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An IoT-Based Robotic Defence System for Soldier Assistance

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Abstract: Today the technology is advancing day by day and robots are being used in various fields and everywhere. This research paper is about how to use robot in military field or how we can help our Indian soldier by using robot. The main objective of this project is the use of robot in secret military operations to defect the enemy. The project is about a robotic defence system that will help the Indian Army to perform high risk missions in a safe manner. The robot-car has ESP32 microcontroller, camera module, pan tilt assembly, radar and automatic gun which is wirelessly controlled. The wheels are fitted with DC motors which are coupled to the Arduino controller and the commands from the accelerometer of the smartphone are sent to the microcontroller on which the motion and direction of the wheel can be controlled. The robot can move forward, backward, left and right and this movement is controlled by Arduino through web page by API calling in the smart phone. We can also see the live video in the web page. The video allows soldiers to behave properly. This robot car is helpful in minimizing the risk of a soldier's life. It can move through rough terrains, take live images, detect threats using radar and take immediate action by remotely targeting and neutralizing threats.

Keywords: Military field, Robotic defence system, Arduino, microcontroller, camera module.

I. INTRODUCTION

In such critical conditions, Indian borders have been facing many attacks. We developed a surveillance robot specially for military purposes. Similar to what occurred between India and Pakistan in 1999, fought in the high-altitude Kargil region of Ladakh. This took place when the Pakistani soldiers and militants stealthily crossed the Line of Control, took the strategic mountain positions in the winter when the Indian posts are less guarded and attacked the camp of the Indian soldiers. And in the answer of their attack India lunched Operation Vijay and they are successful in that. After hard battles in very harsh conditions, India was able to recapture most of the occupied territory. 527 Indian soldiers embraced martyrdom. Our robot car is used especially in secret operations.in this they know the enemy before attack. The main component of the system is Arduino. It is a micro-controller which performs all the processes of system. We can use this kind of technologies in the border area to keep tracking all the activities of opponent by radar system, when any terrorist comes close to the border, through that radar we will be able to know that they are coming close to our border, from there we can immediately take a decision and protect the Indian Army to sudden attack. Equipped with a camera, pan-tilt mechanism, radar system and Wi-Fi-based remote control, the robot offers real-time monitoring and precise control while keeping a safe distance. Our robot car lower portion is designed on the basis of ISRO's Chandrayaan-3 which can move on the rough surface without any difficulty. Our main agenda is to protect the life of our soldier with the help of modern technology. Besides, the base part of the Robot has wheels, so they can travel on rough & watery surfaces too. The sensor helps the robot to avoid collision with unwanted obstacle. The camera module streams the live footage of the scene over Wi-Fi to the receiver screen. So, the person sitting on output screen can have all the records of opponent activities. Such robots can easily replace the soldiers and do the duty with better modifications. So, in the future the warfare is handled by this kind of smart robots. Which minimize the life threats during wars.

II. LITERATURE SURVEY

In recent years advancements in microcontroller technologies, wireless communication protocol, and low-cost camera module have enhanced the capability of such systems. Now a days using these technologies the robot works very well in every field. The Robot term was first presented by Karel Capek, a Czech poet in 1920. The term come from Czecha, the term robot that means tough work. A robot is generally an electromechanical machine that's capable to perform tasks rainfall automatically or manually or in both moods. It's also used in the assiduity, which replaces the mortal being to work in similar condition. Battleground assistive Robot can be defined as a machine that removes the mines in war each on its behalf and can be used espionage on the adversaries.

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Currently with the enhancement of technology, robots are used in military operations, which are not fully automated. The robots or unmanned machines as they're nominated, can be any moving object, fitted with all necessary outfit like detectors, LIDARS (Ray grounded Communication RADARS), cameras etc. [1, 7, 8]. S. Naskar et. al. tried to explore how a radio frequence controlled by robot, that can be used in defence and in real war field. The robot is radio operated, tone- powered, and has countermanding installation, in case of loss of connection from the base station. Wireless cameras will shoot back real time videotape and audio inputs that can be seen on a remote examiner in the base station from where the robot is being controlled and action can be taken consequently [4, 5, 6]. Robots, shows how the ultramodern widgets and munitions are used by fortified forces for reducing the peril to their life and to overcome their adversaries. With the advancement of sophisticated technology, it generally depends on the cutting-edge munitions or systems being employed. Low power wireless technology for artificial operation is a description on how the WSN (Wireless Sensor Network) has reduced burden on people with the use of its network and communication technology. presently Wireless Local Area Networks (WLANs) are extensively used for close field communication indeed though they've faults similar as complexity, large power dispersion. Bluetooth is used now as it uses low power and provides good data transfer speed at close range [2,3]. In the context of robotics, the use of ESP32 for building low-cost surveillance robots capable of capturing and transmitting live video.

