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# Face Authentication Voice Controlled Robot

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***Abstract:** This world is facing various problems in the field of security and surveillance. To overcome such problems face recognition technique plays a very important role. Hence there is a need of a cost effective and efficient system. Our goal is to implement such system by using Raspberry Pi for face detection and recognition by using Haar detection and LBP (Linear Binary Pattern). By using these techniques, the system which uses password and RF-ID tags for access to security systems will be replaced by face recognition system[1].Along with face recognition we are also implementing speech recognition. Users can simply say what they want and get through interactions much faster. In this paper we propose a robot which will first detect the face of an authorized person and then will be controlled by his/her voice commands. Face recognition consists of Pi camera for capturing the image of the person, which is processed by Open CV software [2]. For voic recognition Raspberry Pi itself converts the voice signal into appropriate commands for the robot.*
***Keywords:** Face Recognition, face detection, Haar detection, LBP, Raspberry Pi, Speech recognition, OpenCV, Voice Recognition.*

## I. INTRODUCTION

The face of a human being conveys a lot of information about identity and emotional state of the person. Face recognition is an interesting and challenging problem, and impacts important applications in
many areas such as identification for law enforcement, authentication for banking and security system access, and personal identification. Face detection is one of the biometric based technique which is related to individual recognition. There are many methods like finger print identification, retina scan, iris scan, signature and face recognition. From these various biometric identification methods, face detection is one of the most flexible and works even when the subject is unaware of being scanned.

Face detection is a technology being used in variety of applications which can identify or verify a person from digital image. It only detects the facial features and ignores the background such as buildings, trees and other objects. Face recognition algorithm mainly focuses on detection of frontal human faces. Nowadays face recognition technology is seeing increase in its usage across the world for providing more safety and reliable security technology.

Face recognition system analyses specific features that are common to everyone's face like the distance between the eyes, width of nose, position of cheekbones, jaw line, chin. These quantities are then combined in a single code that uniquely identifies each person

## II. FACE DETECTION USING HAAR CASCADE

Object Detection using Haar feature-based cascade classifiers is an effective object detection method proposed by Paul Viola and Michael Jones. It is a machine learning based approach where a cascade function is trained from a lot of positive and negative images. It is then used to detect objects in other images. It is an object detection algorithm used to locate faces, pedestrians, objects and facial expressions in an image and mainly used for face detection. In Haar-cascade, the system is provided with several numbers of positive images (like faces of different persons at different backgrounds) and negative images (images that are not faces but can be anything else like chair, table, wall, etc.), and the feature selection is done along with the classifier training using Adaboost and Integral images.

general, three kinds of features are used in which the value of two rectangular features is the difference. Object Detection using Haar feature-based cascade classifiers is an effective object detection method proposed by Paul Viola and Michael Jones. It is a machine learning based approach where a cascade function is trained from a lot of positive and negative images. It is then used to detect objects in other images.

To increase the learning performance of the algorithm (which is sometime called as weak learner), the Ada-boost algorithm is used. Ad-boost provides guarantees in several procedures. The process of 'Boosting' works with the learning of single simple classifier and rewriting the weight of the data where errors were made with higher weights. Afterwards a second simple classifier is learned on the weighted classifier, and the data is reweighted on the combination of 1st and 2nd classifier and so on until the final classifier is learned. Therefore, the final classifier is the combination of all previous n-classifiers. sum of the pixels within two rectangular regions. These regions have same shape and size and are horizontally or vertically adjacent. Where as in the three rectangular

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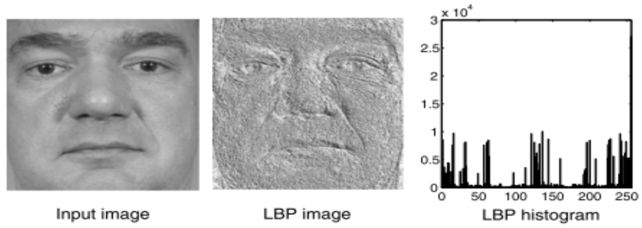
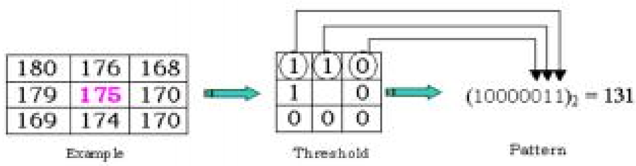
features are computed by taking the sum of two outside rectangles and then subtracted with the sum in a centre rectangle. Moreover, in the four rectangles feature computes the difference between diagonal pairs of rectangles [4].

