type-reducer to convert it to a Type-1 fuzzy set before defuzzification can be carried out [2,6]. shows the main structure of Type-2 FLS.



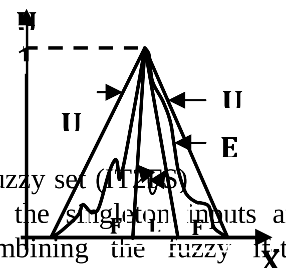


Fig.3. Interval type 2 fuzzy set (IT2FS)

By using singleton fuzzification, the singleton inputs are fed into the inference engine. Combining the fuzzy if-then rules, the inference engine maps the singleton input $x = [x_1, x_2 \ldots x_3]$ into a Type-2 fuzzy set as the output. A typical form of an if-then rule can be written as:

R_i if x_1 is $F_1^{\,i}$ and x_2 is $F_2^{\,i}$ and … … . x_1 is $F_1^{\,i}$ and x_n is $F_n^{\,i}$ then G^i (1)Where F_k^S are the antecedents (k = 1, 2… n) and G^i is the consequent of the i^{th} rule. We use sup-star method as one of the

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various inference methods. The first step is to evaluate the firing set for i^{th} rule as following:

$$F^i(\underline{x}) = \prod_{k=1}^{n} \mu_{F_k}(x_k) \qquad (1)$$

As all of the F_k^s are IT2FSs, so $F^i(\underline{x})$ can be written as $F^i(\underline{x}) = [\underline{f}^i(\underline{x})\ \bar{f}^i(\underline{x})]$ where: $\underline{f}^i(\underline{x}) = \prod_{k=1}^{n} \underline{\mu}_{F_k}(x_k)$

$$\bar{f}^i(\underline{x}) = \prod_{k=1}^{n} \bar{\mu}_{F_k}(x_k) \qquad (3)$$

The terms $\underline{\mu}_{F_k}$ and $\bar{\mu}_{F_k}$ are the lower and upper membership functions, respectively. In the next step, the firing set $F_i(x)$ is combined with the i^{th} consequent using the product t-norm to produce the Type-2 output fuzzy set. The Type-2 output fuzzy sets are then fed into the type reduction part. The structure of type reducing part is combined with the defuzzification procedure, which uses Center of Sets (COS) method. First, the left and right cancroids of each rule consequent are computed using Karnik-Mendel (KM) algorithm. Let's call them y_l and y_r respectively.The firing sets $F^i(\underline{x}) = [\underline{f}^i(\underline{x})\ \bar{f}^i(\underline{x})]$ computed in the inference engine are combined with the left and right centroid of consequents and then the defuzzified output is evaluated by finding the solutions of following optimization problems:

$$y_l(\underline{x}) = \min_{\forall f^k \subset \{\underline{f}^k\ \bar{f}^k\}} \left(\sum_{k=1}^{M} y_l{}^k f^k(\underline{x}) \Big/ \sum_{k=1}^{M} f^k(\underline{x}) \right)$$

$$y_r(\underline{x}) = \min_{\forall f^k \subset \{\underline{f}^k\ \bar{f}^k\}} \left(\sum_{k=1}^{M} y_r{}^k f^k(\underline{x}) \Big/ \sum_{k=1}^{M} f^k(\underline{x}) \right)$$

(6)

Define $f_l^k(\underline{x})$ and $f_r^k(\underline{x})$ as a functions which are used to solve (5) and (6) respectively and let

$$\xi_l{}^k(\underline{x}) = f_l{}^k(\underline{x}) \Big/ \sum_{k=1}^{M} f_l{}^k(\underline{x})$$ and

$$\xi_r{}^k(\underline{x}) = f_r{}^k(\underline{x}) \Big/ \sum_{k=1}^{M} f_r{}^k(\underline{x}).$$

Then we can write (5) and (6) as:

$$y_l(\underline{x}) = \sum_{k=1}^{M} y_l{}^k f_l{}^k(\underline{x}) \Big/ \sum_{k=1}^{M} f_l{}^k(\underline{x}) = \sum_{k=1}^{M} y_l{}^k \xi_l{}^k(\underline{x}) = \theta_l{}^r \xi_{-l}(\underline{x}) \qquad (7)$$

$$y_r(\underline{x}) = \sum_{k=1}^{M} y_r{}^k f_r{}^k(\underline{x}) \Big/ \sum_{k=1}^{M} f_r{}^k(\underline{x}) = \sum_{k=1}^{M} y_r{}^k \xi_r{}^k(\underline{x}) = \theta_r{}^r \xi_{-r}(\underline{x}) \qquad (8)$$

