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Biomimetic Walking Trajectory in Kinaesthetic Learning Sustaining Memory Dependencies in AI Patterns of Humanoid Robot using LSTM in RNN

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Abstract: The training results during the trajectory mobile robot obtained and the overcome In this chapter, of obstacle using the fusion method with fuzzy logic controller in several reactive learning environments is presented. Analysis of the state vector and the result obtained for the scheduling problem by fuzzy based algorithm and enumeration method is plotted, The Tracking results are arrived are also discussed.
Most of the state transition functions are required for achieving the consistency with causality with a response function for fuzzifying the system.
Classical dynamic systems by using the time funcitons and concatenation in the function and the desired properties for consistency by using linguistic approximation and the optimization done and the improvement produced using LSTM where by short term memory can withstand over recurrent neural networks as a LSTM, or Long Short-Term Memory, is a type of recurrent neural network (RNN).
Keywords: RNN, LSTM, ARHR, CoG, ZMP, GCoM, ROS,

I. INTRODUCTION

LSTMs are a specific type of RNN, meaning they are designed to handle sequential data where the order of information matters, such as text, time series, or audioarchitecture designed to address the vanishing gradient problem encountered in standard RNNs, making it effective for processing sequential data.
LSTMs utilize memory cells with gates to regulate the flow of information, allowing them to selectively remember or forget past data points, which is crucial for capturing long-range dependencies in sequences while implementing different kinds of trajectory genereation are zmp and cog, In this research the novel method to generate a bio mimetic walking trajectory for a biped humanoid namely ARHR on a flat surface.
We assume that the configuration in the flat surface is known [1-9], and we solve the human like walking trajectory generation problem by obtaining the solution from the desired zero moment point (ZMP) trajectory to the centre of gravity (CoG) trajectory. We present an analytic solution for the walking trajectory generation by using Fourier series. From the Figure.2 and 3 given ZMP trajectory bio mimetically represented and we focus on how to find the CoG trajectory. In an analytical way. A time-segmentation based approach is adopted for generating the trajectories.
The trajectory functions need to be continuous between the segmens, thus, the solution is found by calculating the coefficients under these connectivity conditions. It was derived a general form of the ZMP using a simple inverted pendulum model (SIPM), which incldues the ZMP and the CoG trajectories in the horizontal and vertical locomotion directions to quantify the walking parameters [10-15]. The performance of the proposed approach is verified by conducting walking simulations from Figure.1 comparing with experimental platfirms using a full body dynamic simulator on three different surfaces and comparing them to the previous approach.

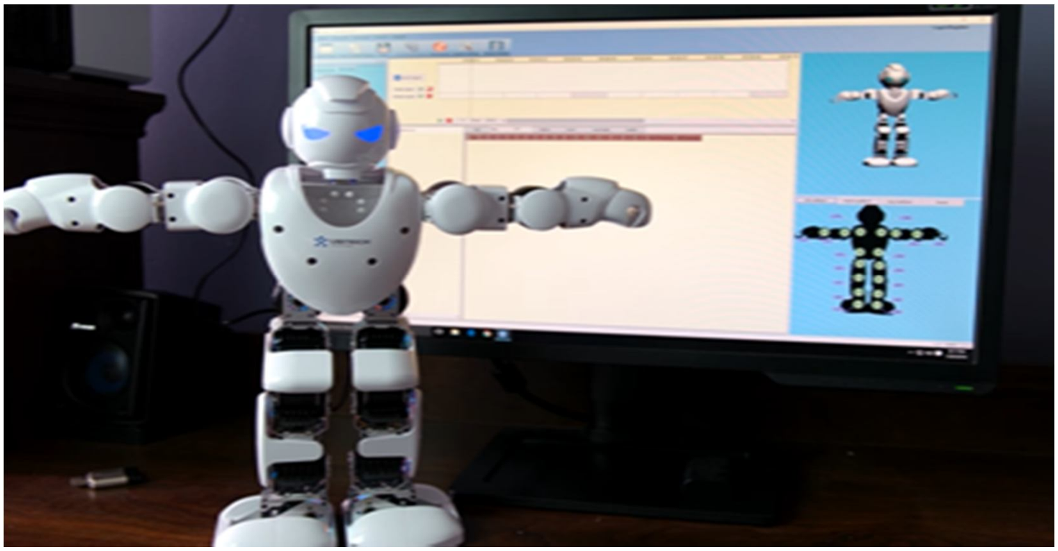

Figure.1 Comparisons of Simulation Vs Experimental AI Model Platform (Output experimental values are plotted as LSTM values)