## III. FACE RECOGNITION USING LINEAR BINARY PATTERN HISTOGRAM (LBP)

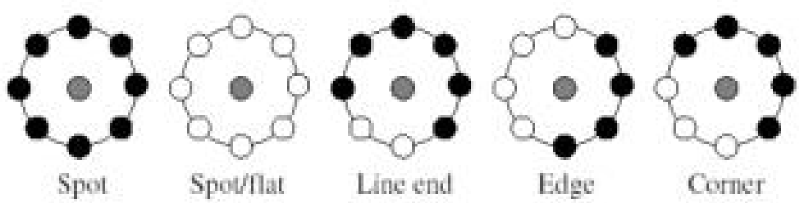
The local binary pattern operator is an image operator which transforms an image into an array or image of integer labels describing small-scale appearance of the image. These labels or their statistics, most commonly the histogram, are then used for further image analysis. The most widely used versions of the operator are designed for monochrome still images but it has been extended also for colour (multi-channel) images as well as videos and volumetric data.

### *A. Basic LBP*




The basic local binary pattern operator, introduced by Ojala et al was based on the assumption that texture has locally two complementary aspects, a pattern and its strength. In that work, the LBP was proposed as a two-level version of the texture unit to describe the local textural patterns. The original version of the local binary pattern operator works in a 3 × 3 pixel block of an image. The pixels in this block are thresholded by its centre pixel value, multiplied by powers of two and then summed to obtain a label for the centre pixel. As the neighborhood consists of 8 pixels, a total of $2^8 = 256$ different labels can be obtained depending on the relative grey values of the centre and the pixels in the neighborhood. An example of an LBP image and histogram are shown below.




The 256-bin histogram of the labels computed over an image can be used as a texture descriptor. Each bin of histogram (LBP code) can be regarded as a micro-texton. Local primitives which are codified by these bins include different types of curved edges, spots, flat areas, etc. Some examples are shown below

The LBP operator has been extended to consider different neighbour sizes. For example, the operator $LBP_{4,1}$ uses 4 neighbours while $LBP_{16,2}$ considers the 16 neighbours on a circle of radius 2. In general, the operator $LBP_{P,R}$ refers to a neighbourhood size of P equally spaced pixels on a circle of radius R that form a circularly symmetric neighbour set. $LBP_{P,R}$ produces 2P different output values, corresponding to the $2^P$ different binary patterns that can be formed by the P pixels in the neighbour set. It has been shown that certain bins contain more information than others. Therefore, it is possible to use only a subset of the $2^P$ LBPs to describe the textured images. Ojala et al. defined these fundamental patterns as those with a small number of bitwise transitions from 0 to 1 and vice versa. The most important properties of LBP features are their tolerance against monotonic illumination changes and their computational simplicity [3].

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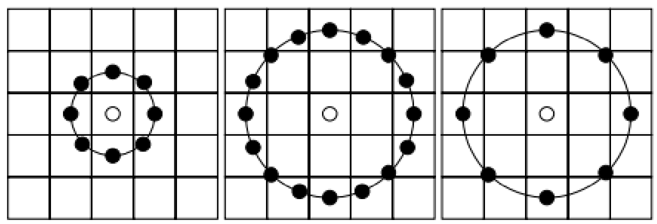
### *B. Calculation of LBP*

Consider a monochrome image I(x,y) and let $g_c$ denote the grey level of an arbitrary pixel (x,y), i.e. $g_c = I(x,y)$.
Moreover, let $g_p$ denote the grey value of a sampling point in an evenly spaced circular neighbourhood of P sampling points and radius R around point (x,y):
$g_p = I(x_p,y_p)$, $p = 0,\dots,P - 1$ and
$x_p = x + R\cos(2\pi p/P)$
$y_p = y - R\sin(2\pi p/P)$
See Fig. given below for examples of local circular neighbourhoods.



