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IoT Based Ploughing and Seeding Robot for Agricultural Applications

Prasada Rao Bobbili[1], Sesha Sai Sajan Tamiri[2], Jhansi Rani Naddimpalli[3], Jyothi Swaroop Manchu[4], Dinesh Yempadapu[5]
[1]Associate Professor, [2, 3, 4, 5]Student, Department of Electrical and Electronics Engineering, Vignan's Institute of Information Technology, Visakhapatnam, India.

Abstract: This project is based on an agricultural model used for ploughing and dropping seeds into the ploughed land using a robot which is controlled via Wi-Fi module and helps in making an interconnection between the user and the robot allowing him to control over very large distances using IoT enabled devices and wireless smart automation of sensors and actuators in the agricultural field as is the only solution to overcome the scarcity of labor in the agriculture sector as mentioned using IoT (Internet of Things). These IoT enabled devices are used in Ploughing, Seeding, and many other applications controlled through the Internet.
Keywords: Manpower, Ploughing, Seeding Mechanism, IoT, Agricultural land.

I. INTRODUCTION

This project maintains a bond between modern technology with the old fashion techniques i.e. using IoT and many other emerged technologies used for performing the agricultural activities. This robot helps the farmers in ploughing and as well as seeding removing their stress and in terms of increasing/maintaining their product output constantly. We used NodeMCU to form a bridge between the internet and the model to perform tasks from even far distances which enables this robot to be flexible at working and a 4-channel relay is used for performing the switching operation i.e. "ON" or "OFF" with controls the robot actions/activities on the field. This model is a combination of different components and materials which are required for a specific task. This model drills the land in a required manner and sequentially drops seeds and the dropping interval can be changed as per required which is controlled with a solenoid lock. Also, this project deals with watering the land in a controlled fashion by measuring the moisture levels of the land which helps in proper germination of the seeds and spraying pesticides to help in crop production by killing the germs without decreasing the fertility levels of the soil.

II. DIFFERENT KINDS OF SOWING/SEEDING METHODS

There are different types of sowing techniques used in irrigation:

A. Broadcasting

It involves the random scattering of seed on the surface of seedbed which can be done either manually or mechanically.

Fig.1. Broadcasting

1) *Advantages*
a) It is a rather less time-consuming process
2) *Disadvantages*
a) 100% germination is not possible
b) Requires a skilled person at the field
c) Seeds can't reach the required depths in the seedbed

B. Dibbing

This is the process of placing seeds in the holes made in the seedbed and covering them. In this method, seeds are placed in holes made at definite depth at fixed spacing. The equipment used for dibbing is called *"Dibbler"***.**

Fig.2. Dibbing

1) *Advantages*
a) Good germination % is found
b) Seeds can be dropped at required depths
2) *Disadvantages*
a) Time-consuming

C. Drilling

This method consists of dropping seeds in furrow lines in a continuous flow and covering with soil. This can also be done both manually and mechanically. This method is very helpful in achieving proper depth, proper spacing and a proper amount of seed to be sown in the field.

Fig.3. Drilling

1) *Advantages*
a) Good germination percentage
b) Lesser time consumption than the dibbing
2) *Disadvantages*
a) Equipment complexity

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D. Seed Dropping Behind the Plough

It is a very common method used in villages and is used for seed like maize, gram, peas, barley, and wheat. A man drops seeds in the furrow behind the plough. Sowing behind is done using "Malobansa".

Fig.4. Malobansa way of seed dropping

1) Disadvantages

a) Slow process and requires labour

E. Transplanting

It consists of preparing seedlings in the nursery and then planting these seedlings in the prepared field. It is commonly done for vegetables and flower. Plants are placed using the equipment called a *"Transplanter"*.

Fig.5. Transplanting

1) Disadvantage

a) It is Time-consuming process

F. Hill Dropping

In this method, seeds are dropped at a fixed spacing

Fig.6. Hill Dropping

G. Check Row Planting

In this method of planting row-to-row and plant-to-plant distance is uniform and seeds are planted along straight parallel furrows. The rows are always in two perpendicular directions. A machine is used for checking row planting called "*Check Row Planter*".