III. SOFTWARE, LIBRARY FUNCTION AND HARDWARE REQUIREMENTS

TABLE I : Software, library function and hardware requirements for the prototype model

Hardware	Software	Library function
1. *ESP32 Cam module* 2. *esp32 WROVER module* 3. *Pan Tilt Servo 1 229 assembly* 4. *Johnson gear motor, Servo motor* 5. *PVC pipe set* 6. *L298N motor driver module* 7. *12v 7ah lithium Battery* 8. *Buck converter, step down voltage* 9. *Arduino Uno* 10. *Jumper wires set* 11. *gel blaster automatic gun* 12. *Wheels (6 units)* 13. *Wireless remote-control* transmitter. 14. *GPS tracking chip*	1. Arduino IDE 2. ESP32 Board Package 3. Web Browser (Chrome) 4. Operating System (Windows)	1. AsyncTCP Library 2. ESPAsyncWebServer Library 3. ESP32 Camera Library 4. Arduino Core for ESP32 5. Wi-Fi Library 6. Servo Library

IV. HARDWARE COMPONENTS USED

TABLE II : Hardware components used in the prototype model

NO.	COMPONENT NAME & DEFINATION	PICTURE
1.	ESP32-CAM module: It is a small, reasonably priced board with a camera (typically OV2640) and an ESP32 chip for Wi-Fi/Bluetooth, making it ideal for Internet of Things cameras, motion detection, and streaming. It can take pictures and videos, save them to SD, stream them to web servers, and perform AI/ML. Typically, code is used with the Arduino IDE to obtain live feeds or stored images for projects like home security or smart monitoring.	 Fig. 1 ESP32-CAM module

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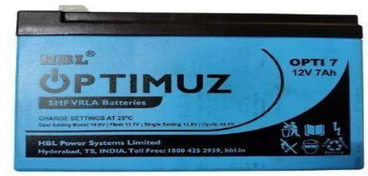
2.	ESP32-WROVER module: This rugged Wi-Fi, Bluetooth and Bluetooth LE MCU module features additional Pseudo-static RAM (PSRAM) besides the standard flash memory in the ESP32-WROOM family. There are several variations, which can be distinguished mainly by the type of antenna (PCB or external IPEX connector) and memory size.	 Fig. 2 ESP32-WROVER module
3.	PVC Pipe Set: It is used to build the physical frame and support structure of the robotic vehicle. PVC offers strength, durability, and lightweight construction.	 Fig. 3 PVC Pipe Set
4.	Pan-Tilt Servo 1×229 Assembly: It Allows horizontal (pan) and vertical (tilt) movement of the camera, enabling wide-angle monitoring without moving the robot.	 Fig. 4 Pan-Tilt Servo 1×229 Assembly
5.	Johnson Gear Motor: Johnson gear motors are built to provide high torque, which makes them ideal for driving robots across rough or uneven ground. Their strong design and gear reduction enable powerful, controlled movement. This helps the robot keep traction and stability in tough conditions.	 Fig. 5 Johnson Gear Motor
6.	L298N Motor Driver Modul: Interfaces between the microcontroller and DC motors. It controls motor direction and speed required for forward, reverse, left, and right movement	 Fig. 6 L298N Motor Driver Module

7.	12V 7Ah Lithium Battery and 12v 7Ah SMF vrla Battery: Supplies sufficient power to operate motors, controllers, camera, and accessories for extended mission duration. This is use for upper part of the project and 12v 7Ah SMF vrla Battery is used for lower part of the model.	 Fig. 7 12V 7Ah Lithium Battery
8.	Buck Converter (Step-Down Voltage Module): The buck converter (step-down voltage module) is used to efficiently reduce an input voltage from an external power source (e.g. a battery) or, if there are power supply issues, to provide an output voltage at a controlled level. Powering sensitive electronic devices (e.g. the ESP32, Arduino and servo motors) requires a lower voltage than the battery provides in order for these devices to operate correctly and at the maximum potential without being damaged or damaged due to unstable voltage levels.	 Fig. 8 Buck Converter
9.	Arduino Uno: Used as a secondary controller to handle motor driving, servo control, and peripheral operations for smooth system performance.	 Fig. 9 Arduino Uno
10.	Gel Blaster Automatic Gun: Used as a defence simulation module to demonstrate threat response capability for educational and prototype purposes.	 Fig. 10 Gel Blaster Automatic Gun
11.	Wheels: Enable smooth movement, stability, and load distribution of the robotic vehicle on ground surfaces.	 Fig. 11 Wheels

