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A Novel Approach for Morse Code Detection from Eye Blinks and Decoding using OpenCV

Dr. Kranthi Kumar[1], V. Sai Srikar[2], Y. Swapnika[3], V. Sai Sravani[4], N. Aditya[5]
[1]*Associate Professor*, [2, 3, 4, 5]*Department of Information Technology, Sreenidhi Institute Of Science and Technology*

Abstract: ***A few medical conditions such as Locked In Syndrome and Amyotrophic Lateral Sclerosis lead to paralysis or motor speech disorder in people which may cause defect in speech or voice. In this case the individual loses his ability to communicate. AAC devices become a rescue for them but they turn out to be expensive and also inaccessible to most of the people. At this pace of time we propose low cost software which helps in converting the message into understandable English language, through eye blinks with the use of Open source Computer Vision, through Morse code which comprises dots and dashes. So, this will serve as an alternative to the AAC devices.***

Keywords: AAC devices, Amyotrophic Lateral Sclerosis, Morse code, Computer Vision

I. INTRODUCTION

Medical ailments like brain stroke, paralysis may result in speech disorders [4]. It may also occur due to accidents which lead to loss of communication [1] in people. Latest research in the United States of America shows more than a million people suffering with such kind of problems. Multiple technologies are existing to develop the communication in patient such as mouth actuated joysticks, tongue movement analysis, switch mounted near user's head, actuated breathe puffing straws, etc [2]. But these turn out to be costly and stressful as it requires skilled labor to use the device. Hence the proposed system makes wonders in such cases. Another reason for developing this system is to create a highly confidential communication system to communication either in military or any other place where two people want to communicate secretly without knowledge of third person. This would work great when people use the Morse code by blinking their eyes. The development of simple and cost-effective system to aid patients suffering from speech disorders and also to communicate confidential messages in areas like military is the leading objective of this paper. We use concepts like eye blinks, facial landmarks, eye blink detection and Morse code which perform the main operation which is capturing the values given in the form of dots and dashes.

II. LITERATURE

Modern technologies are built which can give better opportunities for the silent people to speak. This is the mark of Augmentative and Alternative Communication [3] which contains multiple number of AAC devices available even today. One of the prominent methods in AAC is segmentation or image representation. The main goal of segmentation is to convert the representation of images from complex form to simple form which can be easy to analyze. Literature of lip detection is also considered to be efficient ones[5]. It can be categorized into 3 types, the first one is image based second one is model based and third one is hybrid based which is the combination of both first and second type. Image type is based on pixels and is less expensive. It can further be divided into color and subspace techniques. Model based uses active shape and active appearance models to find out the differences. Hybrid uses the concept of snakes and parabola to detect and decode the output. This turns out to be very accurate amongst the three.

An AVCD is a low-cost speech assistant system which works as the primary eye blink sensor where the measures involved in this system are sensor which is used to detect eye blink and IR led. The microcontroller is fed by the voltage values which are taken during the opening and closing of the eye for analysis of rate and length of eye blink. These eye movements are translated into corresponding alphabet. The output is shown on the LCD panel and converted into speech by the speech conversion module. QRD1114 is used as an IR sensor module which is half a phototransistor device and half an LED which works in order to detect nearer objects and also distinguish between different colored surfaces. It has 4 connectors where 2 pins take out the infrared LED and the other 2 pins knock out emitter pins and phototransistor collector. The low-tension audio amplifier used in this is LM386 which gives audio output for text displayed. The dots and dashes are allocated in this system by checking the eye open and close rate and length here a voltage threshold is set to separate the eye blink status. The IR Sensor will detect the light amount transmitted from eye and will send it to the Arduino where the different amount of light will be transmitted when eye is closed and opened and the voltage value is registered and eye blink threshold is fixed. In this system the short blink is corresponding to a circle and long

blink to Morse code line. The system takes an average of 5 seconds time to enter a random alphabet. After the system detects the alphabet input which is given it converts into the speech output.

