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Design and Simulation of Robot Gripper and Conveyor System for Workstations

Anjaiah Madarapu[1], Jai Sai Ganesh Singh Rajaputra[2], Tirupati Sai Hitesh[3], Yadavalli Phani Bhaskar[4]
Department of Mechanical Engineering, Guru Nanak Institutions Technical Campus, Ibrahimpatnam, R.R. Dist.Telangana, India - 501506

Abstract: Intelligent manufacturing is going to boom in the upcoming years. The characteristic features of Industry 4.0 are fully automated production facilities where all processes are controlled in real-time and take into account the changing external conditions. The core of the Industry 4.0 is made up of digitalization and robotics, in particular, the use of collaborative robots and MES. MES (Manufacturing Execution System) is a specialized system designed to solve the problems of synchronization, coordination, analysis, and optimization of production. It involves the use of conveyor belts for rapid transportation of products. Industries where conveyor belt systems are excelling include automotive, computer, good, packaging, print finishing, bottling and canning, chemical, pharmaceutical, aerospace and food processing

The safety conditions in fundamental industrial jobs are dangerous and harmful combined with ineffective manual work as a result of rising need for mass manufacturing. In industries, automation is the use of technology to jobs that were previously handled by humans. It is a potent instrument that can aid companies in enhancing quality, production, and efficiency.

A typical type of mechanical handling equipment that transports things from one place to another is a conveyor system. These systems consist of conveyor belts that are designed to work seamlessly with robotic arms and other automated equipment. Increased automation and mass production rate reduces the lead time and increases the profit of a firm. The deployed robotic arms are immensely capable of handling various tasks with increased flexibility. Using a robotic arm with an end effector as a gripper to hold/pick and place the material from the conveyor belt improves the product flow process.

The project comes with the NodeMCU firmware and an integrated Wi-Fi chip, the ESP8266 12E. To connect with the controller via a mobile phone, a web page would be constructed using HTML and coded using the Arduino IDE's C language. At either end of the conveyor belt, 2 robotic arms with 2 degrees of freedom (D.O.F.) would be placed. Using one arm to place the product on the belt and a second to pick it up at the other end. Also calculating the analytical data of the system that is involved in real-life industrial processes along with the simulation of entire system for the UR10 industrial robot, using the RoboDK simulation software. Through the usage of this system, productivity is boosted with improved safety of the working environment, become more effective, be more flexible, and have higher levels of job satisfaction.

Keywords: UR10 Industrial Robot, RoboDK simulation software, Material Handling, NodeMCU ESP 8266 12E Microcontroller, Degrees of Freedom.

I. INTRODUCTION

Automated systems can operate more quickly and accurately. Automation in the workplace refers to the control of robotic equipment, computers, and software. Automation systems typically include sensor software and feedback loops that can manually alter activities to achieve a desired result, compared to human employees. Since a robot can accomplish a task for less money than human labour and will perform better once it has been programmed, robotics has become more important in the modern day. Today's industry is moving towards computer-based job monitoring, mostly because it needs to boost productivity and produce final goods of the highest quality. Automation is currently a widespread term for the use of robotics and machines to reduce or replace previously performed work by employees. But there are other ways that automation works in the manufacturing sector besides robotics. Robotics, such as three- or six-axis robotic arms, can be used for material handling and pick-and-place activities, completing them more rapidly and efficiently than through labour alone. These industrial robotic applications can improve high-volume, repetitive tasks like putting an item on a conveyor belt and lifting big things. Controls engineers can program robotics to always execute the same task in the same way, or they can train them to be more adaptive using more advanced technology.

The material handling system is a subject on which many industrialists and academic experts have conducted research, and it has always been an intriguing one to think about.

The ESP8266 12E Wi-Fi chip and NodeMCU firmware are both included with the project. An HTML- and C-coded web page would be created in order to establish a connection with the controller via a mobile device. Two robotic arms with two degrees of freedom (D.O.F.) would be mounted at either end of the conveyor belt. putting the item on the belt with one arm and picking it up with the other. Using the RoboDK simulation programme, the UR10 industrial robot's full system is simulated, including with the analytical data of the system that is involved in actual industrial processes.

II. LITERATURE REVIEW

Priyambada Mishra et al. [15] - In this paper, they employed four servo motors to create the robotic arm's joints, and a potentiometer has been used to govern movement. The used controller is UNO Arduino. The Potentiometer received the analogue input signals from the Arduinos. Cardboard was used to construct the arm, and each component is fastened to the appropriate servo motor. The arm was designed primarily to pick up and set down light objects. When programming, Arduino 1.6.10 was used.

Thus, the paper's main focus is on building a robotic arm out of ineffective materials and using it for productive goals such as lifting objects.

Puran Singh et al. [16] – In this paper, gripper had been employed in the robotic arm's two degrees of freedom, which was used for spot welding. An arrangement of spur gears, threaded shafts, and an AC motor made the end effector.

End effectors were employed in the end effector assembly, one of which was permanent and the other of which was moveable, at the wrist and end effector assembly points.

The center of mass for each linkage in the robotic arm's two D.O.F., which execute the lifting function, was acting at half of its length. The robotic arm could be arranged in a variety of ways, so the maximum rotation of each joint is 180 degrees.

This project helped in increasing the productivity of spot welding with its end effector as a 2 DOF robotic arm.

V. K. Banga et al. [17] – In this paper, a 4 DOF robotic arm with flexible joints that uses soft computing has been employed and developed the techniques for robotic mobility that is under control. With the use of fuzzy logic (FL) and genetic algorithms (GAs), arm and trajectory planning. The architectural design is employed to reduce problems with component motion, friction, and settling time in robotic arms. For this four D.O.F. robotic system, the best joint angles are discovered using genetic optimization.

Thus, the lengthy process of trial and error in search of a better combination of joint angles, which are legitimate according to inverse kinematics for robotic arm movement, has been replaced by this kind of optimization.

Anughna N et al. [18] - This paper used an Arduino Atmega328 controller and accelerometers. Flex and gyro sensors track the movements of the human arm and send signals to the Arduino ATmega328, which in turn manages the servo motors and causes the arm to move. Near the fingers were the Flex and Gyro Sensors.

The controller processes the data from both sensors if a change is noticed.

The paper's future work would use more gyros and up to five flex sensors close to the fingers for the simplest operation feasible.