Assuming that the local texture of the image I(x,y) is characterized by the joint distribution of grey values of P + 1 (P > 0) pixels:
$T = t(g_c,g_0,g_1,..,g_{P-1})$
Without loss of information, the centre pixel value can be subtracted from the neighbourhood:
$T = t(g_c,g_0 - g_c,g_1 - g_c,..,g_{P-1} - g_c)$
In the next step the joint distribution is approximated by assuming the centre pixel to be statistically independent of the differences, which allows for factorization of the distribution:
$T \approx t(g_c)t(g_0 - g_c,g_1 - g_c,..,g_{P-1} - g_c)$
Now the first factor $t(g_c)$ is the intensity distribution over I(x,y). From the point of view of analysing local textural patterns, it contains no useful information. Instead the joint distribution of differences $t(g_0 - g_c,g_1 - g_c,..,g_{P-1} - g_c)$ can be used to model the local texture. However, reliable estimation of this multidimensional distribution from image data can be difficult. One solution to this problem, proposed by Ojala et al. is to apply vector quantization.
Although invariant against grey scale shifts, the differences are affected by scaling. To achieve invariance with respect to any monotonic transformation of the grey scale, only the signs of the differences are considered. This means that in the case a point on the circle has a higher grey value than the centre pixel (or the same value), a one is assigned to that point, and else it gets a zero:
$T=t(s(g_0 - g_c),s(g_1 - g_c),\dots,s(g_{P-1} - g_c))$ ,
where s(z) is the thresholding (step) function
$s(z) = 1, z \geq 0$
or
$s(z)= 0, z< 0.$
The generic local binary pattern operator is derived from this joint distribution. As in the case of basic LBP, it is obtained by summing the thresholded differences weighted by powers of two. The $LBP_{P,R}$ operator is defined as
$LBP_{P,R}(x_c,y_c) = P{=}0P{-}1\ s(g_p - g_c)2^P$.
The Local Binary Pattern characterizes the local image texture around $(x_c, y_c)$. The original LBP operator is very similar to this operator with P = 8 and R = 1, thus $LBP_{8,1}$. The main difference between these operators is that in $LBP_{8,1}$ the pixels first need to be interpolated to get the values of the points on the circle [3].

## IV. METHODOLOGY

### *A. The functionality of our project is categorized in following steps*

*1)* To detect the face using Pi camera connected to Raspberry Pi 3.
*2)* To program the board using python language in order to import certain modules that enable functions such as face detection and recognition.
*3)* Receive the voice commands through microphone and covert it into digital commands via Raspberry Pi3.
*4)* To drive the motor in clockwise and anti-clockwise direction depending upon the corresponding digital commands [1].

