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Fire Fighting Robot

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Abstract: ***This project proposes the development of an Automatic Fire Fighting Robot designed for autonomous fire detection and suppression in indoor environments. The system integrates three flame sensors oriented to monitor the left, center, and right fields of view, ensuring a broad detection range. Upon flame detection in any direction, a microcontroller processes the sensor input and activates a mini servo motor to perform a sweeping motion, enabling dynamic targeting of the fire source. Concurrently, a relay module is engaged to power a submersible pump motor, which initiates water discharge through a sprinkler mechanism aimed at the affected area. The integration of real-time sensing, servo-controlled directional actuation, and water-based suppression offers an efficient and responsive solution for mitigating fire hazards in critical applications.***

Keywords: IOT, Autonomous, Remote control, Water pump.

I. INTRODUCTION

This work is all about the system which can be considered the perfect solution for compact and risky fire zones.Therobotisbuiltinsuchawaythatithasthecapability to put out fires in critical conditions, such as where the risks to human lives are. The rubber wheels help to run the robot ontheground,andthespecialtypeofwheelrotationhelpsto take turns without using any complex turning mechanism. TherobotisfullofSensorswhichhelpextinguishthefireand collect the smoke. In this, a camera module detects if any humanislooked atinfire.Also, thereis asmokecollectorto clarify the camera. By maintaining a safe distance, it fires water on thefireand helpstoreduce thefire.Becauseof this autonomous robot, no one will go into difficult conditions. The robot will individually handle the fire.

II. LITERATURE SURVEY

[1] They worked on the cylindrically shaped robot made of an Aluminium frame. The height of which is roughly around 80 cm, and the diameter is 40 cm. Its features include avoiding obstacles, remote monitoring and detection of fire. Its three flame sensors of the firefighting robot are used for building the fire detection system. Fire detection for firefighting robots is proposed using the adaptive fusion method. We are improving our approach to make it suitable for fire detection using computer simulations. We used sensor-based programming to program the fire detection and suppression process. In case of a real fire incident, the robot can use the proposed fire detection system technology to identify the fire source, move to the fire source and extinguish the fire.

[2] Fire Detection and Fighting Robot and Program is a combat technology based on the sensor. They created IR sensor-based modular obstacle detection at minimal cost to the robot's ultrasonic sensor. They envision using the portable and convenient Human Firefighting Robot Interface to create a generic user interface (GUI) based system status using the touch screen.

[3] The robot named QRob is intended to be smaller in size to make small fires easier; other traditional firefighting robots' entrance point for a narrower depth of fire suppression space. To prevent from colliding with nearby objects and obstructions while a flame is, QRob also has an ultrasonic sensor. QRob was the outcome. Showcasing knowledge of how to locate fires remotely and automatically put out a certain type of fire distance using a mobile operated by the user.

[4] This research proposes and develops a novel indoor firefighting robot concept. It has the capacity to traverse a variety of indoor flooring surfaces, including stairs. It can endure temperatures as high as 700o C for roughly 60 minutes using various thermal insulation techniques. It delivers visual and audio data to the control unit for the description of the fire environment inside the structure in addition to communicating with trapped and hurt victims inside the visible fire. With the aid of a remote-control device, several of those firefighting robots can be deployed to operate together.

[5] They looked at the robots' current state and their specifications. Then they highlighted their issues and topics. The ability of group robots to cooperate is the key to the next generation of firefighting and rescue robots. Better is the usable fundamental unit development. Public support is required, and global cooperation is crucial. Additionally, regular and close communication between researchers and firefighters is required.

III. .DESIGN CALCULATION& WORKING

A. *Calculations*

1) Velocityofwater:Itisthelengthcoveredbyflowing fluid in 1 sec.

Velocity=Displacement/Time Velocity = 28/1.5

Velocity=18.7cm/sec

2) FlowrateorDischargeofwater(Q):Itisthevolumeof fluid flowing through a pipe per second.