Shamsheer Verma [19] – This paper involves a manipulator with 3 DOF that could be operated with hand motions was created. A glove serves as a transmitter, while a robotic arm serves as a receiver that responds to signals from the transmitter. The hardware in the glove is made up of an Arduino Mega 2560, which is programmed to send and receive data from the robotic arm through an APC220 Module. The hand is assigned three angles, alpha, beta, and gamma. The gyroscope and accelerometer take care of these, as well as the acceleration in the three directions, by delivering the signal to the Arduino Mega by wires, where all the information is combined and analyzed. Additionally, the signals for the movement were sent using a flex sensor.

This project can be used in the remote sensing and signals processing applications.

T. Sunil Kumar et al. [20] – This paper involves servos that were used to power the joints in the robotic arm, resulting in a manipulator with increased accuracy. CATIA software has been used to design the robotic arm. The method for choosing the servos used to drive each joint of the arm is covered in detail in the project.

In the project, the torque acting at each of the joints have been calculated, and a servo with the necessary torque rating has been chosen for each joint. Microsoft's programming language is used to construct the robotic arm's control software and choose an appropriate servo controller.

Rahul Kumar et al. [21] – In this paper, two classifiers for object recognition and detection, as well as the modelling and implementation of the feature extraction approach have been used. Making the test subjects comply with the classifier parameters was the main difficulty in designing the image processing system, as scaling the photos resulted in the loss of pixel data. A centered image approach method was therefore used. The techniques for feature extraction and classification are also covered in the work.

The paper discusses object position determination in further detail and shows all of the outcomes obtained during algorithm development.

Răducan Elena et al. [22] – This paper presents a speed regulation method of a conveyor system from sintering process. The method consists in developing a mathematical model based on the temperature difference between different measuring points situated along the sintering bed. The adjustment of the model was made on site taking into consideration the temperature limits in order to not cause any major damage to the equipment or to endanger the whole process. The algorithm was developed by using real data and the model was simulated using Maple. After the simulation, an approximation of the complete combustion for the raw material was estimated and the automated speed regulated of the belt conveyor was resulting by using the Lagrange interpolation method.

Following the implementation of the mathematical model in the PLC, the speed of the machine changes automatically based on the process temperatures. The sintering process it is followed better and there is not major fluctuation in operation, as in manual mode.

Considering the outcome of the paper, it can be state that for the most efficient positioning of BTP in sintering process the data from the carbon monoxide analyzer are very important.

Jacob Nichols Cook et al. [23] – This paper involves facile fabrication strategy by 3D-printing thermoplastic polyurethane (TPU) employed to fabricate the soft tri-gripper consisting of 9 capacitive tactile sensor-laden phalanges. The 3D-printed TPU itself was used as a sensory dielectric for the fabricated tri-gripper. The sensor and interconnect electrodes have been designed to have minimum cross-sensor capacitive coupling with stretchable interconnects to ensure robust integration. The designed sensors were patterned as copper electrodes on top of flexible polyimide film and embedded within the gripper during the 3D-printing process.

In conclusion, a sensor-array laden soft gripper that can be used to lift and grasp delicate objects has been developed. A representative tactile sensor in the sensor array exhibited a non-linear characteristic with a maximum sensitivity of 2.87%/kPa.

Andrija Milojević et al. [24] - This paper presents a further investigation of a novel adaptive soft robotic gripper with integrated active elements, i.e., sensors and actuators. In many contemporary robotic applications, there is a great need to grasp differently shaped and sized objects as well as objects of different stiffness or soft objects. Sensors are formed by using conductive graphite foam. The machine learning models of tactile foam sensors are presented. Actuators are formed by using a shape memory alloy wire nitinol.

In this paper, it is demonstrated that the developed soft gripper concept with integrated active elements can realize multiple grasping patterns. Many potential applications in robotics are foreseen for the novel smart adaptive gripper.

Sandro G.A. Sobreira et al. [25] – This work proposes the development of machine-learning techniques to estimate the mass flow of ore in a conveyor belt that is not equipped with a belt weigher. The virtual sensors were designed using current, torque, and motor speed data from a conveyor belt and iron ore flow measurements from a belt weigher installed on a different conveyor. Two of the proposed virtual sensors were implemented in a programmable logic controller of a belt conveyor in a mining area, where it was possible to verify the performance of the virtual sensors in a real situation. As a result, the proposed virtual sensors were able to measure the ore flow with an acceptable error rate compared to a physical belt weigher. The accounting of the production of the proposed sensors also proved to be close to the total production accounted for the physical belt weigher.

The work showed the development of virtual sensors, using machine-learning techniques, which could estimate the mass flow of ore in a belt conveyor that is not equipped with a belt weigher.

Yunfeng Ni et al. [26] – This paper involves a new energy saving control method of belt conveyor based on fuzzy algorithm is proposed. This method analyzes the composition and structure of the control system for belt conveyor, selects frequency control method to reducing energy consumption, at the same time, matches belt conveyor speed and transportation capacity. On the basis of the above, through the formula of speed of induction motor, combined with fuzzy algorithm, energy saving control System of mine belt conveyors is completed.

The simulation results show that the proposed method can effectively match speed and transportation capacity of the belt conveyor and reduce speed of the belt conveyor and energy consumption. The maximum economize energy is thirty percent. The practical application shows that this method has a certain effect of energy saving.

Vladislav Ivanov et al. [27] – This work focuses on developing a self-learning robotic system which can replicate the human learning capabilities in a handing-over task. The proposed system consists of two submodules Vision analysis and environment monitoring, which provides accurate global and local information about the area in which the robot has to hand over the specific object Safe and flexible bin-picking gripper, which handles various objects with complex geometries.

Fredrik Ore et al. [28] - This research proposes a HIRC workstation design process. The novelty of this design process is the methodology to evaluate the HIRC workstation design alternatives by considering both performance and safety characteristics through computer-based simulations. As a proof of concept, the proposed HIRC design process is applied on an industrial manufacturing case from a heavy-vehicle manufacturing company.

The research concerns human–industrial robot collaboration (HIRC) in manufacturing industry. Although this concept is very promising in terms of productivity and profitability, industrial practitioners currently have many apprehensions regarding its applicability in an industrial context, especially due to human safety considerations. In order to address this, several simulation-based methodologies have been presented in the literature to evaluate HIRC workstation design characteristics.