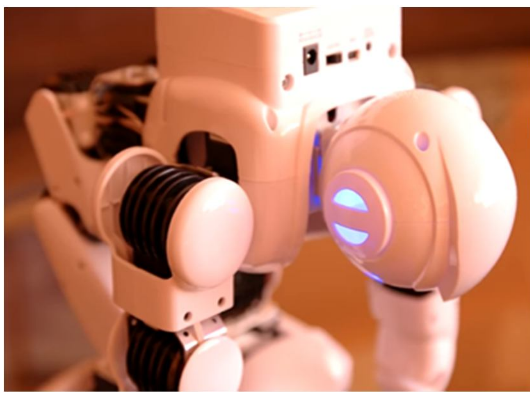

Figure.2 ZMP Figure.3 CoG

II. METHODOLOGIES

A. *Biomimetic walking trajectory in Kinaesthetic learning*

Kinaesthetic learning is an approach to provide demonstrations to a robot learning from Demonstration whereby a human physically guides a robot to perform a skill Figure.1. In the common usage of kinaesthetic teaching, the robot's trajectory during a demonstration is recorded from start to end. Similar to Biped anthropomorphic robots here ARHR motions are composed by three or more serial kinematic chains that are detached from an inertial reference frame and its configuration varies in time. It is observed from Figure.2 Leg Stretching is observed and therefore, it is not only necessary that the biped motion ensures the structural stability of the robot [16-19], but also it has to guarantee that the robot will not fall down on the ground during its locomotion. It is seen from Figure.3 observed that the ARHR will not fall down on the ground during its motion. The generation of the trajectory is made using the geometric constraint method in a similar way as done on because besides being intuitive, to apply this method, it is not necessary to use the switching graph representation of the parallel mechanism composed by the humanoid robot and the virtual chains with the designation of the number of directions and its positions [20]. Firstly it is needed to choose points on the humanoid structure for which the trajectory will be generated[21,22]. As it was said before and because of the use of the virtual reality these points are the ones in which were attached the positions on the humanoid robots. Then for each point of interest, one trajectory is elaborated using third order spline interpolation. During a gait, the arms have a passive role – they are not used to manipulate objects or tools and they do not rely on any point in space – because they are used to assist on structural balance of the biped mechanism. Thus, the trajectory was generated considering [23], only the swing motion in humanoid gait.

In the initial position of the Learning, the left foot is forward of the right one by a distance of Stepini = 0.1 m. The step length is Step = 0.2 m and its maximum high during one step is Zmax = 0.03 m(Zmin = 0). In the gait planning, it was considered that the ARHR remains on the double support phase (when the biped is supported by both feet) to reallocate the ground projection of the cente of mass (GCoM) from the previous support to under the next support foot Figure.4. As the feet are composed by just one piece, then, it is not necessary to change the orientation of the feet during the gait. That is, in a humanoid gait, as the foot has one DoF, it gets off the ground in two movements the first one boosts forward the body in the direction of the gait, and the second finishes the double support phase

