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AGRIBOT (Groundnut Uprooting System)

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Abstract: ***We are applying the idea of robotics technology in agriculture. In agriculture, the opportunities for robot- enhanced productivity are immense and the robots are appearing on farms in various guises and in increasing numbers. We can expect the robots performing agriculture operations autonomously such as spraying and mechanical weed control, fruit picking, patrolling the farms etc. AgriBOT is a robot designed for agricultural purposes. So, the name is derived from Agriculture Robot. Generally, it works on a principle that electricity is converted into the mechanical motion using compressed gases. It is designed to minimize the labor of farmers in addition to increasing the speed and accuracy of the work. It performs the elementary functions involved in farming i.e. harvesting, spraying, seeding and removing the weeds. And they gradually appear advantages in agricultural production to increase productivity, improve application accuracy and enhance handling safety.***
Keywords: AgriBOT, Arduino, CREO, Solenoid, DCV

I. INTRODUCTION

India is an agrarian country. Agriculture plays an important role in the economic stability of the country. It accounts for about 26% of the total national income. But there have been very less technological advances in this sector. As a result, the productivity of this sector is very low when compared with other economy sectors. To increase this productivity, the technology must be provided to farmers that is not only user friendly but also inexpensively available to them. The current machines available in the market do not comply with both these necessities. As a result the productivity has remained low and the farmers are facing various kinds of problems.

A. Project Purpose

1) *Problem Solution:* We are trying to build a robot that will not only reduce the labor required in the field but will be easy to operate and handle. It will help to perform functions quickly and easily which in turn will increase the efficiency as well as productivity of the agricultural fields. Our robot will have various assemblies, each to be used for specific purpose. This will increase its usability and will help to make it economical for the farmers. It will carry out basic functions like planting seeds, spraying pesticides, uprooting crops, harvesting crops, etc. Also this robot will work on solar power. This will help in conservation of environment and reduction in consumption of conventional fuels like petrol and diesel to generate power. Thus its operation will be eco- friendly, emission-free and silent. This type of solution will be beneficial to farmers, economy as well as environment [6]
2) *Project Aim and Objective:* Our project will come under the category of drone based solutions in agricultural sector. We are trying to build a multi-purpose agriculture automatic robot that may not need human interference to work in the farms. This robot is specifically designed for uprooting of groundnut plants. To increase the utilization of this robot, assemblies might also be provided for purpose of pesticide spraying and ploughing. These assemblies will help to make the robot economical for the purchasers by increasing the usefulness of the robot. Currently, pesticide spraying is either done manually or by means of assemblies attached on tractors. Both these ways have certain disadvantages. While spraying pesticides manually, there is a danger of side effects to the person spraying it. Besides, it is also not efficient and consumes much time. When tractor assemblies are used, there is always a question of harming the crops. So our robot will be useful to negate disadvantages of both these ways of spraying pesticides [4].
3) *Equipment's Required*

a) Battery
b) Solar Panel
c) Voltage Controller
d) Microcontroller
e) Relay

f) Portable Air Compressor
g) FRL unit
h) Pressure switch
i) Solenoid Valve
j) Single/Double acting Valve
k) Directional Control Valve (DCV)
l) DC Series Motor
m) Gear box
n) Gripper Arms (Actuators)

4) Equipment Specifications

a) 24 V, 100Ahour DC battery.
b) 24 V solar cell, 12 cells in series, 2V each.
c) Ic7805 Voltage Controller, 3 legs.
d) 6V relay.
e) 5/3 solenoid control DCVs.
f) Gearbox with gear ratio 15:1.
g) Grippers: 30 cm × 10 cm area.
h) Pneumatic cylinders: Bore 50/32 mm, Stroke 160/125 mm.