III. METHODOLOGY

To understand the requirement for necessary needs, the design of gripper along with the conveyor system has been done.

Proper design values of gripper and conveyor are important to ensure whether the system meets our needs such as the capacity / amount of product to be transported in 1 hour, the load to be lifted by the gripper etc.

After the design of gripper and conveyor, to integrate both together, a simulation of the real-time industrial process has been created for the UR10 industrial robot using the RoboDK software.

The simulation created is to visualize the real industrial process and for the path planning of the trajectory of the UR10 industrial robot.

A prototype of the similar system has been created using the microcontroller NodeMCU ESP8266 12 E.

The project involves wide arena of details as mentioned below:

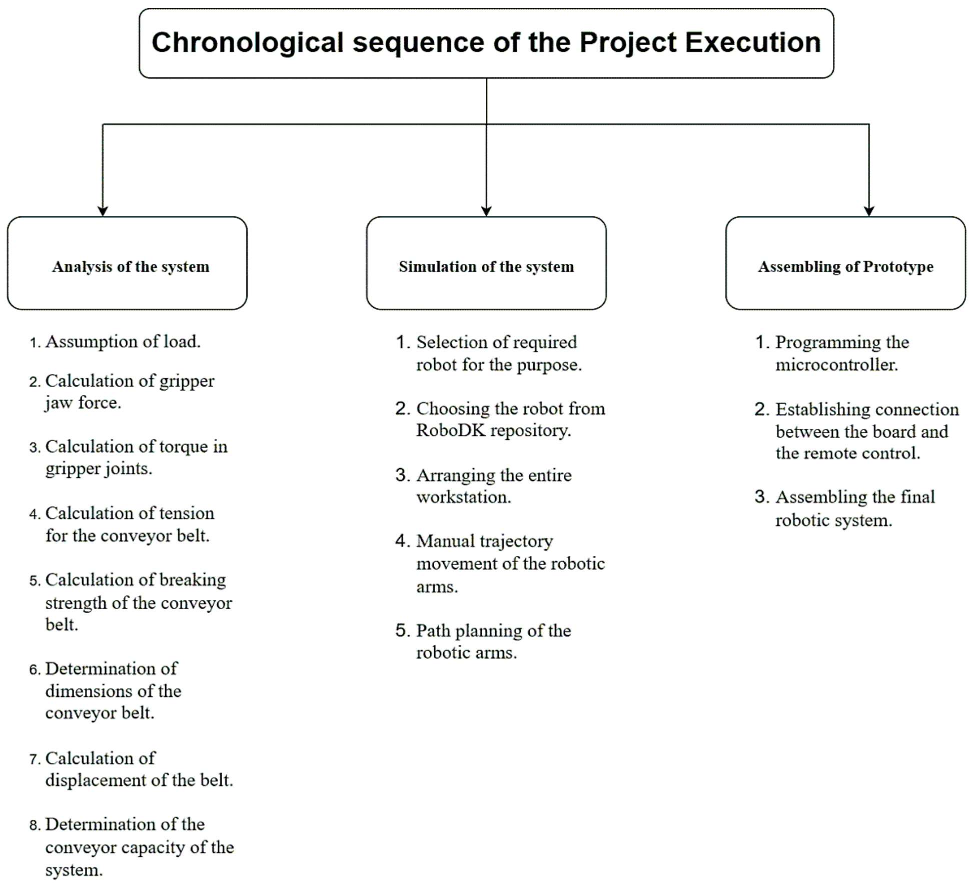

Figure-1: Flow chart of the project methodology

IV. EXECUTION AND FABRICATION

A. Analysis of the system:

The system is analyzed for various needs such as

1) Force and Torque generated in the jaws of robotic arm to lift the given weight.
2) Breaking Strength of the belt used in the conveyor.
3) Dimensions and Displacement of the conveyor system.
4) Capacity of the material handling process.

a) Gripper Force Measurement

Calculate the minimum grasping force,
Minimum grasping force is the friction force of the gripper.
It is necessary to balance the forces vertically on the given body.

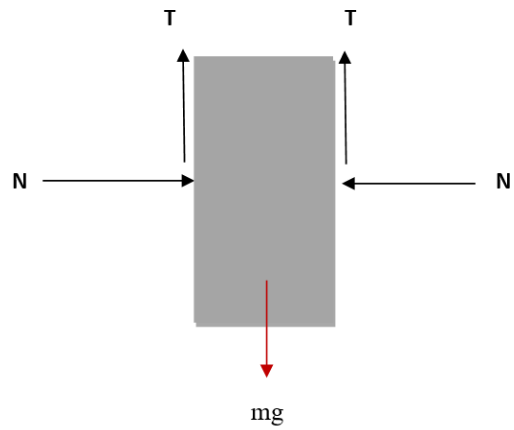

Figure-2: Free body diagram of a body lifted by robotic arm

Mass of the can = 15 kg
mg = 2*T
Minimum force exerted by the jaws perpendicular to the surface,
Considering stability condition,

$T \leq N*\mu$

$N \geq \frac{73.575}{0.15}$ = 490.5 Kg.m

Using the force curve [7] the relation between the force in the jaw and torque in the actuator for the can diameter can be found. As only 1 motor generating forces of both jaws, the actual torque is double than that of the graph [7].

Minimum torque = $N*2*\frac{Torque}{Force}$

$\Rightarrow$ 490.5*3.34 = 1638.27 **N.m**

$\Rightarrow$ Minimum torque = 1638.27 **N.m**

b) Determining the conveyor capacity

Considering a schematic input data from a real-life machinery:
Let,
Gear box ratio = 30:1
Motor RPM (Rotations per minute) = 1500
Head pulley diameter = 600 mm

- Calculating the head pulley RPM:

Head pulley RPM = $\frac{\text{Motor RPM}}{\text{Gear Ratio}} = \frac{1500}{30}$ = 50 RPM.

- Conveyor belt displacement:

Head pulley of diameter 600 mm in 1 revolution,

$\Rightarrow 2\pi R = 2*\pi*300$ = 1884.95 mm.