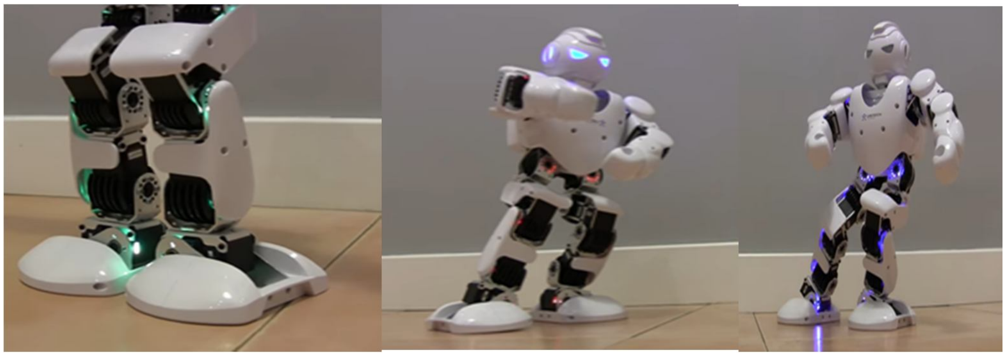

Figure.4 Knee bending during locomotion in LSTM

III. CONTRIBUTION BY TRAINING RESULTS USING LSTM IN RNN

Given the proximity of the center of mass and the waist, these two points will be treated as equals. Therefore, the trajectory generation to the waist with respect to the X and Y axis, respectively, are generated in a way that the motion of the center of mass ensures a balanced gait by the ZMP criterion Figure.5. As it is considered a quaistactic motionm if the GCoM always remains inside of the support polygon, the humanoid will not gall down. Moreover, the proximity between the GCoM and the ZMP ensures a baanced gait

Figure.5 Hip balance single feet of RNN Figure.6 Hip balances two feet in LSTM

It is seen that the mobile robot is able to avoid an obstacle in whole training conditions as derived from equation 1 and equation 2. A fuzzy system based on the obtained information of four infrared (IR) sensors and on electronic compass is proposed and implemented on an ARHR humanoid robot to avoid obstacles. With 18 degrees of freedom (DOFs) it is designed so that it can do five basic motions Figure.6. Four IR sensors and one electronic compass are installed on to detect the environment information including obstacles, the distances of the obstacles, and the directional angle of the robot. Based on the obtained information, an obstacle avoidance method is proposed to decide one behaviour from five motions so that it can avoid obstacles and go to the destination area effectively in Figure.5. ROS simulation results with different number of obstacles and go to the destination area effectively. ROS simulation results with different number of obstacles and real experiments are presented to illustrate the effectiveness of the proposed method. This work presents methods for path planning and obstacle avoidance for the humanoid robot Figure.6, allowing the robot to autonomously walk around in a home environment equation 3. For a humanoid robot, obstacle detection and localization as well as representing them in a map are crucial tasks for the success of the robot. Our approach is based on plane extraction from data captured by a stereo-vision system that has been developed specifically. This was implemented through the general software architecture composed of perception, short and long term memory, behaviour control, and motion control, and emphasize on our methods for obstacle detection by plane extraction, occupancy grid mapping and path planning. Experimental results complete the description of humanoid robotic system.

An approach to path planning for humanoid robots that computes dynamically-stable, collision-free trajectories from full-body posture goals. Given a geometric model of the environment and a statically-stable equation.4, desired posture, we search the configuration space of the robot for a collision-ree path that simultaneously satisfies dynamic balance constraints. It is adapted existing randomized path planning techniques by imposing balance constraints on incremental search motions in order to maintain the overall dynamic stability of the final path. A dynamics filtering function that constrains the ZMP (zero moment point) trajectory is used as a post-processing step to transform statically-stable, collision-free paths into dynamically-stable, collision-free trajectories for the entire body. Although experiments were focused on with a humanoid, the method generally applies to any robot subject to balance constraints (legged) equation.5 and equation 6. The LSTM is presented along with computed examples using the humanoid robot ARHR. Wide potential applications of humanoid robots require that the robots can walk in complex environments and overcome various obstacles. To this end, it is addressed the problem of humanoid robots walking over obstacles. It is focused on two aspects which are feasibility analysis and motion planning.

Experimental calculations using fuzzy expert robotic system ros shell

$$fitness_{re} = \sum_{n=1}^{n_r}(w_{rd}\, X\, d_{fit}^{n} + w_{rt} X time_{fit}^{n} + w_{rr} X road_{fit}^{m} + w_{rbd} X\, B_{dfit}^{n} + \quad w_{rba} X B_{afit}^{n}) \tag{1}$$

With

$$d_{fit}^{n} = \frac{d_{end}^{n}}{Sensor_{re}} \tag{2}$$

$$time_{fit}^{n} = \frac{t_{max-time_{end}^{n}}}{t_{max}} \tag{3}$$

$$road_{fit}^{n} = \frac{Sensor_{re} - road_{end}^{n}}{Sensor_{re}} \tag{4}$$

$$B_{afit}^{n} = \frac{\tau_{\max - \sum_{l=1}^{n_{rr}} |B_{a}^{n}(l)|}}{\tau_{max}} \tag{5}$$

$$B_{dfit}^{n} = \frac{\tau_{\max - \sum_{l=1}^{n_{rr}} |B_{d}^{n}(l)|}}{\tau_{max}} \tag{6}$$

