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Automatic Disfluency Identification and Recognition from Conversational Speech

Geethamani.A.V[1], Rajkumar.S[2], Sasikumar.A.V[3]
[1]Pg Scholar, [2]Assistant Professor,Dept of ECE,Kathir College of Engineering
[3]Assistant Professor, Dept of ECE, Sri Sakthi Institute of Engineering and Technology

Abstract—Speech is the central mechanism that supports daily communication with others and plays an important role in establishing and sustaining social relationships. Stuttering disrupts normal flow of speech and interferes with social interactions and quality of life. Disfluencies and secondary behaviors associated with stuttering can be socially disconcerting and individually frustrating.Stuttering is a problem with fluency, voice, and or how a person produces a speech sound. The main focus of this study is to identify the difference between normal and disordered speech. The proposed work classifies the normal and abnormal speech.

Keywords: Disfluencies, Secondary behavior, frustrating,stuttering.

I. INTRODUCTION

Humans use speech as a verbal means to express their feelings, ideas, and thoughts in communication. In this world, there is 1% of the population having the problem of stuttering and it has been found to affect females and males at a ratio of 1:3 or 1:4 [1,2]. Disfluency and stuttering are a break or interruption of normal speech, such as repetition, prolongation, or interjection of syllables, sounds, words, or phrases, and involuntary silent pauses or blocks in communication [1,3]. Stuttering cannot be completely cured, although it may go into remission for some time [1]. Stutterers can learn to shape their speech into fluent speech with the appropriate speech pathology treatments. Therefore, a stuttering assessment is needed to evaluate the performance of stutterers before and after therapy. Traditionally, a speech language pathologist (SLP) counts and classifies the occurrence of disfluencies, such as repetition and prolongation, in stuttered speech manually. However, these types of stuttering assessment are subjective, inconsistent, time-consuming, and prone to error [1,4,5]. Therefore, it might be good if stuttering assessment can be done through classification of disfluencies using digital signal processing (DSP) and artificial intelligence (AI) concepts. In the last 2 decades, researchers have focused on developing objective methods using DSP and AI concepts to assist the SLP during stuttering assessment. The work is beneficial to know the area of improvement in abnormal speech at early stages. Speech pathology treatments help stutterers to shape their speech into fluent speech.

Speech is the verbal method of communication and is crucial for effective social communication, occupational achievement and quality of life. Stuttering is a speech disorder that interrupts smooth flow of speech and hence communication. Stuttering manifests as automatic interruption of an individual's ability to speak. It is a fluency disorder that results in frequent repetitions or prolongations of sounds or syllables, while speaking or reading aloud1. It manifests in childhood and may persist into adulthood. It is primarily characterized by repetitions of sounds, syllables or words, audible or inaudible prolongations (around 1-4 sec) or blocks. These may be seen in the beginning of a word or sentence. Several secondary behaviours also accompany stuttering behaviors. This may include eye blinking, avoiding eye contact, jaw jerks while speaking, hand or finger fidgeting, restlessness while speaking etc.

Stuttering is a speech disorder in which sounds, syllables or words are repeated or prolonged, disrupting the normal flow of speech. This speech disruption may be accompanied by struggling behavior, such as rapid eye blinks or tremors of the lips. Stuttering can make it difficult to communicate with other people, which often affect a person's quality of life. Early identification of stuttering is advisable because these disorders may progress to lifelong communicative impairments if left untreated. It is important to determine whether a speech pattern represents normal dysfluency or actual stuttering. At present, there is no device or method for the early detection of stuttering.

II. CAUSES FOR STAMMERING

The cause for stuttering is unidentified. It is speculated that cognitive-linguistic processing abilities (reaction time and speech

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processing), gender, environmental situations and genetics abilities may play a role in stuttering. Stuttering can affect children, adolescents and adults in particular ways. It may be in the form of children being intimidated in school and adolescents performing below their abilities in school and having poor peer interaction.