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- Belt displacement in 1 minute:

The head pulley revolved 50 times in 1 minute.
Belt displacement in 1 minute = 1.9*50 = 95
(Belt displaced 1.9 m in 1 revolution)
So, speed of the conveyor belt = 95 $^{m}/_{min}$

- Calculating the capacity of conveyor belt:

Stopping and checking the load of product / material in 1 meter length of conveyor belt.
The load is removed and measured separately.
Now assuming an industrial situation for the given load problem,
Let,
Product / material was removed from 1 m length of conveyor belt which turned out to be bearing a load of 15 kg.
From calculations above,
Belt displaced in 1 minute = 95 m
And considering our assumption, the belt carries a load of 15 kg within a span of 1 m length.
So, the total load of product / material shifted in 1 minute = 95*15 = 1425 kg.
Now,
Product / material shifted in 1 hr / 60 min = 1425*60 = 85500 kg = 85.5 Ton.
Conveying capacity of the conveyor belt = 85.5 Ton/hr ~ 90 Ton/hr.

- Belt Width:

Now as we calculated the conveying capacity of the belt, we can determine the width of the belt which is important to understand the amount of material that could be placed on the system also ensuring the structural integrity of the belt is undisturbed.

$$B_{min} = 1.11\left[\left\{\frac{Q}{c*v}\right\}^{\frac{1}{2}} + 0.05\right] = 1.77 \text{ m} \sim 1.8\text{m}$$

Where,
c = 240, For flat belt conveyor
Q = 85.5 Ton/hr ~ 90 Ton/hr

c) Determination of belt strength

The belt conveyor always experiences a tensile load due to the rotation of the electric drive, weight of the conveyed materials, and due to the idlers. The belt tension at steady state can be calculated as:

$$Tb = 1.37 * f * L * g[()2 * Mi) + (2 * Mb + Mm)cos(\delta)] + (H * g * Mm)$$

Eq. 1.1

Where,

f = *Coefficient* of friction
L = Conveyor length in meters. Conveyor length is approximately half of the total belt length.
g = Acceleration due to gravity = 9.81 m/sec^2
Mi= Load due to idlers in Kg/m
Mb = Load due to belt in Kg/m
Mm = Load due to conveyed materials in Kg/m
Delta = Inclination angle of conveyor in Degree

d) Idler load and Power

It can be calculated as:

Mi = ***(Mass of a set of idlers) / (Idlers spacing)*** *Eq. 1.2*

Power at driver pulley: The power required at the drive pulley can be calculated from the belt tension value as:

$$Pp = (Tb * V)/1000 \qquad \textit{Eq. 1.3}$$

Where,
Pp is in KW
Tb = Steady state belt tension in **N**
V = Belt speed in *m/sec*

e) Initial belt tension & sizing of motor

- Initial Belt Tension:

Initially during the start of the conveyor system, the tension in the belt will be much higher than the tension in steady state. The belt tension while starting can be calculated as:

$$Tbs = Tb * Ks \qquad \textit{Eq. 1.4}$$

Where,
Tbs is in **N**
Tb = Steady state belt tension in **N**
Ks = Start-up factor

- Sizing of motor:

$$Pm = Pp/Kd \qquad \textit{Eq. 1.5}$$

Where,
Pm is in KW
Pp = Power at the drive pulley in KW
Kd = Drive Efficiency

f) Acceleration of Conveyor Belt

The acceleration of the conveyor belt can be calculated as:

$$A = (Tbs - Tb)/[L * (2 * Mi + 2 * Mb + Mm)] \qquad \textit{Eq. 1.6}$$

Tbs = Belt tension while starting in N
Tb = Belt tension in steady state in N
L = Length of the conveyor system in *m.*
Mi = Load due to the idlers in *Kg/m*
Mb = Load due to belt in Kg/*m.*
Mm = Load due to the conveyed materials in *Kg/m.*

g) Calculation of the belt breaking strength

The belt breaking strength decides the selection of the conveyor belt. The belt breaking strength can be calculated as:

$$Bs = (Cr * Pp)/(Cv * V) \qquad \textit{Eq. 1.7}$$

Where,
Bs is in **N,**
Pp = Power at the drive pullet in **N**
Cr = Friction factor, Cv = Breaking strength loss factor, *V* = Belt speed in **m/sec**

h) Analysis of the Strength of the Conveyor Belt

Considering the real-life industrial processes, taking the following working input data:
Input Data:
Conveyor Capacity (C_c) = 90 Ton/hr. = 25 Kg/sec
Belt speed (*V*) = 1.7 m/sec

Conveyor height (H) = 30 m
Conveyor length (L) = 300 m
Mass of a set of idlers (M_I) = 15 Kg
Idler spacing (I') = 1.5 m
Load due to belt (M_b) = 30 Kg/m
Inclination angle of the conveyor (δ) = 6^0
Coefficient of friction (f) = 0.02
Start-up factor (K_s) = 1.5
Drive efficiency (K_d) = 0.9
Friction factor (C_r) = 15
Breaking strength loss factor (Cv) = 0.75
Calculation:

- Using Eq. 1.2 to calculate the load due to idlers:

Mi = 15/1.5 = 10 *Kg/m*

- Now using Eq. 1.2 to calculate the belt tension in steady state:

Tb = 1.37(0.02)(300)(9.81)*[16.67+{2(30)+($\frac{25}{1.7}$)}*cos*(6^0)]

$\Rightarrow$ 80.6382(346.2588)+81750.654

$\Rightarrow$ 27921.68637+81750.654

$\Rightarrow$ 7335.3857 N

- Tension in the belt while starting the system can be calculated using Eq. 1.4:

Tbs = 1.5(7335.3857)

$\Rightarrow$ 110.03 KN

- Calculating the power at drive pulley, using Eq. 1.3:

$$Pp = \frac{1.7(7335.3857)}{1000} = 12.47 \text{ KW}$$

- Using Eq. 1.5 to estimate the size of the motor:

$$Pm = \frac{12.47}{0.9} = 13.85 \text{ KW}$$

- Using Eq. 1.6 to calculate the acceleration of the motor:

$$A = \frac{110.03-73.3538}{300[2(10)+2(30)+(\frac{25}{1.7})]} = 0.129\ m/s^2$$

- $Bs = \frac{15(110.03)}{0.75(1.7)} = 1294.47\ N/mm$

This Bs value is used to select the conveyor belt from the manufacturer’s catalogue.

B. *Simulation of the process*

The simulation is done using the RoboDK software, replicating the entire system process.
The robotic arm used for replicating the real-life process is UR10.