AVCD aims to give an aid to the people with speech impairments to make them communicate to people and also given a voice output which will make the communication easier and the alphabets are displayed on the LED. As the AAC devices are used to give output in the form of words but AVCD is the modified version which can also be used by blind people who have eyes but couldn't see they can hear the sound output which is given by the system. This AVCD whereas could display few alphabets as the display medium used here is an LED screen where we can see only few alphabets so this couldn't show large words at a single time.

III.PROPOSED SYSTEM

Our project is achieved using Morse code encoded through eye blinks. In this chapter we discuss about Morse code detection from eye blinks and decoding using OpenCV.

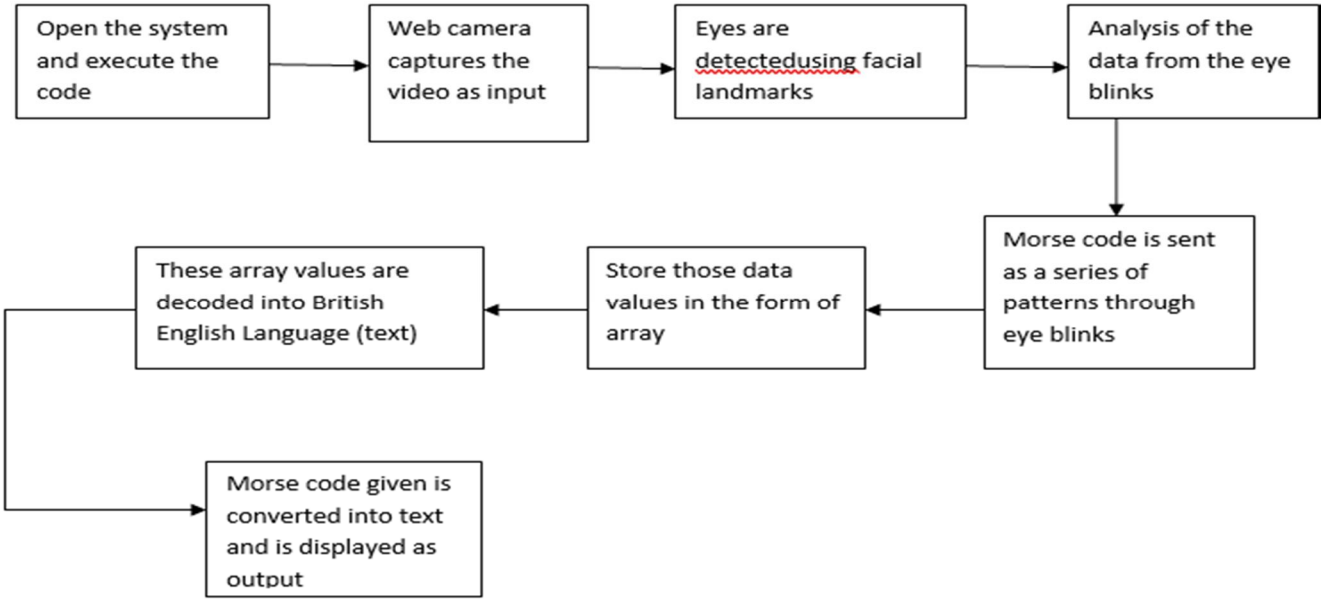

Fig 1: Architecture of Proposed System

In general, human face pattern recognition is done through training data with different data sets and create data models. Here Human facial patterns are recognized through facial landmarks created manually which consists of 68 points (1-68) which form face pattern helps in recognizing eyes, eye brows, nose, mouth and chin cuts.