Table 1 displays the size of database which includes 150 utterances of both normal subjects. The same parameters like age and gender with same number of sentences and utterance are considered for collection of abnormal speech samples.

TABLE 1. DETAILS OF DATABASE

Age	Gender	Sentence	Utterance
26	M	10	3
17	M	10	3
21	F	10	3
21	M	10	3
26	M	10	3

Spontaneous speech differs from written text. One difference is the presence of disfluencies. Accurate identification and cleanup of disfluencies can improve readability and aid performance of downstream language processing modules. Disfluencies can be broken down into three regions: the reparandum, an optional editing phase1, and the resumption. Here we study three types of disfluencies: repetitions: the speaker repeats some part of the utterance.

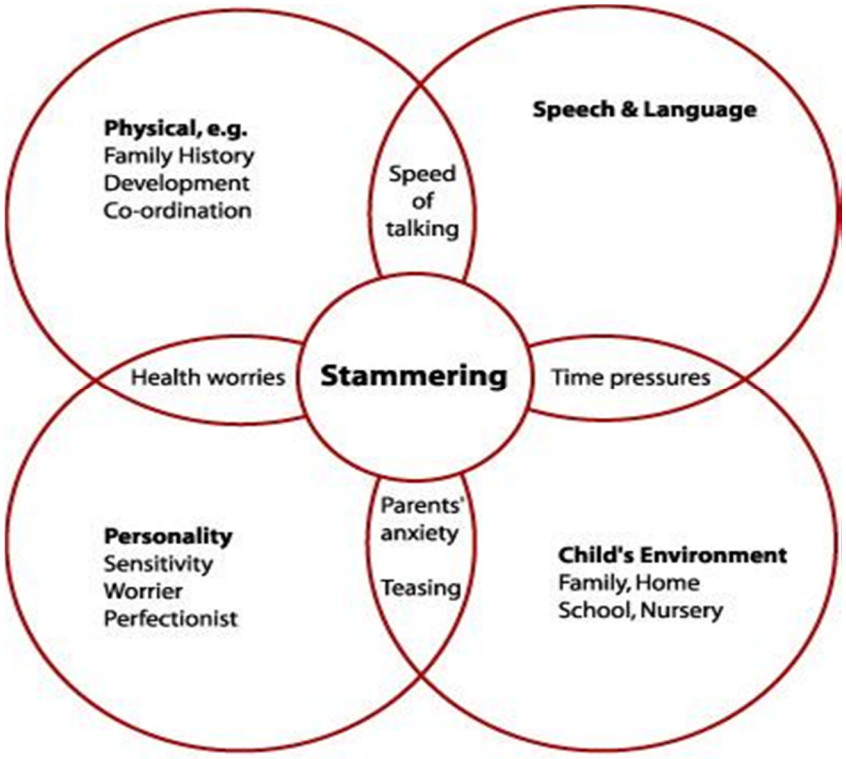


Fig 1: Various causes for stuttering /stammering

III. DIFFERENT LEVELS OF STUTTERING

The abnormal speech samples are collected from stammering patients and normal speech samples of respective parameters like age and gender is considered. Here table 2 & 3 represents the various level of stuttering and types and severity level of stuttering and its percentage.

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TABLE 2. VARIOUS LEVELS OF STUTTERING

	Severity level	Less typical type (LTT)	More typical type (MTT)
Normal	<2%	>10%	None
Border line	2 % – 3%	>10% or both	Infrequent signs of tension
Mild	3% - 8%	10% - 15%	None
Moderate	8 % - 15%	greater	More severe stutter
Severe	12% or more	Significantly high	Significantly tension