II. DESIGN & ANALYSIS

A. Components in Detail

1) *Grippers*: A set of two grippers is used with dimensions of 0.3x0.1 m. They are used to hold the crops while uprooting the crops and while vibrating the uprooted crops to remove unwanted soil and dust from seeds. The grippers are operated by pneumatic cylinders.
2) *Battery:* A 24 Volt, 100 Ampere-hour dc battery is to be used. It will provide enough power to the motor to perform required functions. Battery is used to supply electrical supply to the motor as and when it requires.
3) *Motor:* A 0.5 horse-power motor is use to perform all the operations. The selection of this motor is done based on various calculations about the power required for movements of the grippers as well as the whole robot. The motor will convert electrical power obtained from battery into mechanical work required at the grippers and the wheels.
4) *Wheels:* The wheels have been designed specifically to operate well and nicely in rough conditions that we usually find in farms i.e. muddy conditions. The clearance required for frame to move across the field without hampering the crops is around 15 cm. Thus to be on a safer side and to facilitate the operations to be performed by the robot, we zeroed in on keeping a clearance of 20 cm. Thus the diameter of the wheel is 40 cm.
5) *Gearbox:* The gear box is used to reduce the rpm of the motor to a substantial value so as to obtain the speed which we need for the movement of the robot. Motor operates at 3000 rpm. (n = 3000 rpm). We need to operate at normal speed that humans walk. It is assumed widely to be 5 km/h. thus the velocity of motion of robot and effectively the wheels will be [5],

Thus V = 1.38 m/s.

$$V = \frac{5 \times 1000}{3600}$$

Now, for finding the rotations per minute required for the wheel to operate at this speed, we know,

$$V = \frac{\pi\, d\, N}{60}$$

$$Th\,,\ N = \frac{60\, V}{\pi\, d}$$

Here d = 40 cm, i.e. d = 0.4 m.

N= 65.92 rpm

We have to amount for loading conditions and operating conditions. Taking this factor to be 1.5, final rpm will be 98.88 rpm.

Thus N = 98.8 rpm = 100 rpm The robot requires a very less speed so a gearbox with a gear ratio of 30:1 will be used so as to reduce the speed 30 times than that of motor and obtain a speed of 100 rpm.

6) *Frame:* The frame is the base of the robot that is to be used to support all the other parts of the robot. It is a rectangular structure of mild steel rods of 2 cm thickness covering an area of 1 m × 1.2 m. There will be some side members used to support the load of the assemblies and weight of the wheel. These dimensions have been selected on the bases of average width and distance between two consecutive rows of crops. The data has been collected from fields in different regions and has been generalized.
7) *Pneumatic Cylinders:* One primary Cylinder is used for uplifting of the load and two secondary cylinders are used for providing the clamping actions. The primary cylinder has a stroke of 160 mm and bore of 50 mm. The secondary cylinders have a stroke of 125 mm and 32 mm bore. These dimensions have been selected after gathering field data and accounting for the losses that can incur and there after selecting the nearest standard cylinders available from the market [7]. Usually the automatic seed planter plants the seeds in a gap of 80 mm. Thus to have a proper grip of all the seeds, it is necessary for the secondary cylinders to have a stroke of at least 80 mm. Now, we have to provide the function of vibrations of the grippers due to which we need high frequency of forward and backward strokes. The frequency of these operations decreases with increase in bore of the cylinders. Thus to get an optimum cylinder from the range of standard cylinders available I the market, we preferred to choose the cylinder with bore of 32 mm and stroke of 125 mm. For the primary cylinder, it is important to pull the crops out of the ground. For this purpose, we need a longer stroke than the cylinders selected as secondary cylinder. Also, the operation of primary cylinder does not require speed or high frequency. Thus the bore of the cylinder can be selected as per our choice. From data gathered from a few fields, we zeroed in on the lifting height of around 15 cm. Thus we selected the cylinder with stroke of 160 mm.
8) *DCV:* Direction Control Valves are used to operate the actuators when we want, as we want. In our robot we will use 5 port 2 position valves which will have solenoid control. This is done to help control the double acting cylinders. Solenoid control will help to have only an electrical switch to operate the dcv which in turn will operate the actuators that carry out the functions of grippers and the motors. Thus the complete control of this robot will be on a few switches [8].