Q=AreaxVelocityorQ=Volume/time Area of pipe = $(\pi/4)\ D^2$

$=0.7853x(0.8)^2$

$= 0.5026cm^2$

Velocityofwater=18.7cm/sec Q = A x V

Q=0.5026x18.7

$Q=9.4cm^3/sec$

Table1.Designspecificationsoftherobotanditscomponents

S.No.	Component	Measurement
1	TotalWeight	350 g
2	Velocityofwater	18.7cm/s
3	Discharge/Flow rate	9.4 cm^3/sec
4	WaterRange	22 cm
5	Flamesensorrange	5-30cm
6	Tankdiameter	7cm
7	Tankheight	11cm
8	Pipelength	28 cm
9	PipeDiameter	0.8cm
10	WheelDiameter	6cm

B. *Working Flow*

An algorithm was developed to describe the behavior of a robot equipped with a firefighting system. A flow chart of the operation of the robot and sensor assembly is shown in Figure 4, and a flow chart of detecting fire is shown in Figure 5. It is mainly based on Arduino Uno and the Node MCU platform. An Arduino Uno board and a Nod MCU are employed on top of the robot, as shown below in the robot's circuit design. One is used to control the robot's wheels, and the other receives input from sensors and performs specific tasks upon request. Hardware and software requirements and their usage are described in the section below.

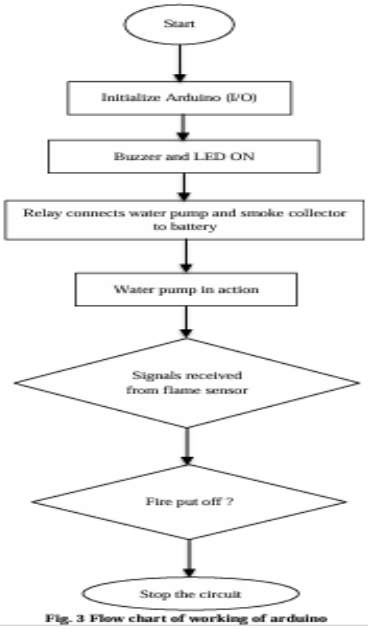

Fig. 3 Flow chart of working of arduino

C. Hardware Requirements;

The system's hardware is primarily based on the Arduino Uno and Node MCU platforms. The robot circuitdesign has an Arduino Uno board and a Node MCU placed on top of the robot, as shown below. One is used to control the robot's wheels, and the other receives input from sensors and performs specific tasks as requested. Following is the hardware we used.

1) Arduino UNO R3: The microcontroller used in the Arduino UNO platform is ATmega328. All sensors and actuators, excluding DC motors, are connected to the Arduino board. All the actions like detecting fire and taking action on it are done by this microcontroller according to code
2) Node MCU: The microcontroller is based on the ESP-12 module of ESP8266. We used this microcontroller for robot movement and connected this robot to a smartphone by using the WIFI
3) L298N: L298N controls the speed and direction of two DC motors simultaneously. This module can drive a DC motor with a voltage from 5 to 35 V and a peak current of up to 2A.
4) 18650 Lithium Ion Battery: We are using this rechargeable battery for powering our robot. This is the primary battery type used in portable appliances and electric vehicles.
5) 12 Volt Water Pump: We are using this for supplying water to the pipe mounted on the servo motor.
6) Buzzer: It sounds after the fire gets detected. It is used as an emergency indication.
7) LED: It is used as an indicator when a fire is detected. It blinks after the detection of fire.
8) Servo Motors: It is used to control the angle of the water pipe and hence control the water direction. Also, it is used to control the angle of the camera module by which we can get different views of the camera on our display.
9) Flame sensor: It detects the flame and sends signals to the Arduino board then the Arduino board takes action according to that.
10) 9 Volt Power: The 9 Volt Battery is an electric battery that provides a nominal voltage of 9 volts. This power supply is only for Node MCU.
11) DC motors: It is used to forward and backward movement of the robot.
12) 5V relay: 5V relay is an automatic switch widely used in automatic control circuits, controlling high currents with low current signals—Relay Signal Input Voltage Range 0 to 5V.
13) Water Tank: We use this water tank for water storage and supply to the pipe when required.
14) LCD Display: It is used for showing the current condition. In emergency cases, go to the safe zone, and the display shows this type of massages.
15) ESP CAM 32 Module: It captures live images or video of the surrounding situations and shows on the IP address on our mobile phone. This also works on the Wi-Fi module.
16) 12V DC Fan: This fan we used for suction of the smoke caused by the fire.