TABLE 3. TYPES OF STUTTERING AND ITS PERCENTAGE LEVEL

	(1) Mild	(2) Mild-Mod	(3) Moderate	(4) Moderate-Severe	(5) Severe
I.(a)Frequency of blocks include : prolongation & repetition or	2%-5%	6%-10%	11%-18%	19%-24%	25% or more
(b) Stutter words per minute	6%- 5%		6%-10%		11+
II.(a) Duration – average of 3 longest blocks	Upto 1 sec	2 to 4 Secs	5 to 9 Secs	10 to 15 Secs	16 Secs or more
(b) Total words spoken per minute	90-99		70-89		69
III.Secondary Characteristics: Sounds,Head moves	Not noticed by average person		Distracts from content of communication		Displays severe secondaries

IV. SEVERITY AND MEASUREMENT OF STUTTERING

Measuring stuttering is notoriously difficult. You can measure several aspects of stuttering:

A. Frequency of disfluencies. I.e., disfluencies per hundred words or syllables. The "average" stutterer is dysfluent on 10 percent of words. People who don't stutter are disfluent on about 2% of words.
B. Duration of disfluencies. The "average" disfluency lasts about 1 second.
C. Speaking rate, or word per minute. The average speaking rate for people who don't stutter is 167 words per minute (Darley,

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1940). The average speaking rate for stutterers is 123 words per minute. The average stutterer speaks about 25% slower than the average non-stutterer.

D. Types of disfluencies. Wendell Johnson developed eight categories of disfluencies in 1959. The first three are common to both stutterers and non-stutterers. The last five are stuttering disfluencies.

E.

1) Interjections ("uh," "er").
2) Revisions ("I was - I am going").
3) Incomplete phrases.
4) Part-word repetitions ("ba-ba-ba-baseball").
5) Word repetitions.
6) Phrase repetitions ("I was I was going").
7) Broken words ("I was g - (pause) - oing home").
8) Prolonged sounds.

F. Psychological effects.

A study by Young in 1961 found that ordinary listeners judged stuttering to be "severe" when there were part-word repetitions, prolongations, broken words, and a new category, "undue stress or tension." But many speech samples were judged "severe" with relatively few of these disfluencies, suggesting that there are yet more, unidentified types of stuttering disfluencies.

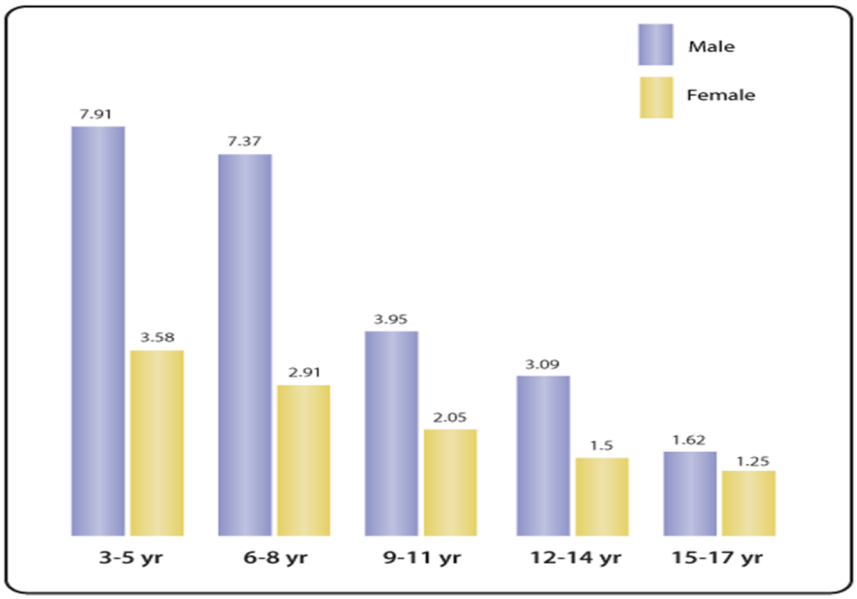


Fig 2: Stuttering level

V. STUTTERING REDUCES STRESS

Systolic blood pressure is an indicator of stress. Stuttering reduced stutterers' blood pressure 10%. In contrast, fluent speech, chewing gum, and sitting quietly each reduced blood pressure about 2%.Stutterers are, on average, disfluent on 10% of syllables. We say 90% of syllables fluently. But we don't say one hundred syllables fluently, and then finish a conversation with ten dysfluencies. Stuttering usually occurs on the first sound of the first word, in a stressful situation. I.e., your stress builds up as you anticipate speaking. You stutter, and this releases stress. You then say several syllables fluently.