Table.1 Experimental values of LSTM range dependencies in AI robotic system

t_{max}	$time_{end}^{i}$	D_{end}^{i}	$road_{end}^{i}$	$Sensor_{ob}$ (Z-Score)
12	9.6	6.7	9.0	-2.27
3	7	6.29	1.02	8.27
5	-0.5	0.04	0.28	7.67
6	5	8.68	7.21	2.47
7	-0.5	0.04	0.25	-1.96
9	-0.5	4.76	4.17	5.59
8	0	3.79	3.21	6.58
6	-0.5	0.04	0.29	6.42
2	0	8.55	4	5.85
3	-0.5	0.04	0.24	-1.23
4	8.6	4.92	4.19	5.73
6	-0.5	0.04	0.22	8.06
8	-9.8	7.4	3.02	7.2
8	-0.5	0.04	0.26	6.07
1555	-9.3	9	3.16	7.24
0	-0.5	6.4	4.39	6.09
0	-0.5	0.04	0.23	9.24
8	-7.4	9.6	11.5	-0.81
8	-0.5	0.04	0.29	8.86
8	-0.5	0.04	0.25	7.8
8	-0.5	0.04	0.26	0.38
10	0	-0.15	2.59	8.33

IV. RESULTS AND DISCUSSIONS

The Training Results are shown in Table.1 From the comparison of results obtained for the scheduling Problem by fuzzy based algorithm and enumeration method is studied for various regression analyses and the comparison of the fuzzy enumeration is plotted obtaining various tracking results from the time for max values with the corresponding road and sensor data arrived is shown in the Table.1 which shows that maximum number of minimum -0.5 $time^{i}_{end}$ values are obtained, with corresponding D^{i}_{end}, $road^{i}_{end}$ values as 0.04 and 0.2 respectively which is also minimum which implies minimum data overloading thereby minimising data redundancy which enables to achieve data concurrency.

It is also observed from Table.1 that the minimum of the minimum values from the obtained maximum number of 10 minimum values in one particular training conditions resulted as $\boldsymbol{time^{i}_{end}}$ = 0.5, $\boldsymbol{D^{i}_{end}}$ = 0.04, $\boldsymbol{time^{i}_{end}}$ = 0.5, $\boldsymbol{road\,^{i}_{end}}$ = 0.22 and the Sensor values taken as Z-Score and is obtained as $\boldsymbol{Sensor_{ob}}$= 8.06 which Scored 80% ((8.06/10*100) = 80%) in the Training Results.

V. DETERMINING SAMPLE SIZE

Determining the appropriate sample size appears to be a challenge in humanoid robot studies. As a power analysis which was conducted to estimate the number of locomotion's necessary, A power analysis is a statistical calculation that was done to determine the appropriate number of locomotion's of ARHR needed for obtaining accurate and reliable results based on the number of groups in the sample size, alpha level, expected, alpha level, and effective size, and a certain level of statistical power.

Additionally, there is a software available online that will assist within type of calculation (e.g., G* Power 3 software located at the http://www.psycho.uniduesseldorf.de/abteilungen/aap/gpower3/). A power analysis was conducted for the study discussed based on using two groups, power of -0.5, a medium effect size of 0.04, and an alpha = 7.2, the calculation resulted in two groups of 22*5 = 110 spaces for 22 samples for a total of 110 occurrences from preliminary analysis of the data the effective sizes were small to medium sized and had there not been such a large sample size used for the study, the results may not have been statistically significant; however that was not the case. In the self-assessment data Figure.7, statistically significant results were obtained for the main effect of arousal and a three-way interaction was obtained for equivalence methods of evaluation. There are four primary methods of evaluation (1) Self-assessment, (2) Observation or behavioural measures, (3) Psychophysiology measurements, and (4) task performance metrics. Each of these methods have advantages and disadvantages; howerever most problems were overcome with the use of multiple methods of evaluation.In determining the sample size it is ensured that to get correct sample size, like Sample size while handling sequential data in LSTM.