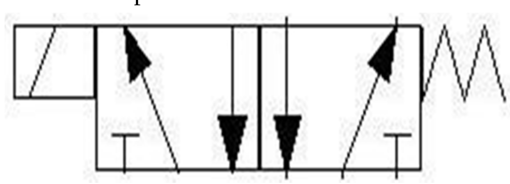

Fig. 1 5/2 DCV

B. 3D Model [AgriBOT]

This model was developed in CREO software by us after various alterations and editing in the components and assembly of the robot. The dimensions have been taken exactly as stated before in this report and hence, this can model can be observed and analyzed in analysis software for various tests under different variable conditions that it may have to face during its operational hours. The model is as follows.

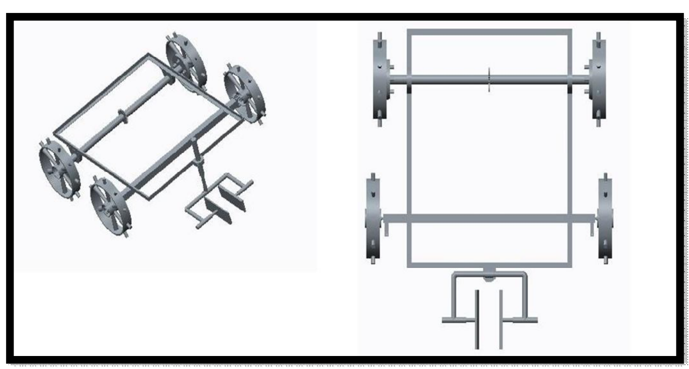

Fig. 2 Dimensional Model of AgriBOT

1) *AgriBOT Working Procedure:* At first, DC motor will run in forward direction. Here motor RPM will high. But requirement is only up to 100 RPM according to speed of operation. So using GEAR BOX rpm reduction is achieved. Gear is directly attached with axial shaft of the wheel through chain and sprocket. So robot will move forward/backward direction. After moving operation, the turn of clamping of ground nut plant, for this purpose clamper device is used. Here clamper device is directly connected with the connecting rod of cylinder and controlling the flow regulation of air using air flow control valve,

by using the controller programming. Time delay is provided for flow regulation is decided according to the calculation. Now lifting process is done by the vertically mounted master cylinder. Here calculation data is bases on the practical field work. And load will decided to the soil pattern. For ejecting the ground nut, clamper device is lifted vertically upward up to some height. And finally ground nut will be out from the soil. Now turn the ground nut cleaning from the some part of the soil which is attached with it. For performing this process, we can vibrate the total ejecting the ground nut plants which is clamping by the gripper. Through particular movement designing phenomenon this vibrating will produce with proper time delay. Ending this process most of the ground nut will clean from the soil. For next process, clamper device should be free for other plants. So by realising the clamper device after the time delay is provided by controller. And plants are dropping on the floor area. Moving forward for the robot for this process, controller switched on the DC motor supply. This supply continued according to the distance cover up by the robot as well as design of the clamper. After this process again clamping process will perform and so on. Here robot provided separately human handle which directly connected to front wheel through steering mechanism for giving particular direction in abnormal or malfunction of robot. Also providing circuit for RESET the programme or disconnects this for the continuous operation of the motor in turning the robot.