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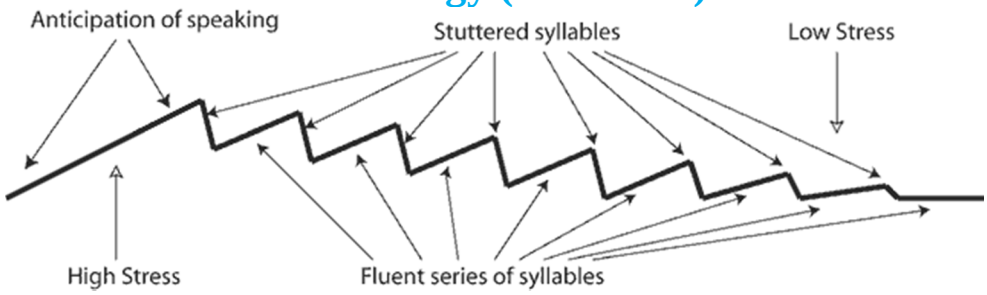


Fig 3. Stutter calculated based on syllable

Your stress increases as you anticipate speaking. You block on the first syllable. This reduces your stress, and you speak fluently. Your stress builds up again, and you stutter again. This reduces your stress, and the cycle repeats until you're speaking fluently at the end of the conversation

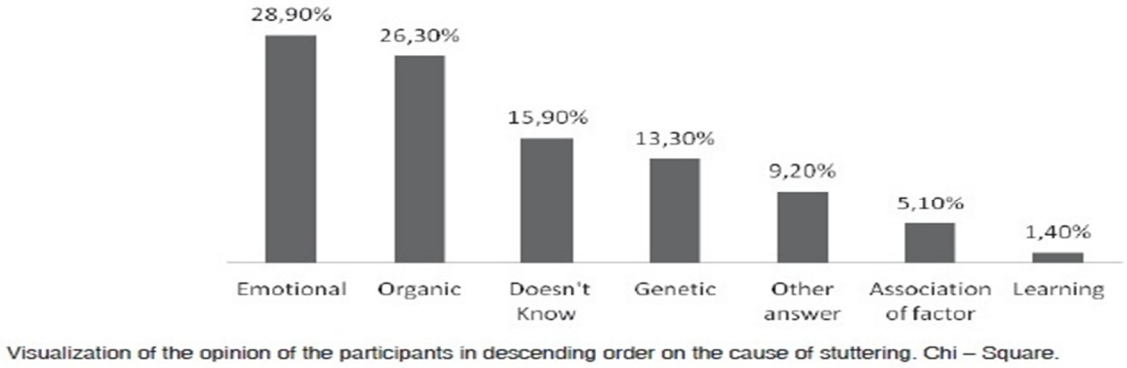


Fig 4. Various reasons for stuttering and its percentage level

A. Treatment options

Based on the various behavioral reasons and its percentage level ,the treatment can be done for the stuttering persons. Treatments for people who stutter tend to be aimed at teaching the person skills, strategies, and behaviors that help oral communication. This may include:

B. Fluency shaping therapy

1) *Controlling monitoring speech rate* - this may involve practicing smooth, fluent speech at very slow speed, using short sentences and phrases. The person is taught to stretch vowels and consonants, while trying to secure continuous airflow. With practice the person gradually utters smooth speech at higher speed, and with longer sentences and phrases. Patients have higher long-term success rates if the sessions with the SLP are followed up regularly - this helps prevent relapses.
2) ***Breathing control*** - as the patient practices prolonged speech he/she also learns how to regulate breathing. Added to this is operant conditioning (controlling breathing, as well as phonation, and articulation (lips, jaw and tongue).