Where, $\xi_l(\underline{x}) = [\xi_l{}^1(\underline{x})\ \xi_l{}^2(\underline{x}) \dots\dots\dots\dots \xi_l{}^M(\underline{x})]$ and $\xi_r(\underline{x}) = [\xi_r{}^1(\underline{x})\ \xi_r{}^2(\underline{x}) \dots\dots\dots\dots \xi_r{}^M(\underline{x})]$ are the fuzzy basis functions and $\theta_l(\underline{x}) = [y_l{}^1(\underline{x})\ y_l{}^2(\underline{x}) \dots\dots\dots y_l{}^M(\underline{x})]$ and $\theta_r(\underline{x}) = [y_r{}^1(\underline{x})\ y_r{}^2(\underline{x}) \dots\dots\dots y_r{}^M(\underline{x})]$ are the adjustable parameters.Finally, the crisp value is obtained by the defuzzification procedure as follows:

$$y(\underline{x}) = \frac{1}{2}(y_l(\underline{x}) + y_l(x)) = \frac{1}{2}\left(\theta_l{}^r \xi_l(\underline{x}) + \theta_l{}^r \xi_l(\underline{x})\right) = \frac{1}{2}\theta^r \xi_l(\underline{x}) \qquad (9)$$

Where, $\theta = [\theta_l{}^r\ \ \theta_r{}^r]^r$ and $\xi = [\xi_l{}^r\ \ \xi_r{}^r]^r$

VI. PERFORMANCE EVALUATIONS AND RESULTS

In order to demonstrate the performance of the proposed approach a lot of experiences have been done on database images. Accuracy of the algorithm for recognition of each expression is given in Table 1.

1	Expression	Accuracy of Recognition
2	Happiness(HA),	73%
3	Surprise(SU),	89%
4	Anger(AN)	92%

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5	Fear(FE)	87%
6	Average Recognition Rate	85.25

The IT2FLS Toolbox contain the functions to create Mamdani and TSK Interval Type-2 Fuzzy Inference Systems (newfisType-2.m), functions to add input-output variables and their ranges (addvarType-2.m), it has functions to add 22 types of Interval Type-2 Membership functions for input-outputs (addmfType-2.m), functions to add the rule matrix (addruleType-2.m), it can evaluate the Interval Type-2 Fuzzy Inference Systems (evalifisType-2.m), evaluate Interval Type-2 Membership functions (evalimfType-2.m), it can generate the initial parameters of the Interval Type-2 Membership functions (igenparamType-2.m), it can plot the Interval Type-2 Membership functions with the input-output variables (plotimfType-2.m), it can generate the solution surface of the Fuzzy Inference System (gensurfType-2.m), it plots the Interval Type-2 membership functions (plot2dType-2.m, plot2dcType-2.m), a folder to evaluate the derivatives of the Interval Type-2 Membership Functions (dit2mf) and a folder with different and generalized Type-2 Fuzzy operators (it2op, t2op). The implementation of the IT2FLS GUI is analogous to the GUI used for Type-1 FLS in the Matlab® Fuzzy Logic Toolbox, thus allowing the experienced user to adapt easily to the use of IT2FLS GUI.

VII. CONCLUSION

An analysis of the results in Table 6.1 shows that the system correctly classified expressions for each individual using only still images. It distinguishes 3 expressions (Happiness (HA),surprise, anger, and fear) precisely and identifies 1 other, Happiness by the Average Recognition Rate accuracy of 85.25%. Also many people made mistake identifying surprise from happiness. According to Carlo research Surprise is mis-recognized as happy. Following this information, Output membership functions are built and clearly depicted some expressions due to the mentioned facts. Experimental results demonstrate the superiority of the proposed method to existing ones.