D. Software Requirements:

The entire system is designed and developed using the Arduino IDE software and the Blynk app. These tools play a very important role in the software part of the project.

1) Arduino IDE: The popular open-source integrated development environment (IDE). This allows the user to program her and control compatible cards according to the requirements. The Arduino board is programmed using the Arduino IDE to read sensor inputs and direct actuators to control the wheels and robotic arm. The function and working with it becomes more interesting as it is compatible with the Blynk app that controls the mechanism.
2) Blynk App: This is the digital platform that allows users to create a graphical user interface (GUI) by dragging and dropping its widget onto their smartphone. This is used for real-time control of the robot's movement, speed and orientation.

IV. METHODOLOGY

Special material protects the robot body and its components from fire. This allows it to be used for extinguishing in any situation. This system uses different sensors to get inputs and perform actions. After the fire is extinguished, the pump, smoke collector, relay and flame sensors are turned off, which saves battery. Signals from these sensors are provided to the microcontroller, which drives the robot and nozzles connected to the water pump. So, when the robot detects a flame, the flame sensor sends a signal to the Arduino board, which resolves. We are using a camera module to get live images of the situation around the robot. This will help the controller to know the current condition surrounding the robot.

The live streaming of the camera's views can be seen on the computer.

This camera is fixed on the servo motor, which helps with the camera's movement at different angles and for getting different views through it. Obviously, there will be a lot of smoke around the robot due to the fire, which will hinder the camera from getting the proper images. It will get blurry images due to smoke. Hence, we are using a smoke collector for collecting smoke around the robot, and as a result, the camera can collect clear images around it.

Meanwhile, the relay is turned off, the circuit is opened, the water pump is stopped when the fire is extinguished, the circuit is automatically cut off, and everything stops. The system is semi-autonomous as all the functions are performed automatically, and only the movement mechanism is controlled by the user using the mobile phone. The design concept of the system is described in two phases. The first stage includes a robot with sensor mounts, and the second stage includes the Blynk app. We used a cloud database to store the actions. Two types of boards use the first is an Arduino, and the second is a Node MCU. Arduino is used for all flame detection and water pump control, and a Node MCU is used to control the bot. The most interesting fact about the project proposed in this document is that the range is the same as that of the Wi-Fi, so users get the flexibility to operate this robot from their mobile phones with a wide range. For example, let's say a cylinder of LPG caught fire; then, in such cases, firefighters enter the house and extinguish the fire, which is a very risky task. In this case, the Fire Robot enters the house and safely extinguishes the fire. We also focused on making it trustworthy to the common public and providing its user manual as appropriate.

V. IMPLEMENTATION

Physical development of the project has been completed, including circuit fabrication and 3D design for the project. The robot's design and the system's layout of sensors were designed using SolidWorks and AutoCAD. Both circuit boards are precisely programmed to operate each sensor according to available conditions. The circuit runs in two phases. The first phase contains the mobile phone-controlled DC motor assembly connected to the node MCU. This mechanism is shown in Figure 1. The second phase is for control of the remaining units. Its mechanisms and operations are shown in Figure 2.

VI. RESULT AND DISCUSSION

After assembling all the components and sensors on the chassis, we uploaded the code in node MCU and Arduino UNO. Then we successfully tested the working of the project. The project worked successfully. All the sensors got perfect inputs, and all the signals were perfectly sent to respective actuators. We burned a piece of paper and operated the robot to extinguish the fire for testing purposes. The smoke was perfectly collected, and the camera module took the perfect view around the robot. The safe and emergency zones are displayed on the LCD display according to the fire conditions.