VI. OUTPUT AND DISCUSSION

The recording took place in the normal room without noisy sound and effect of echo. The sampling frequency for all recordings was 16000 Hz at the room temperature and normal humidity. The speaker were seating in front of the direction of the microphone with the distance of about 12-15 cm .The female and male stutter sample voice is recorded to recognize the stuttering person from the speech. Mainly the pitch frequency and Formant frequency is calculated from the stuttering person .usually the female frequency

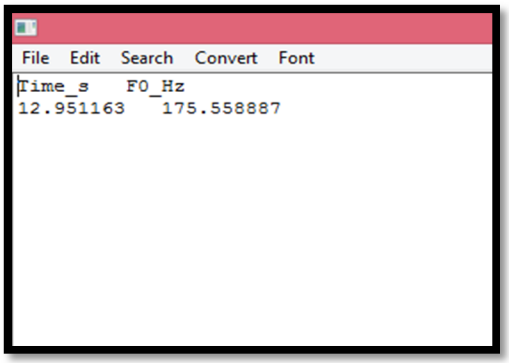
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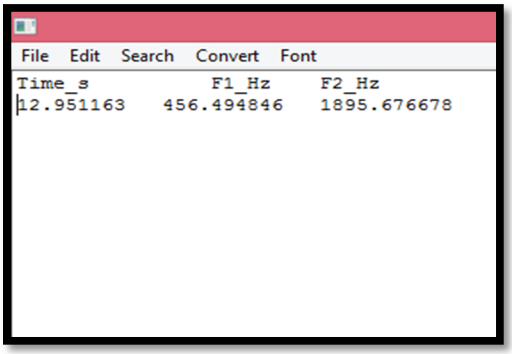
range is always higher than the male frequency.

FEMALE STUTTER VOICE

Pitch frequency of Female stutter voice

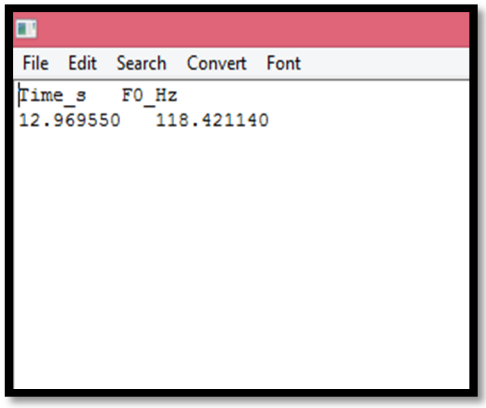


Formant frequency of Female stutter voice

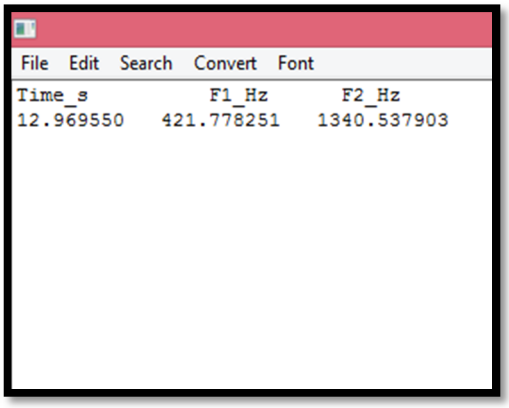


MALE STUTTER VOICE

Pitch frequency of Male stutter voice



Formant frequency of Male stutter voice



VII. CONCLUSION

Stuttering is a speech disorder that interrupts smooth flow of speech and hence communication. Stuttering manifests as automatic interruption of an individual's ability to speak. From the above output and discussions ,the stutter male and female-pitch and formant frequency range is varied from the normal male and female- pitch and formant frequency . The stuttered person can be recognized while the treatment is taken from the childhood stage. There are many treatment options available for stutter person based on the severity level.