Fig 2: Facial Landmarks in dat File

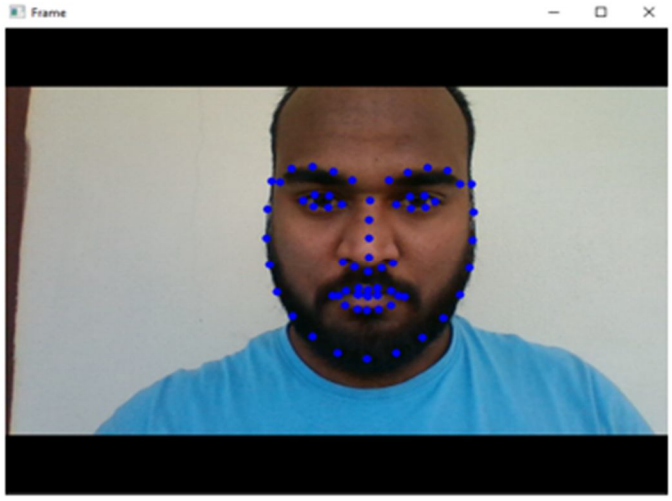

Fig 3:Facial Landmarks Example

Here we can concentrate on particular parts of the face through corresponding points (left eye 37-42, left eyebrow-18-22, right eyebrow-23-27, right eye 43-48, nose 28-36, chin 1-17, outer lip 48-60, inner lip 60-68). In this project we mainly concentrate on eyes and their blinks.

Computing eye blinks which is different from traditional image processing methods, we use three methods

1) Eye localization.
2) Thresholding for eye blinks
3) Determining blinks using eye aspect ratio

Eye aspect ratio is the simple calculation which is based on ratios of distance between points in the eye landmarks. Each eye landmarks are constructed using 6 points x,y-coordinates. We take it as P1-P6, eye aspect ratio is the distance from P1, P4 to distance from (P2, P2) and (P5, P6). Indirectly we are finding the horizontal and vertical distance of an eye.

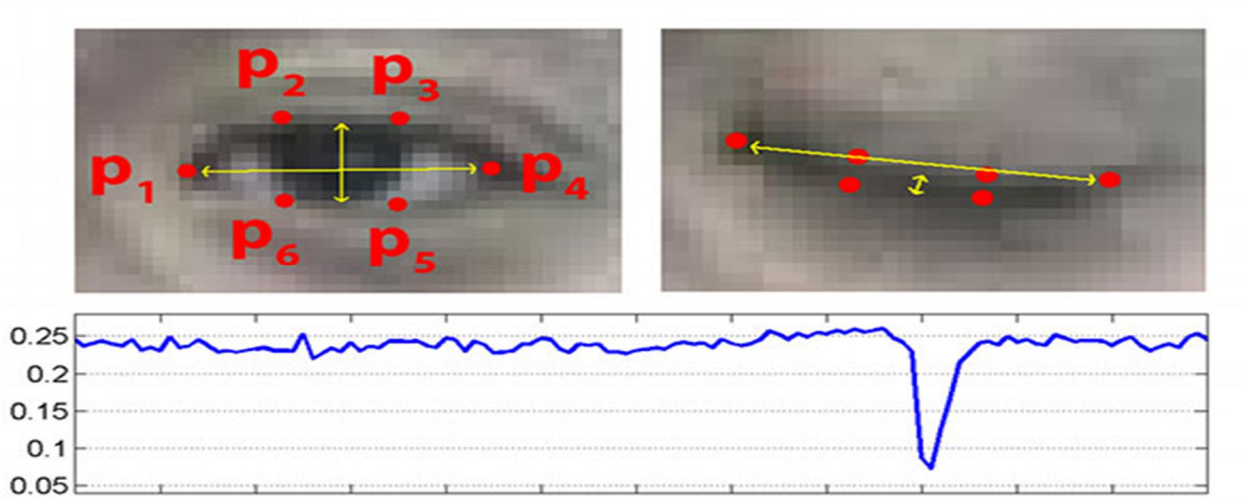

Fig 4: Eye Landmarks on opening and closing eye

The graph in the image represents the EAR value during opening and closing of eye. If we observe keenly the eye aspect ratio when eye is opened is high nearly 0.25. when eye is closing the eye aspect ratio decreases gradually and comes near to zero and all the points plotted on eye form a straight line when the eye is closed.The equation which is used to find eye aspect ratio as follows

$$EAR = \frac{||p2 - p6|| + ||p3 - p5||}{2||p1 - p4||}$$

The numerator computes distance between vertical eye marks and denominator computes horizontal eye marks. We multiplied denominator with 2 because there are two sets of vertical points and single set of horizontal points. When the eyes are opened EAR will be larger than the threshold point and relatively constant. When eyes are closed EAR will cross the threshold value i.e. 5.7.

