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Semi-Automatic Painting Machine for Door and Flat Sheets

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Abstract: ***Now a days automatic painting machine industry is growing industry. Automatic Painting machines are very expensive and also very big in size. Small & medium level industries cannot purchase these machines. So, there is a need to make a painting machine for small and medium level industries.***
In these projects, 'Design of Semi-Automatic Painting Machine for Flat Doors and Sheets. 'Design is based on lead screw mechanism which is coupled with motor.
When lead screw will rotate, movable guide on lead screw moves linearly and nozzle on guide will spray paint according to given path. Using this mechanism flat surfaces like sheets, doors and cement walls can be painted. ANSYS will give force analysis on parts of machine. Motors will be used to rotate helical lead screw rod. This system will result in painting of many flat surfaces.
Keywords: painting machine, small flat surfaces, movable guide, motors, lead screws, nozzle.

I. INTRODUCTION

This invention relates to a machine adapted to affect automatically the painting of a celling or wall surface of a room or other enclosure. In its broadest aspect, the invention is designed of effect the coating of a surface of substantial area by means of a self-propelled apparatus that moves along the floor surface adjacent said area and which includes means applying power a to a movably mounted applicator in the manner to cause the applicator to coat, in a minimum amount of time on area of a surface of substantial size. Now a days all things are changed by artificial intelligence and software things. Day by day system get improve and it overcome the human effort by using robotic machine.

This machine can be use for painting various components like door, cement wall and sheet metal. This machine is use in small scale industries, workshop, homes etc. it is cost effective machine made with very small investment and it is compact in design and occupied very less space to work.

The construction industry is labour centred and operated in dangerous situations; therefore, the importance of robotics has been realized and is grown rapidly. In Robotics and Automation Industry application and activities started in the early 90‟s aiming to minimum equipment work, improve safety, enhance perception of workspace and furthermore, ensure safe environment for building occupant.

After this, the inventions in the robotics and automation in the construction industry has increased rapidly. The development of service robots became popular recently due to the fact that the society needs robots to relax humans from tedious and dangerous jobs. In developing countries, the increasing population stimulates the construction-related activities such as interior finishing and painting.

Painting is classically done by humans and generally requires exhaustive physical efforts and involves exposure to dangerous chemicals.

Chemicals can seriously impair the vision, respiratory system but these painting can be used by an ideal candidate process for automation.This machine is simple and movable. The machine is designed by using few steels, steel rods, spray gun, electric motor and a controller unit to handle the entire operation of the machine. This machine is compact due to moderate speed and pressure capabilities they have.

They have a less weight to power output ratio and expected performance i.e. losses are less due to a smaller number of moving parts used in this machine and hence gives expected performance. Due to better and easy control systems it can control noise, vibration and does silent & decent operation and small amount of vibration is produced. It has longer life, flexibility, efficient and trustworthy. The installation and maintenance are easy.

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II. DESIGN

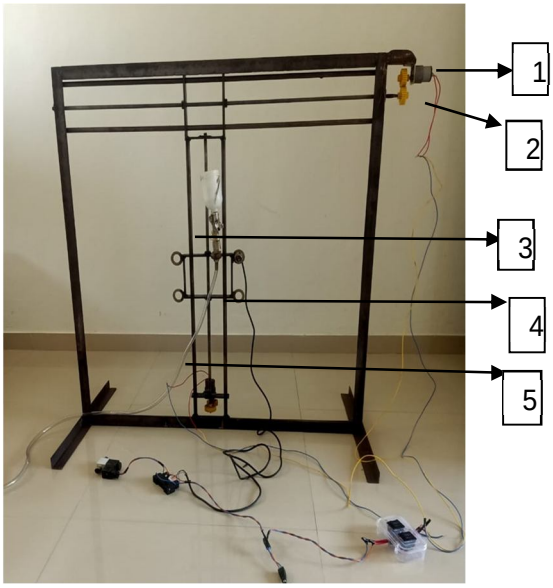

Fig.1 Construction Diagram

A. Construction

1) Motor
2) Spur Gear Pair
3) Venturi Nozzle
4) Movable Square Platform
5) Lead Screw Rod