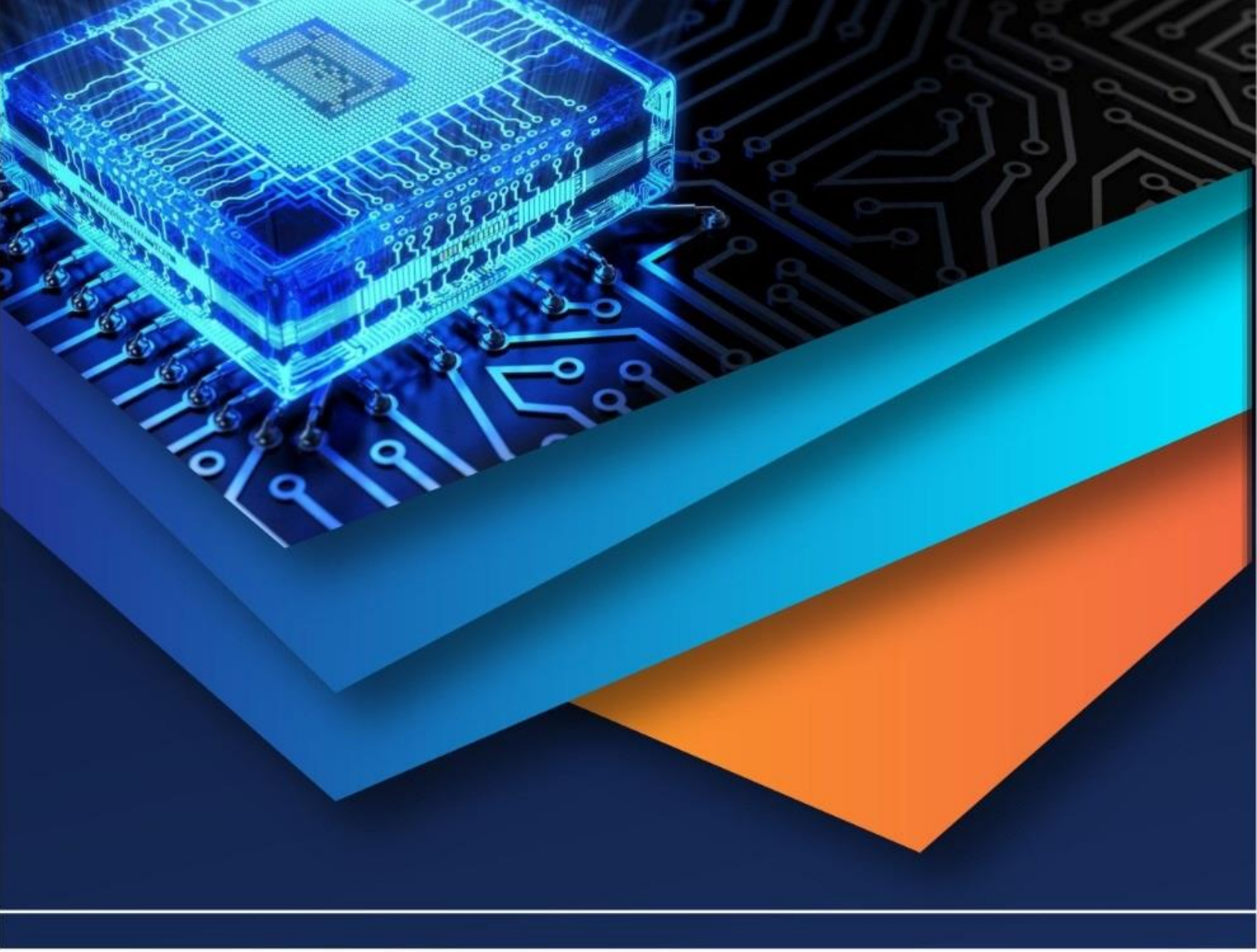
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