12.	Wireless Remote-Control Transmitter: Allows manual control of the robotic vehicle from a safe distance, ensuring operator safety during high-risk missions. This Wireless Remote-Control Transmitter used to robot car Suicide bomb attack control.	 Fig. 12 Wireless Remote-Control Transmitter
13.	GPS tracking chip: The GPS tracking chip is used to find out where the robotic vehicle is in and give us real time location during the secret mission. It continuously receives satellite signals and calculates the robot's latitude, longitude, and movement path.	 Fig. 13 GPS tracking chip

V. IMPLEMENTED ARCHITECTURE

A. Lower Part Design

we are going to make robot-car with pan tilt that control and using this assembly, we can rotate the camera horizontally and vertically from 0 to 180°. We will use to micro controller is ESP 32 robber model control command to ESP 32 model or serial communication will capture images using camera present of the car and send these images to our mobile phone using web socket through Wi-Fi connection. We will use that car can be moved in any direction. We will also control the robot-car with our own webpage**.**

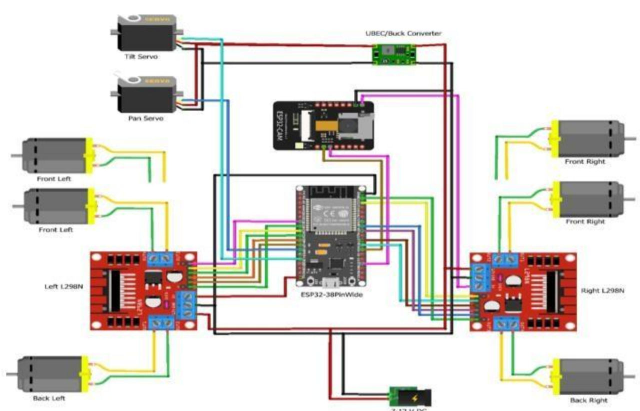


Fig. 14 Lower part Circuit diagram

Fig. 15 Lower part design

This diagram represents an ESP32-based surveillance robot car. A 7–12 V DC battery supplies power to the system. The voltage is reduced to 5 V using a UBEC/buck converter, which powers the ESP32 controller, ESP32-CAM, and the pan-tilt servo motors.

The ESP32 (38-pin) acts as the main controller. It sends control signals to two L298N motor drivers. The left L298N drives the front-left and back-left motors, and the right L298N drives the front-right and back-right motors, allowing forward, reverse, and turning movements.

The ESP32-CAM provides live video streaming, while the pan and tilt servos rotate the camera horizontally and vertically. All components share a common ground, ensuring synchronized movement, camera control, and real-time monitoring.

We have installed this remote-control transmitter on our robot car to launch bombs in case of emergency or to take it to the terrorist camp because now if we do not attack with a drone or drone jammer, it will fail and all the plans and money will be wasted.

Again, during a secret operation, if the enemy attacks our robot car and then our robot car stops working, then in that situation, if the enemy comes in front of our robot car or comes to take possession of our robot car and technology, then by clicking the emergency button and blasting, all the enemies who come along with the robot car will also die. That's why we have used this remote-control transmitter.

B. Upper part design

We use to micro controller is ESP 32 robber model control command to ESP 32 model or serial communication will capture images using ESP32 camera present of the car and send these images to our mobile phone using web socket through Wi-Fi connection.
We will control the gun through our own web page. Camera and Gun both rotate the camera horizontally and vertically from 0 to 360°.

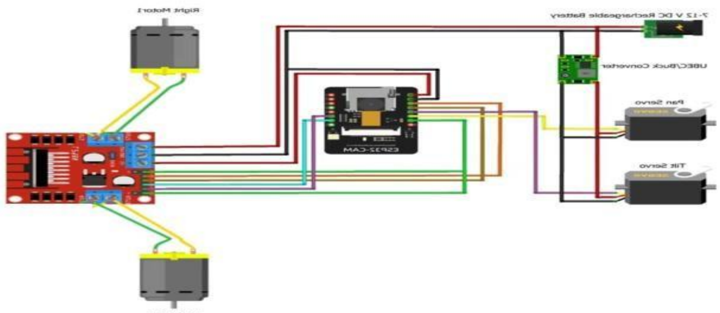


Fig. 16 Upper part Circuit diagram

This diagram shows an ESP32-CAM based robot system. A 7–12V rechargeable battery supplies power to the system. The voltage is reduced to 5V using a UBEC (buck converter) to safely power the ESP32-CAM and the pan and tilt servo motors. The ESP32CAM acts as the controller and camera module. It sends control signals to the L298N motor driver, which drives the left and right DC motors to move the robot. The pan and tilt servos rotate the camera for better viewing. All components share a common ground, allowing coordinated movement and live video surveillance. Basically, this the small prototype.