B. Working

This project consists of semi-automatic spray-painting machine which is mounted on end side of movable square platform on M.S. frame stand. The sprayer nozzle holder is operated by power screw & DC motors. The gear drives are provided to move sprayer nozzle holder X-Y direction using motion of DPDT switches. A compressed air is supply through compressor using 2/2 solenoid direction control valve DCV from remote air tank and sprayer nozzle with the application of sensor operation when it senses the occupancy at that time sprayer nozzle is spray the paint. When we required operating the painting nozzle, we can operate the solenoid direction control valve DCV automatically with the application of sensor by 12 Volt supply. So that the air from DCV is passes through nozzle which spray highly pressurized air &paint mixture on wall.
From DCV it passes through nozzle which spray highly pressurized air &paint mixture on wall.

C. Mechanical Design

In mechanical design the components are listed down and stored on the basis of their procurement in two categories.

1) Design parts
2) Parts to be purchased.

For designed parts detailed design is done and dimensions obtained are compared to next dimensions which are available in market already. This simplifies the assembly as well as the post production and maintenance work. The various tolerances on work are specified. Process charts are prepared and sent to manufacturing stage. The parts that are to be purchased are selected directly from various catalogues and are specified to have case of procurement. In mechanical design at first stage of selection of appropriate material for the parts to be designed for application of specific purpose. This selection is based on standard catalogues or data books;

eg:- (PSG's DESIGN DATA BOOK) (SKF's BEARING CATALOGUE) etc.

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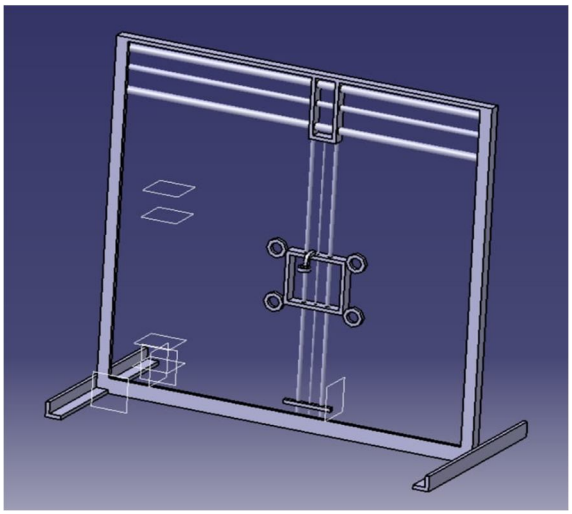

Fig.2 Cad model

D. Motor Selection

Fig.3 Motor

T = Torque transmitted by the motor N.m.
F = force to be applied on conveyer = 1 kg = 9.81 N. (Assume)
R = gear Dia. = 40mm.
T = Fx R
= 9.81 X 40
T = 3.924 N.m.
P = Power of motor
N = Speed of the motor = 60 rpm. (Assume)

$$P = \frac{2 \Pi N T}{60}$$

$$= \frac{2 \Pi \times 60 \times 3.924}{60}$$

P = 24.654 Watt.
Thus selecting a motor of the following specifications

- Single phase DC motor
- Power =50 watt
- Speed= 60 rpm

Motor Torque

$$P = \frac{2\,\Pi\,N\,T}{60}$$

$$T = \frac{60 \times 50}{2\,\Pi \times 60}$$

T = 7.96N-m

Power is transmitted from the motor shaft to the input shaft by means of a gear drive,

Spur gear pair system

No teeth on gear Zg = 25

No teeth on pinion Zp=25

Material of gear & pinion both are nylon, DDB. P No.1.41.

Sut p =82 N/ mm^2

Sut g =82 N/ mm^2

Application factor ka = 2

Load distribution factor km= 1

Factor of safety Nf = 1.5

BHN = 24

Power P = 50 Watt.