Fig.7. Check Row Planting

In this project, we have implemented the "DRILLING" method as we found it close enough for our idea.

III. BLOCK DIAGRAM

The overall block diagram is shown below

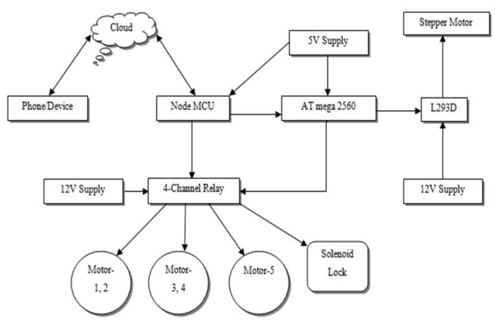


Fig.8. Block Diagram

From the above block diagram, it can be understood that the model is controlled using a mobile or a device that can control the NodeMCU through an application. The device is supported by the internet and can control the model wirelessly. The NodeMCU is interconnected with different sensors and actuators which serves an individual purpose.

IV. SIMULATION AND RESULTS

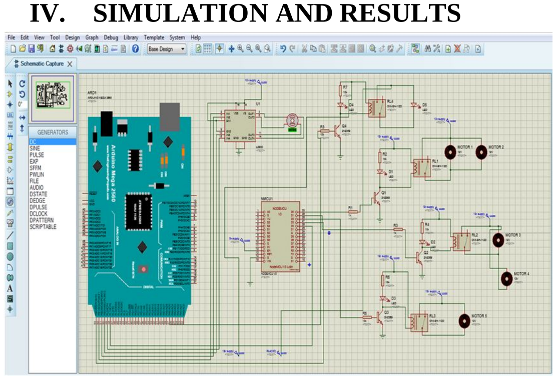
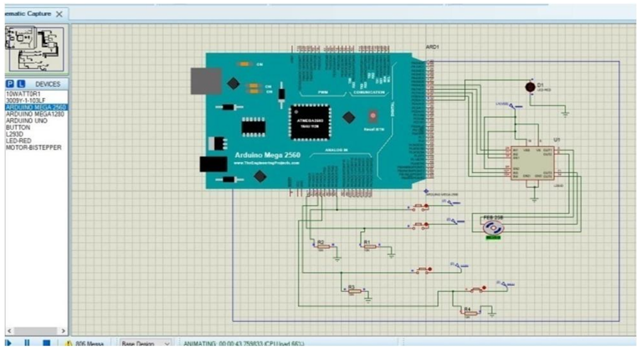
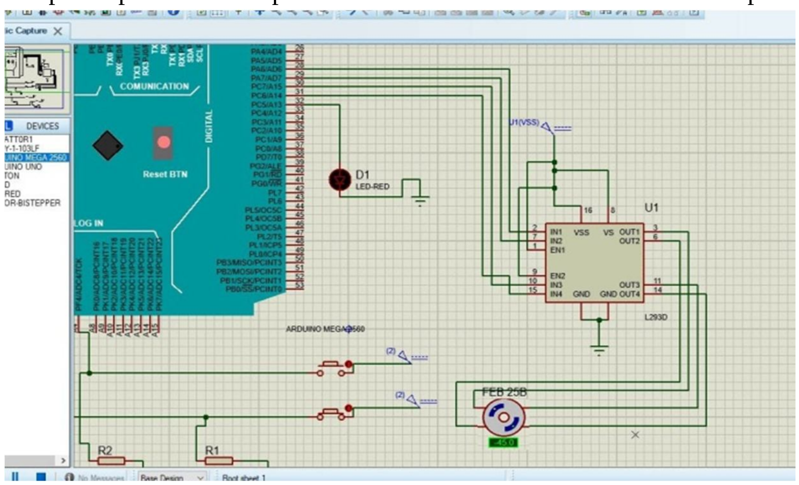


Fig.9. Overall Schematic Diagram

This schematic represents the overall connection diagram of this model and it shows the interfacing of NodeMCU, DC Motors, Relay Channel, Stepper Motor and controller (L293D) used to drive the stepper motor for positioning the driller (i.e., the DC motor coupled to a Drill Bit). This gives the flexibility of positioning the driller at different angles with respect to the wooden base.