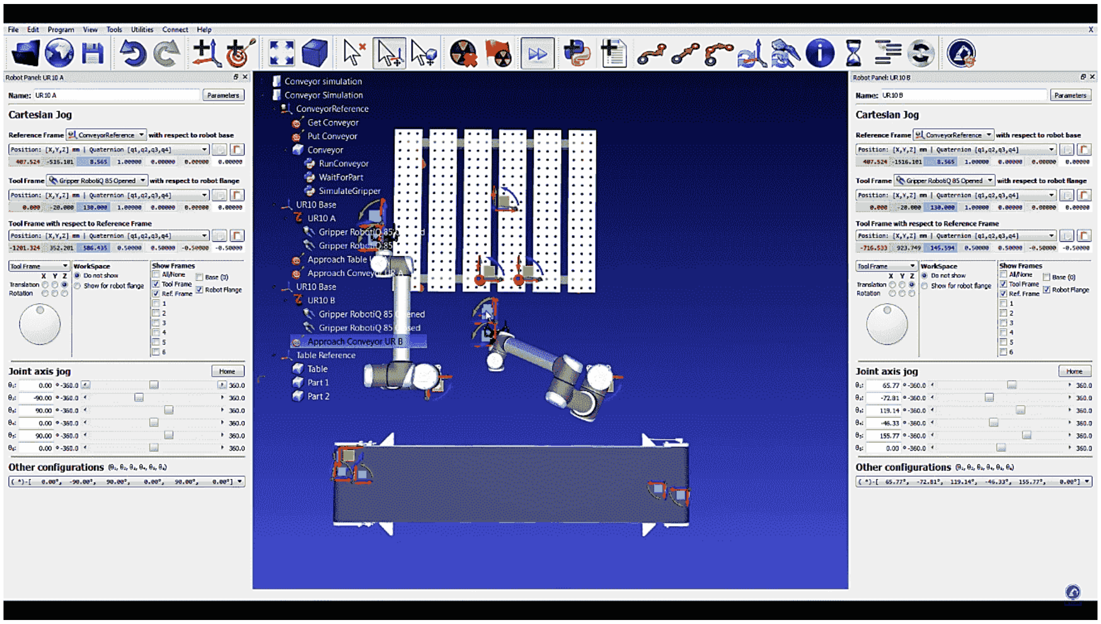

Figure-3: Movement of arm approaching the table

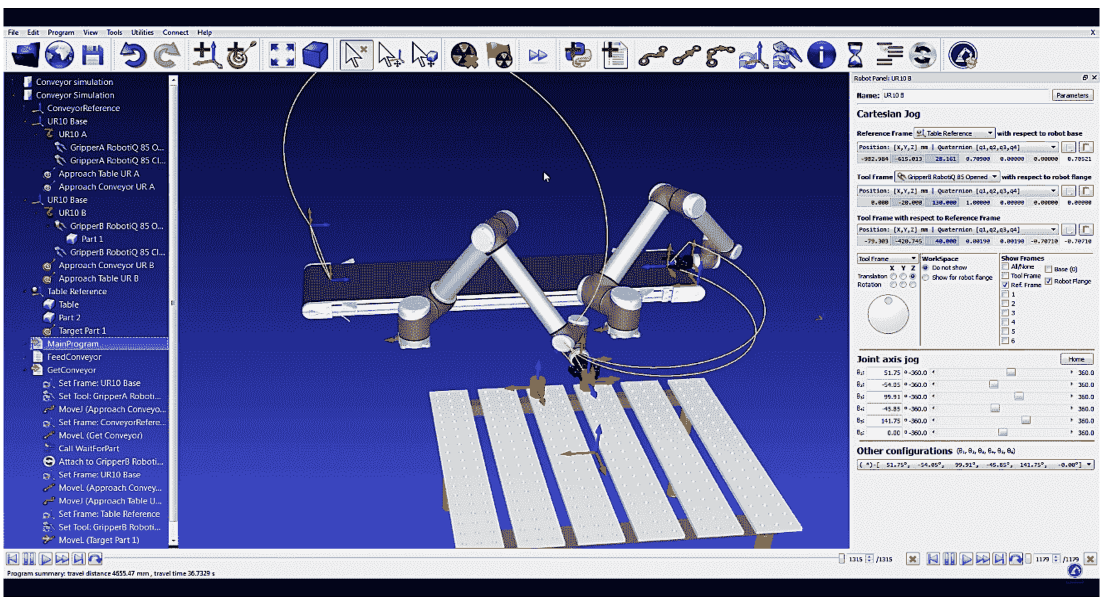

Figure-4: Robic arm feeding the material on conveyor system

The basic operations in the RoboDK simulation software are to be done. They are as follows:

1) Load the UR10 robot from the Online Library.
2) Load the miscellaneous items such as table, cylinder blocks.
3) Load the conveyor system to transport the products.
4) Re-allocate the trajectory of both the robotic arms for 'Pick-and-Place operation'.
5) Analyze the final simulation,

a) Collecting the analysis and simulation requirements and fabrication of the prototype:

The prototype along with the microcontroller ESP 8266 12 E is programmed for the required task.

The program is done in 2 ways:

- Manual operation – The microcontroller generates a hotspot that is connected to a mobile device through a webpage. The robot is controlled using the webpage where it includes different buttons for various operations.

- Automatic operation – The microcontroller is set to work on its own, adjusted with its angle for the movement of gripper and robotic arm.

➢ Robot hardware fabrication:
Hardware components used:

✓ NodeMCU ESP 8266 12 E Micro controller
✓ L298N Motor driver
✓ Conveyor belt
✓ DC Motors
✓ Servo Motors
✓ Pulley
✓ Grippers
✓ Power Supply with Lithium-ion battery

➢ Assembling the plain Acrylic Board together. The structure forms the base for DC motors.