Np= 60 rpm

Beam strength (δb)

$6bp = \frac{Sup}{3} = \frac{82}{3}$ = 27.33 N/mm^2

$6bg = \frac{Sug}{3} = \frac{82}{3}$ = 27.33 N/mm^2

Assuming 20^0 full depth involution system,

Yp=0.484 -$\frac{2.87}{Zp}$=0.484 -$\frac{2.87}{25}$= 0.3692

Yg=0.484 -$\frac{2.87}{Zg}$=0.484 -$\frac{2.87}{25}$= 0.3692

Now, δ_{bp} . Yp = 27.33 ×0.3692= 10.0902 N/mm^2

δ_{bg} . Yg = 27.33 ×0.3692= 10.0902 N/mm^2

As δ_{bg} . Yg ≤ δ_{bp} . Yp

Gear is weaker than pinion. Hence, it is necessary for bending to design gear.

Bending force (Fb)

Fb=6bg.b .m.Yg

=27.33 $X10m\ X\ m\ X$ 0.3692

Fb =100.902 m^2 N

Wear strength (Q)

Q = $\frac{2Zg}{Zg\ +Zp}$ = $\frac{2X25}{25+25}$ =1

Load stress factor (K)

K=0.16[$\frac{BHN}{100}$]^2= 0.16[$\frac{24}{100}$]^2= 9.216 x 10^{-3} N/mm^2

Bucking eq^n for the weer strength (Fw)

Fw =$dp \times b \times Q \times K$

= 25m x 10m x 1 x 9.216 x 10^{-3}

Fw=2.304 m^2

Fb ≤ Fw design should be on wear failure

Effective load

V=$\frac{\pi \times dp \times np}{60 \times 1000}$ = $\frac{\pi \times 25m \times 60}{60 \times 1000}$ = 0.078 mm/s

Tangential force (f_t)

$F_t = \frac{P}{V} = \frac{50}{0.078\,m}$N = $\frac{636.619}{m}$N

As per the gear pair is manufactured by generation, the velocity factor is given by,

$Kv = \frac{3}{3+V} = \frac{3}{6+0.078m}$

$Feff = \frac{Ka.Km.Ft}{Kv}$

Feff=effective load

Ka=application factor

Km=distribution factor

Kv=velocity factor

$Feff = \frac{2\times1}{\frac{3}{3+0.078m}} \times \frac{636.619}{m}$

Estimate the module-

Fw=Nf .Feff

$2.304\ m^2 = 1.5\times \frac{2\times1}{\frac{3}{3+\sqrt{0.078m}}} \times \frac{636.619}{m}$

Solving by above equation by trial & error, we get,

Dimensions of gear pair -

m = 1.5

$Z_p = 25$

Zg =25

B = 10 m = 15mm

Dp = m×zp = 1.5×25=37.5mm

Dg = m×zg = 1.5×25=37.5mm

ha = 1m = 1.5mm

hf = 1.2m = 1.857 mm

5.6. Screw design:

Lead screw design X-Y Slide.

For screw material C40 yield stress σy= 330 N/mm^2

Ultimate shear stresses = 0.5 σy=165 N/mm^2

Tensional shear stress T = Π/16 x τ xd^3

$\Rightarrow \tau = \frac{16xT}{\Pi x d^3}$

$7.96 \times 10^3 = \frac{16 \times 165}{\Pi \times d^3}$

dc =6.2626mm select dc=7 mm.

Nominal dia. d= 10mm.

Core dia. dc=7mm.

Pitch p = 3mm.

Operating load W= 150 N.

Coeff. Of friction μ = 0.11 (For steel lubricated screw)

Coeff. Of friction μc = 0.125 (For collar)

$\lambda = \tan^{-1} \frac{L}{\Pi \times dc} = \frac{Nt \times p}{\Pi \times dc}$

(N_t= 1)

$\lambda = \tan^{-1} \frac{1 \times 3}{\Pi \times 7}$

$\lambda = 7.7682^0$ (For single start)

$\mu_1 = \frac{\mu}{Cos\beta}$

$= \frac{0.11}{\text{Cos } 14.5}$

$\mu_1 = 0.1136$

$\Phi_1 = \tan^{-1}\mu_1$

$= \tan^{-1}0.1136$

$\Phi_1 = 6.4820^0$

Efficiency for screw

$\eta_s = \frac{\tan \lambda}{\tan(\Phi 1 + \lambda)}$

$= \frac{\tan\ 7.7682}{\tan(6.4820 + 7.7682)}$

$\eta_s = 0.5371$

$\eta_s = 53.71\%$

E. Metallurgical Specification

The machine is made up of mild steel.