2) *Block Diagram [Agribot]*

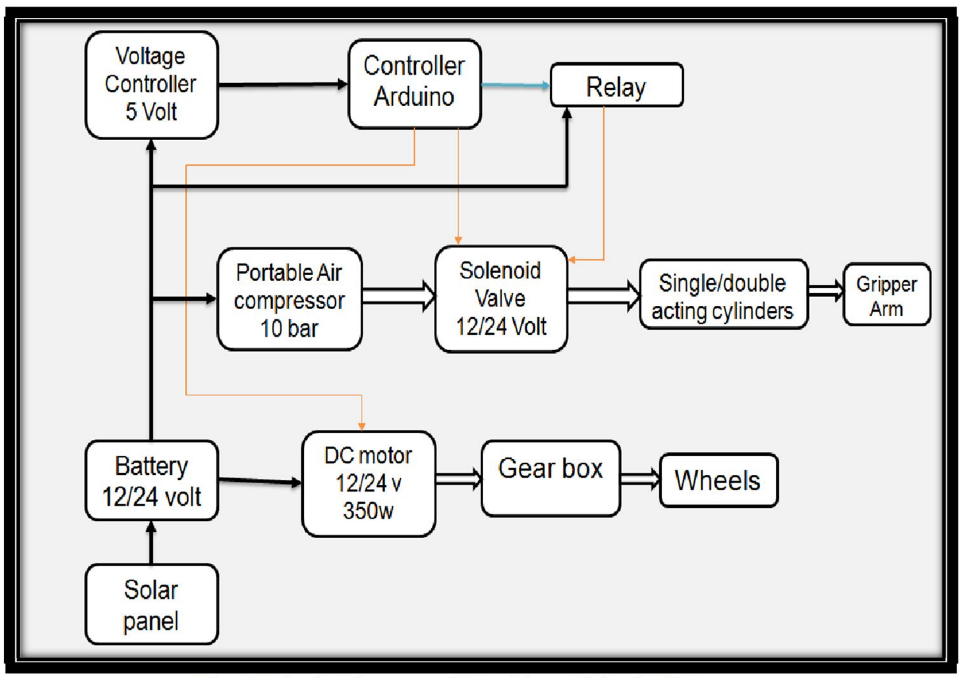

Fig. 3 Block Diagram of Working of AgriBOT

C. *Implementation*

1) *Snapshots of Component*

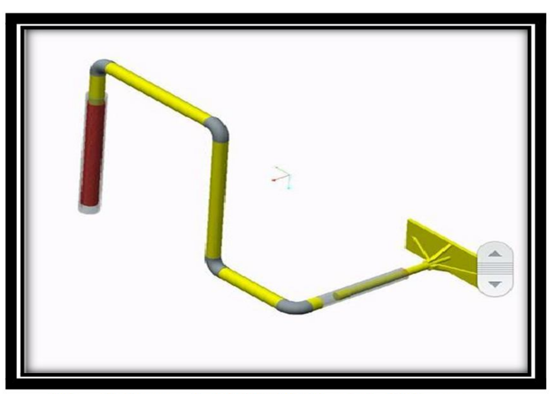

Fig. 4 Arm of AGRIBOT with Gripper

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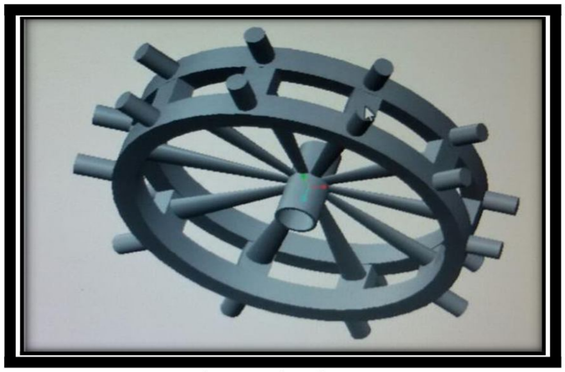