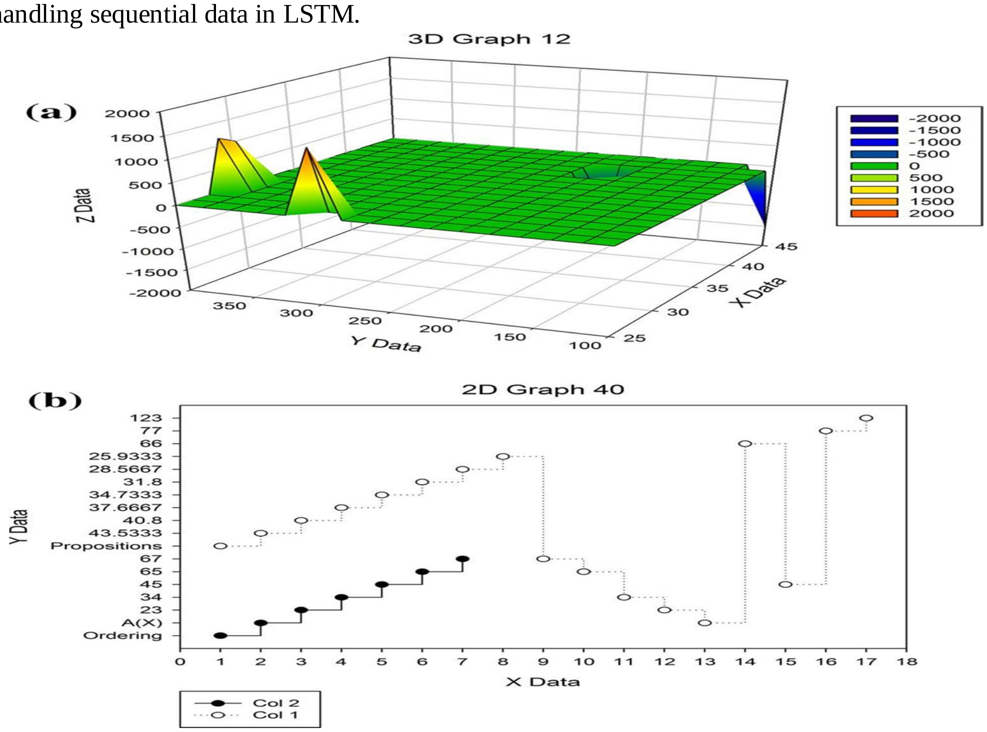

Figure.7 Optimization of data sequence in AI of large range dependencies in RNN

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Table.2 AI Z-Score Confidence level in gradient vanishing of RNN using LSTM

Z-Score (confidence level) From Table 5.1	StdDev	1-StdDev	Margin of error (Error) From Table 7.1	Sample size (Data's needed)
-2.27	0.5	0.5	-2.27	0.25
8.27	4.5	-3.5	8.27	-15.75
7.67	3.2	-2.2	7.67	-7.04
2.47	0.6	0.4	2.47	0.24
-1.96	0.1	0.9	-1.96	0.09
5.59	3.9	-2.9	5.59	-11.31
6.58	4.1	-3.1	6.58	-12.71
6.42	4.3	-3.3	6.42	-14.19
5.85	3.8	2.8	5.85	10.64
-1.23	0.1	0.9	-1.23	0.09
5.73	3.3	-2.3	5.73	-7.59
8.0	**4.6**	**-3.6**	**8.06**	**-16.31**
7.2	3.7	-2.7	7.2	-9.99
6.07	3.9	-2.9	6.07	-11.31
7.24	3.2	-2.2	7.24	-7.04
6.09	3.5	-2.5	6.09	-8.75
9.24	5.2	-4.2	9.24	-21.84
-0.81	0.1	0.9	-0.81	0.09
8.86	4.9	-3.9	8.86	-19.11
7.8	3.3	-2.3	7.8	-7.59
0.38	0.1	0.9	0.38	0.09
8.33	**4.6**	**-3.6**	**8.33**	**-16.56**

VI. OUTCOME

It can be seen that the initial schedule of the robotic system is in concurrence with the schedule after fuzzy logic controller in robotics system as in Table.2. Hence it can be concluded that the fuzzification is optimized. Thus non monotonism for the existing relations could be made to preserve some of the properties of relation that all pairs have corresponding approximation using LSTM with long range depencies

VII. ANALYSIS OF THE INFERENCE RESULTS

Experimental calculations for Fuzzy expert Robotic System ROS shell were done as per the analysis, validation of algorithm with experimental values for the trajectory of robot in several reactive learning environments were studied. Fuzzifications using dynamic systems using linguistic approximation were shown. Optimization was done by rearranging data perfectly with the efficiency in retrieval of learning data. It is proved that the fuzzy based algorithm growth was tremendously stronger with the increasing size of the scheduling problem. Comparison of the results was obtained for the Scheduling Problem by fuzzy based algorithm and enumeration method was studied for various regression analyses. Scheduling after fuzzy logic controller in robotics system with the initial schedule of the robotic system was observed.