Reasons

1) Mild steel is readily available in market.
2) It is economical to use.
3) It is available in standard sizes.
4) It has good mechanical properties i.e. it is easily machinable.
5) It has high tensile strength.
6) Low co-efficient of thermal expansion.
7) It has moderate factor of safety which is useful for both heavy duty and medium duty application.

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F. Properties of Mild Steel

M.S. has carbon content from 0.15% to 0.30%. They are simply wieldable thus can be hardened only. They are similar to wrought iron in properties. Both ultimate tensile and compressive strength of this steel increases with increase in carbon content. They can be simply gas welded or electrically or arc welded. With increase in the carbon percentage the ability to be welded decreases. Mild steel serve the purpose and hence selected because of the mentioned purpose.

G. Approach to Mechanical design of System

In design the of parts we shall adopt the following approach;

Selection of appropriate material.

1) Assuming an appropriate dimension according to system design.
2) Design check for failure of component under any possible force system.

III. RESULT

Whole design of semi-automatic painting machine is designed with factor of safety 1.5 .So theoretically this design is Safe. Material which is under more stress will be helical screw and spur gear since they are rotating parts and carry different types of loads. To check whether design is safe or not maximum stress is find out with the help of Ansys software. Stress on helical rod is calculated with these conditions:

1) Maximum weight on rod is 200N
2) Fixed Supports are applied

After applying this values results came as
63MPa.Material used for this part is Mild steel which have yield strength 370MPa.It means Factor of safety for screw design is 6.So Helical Rod design is Safe.

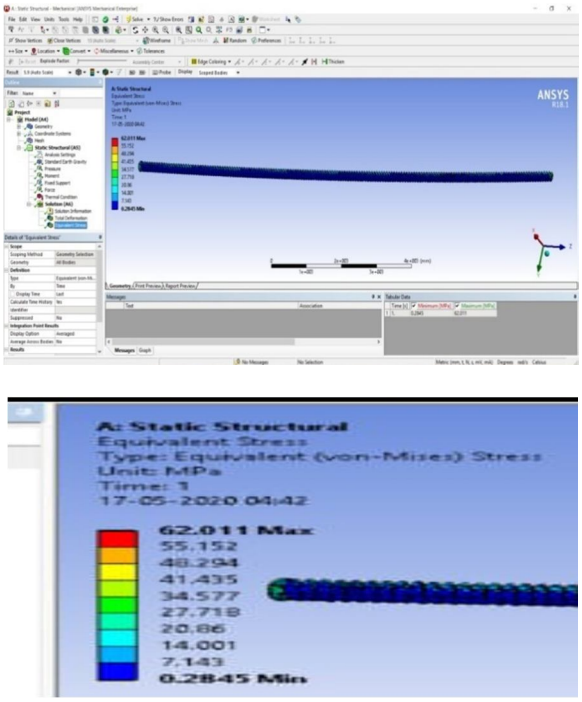

Fig.4 Maximum stress on Helical screw

Total Deformation on helical rod is came out as 1.17 .For maximum load total deformation is very less