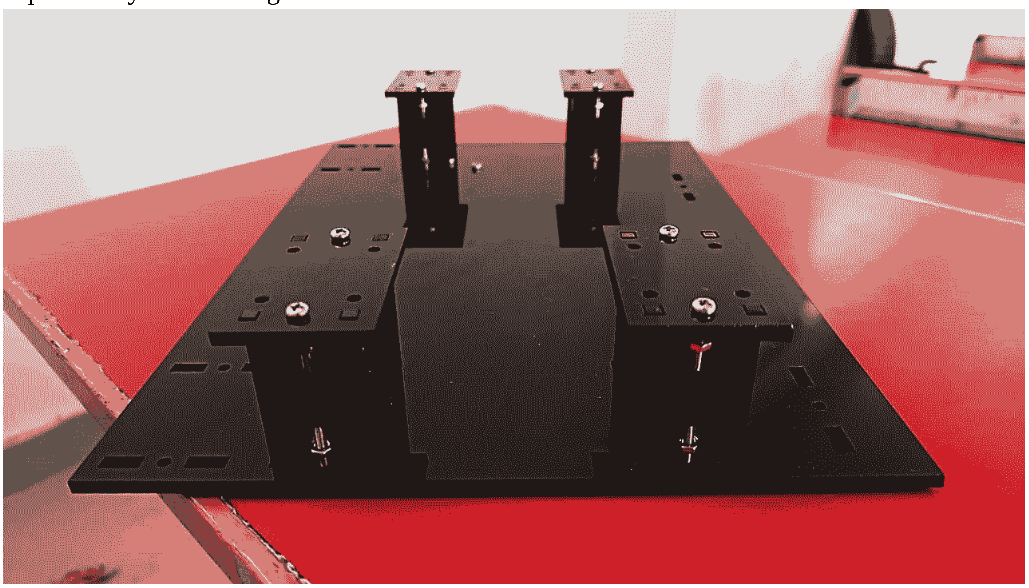

Figure-5: Acrylic board assembly

➢ Attaching the DC motors in their respective positions.

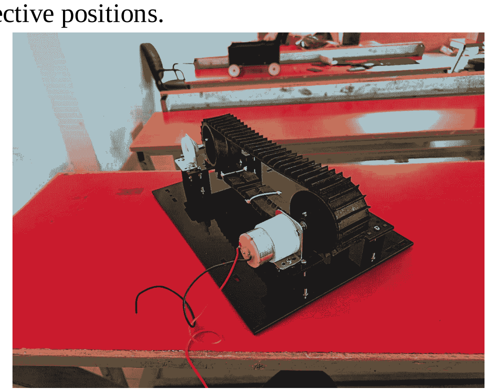

Figure-6: Assembly of the prototype

The system has to be connected with the respective circuit connections that are to be given to the microcontroller, motors and motor driver respectively.

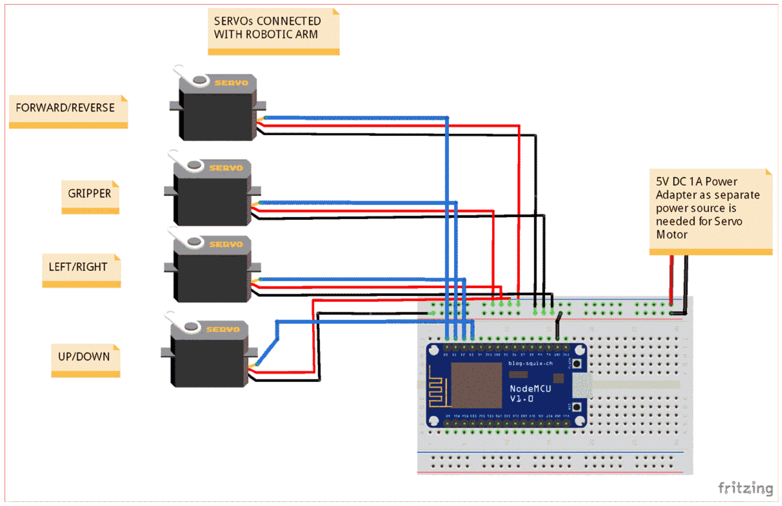

Figure7: Circuit diagram of servomotors and microcontroller

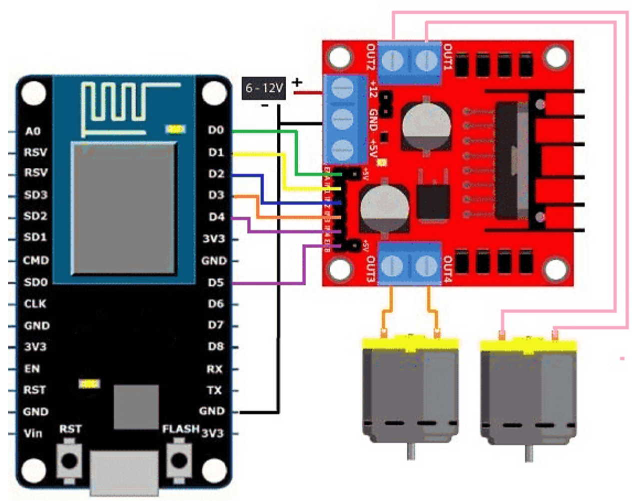

Figure-8: Circuit diagram of DC motors and microcontroller

- Giving the circuit connections to the robot:

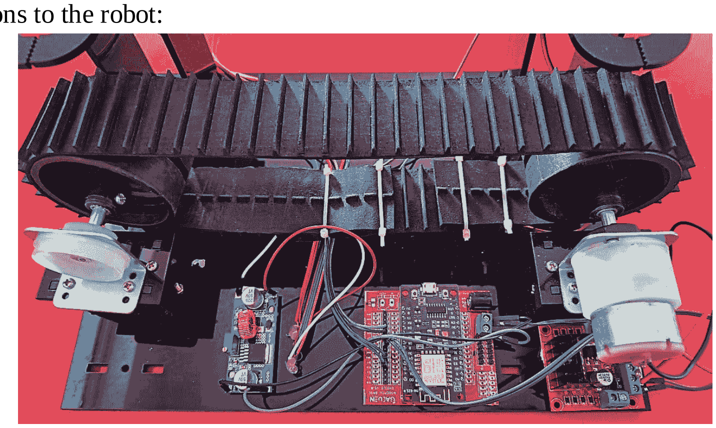

Figure-.9: Circuit connections of the prototype

- Assembling the robotic arm with 2 degrees of freedom. It includes the gripper and servo motors assembly attached together.