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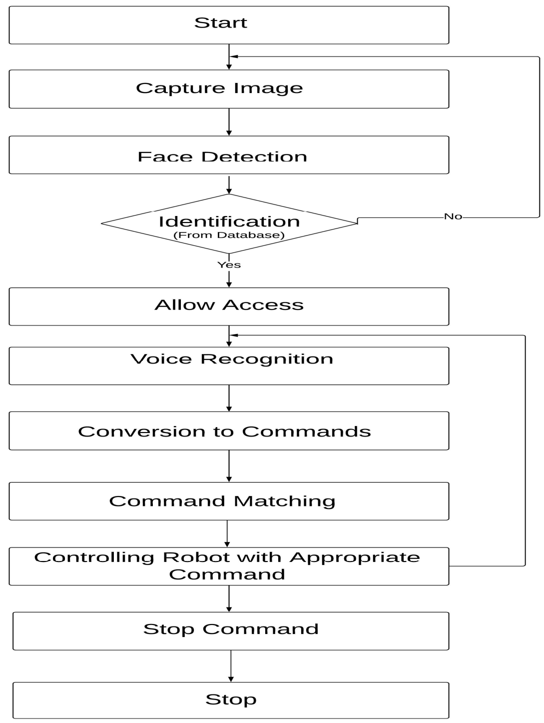
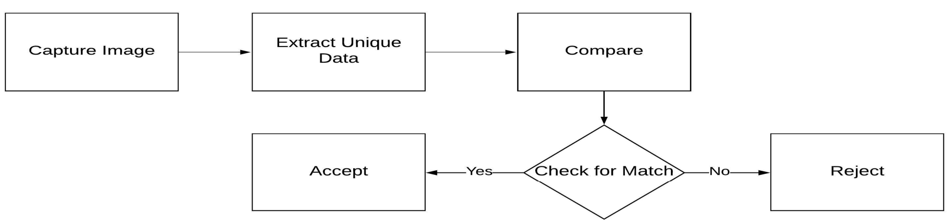
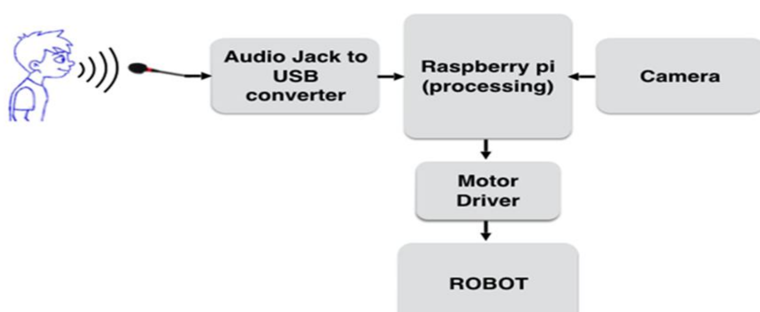



*B. The identification and authentication operates in four steps.*




1) *Capture image:*-A physical or behavioral sample of a person's face is captured by using the Pi camera.
2) *Extraction of unique data:*-Unique data associated with these samples are extracted and a template is created.
3) *Comparison:*- These templates are then compared with an existing samples of an authorized users.
4) *Match/No-Match:*- If the templates compared to existing samples are similar then they are considered as a Match and accordingly access is provided to the users [1].

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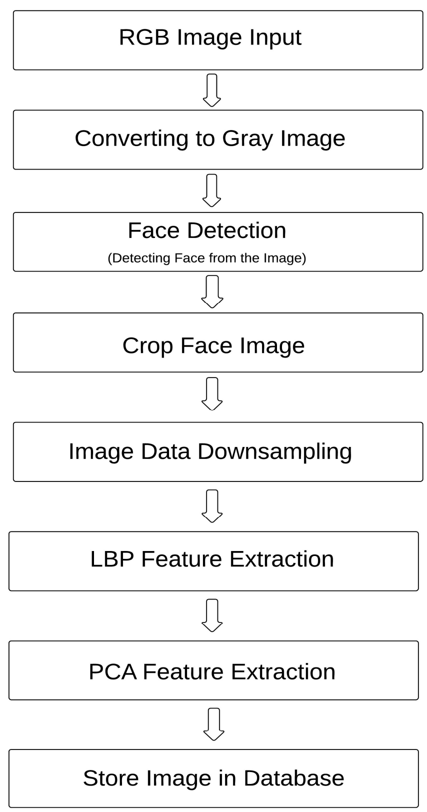
### *C. Block Diagram*

The input/output modules are interfaced to the Raspberry Pi. The input port include microphone followed by USB sound card which passes the voice commands to the Raspberry Pi 3. Pi camera is also connected to capture the image of the person's face which is stored in secure digital card. This image is compared with those stored in database. On the other hand the output part includes DC motor followed by DC motor driver L293D [1].

The samples which are compared with the new sample are stored in database. Database consists of images of number of authorized users faces. Creation of this database is categorized in following steps.