The above schematic diagrams represent the circuit connections and the overall model representation related to the functioning based on signals received by the NodeMCU. The NodeMCU receives the command from a mobile that is interlinked with a cloud server where the code for the NodeMCU is stored, based on the command the NodeMCU sends signals to the output pins and based on the connections made at the output a specific task is performed. The table below shows the tasks performed by the robot.



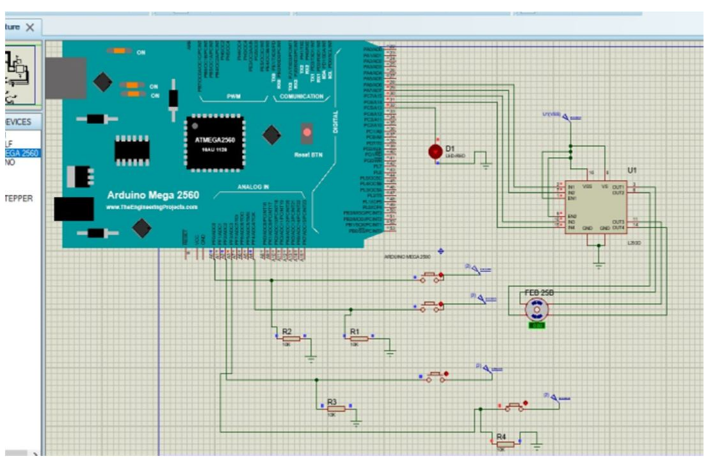


Fig.10. Solenoid Working indicated via LED

This Schematic Diagram represents the working of the Stepper Motors as well as the Solenoid Lock (represented with a LED) through which seeds are dispensed; dispensing is controlled by controlling the solenoid lock by sending control signals through Arduino MEGA 2560. The control signals sent through NodeMCU are indicated with push buttons. So, we can see that whenever the push button is turned ON the Arduino pin to which the push button is connected is given a “+5V” i.e., Logical ‘1’, and when the push button is turned OFF the corresponding pin is grounded i.e., “0V” or Logical ‘0’. In this way, we are replicating the working of NodeMCU using push buttons.

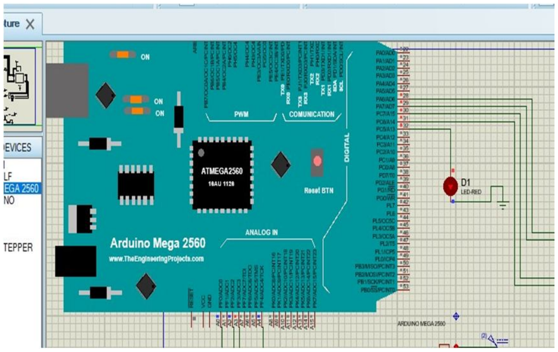


Fig.11. Solenoid working

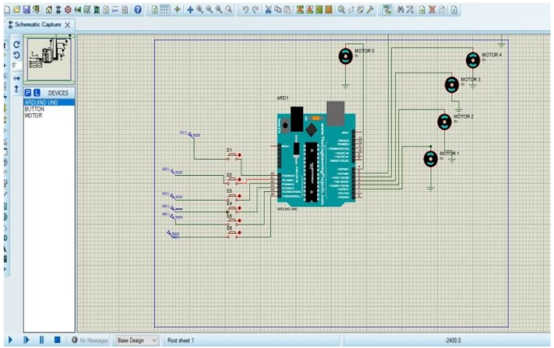


Fig.12. Schematic of the Water Sprinkling Mechanism

In the above schematic, the moisture sensors are indicated with push buttons. Whenever the moisture sensor sense low moisture content in the area which it's placed the sprinklers near that area will turn ON (Sprinklers are indicated using motors which are nothing but pumps). So, when the moisture content reaches the required or the optimum based on the moisture content reading the motors which are turned ON will be Turned OFF, also the corresponding valves will be closed. Valves create a barrier for the water flow even if one of the motors is turned ON when it's not required. This technique is also used to spray pesticides at regular intervals when required. The table below specifies the working of different actuators based on the signal received through the NodeMCU as we are controlling the robot through the internet. NodeMCU makes this possible by connecting the user and the robot through the internet which gives us a greater margin of connectivity range over the others.