We assign different functionalities by blinking different eyes. If right eye is blinked then it encodes as dot(.). Similarly, when left eye is blinked then it is encoded as dash (-). Based on the sequence of blinking it will construct patterns represents corresponding English alphabets. Each English alphabet consist of unique Morse code pattern, decoding such patterns will form a word which is used for communication

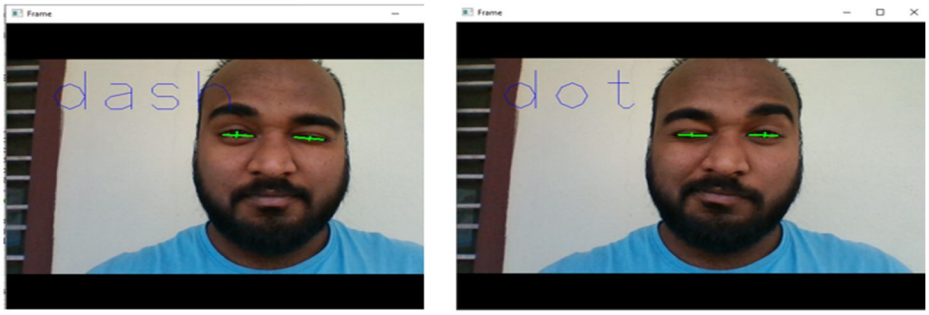

Fig 5: Dot and Dash from Eye Blinks

A. Algorithm

1) *Step 1:* Start
2) *Step2:* Make sure the system is working and execute the code
3) *Step3:* Video is captured through web-camera as input
4) *Step 4:* Eyes are detected through camera using facial landmarks by Open CV
5) *Step 5:* Eye blinks are recorded and analyzed
6) *Step 6:* If the right eye blinks then consider it as dot(.)
7) *Step 7:* If the left eye blinks then consider it as dash (-)
8) *Step 8:* Press "A" key to generate space
9) *Step 9:* All the values i.e. dots and dashes are stored in an array
10) *Step 10:* The array values are sent to decoder as input
11) *Step 11:* Decoder converts Morse code into English (British) letters using International Morse Code as a reference
12) *Step12:* Text is seen in Python Jupyter Notebook which is considered as output
13) *Step 13:* Stop