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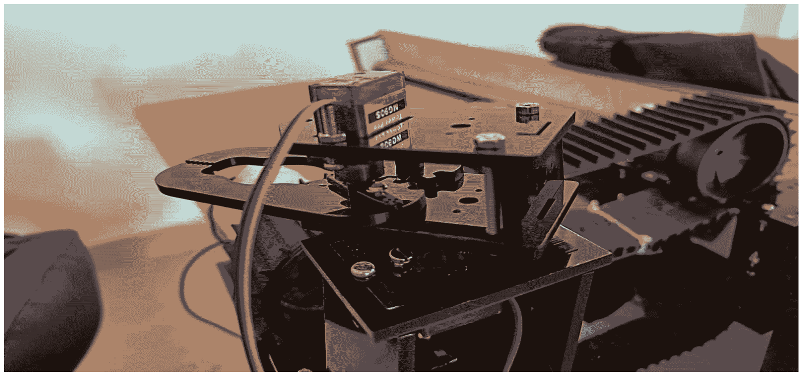

Figure-10: Gripper as an end effector

➢ Robot software programming:

The NodeMCU ESP 8266 12 E chipset used in the physical prototype has been programmed using the Arduino IDE.

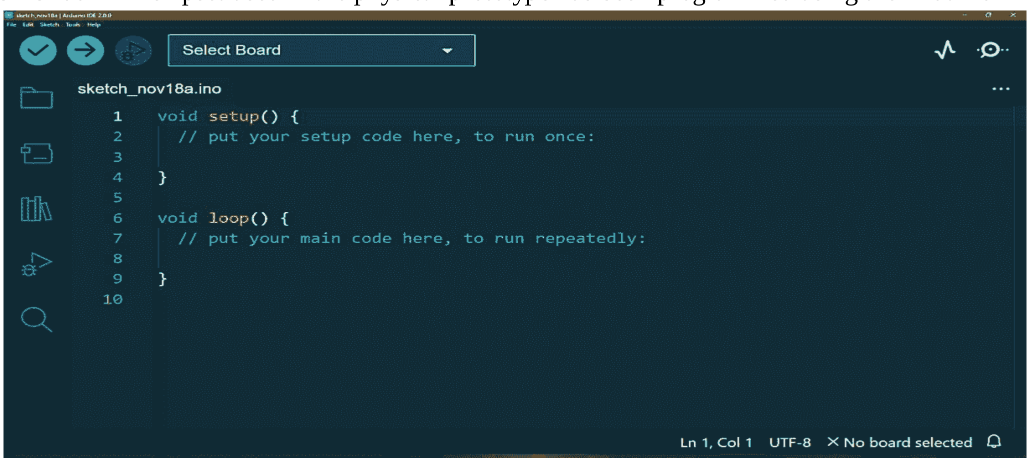

Figure-11: Arduino IDE Interface

Arduino IDE (Integrated Development Environment):

Arduino is an open-source platform that helps circuit developers build electronic projects. It consists of both hardware and software. Arduino software is an IDE (integrated development environment) through which we write and upload the code to the microcontroller. It has its native language analogous to C, called Arduino Programming Language

V. RESULT AND DISCUSSION

A. Prototype Results:

Finalizing the assembly and checking the working conditions:

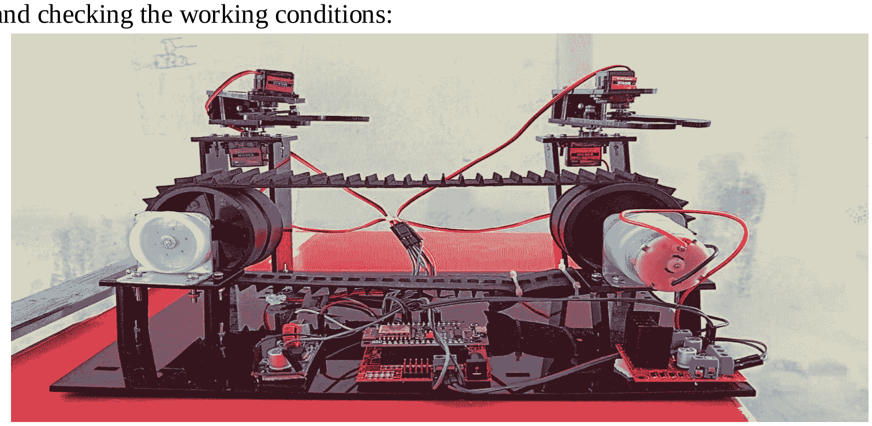

Figure-12: Final assembly of the robotic system prototype

The first robotic arm places the material on the belt from one side. Material travels through the belt and reaches other end. The second robotic arm picks the material up from the belt.

This system is an improvised version of the existing production flow systems, where the use of robotic arm and the suitable conveyor belt helped in boosting the process time.

Characteristics of the prototype:

Belt length: 1000 mm

Pulley width: 40 mm

Pulley diameter: 80 mm

Load carrying capacity: 0.05 kg

B. Simulation Results

RoboDK software has been used to simulate the entire system. The software has an inbuilt repository that can be used to employ the simulation objects.

Mapping of the trajectory path has been done to get the suitable results for the required application of picking and placing of packages.

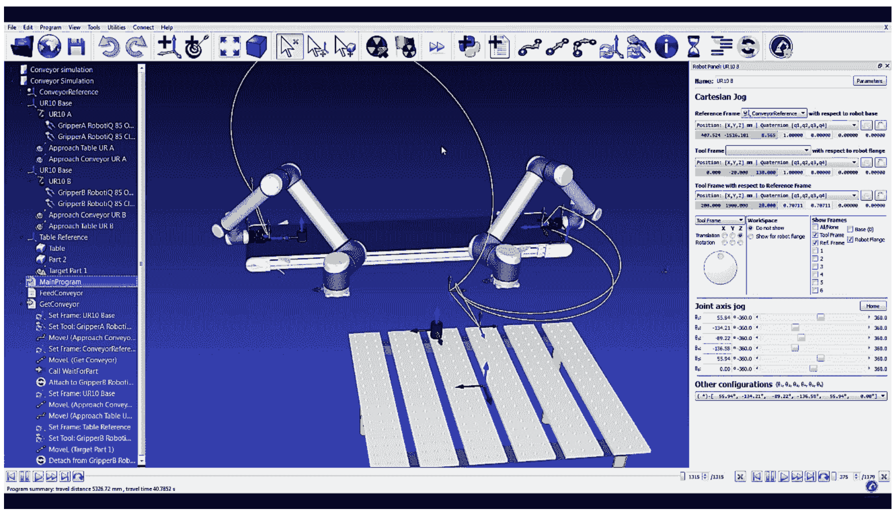

Figure-13: Simulation of the pick-and-place process

The pick-and-place process is continued making use of the UR10 robotic arm, replicating real-life conditions.