Table.1. Working Table

S. No	Pin Turned HIGH (1)	Relay's Turned ON	Actuator's Turned ON	The Motion of the Robot
1	D0	RL 1	Motor-1, Motor-2	Left
2	D1	RL 2	Motor-3, Motor-4	Right
3	D2	RL 3	Motor-5	-
4	D3	-	Stepper Motor	-
5	D4	RL 4	Solenoid Lock	-
6	D0, D1	RL 1, RL 2, RL 3, RL 4	Motor-1, Motor-2, Motor-3, Motor-4	Forward

V. HARDWARE IMPLEMENTATION

The below table consists of the components used in the hardware model

Table.2. Hardware Components and their Specifications

S. No	Component	Specifications
1	Wooden Base	60cm*35cm
2	DC Motor	Operating Voltage- 12V DC Operating Current- 4.36 mA Operating Torque- 5 kg-cm/s^2 Operating R.P.M- 10
3	DC Motor	Operating Voltage- 12V DC Operating Current- 0.4363 Amps Operating Torque- 5 kg-cm/s^2 Operating R.P.M- 1000
4	Arduino Mega 2560	Operating Voltage- 5V Input Voltage (Recommended)- 7-12V Input Voltage (limit)- 6-20V Digital I/O Pins- 54 (of which 15 provide PWM Output) Analog Input Pins- 16 DC Current per I/O Pin- 20mA DC Current for 3.3V Pin- 50mA+ Flash Memory- 256 KB of which 8 KB used by Boot Loader SRAM- 8 KB EEPROM- 4 KB Clock Speed- 16 MHz
5	L293D	Motor Voltage Vcc2 (Vs)- 4.5V to 36V (DC) Maximum Peak Motor Current- 1.2A Maximum Continuous Motor Current- 600mA Supply Voltage to Vcc1(Vss)- 4.5V to 7V Transition Time- 300ns (at 5Vand 24V)
6	Stepper Motor	Operating Voltage- 12V Operating Torque- 10 kg-cm/s^2
7	NodeMCU	Microcontroller- ESP8266(32-bit) Model- Clone LoLin Clock Speed- 80MHZ USB to Serial- CH340G USB Connector- Micro USB Operating Voltage- 3.3V Input Voltage- 4.5-10V Flash Memory/SRAM- 4MB/64KB Digital I/O pins- 11 Analog In pins- 1 ADC Range- 0-3.3V UART/SPI/12C- 1/1/1 Wi-Fi Built-In- 802.11 b/g/n Temperature Range- -40°C-125°C
8	Clamps	-
9	Wheels	10cm (Diameter)
10	Battery	Voltage- 12V Electric Charge- 12 Ah
11	Drill Bit	8mm (Diameter)
12	Solenoid Lock	Operating Voltage- 12V Draws 650mA at 12V, 500mA at 9V when activated Designed for 1-10sec Long Activation Time
13	Relay	Operating Voltage- 12V Max Voltage- 30V DC/250V AC Max Current- 10A(AC/DC)
14	Nuts and Bolts	-
15	Funnel	-
16	Connecting Wires	-

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The robot is controlled through a phone which sends a signal to the NodeMCU which in turn sends signals to the output pins and the devices connected at the output, respond to the corresponding signal at the output. MOTOR-5 is used to drill the field (MOTOR-5 and the DRILL BIT are coupled) and the seeds are dropped through the funnel at regular intervals. Seeds dropped through the funnel are controlled by a solenoid lock which opens and closes at regular intervals allowing the seed dropping to be uniform throughout the process. The stepper motor is used to control the MOTOR-5's position i.e. the angle at which the driller is positioned with respect to the WOODEN BASE. When the drilling process isn't necessary the stepper motor will pull back the driller to a position parallel to the wooden base. Likewise, the remaining motors are used for controlling the robot's direction.