*1)* Capture the image which is a color image having RGB components.
*2)* Convert this RGB image into Grey image. Grey image consists of only shades of black color i.e less color components which make it easier for comparison of faces with database.
*3)* Detection of face from the image and then cropping the facial area.
*4)* Linear binary pattern (LBP) features are extracted from the face which is different for every face.
*5)* Storing the image in the database.

Flowchart for face data creation:




## V. SYSTEM DESIGN

System includes Raspberry Pi 3 board, Pi Camera, connecting cables, USB sound card, Microphone, DC motor driver, DC motors.

### *A. Raspberry Pi 3*

Raspberry ARM based credit card sized SBC(Single Board Computer) created by Raspberry Pi Foundation. Raspberry Pi runs Debian based GNU/Linux operating system Raspbian and ports of many other OSes exist for this SBC.

Raspberry Pi Foundation has announced a new version Raspberry Pi 3. Read announcement here. With on-board WiFi / Bluetooth support and an 64bit improved Processor, Raspberry Pi v3 is an exciting board for Makers, Engineers and Students.

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### *B. Application Processor*

1) 64 bit
2) Quad Core
3) 1.2 GHz
4) ARM Cortex-A53 Processor (ARM V8 ISA)
5) GPU
6) 400 MHz
7) Video core IV Multimedia Co-Processor.

## VI. PI CAMERA

The Raspberry Pi Camera Module is a 5MP CMOS camera with a fixed focus lens that is capable of capturing still images as well as high definition video. Stills are captured at a resolution of 2592 x 1944, while video is supported at 1080p at 30 FPS, 720p at 60 FPS and 640x480 at 60 or 90 FPS. The camera is supported in the latest version of Raspbian, Raspberry Pi's preferred operating system.

This package provides a pure Python interface to the Raspberry Pi camera module for Python 2.7 (or above) or Python 3.2 (or above).

## VII. USB SOUND CARD

A sound card (also known as an audio card) is an internal expansion card that provides input and output of audio signals to and from a computer under control of computer programs. The term sound card is also applied to external audio interfaces used for professional audio applications. Typical uses of sound cards include providing the audio component for multimedia applications such as music composition, editing video or audio, presentation, education and entertainment (games) and video projection.

## VIII.MICROPHONE

A microphone is a transducer that converts sound into an electrical signal. Microphones are used in many applications such as telephones, hearing aids, public address systems for concert halls and public events, motion picture production, live and recorded audio engineering, sound recording, two-way radios, megaphones, radio and television broadcasting, and in computers for recording voice, speech recognition, VoIP, and for non-acoustic purposes such as ultrasonic sensors or knock sensors.

Several different types of microphone are in use, which employ different methods to convert the air pressure variations of a sound wave to an electrical signal. The most common are the dynamic microphone, which uses a coil of wire suspended in a magnetic field; the condenser microphone, which uses the vibrating diaphragm as a capacitor plate, and the piezoelectric microphone, which uses a crystal of piezoelectric material. Microphones typically need to be connected to a preamplifier before the signal can be recorded or reproduced.

## IX. DC MOTOR DRIVER

Adafruit designed a very useful shield (in 2008), called "Adafruit Motor Shield". It was a useful shield with older components. In 2014, Adafruit has a discontinued this shield and has a new and much better motor shield.

The shield contains two L293D motor drivers and one 74HC595 shift register. The shift register expands 3 pins of the Raspberry pi to 8 pins to control the direction for the motor drivers. The output enable of the L293D is directly connected to PWM outputs of Raspberry pi.

## X. DC MOTORS

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor.

DC motors were the first type widely used, since they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight motor used for portable power tools and appliances.

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## XI. ACKNOWLEDGMENT

We feel delighted to present paper our project on "FACE AUTHENTICATION VOICE CONTROLLED ROBOT " during our academic year (2017-2018). We take this opportunity to express our sincere gratitude to everyone who has helped and co-operated us in making this report.We express our deep gratitude to our professor and project guide Prof, S.R. Wategaonkar Sir and Parents for their help support, guidance and inspiration.