Fig. 5 Wheel Frame

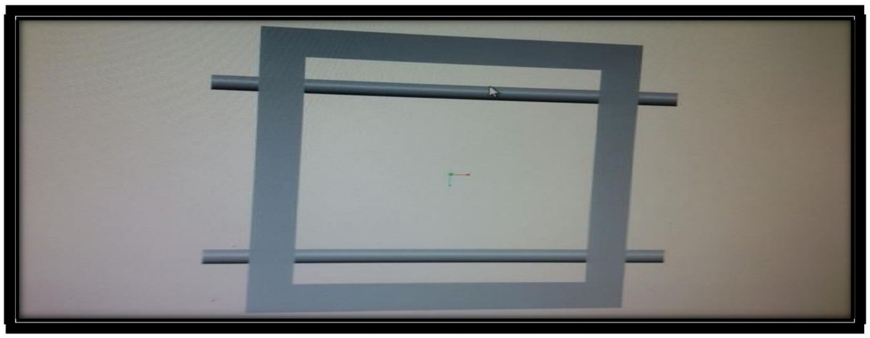

Fig. 6 Frame-Shafts Assembly

Fig 7. DCV, Cylinders, Pressure switch and pipe etc

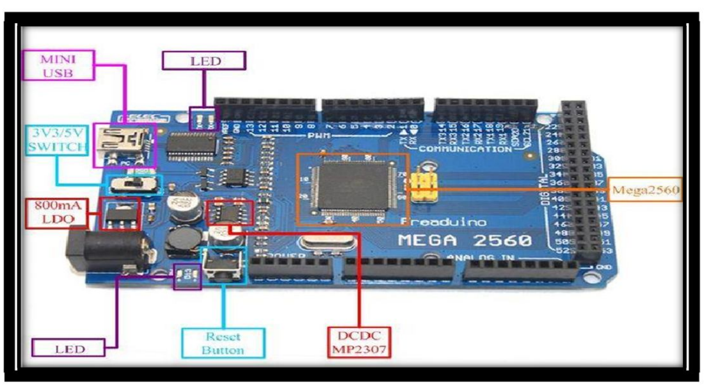

Fig 8. ARDUINO MEGA 2560

2) Program for Arduino [3]

```
Void setup( )
{
pinMode(13,
OUTPUT);
pinMode(12,
OUTPUT); pinMode(6,
OUTPUT); pinMode(5,
OUTPUT); pinMode(4,
OUTPUT); pinMode(3,
OUTPUT); pinMode(2,
OUTPUT); pinMode(1,
OUTPUT);
pinMode(11, INPUT);
}
Void  loop( )
{
digitalWrite(3, HIGH);
digitalWrite(5, HIGH); delay(1000);
digitalWrite(2,
HIGH); delay(2000);
digitalWrite(4,
HIGH);
digitalWrite(5,
HIGH);
digitalWrite(3,LOW);
delay(500);
digitalWrite(3,
HIGH);
digitalWrite(6,
HIGH);
digitalWrite(4,
LOW);
digitalWrite(5,
LOW); delay(500);
digitalWrite(4,
HIGH);
digitalWrite(5,
HIGH);
digitalWrite(3,
LOW);
digitalWrite(6,
LOW); delay(500);
digitalWrite(3,
HIGH);
digitalWrite(6,
HIGH);
digitalWrite(4,LOW);
digitalWrite(5, LOW);
delay(500);
```

```
digitalWrite(4, HIGH);
digitalWrite(5, HIGH);
digitalWrite(3,LOW);
digitalWrite(6,LOW);
delay(500);
digitalWrite(4, HIGH);
digitalWrite(6, HIGH);
digitalWrite(3,LOW);
digitalWrite(5,LOW);
delay(1000);
digitalWrite(1, HIGH);
digitalWrite(2, LOW);
digitalWrite(13,
HIGH); delay(5000);
digitalWrite(13,LOW);
}
```