VI. HARDWARE MODEL

The Model has dimensions of '60cm' in length and '35cm' in width

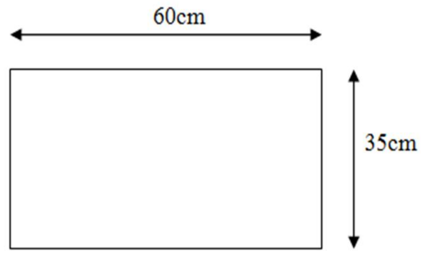

Figure.13. Dimensions of the robot's body

The base of the robot is made of wood, and the wheels are of '15cm' in diameter.

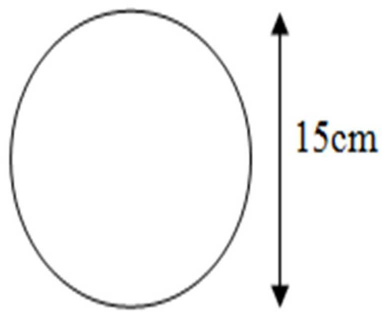

Fig.14. the Dimension of the wheel

A. *Torque Calculations*

Based on the weight of the entire model (considering heavily loaded) we have calculated the required torque of move the model.

$$Force = \mu N$$
$$N = mg = W$$
$$Torque = Force * R$$

So, $Force = \mu mg$

Where,

μ=Coefficient of Friction.

m=Mass of the Model.

N=Normal to the Wooden Base.

g=Acceleration due to Gravity (9.81m/s).

R=Radius of the Wheel (7.5cm).

W=Weight of the Model.

Let the coefficient of friction =0.1 and the mass of the model= 7 kg.

$$Torque = 0.1 * 7 * 9.81 * 7.5 * 10^{-2}\ N - m$$
$$Torque = 2.5751 N - m$$

The torque calculated is assumed for a surface having a coefficient of friction of "0.1" and this will vary for every surface. Higher the coefficient of friction, then higher will be the torque required for moving the robot. And the coefficient of friction between the surface and tyre should exist to maintain the grip otherwise, the robot will skid.

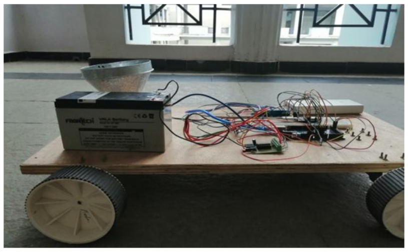

Fig.15. Hardware Model of the robot

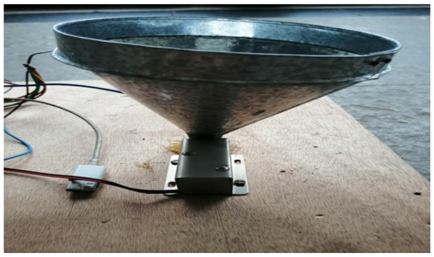

Fig.16. Solenoid Lock Coupled to a Funnel

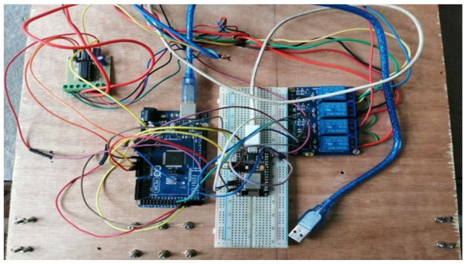

Fig.17. Interfacing of different component

VII. CONCLUSION

The main focus of this system is an automatic way of sowing seeds. The seeds are been sowed in a proper sequence which results in proper germination. The automatic way of sowing seeds using a robot reduces the labor requirement. Here the wastage of seeds is also been reduced to a greater extent. Herewith the help of a robot, the seeds are been dispensed in the soil in a proper sequence. This robot will help the farmers to do the farming process more effectively and efficiently.