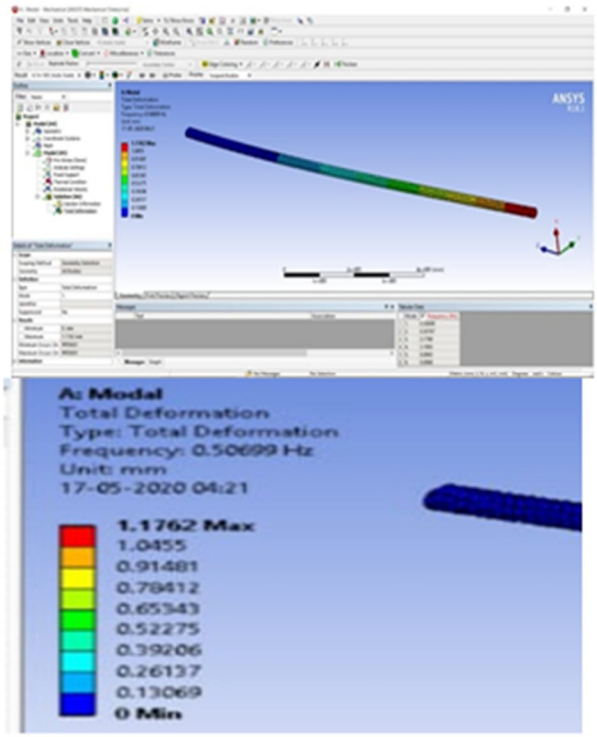

Fig.5 Total deformation on helical screw

Which implies design of helical rod is safe.
Boundary conditions for Spur gear according to system designed is considered as :
Maximum load on Spur Gear: 30N
Support: Fixed Support
Angular Velocity: 6.28
Torque: 7.96Nm

After applying these values result came as 19.7Mpa.Material of Spur gear is Nylon66 with UTS value 30MPa.So Factor of safety is calculated as 1.52.Hence Design is Safe

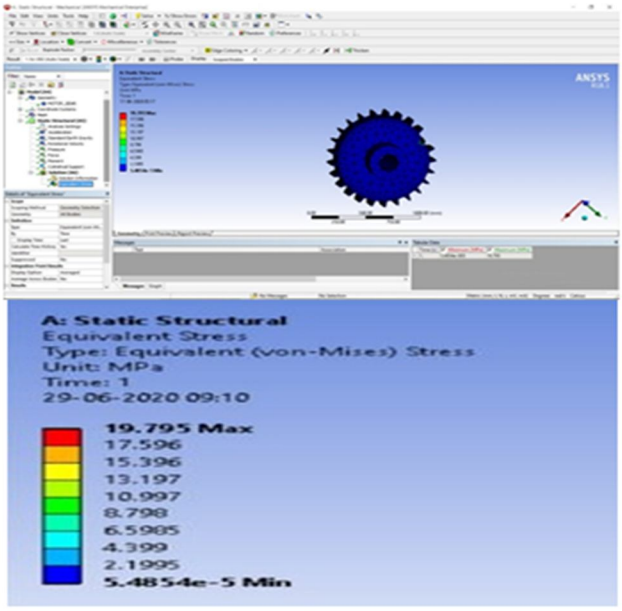

Fig.6 Maximum stress on Spur Gear

Total deformation on spur gear is came out as 1.4 .This value is very less for maximum applied load. It means Design of Spur gear is Safe.

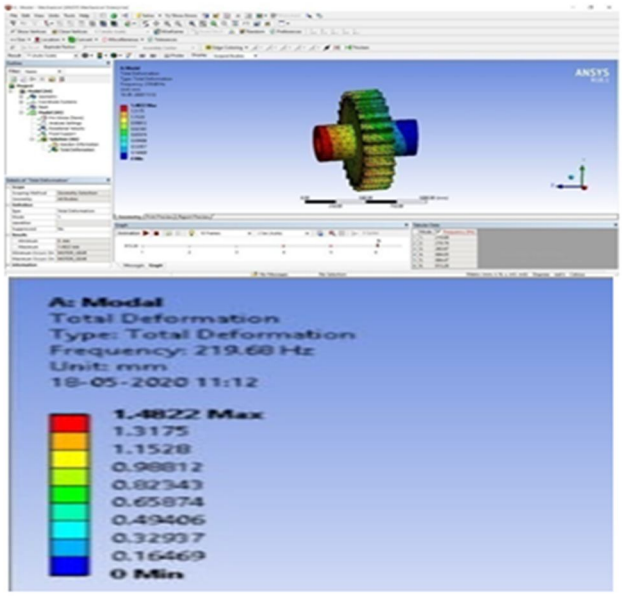

Fig7 Total Deformation on Spur Gear

IV. CONCLUSION

The Design of machine is proved out to be safe and successful theoretically. Power, torque which is required to move a nozzle is calculated. With the help of these arrangement and calculated values painting of flat surface can be done. Machine requires less components so its easy to manufacture with low cost. Due to its easy operating mechanism the machine is very convenient for use.