B. Flow Chart

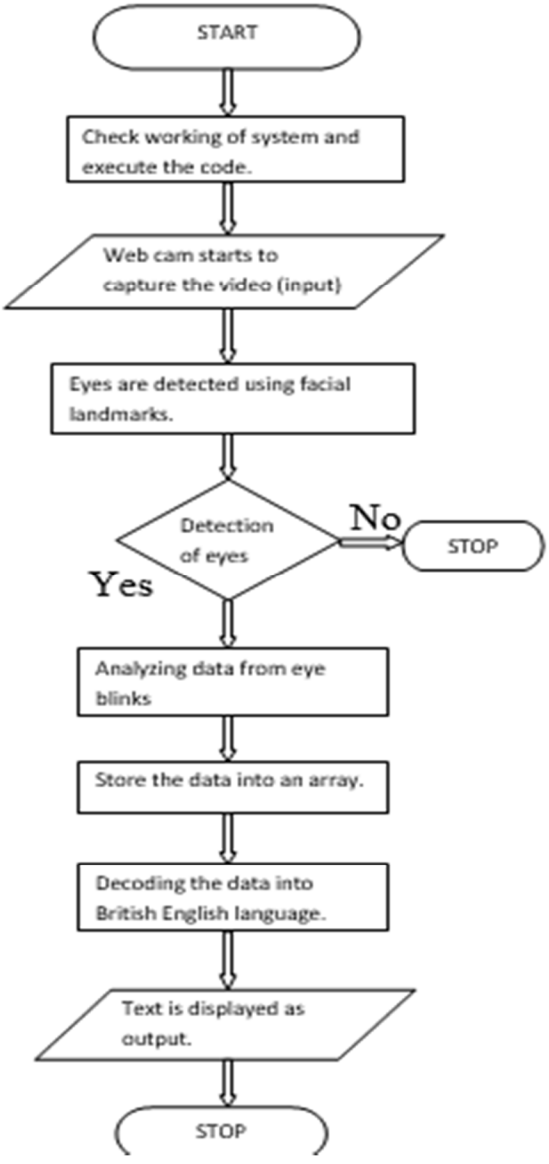

Fig 6: Flow Chart

IV. PERFORMANCE ANALYSIS

LETTER	MORSE CODE	BLINK CODE	EXISTING SYSTEM TIME ANALYSIS	PROPOSED SYSTEM TIME ANALYSIS
A	.-	R, L	4	2
B	-…	L, R, R, R	6	4
C	-.-.	L, R, L, R	8	4
D	-..	L, R, R	5	3
E	.	R	1	1
F	..-.	R, R, L, R	6	4
G	--.	L, L, R	7	3
H	….	R, R, R, R	4	4
I	..	R, R	2	2
J	.---	R, L, L, L	10	4
K	-.-	L, R, L	7	3
L	.-..	R, L, R, R	6	4
M	--	L, L	6	2
N	-.	L, R	4	2
O	---	L, L, L	9	3
P	.--.	R, L, L, R	8	4
Q	--.-	L, L, R, L	10	4
R	.-.	R, L, R	5	3
S	…	R, R, R	3	3
T	-	L	3	1
U	..-	R, R, L	5	3
V	…-	R, R, R, L	6	4
W	.--	R, L, L	7	3
X	-..-	L, R, R, L	8	4
Y	-.--	L, R, L, L	10	4
Z	--..	L, L, R, R	8	4
1	.----	R,L,L,L,L	13	5
2	..---	R,R,L,L,L	11	5
3	…--	R,R,R,L,L	9	5
4	….-	R,R,R,R,L	7	5
5	…..	R,R,R,R,R	5	5
6	-….	L,R,R,R,R	7	5
7	--…	L,L,R,R,R	9	5
8	---..	L,L,L,R,R	11	5
9	----.	L,L,L,L,R	13	5
0	-----	L,L,L,L,L	15	5
TOTAL TIME			258	132

Analysis of performance is generally taken in comparison with the existing system. In Morse code the time limit is considered as the ratio of 1:3 between dot and dash respectively. The existing system generally takes around 258 seconds to complete a moderate word but the proposed system takes only 132 seconds for the same word. The performance of proposed system is 51.16% which clearly indicates that the proposed system is more efficient by approximately two times

V. CONCLUSION AND FUTURE SCOPE

The system we've developed may be a flexible one. We've used this technique with the Morse code because it may be a very fashionable code that's universally known and accepted. For patients with lower communication requirements, a special code could be easily devised (with dots and dashes) where a specific pattern would represent a specific phrase or command (instead of an alphabet). There is an array of basic life functions can easily be communicated by a couple of commands which may be learnt effortlessly by the patient

The system developed is a versatile one which can be accepted and celebrated all around the world. This also associates in basic life functions which can be effortlessly learnt by the patient. Its price sums up to the bottom line of $20-$25 which includes of all hardware and software components which is low when compared to AAC device which costs around $7000.The system created is highly economical and is cheaper than the available AAC devices. These can be implemented not only to people who have body disorders or speaking issues but also be implemented in places like libraries, hospitals or schools in order to maintain these places with less or no sound and the process of communication. These work great for spy or people working in military to convey secret message without other person's knowledge.