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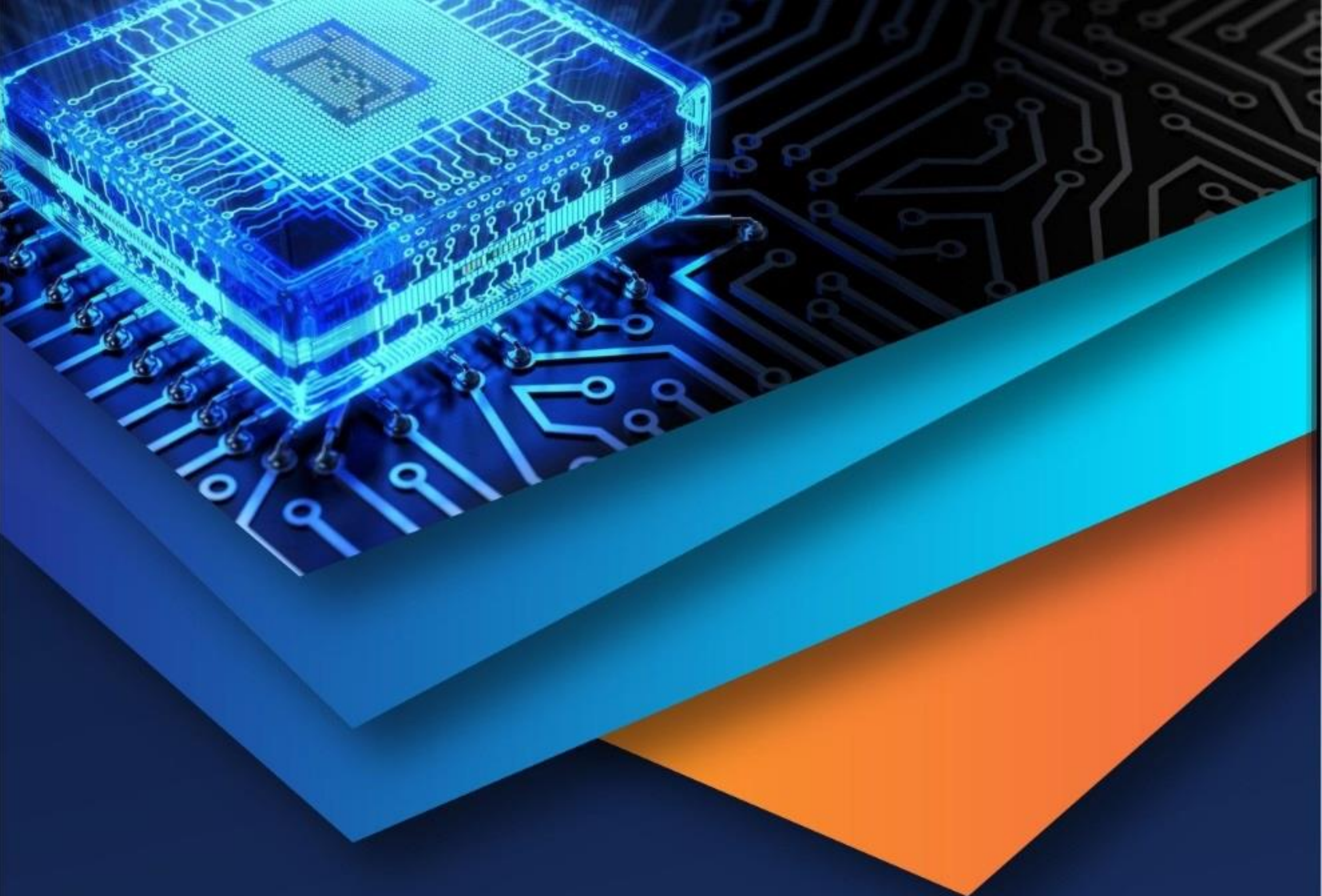


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