VIII.APPLICATIONS

1. Recognize criminals
2. In public spaces (airports, shopping centers)
3. In stores
4. Verify identity to grant access in restricted
5. Areas: non-invasive Biometrics
6. Airports
7. Office Risk: privacy rights

FUTURE WORK

In future scope, the capability of interval type2 fuzzy set theory to obtain the degree of belonging of different pixels of a face image to different classes. We obtained the membership grade vectors for each face image of training and test set. To find the Interval Type2 Fuzzy Nearest Neighbor Classification of a test vector, we have used two variants of distance metric. That is minimum value of Euclidean distance in Eigen space. Interval Type2 Fuzzy set theory and interval type2 fuzzy logic offer us powerful tools to represent and process human knowledge in form of fuzzy if-then rules. Because of the uncertainties that exist in many aspects of image processing, fuzzy processing is desirable.

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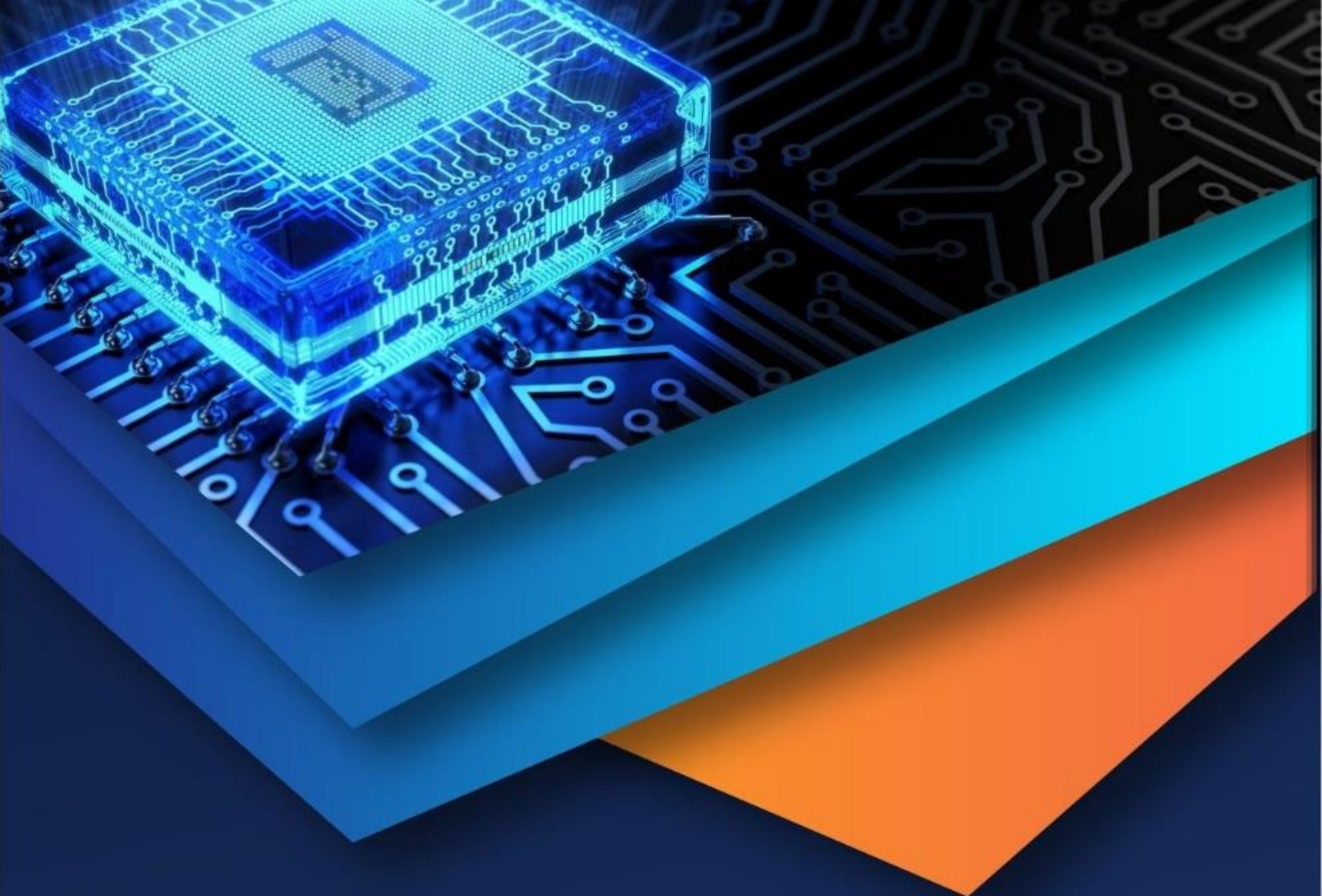

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