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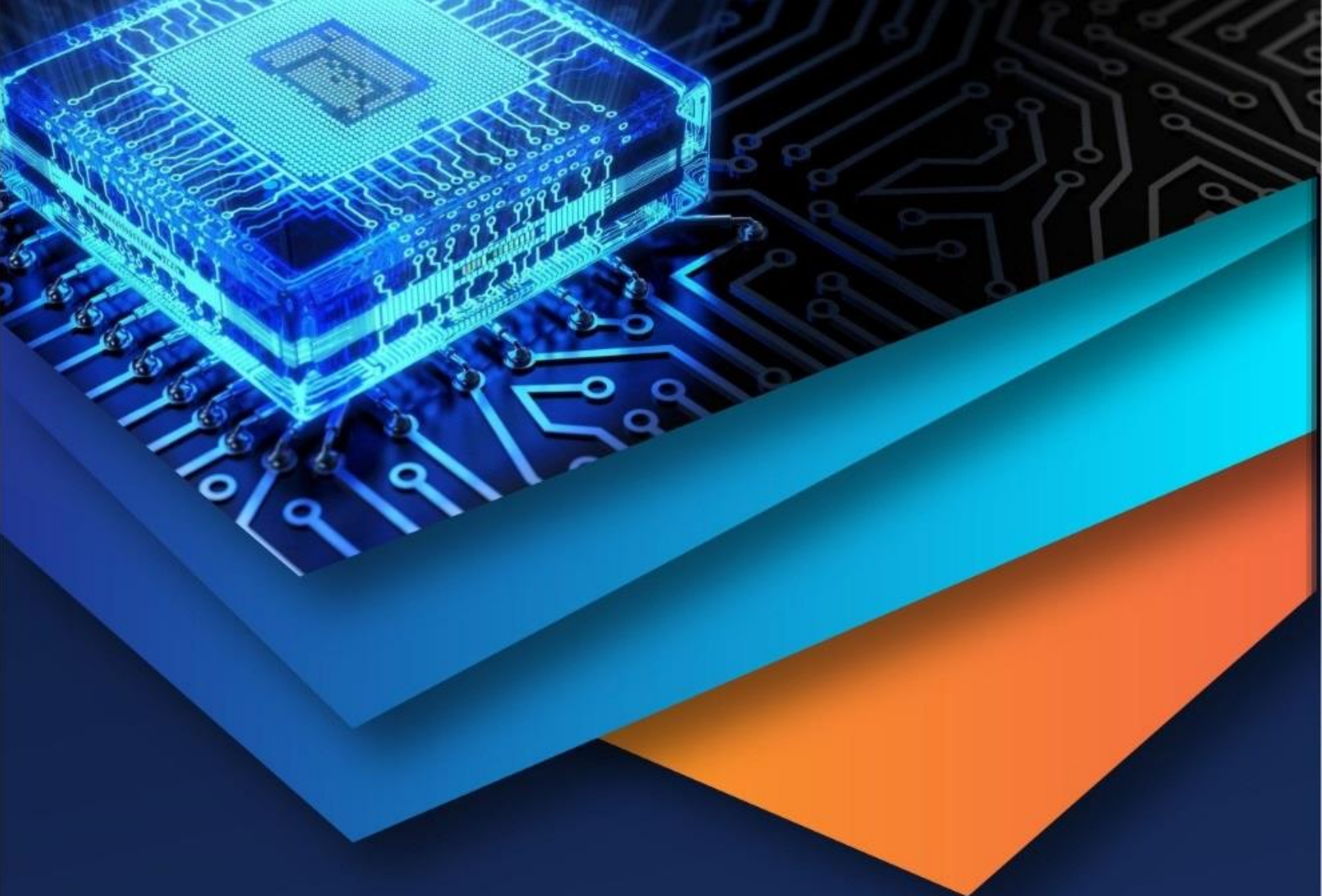

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