Most of the present successful agricultural robot models represent the use of powerful fuel-based IC engines and heavy machinery, which requires a skilled technician and causes unnecessary environmental pollution and also a reduction in fossil fuel. To solve this problem, the use of automation unmanned agriculture is implemented by this model.

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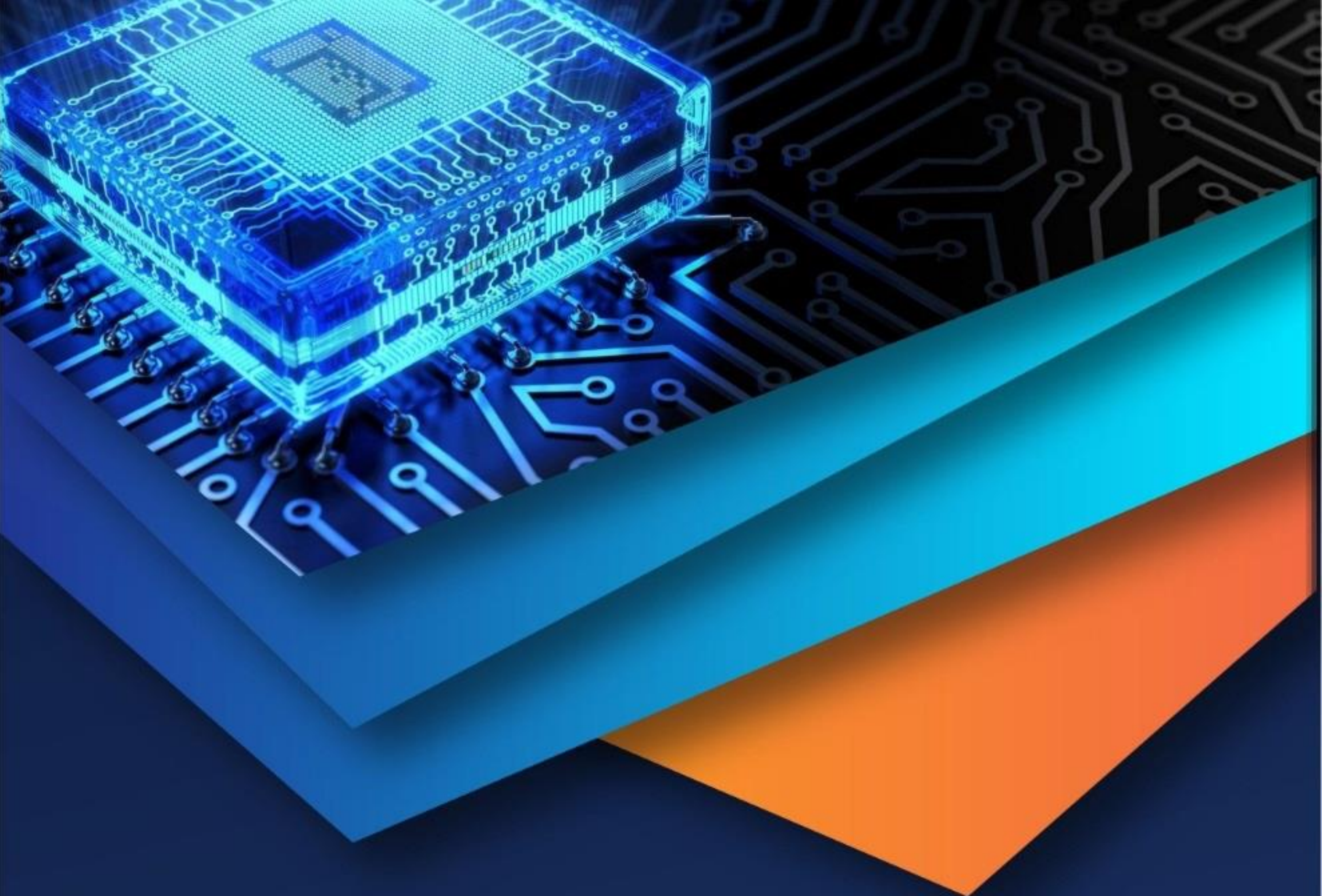

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