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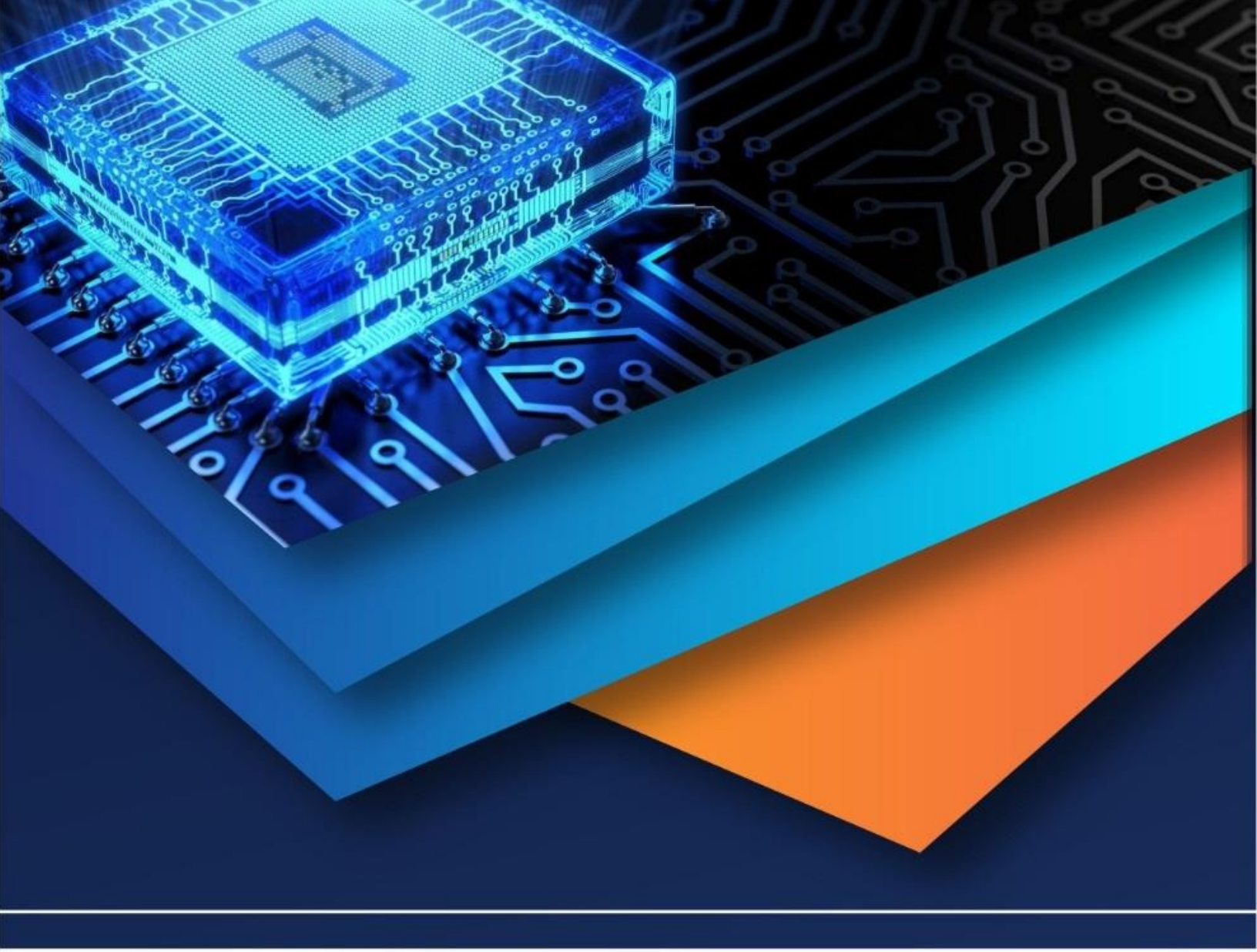

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