All these operations were perfectly performed by the robot. All its results are shown in the images below

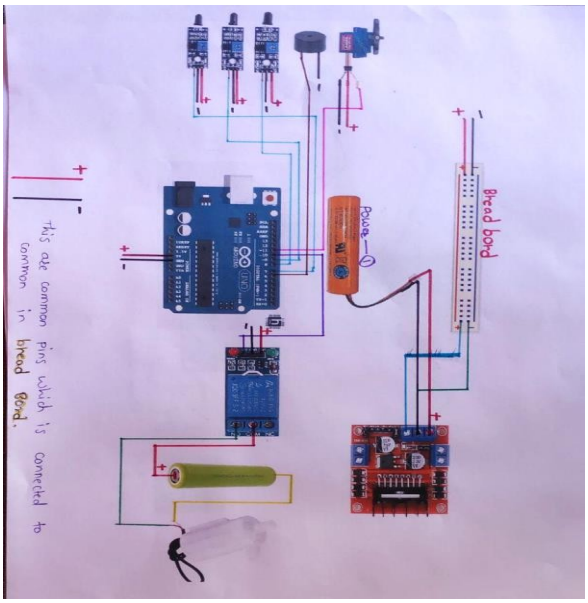

Fig.4CircuitdiagramofArduino

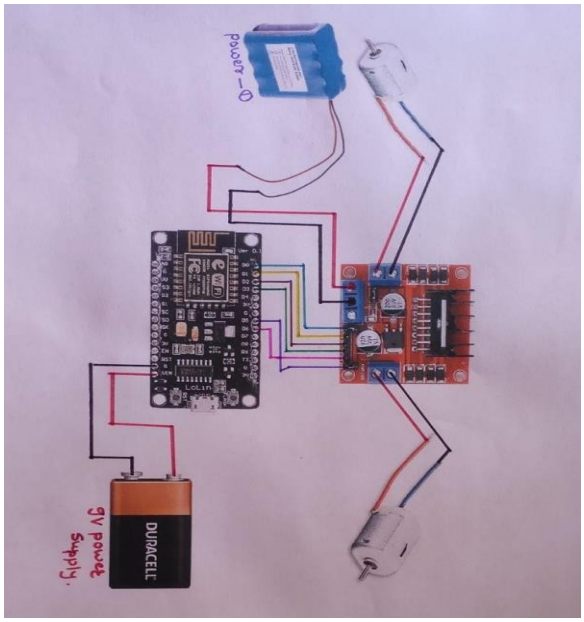

Fig.5CircuitdiagramofNodeMCU

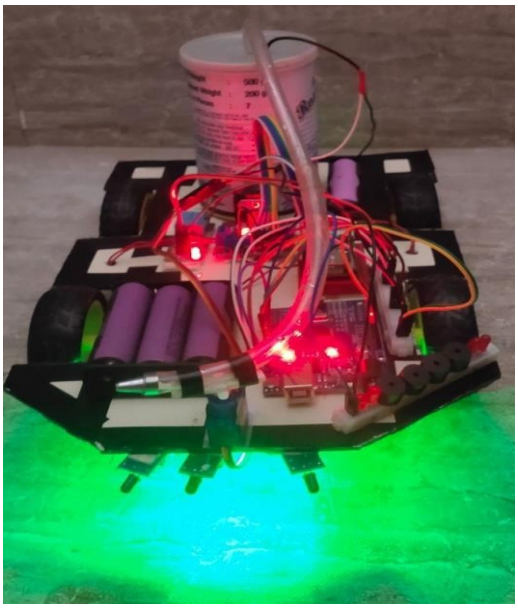

Fig. 6 Top view of Fire Fighting robot

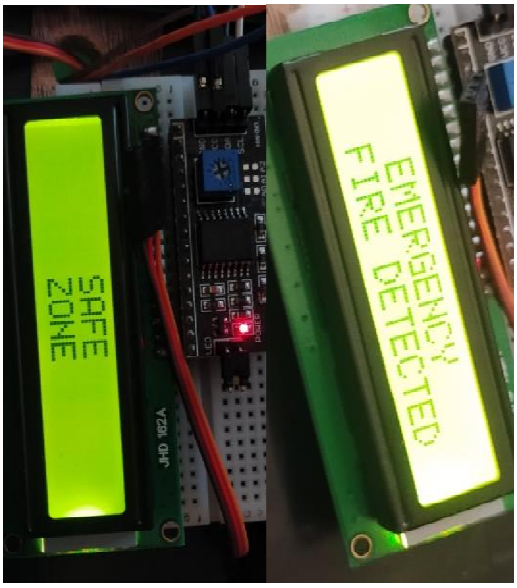

Fig. 7 LCD display in working mode

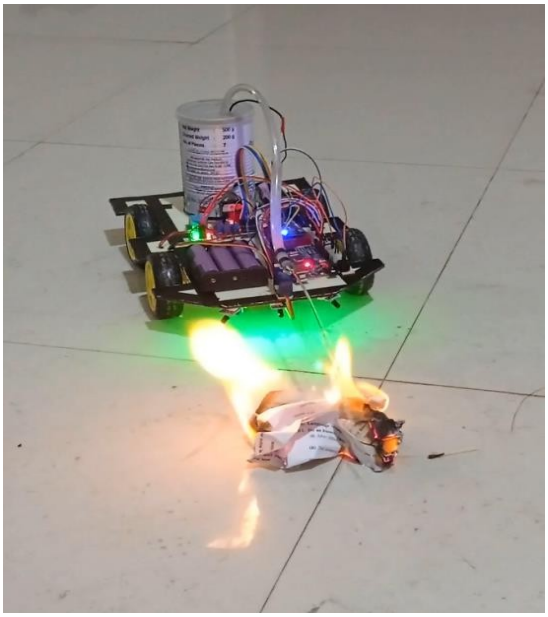

Fig. 8 Front View of Fire Fighting Robot

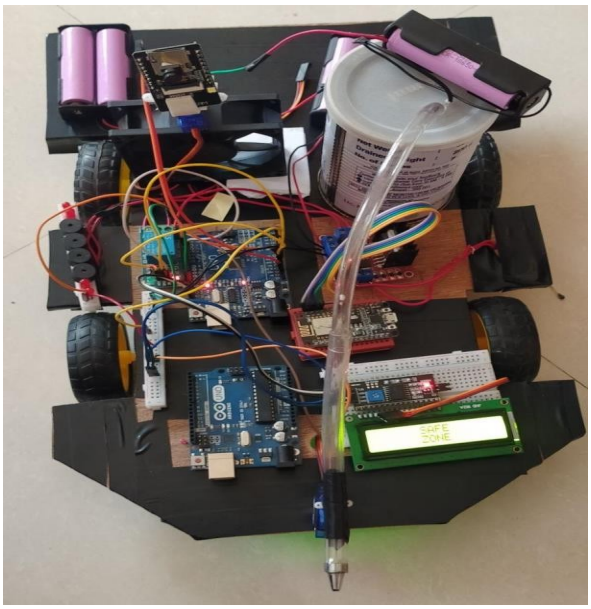

Fig. 9 Robot in working mode

VII. CONCULUSION

The most efficient result of our project is its successful outcome. This project is really power efficient, effective and works fine. 'A Firefighter Robot' proposed in this document is a solution to all real-world problems. The way the project works is that it is programmed to work according to signals from sensors and signals from mobile phones. The microcontroller used in the Arduino UNO reads the input from the flame sensor, and the node MCU reads the input from the mobile phone. Arduino controls the trip time of the relay and sends the signal to the pump to take appropriate action. Its unique property is that it works under critical conditions and saves lives. Therefore, the robot can also be called a rescue robot. As a result, the project proved to be highly innovative and effective in reducing firefighters' risk.