3) *Working Model Photos*

Fig 9. Arrangement of Pneumatic Cylinders

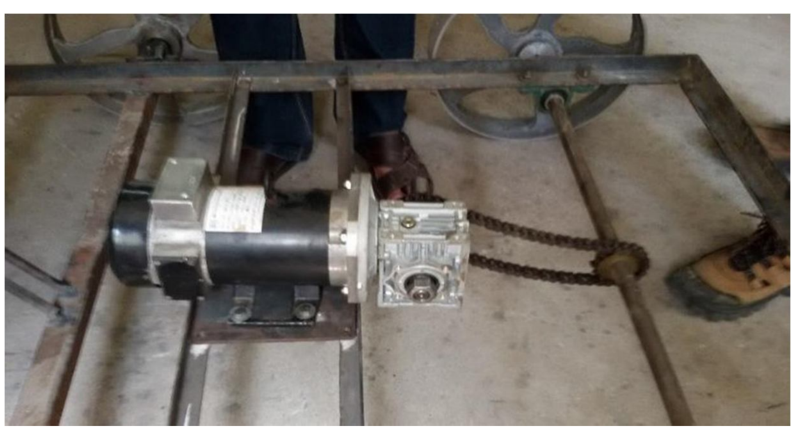

Fig 10. Setup of Motor and Chain Drive

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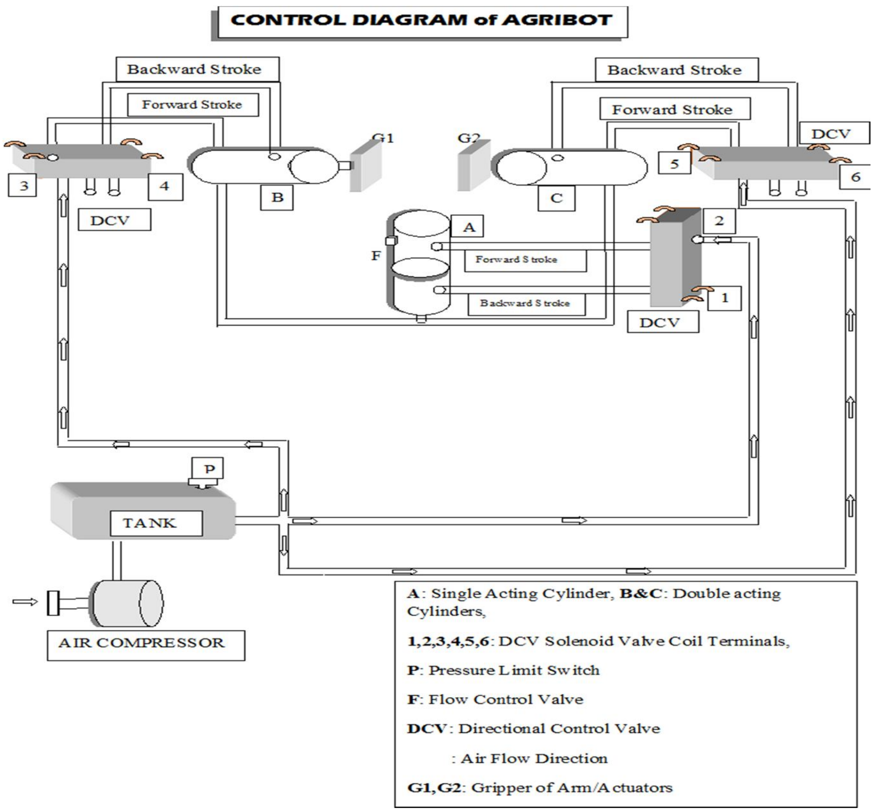
Fig 11. Testing of on-load conditions on AgriBOT with all the components

Fig 12. Working Conditions

Fig 13. Traction system of AgriBOT

Fig 14. Electrical program testing and components

4) Control Diagram



III.CONCLUSIONS

This robot will help to reduce the manpower required on the fields as it will promote automation in the agricultural sector. This will help in reducing the cost of labor and the cost of providing facilities, services and demands of the laborers. This robot will increase the efficiency of many tasks being carried out on the field because it will work tirelessly and without any facilities required when the conditions are suitable to its working environment [11]. The time span of completing the works being done will be reduced as the robots do not need breaks and work tirelessly and with same efficiency up to its maximum potential. This will decrease the time required for completing the task as compared to the time taken by humans. Control and usage of this robot will be easy and simple. In case of program failure, the robot will be operated by switch which is pretty easy to operate. Thus farmers will not require any special technical knowledge to work with this robot [10]. As the robot is used by batteries and no conventional fuel is required for it operation, the emission will be almost negligible. This will help in conservation of environment. This will be advantageous for maintaining the purity of the environment of the land and air surrounding the farms. This will in turn be helpful for obtaining hygienic crops and products which are good for health [1]. As the robot does not use conventional fuels like petrol and diesel, the operating cost for the robot will be very less compared to currently used machines running on these fuels. Robot will decrease the environmental emissions thus helping in conservation of the environment which has become a global priority [2].