C. Design results of the system

(This analysis is done assuming the standard working values referred from various sources such as [5] in the real-life industrial processes.)

Breaking strength of the belt Bs: 2193.44 *N/mm*

The above belt strength value is based on the standards used in the industry and the manufacture catalogue referred to choose the correct belt for the required necessities.

Belt tension Tbs : 110.03 KN

Width of the belt: 1.8 m

Capacity of the conveyor system: 90 Ton/hr

Torque in gripper joints: 1638.27 N-m

Suitable strength and load capacity for the applied use case so the system can sustain is important. Both the conveyor belt and gripper have been analyzed to fit into the predefined application for which the system is going to be used.

Parameters such as strength, load capacity of the belt and gripper are necessary to ensure proper functioning of the system.

Synchronization of robotic arm and the conveyor belt plays a huge role in the stable working of the system and is an important factor to ensure smooth work flow.

The required outcome has been achieved as the designed system completes the assigned task the way it is supposed to be. This in-turn has the potential to increase the production flow.

Prototype has been created to replicate the process using ESP8266 12 E microcontroller. It is a model of the designed system and is capable of transporting small volumes of material.

Similar type of design can be modified to match the requirements of a different problem such as different loads, different objectives with the end effector such as welding etc.

Above discussed process can be applied in various real-time processing and product flow applications such as –

1) Package delivery through E-commerce industries such as Amazon.
2) Production flow system of pharmacy industries, milk production industries etc.
3) Automobile industries
4) Food processing industries etc.

VI. CONCLUSION

1) The project employs the use of conveyor system and a robotic arm with a gripper as an end effector. This system is useful in industries as more effective equivalent of a human hand. Robotic arm use in manufacturing decreases production process delays and aids in task completion more quickly and effectively. The processes can be completed faster than a manual process.
2) The project includes an amalgamation of software (where the programming of the robot has been used), hardware (development of the prototype), simulation (that has been done using the RoboDK software for the UR10 robot) and design construction characteristics, integrating all the major necessities in the design of an industrial automated processing system.
3) This attempt has been made to bring out the result-oriented approach in the project, a model has been prototyped that can run using the microcontroller NodeMCU ESP 8266 12 E. This concept can be scaled-up to industrial standards to adjust to larger domain of works, such as packaging or storage industries that employ such systems to boost the process.

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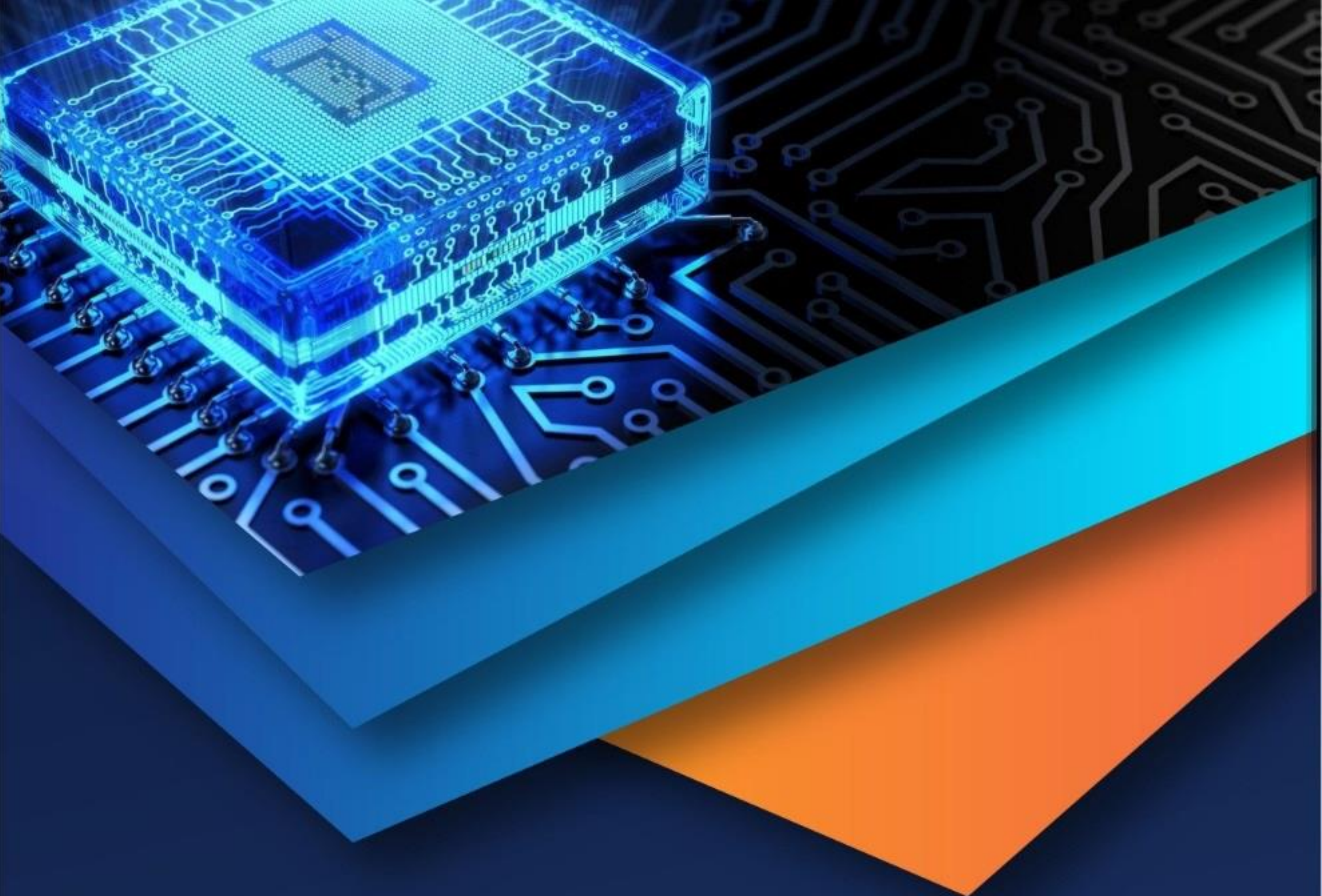

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