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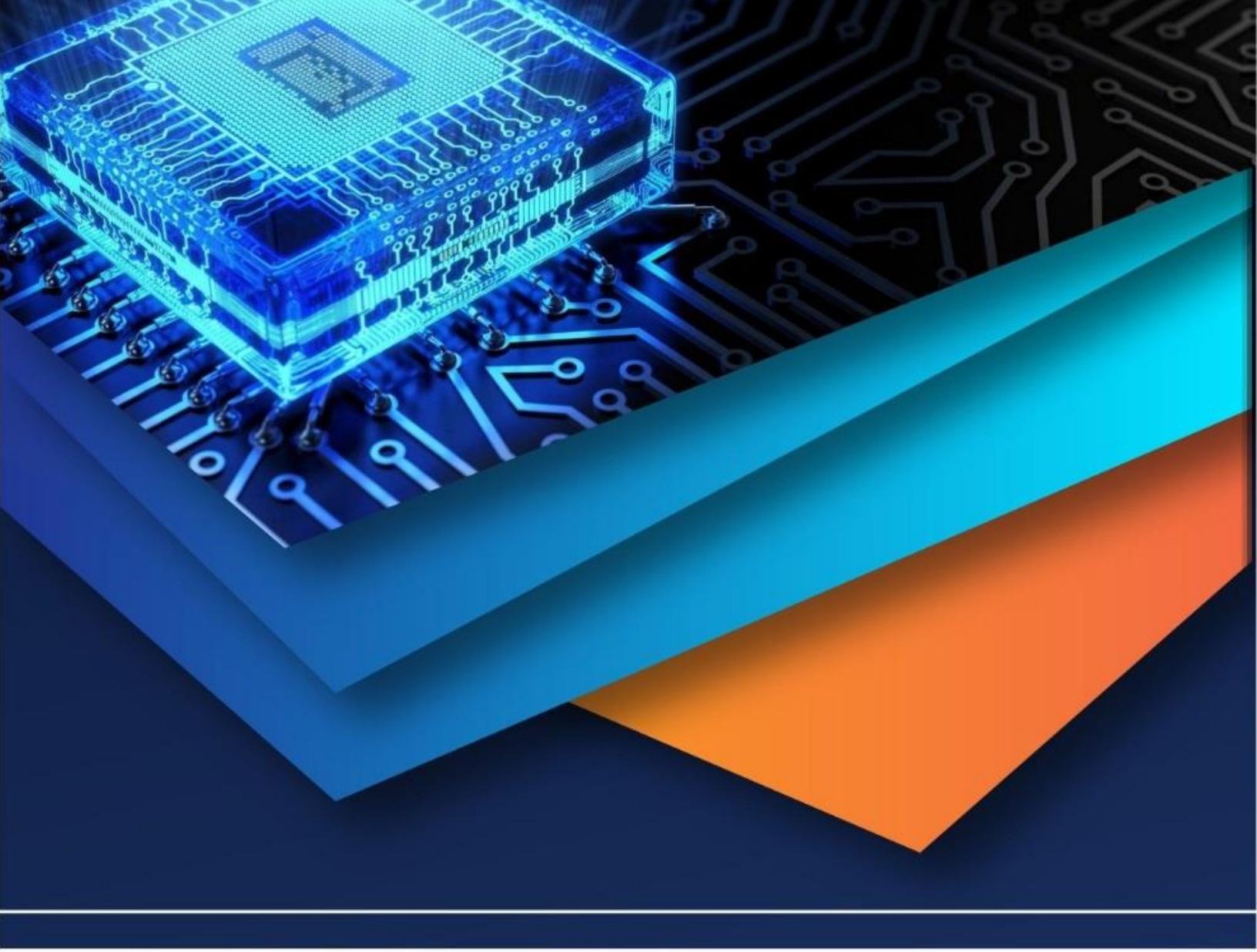

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