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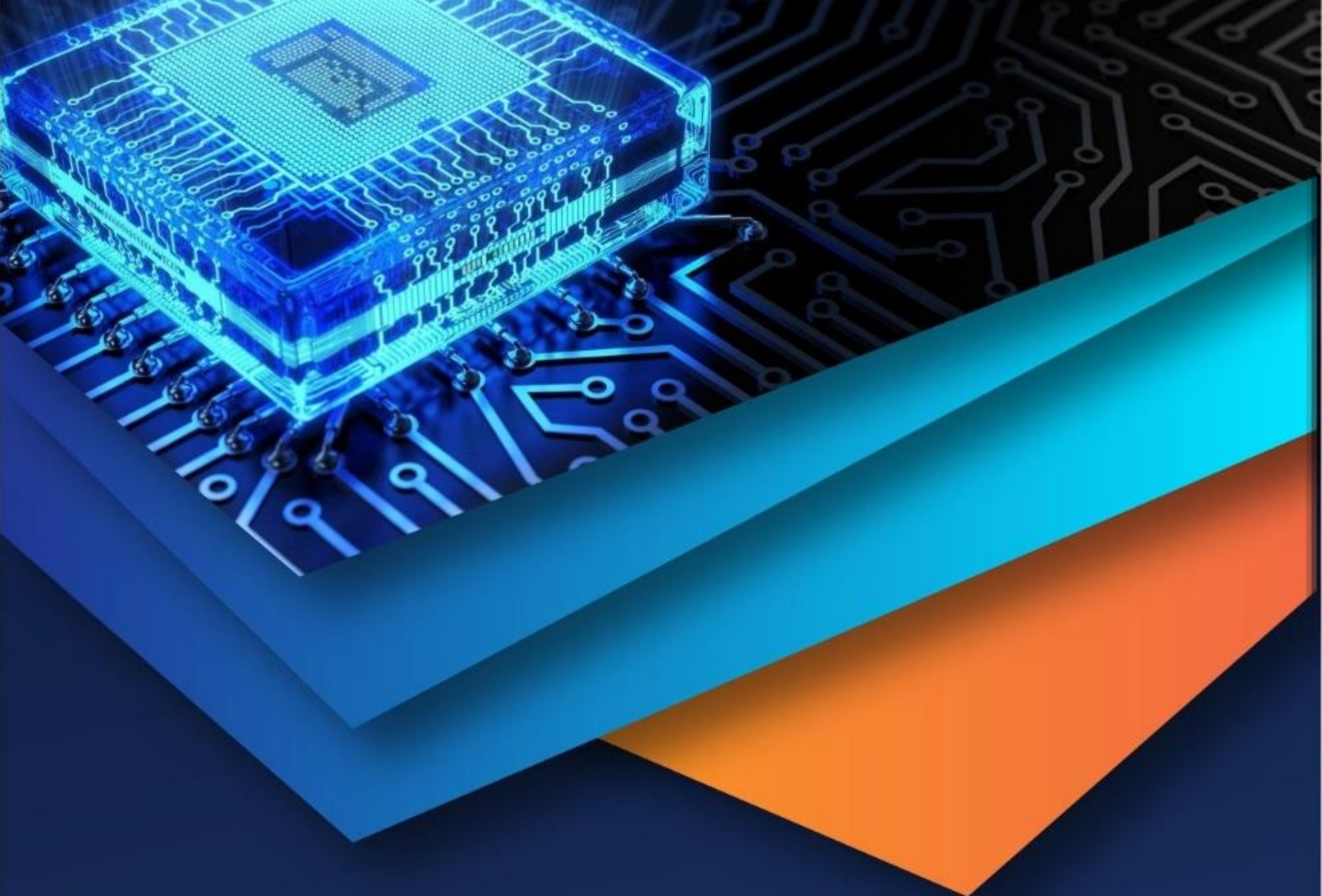

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