V. ACKNOWLEDGEMENT

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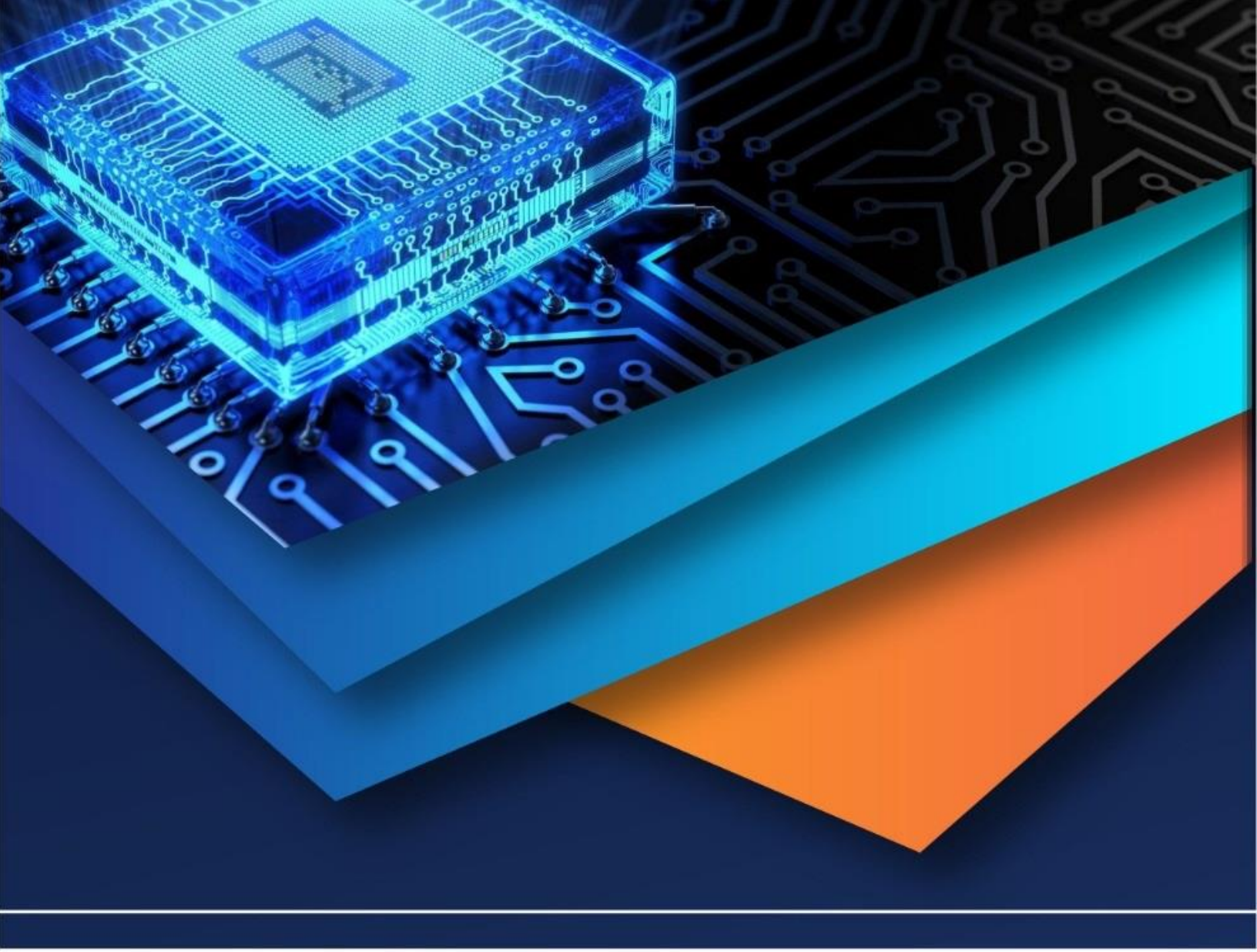

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