VI. SYSTEM TESTING

The system testing process aimed to determine all defects in our project. The program was subjected to a set of test inputs and various observations were made based on these observations it will be decided whether the program behaves as expected or not.

A. Upper part of prototype model

The upper portion of our invention has a gun and a camera that we can use to observe anything. If an adversary approaches the car, we can see them and use the pistol to kill them. We have control over those things on the web page.

B. Lower part of prototype model

The main camera and wheel are located in the lower portion of our project. The robot car is moving forward and backward on this wheel, and the camera shows where it has vanished. We also have control over those things on the web page.
Web page: It handle the whole project using this web page. The fig18. image shows a mobile web interface (an ESP32-CAM, car camera module) accessed through the IP address 192.168.4.1.

C. Top Section – Live Camera Feed

The large top portion is a live camera video stream.

- A view from inside a vehicle or a mechanical space.

D. Middle Section – Control Buttons

In Fig 17, there are black rounded buttons with red arrows indicating motion control having the meanings of,

Up arrow → Move forward | Left arrow → Turn/move left
Right arrow → Turn/move right | Down arrow → Move backward

E. Bottom Section – Sliders / Adjustable Controls

There are four labelled sliders:

1. Speed
   - Controls how fast the robot is working.
2. Light
   - Likely controls LED brightness on the camera.
   - The slider is around the left-middle, meaning moderate brightness.
3. Pan
   - Used to gun trigger is squeezed, releasing the firing pin.
4. Tilt
   - Used to rotate the camera and gun up–down.
   - Slider is around the right-middle, tilting the camera somewhat upward or downward depending on direction.

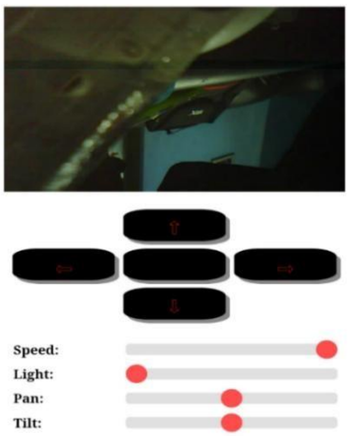


Fig. 17 Overview of webpage

Fig. 18 Prototype Model of Robot Car

DATAFLOW DIAGRAM FOR WORKING

A Data Flow Diagram (DFD) is a diagram that illustrates the flow of data in a system. It is used to visualize the steps of the data processing and the interactions between different components. DFD is useful in encryption and decryption processes to understand how data is transformed from plaintext to ciphertext and vice versa to plaintext.

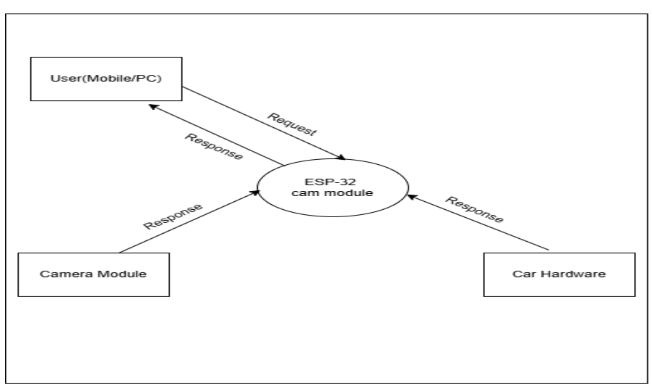


Fig. 19 Level 0 DFD

Fig. 19 is a Level-0 Data Flow Diagram (DFD) for an ESP32-CAM based car control system. A Level-0 DFD shows the whole system, its external entities, and the main data flows, without going into too much detail.

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1. Central Process

ESP32-CAM Car Control System

- • This is the main system (shown as an oval).
- It receives commands, processes data, controls the car hardware, and streams video.
- All interactions pass through this central unit.

2. External Entities

a) User (Mobile / PC)

- Represents the person controlling the car using a mobile phone or computer.
- Data sent to system:
- Control commands (move forward, backward, left, right, stop, etc.)
- Data received from system:
- Live video streaming from the ESP32-CAM

b) Camera Module

- Supplies real-time video input to the ESP32-CAM system.
- The ESP32-CAM processes this video and sends it to the user as a live stream. c) Car Hardware

Includes motors, motor driver, wheels, lights, and other mechanical components.

- Receives control signals from the ESP32-CAM.
- Executes physical actions such as:
- Moving the car
- Turning
- Speed control

3. Data Flows

- User → ESP32-CAM
- Control commands from mobile/PC.
- ESP32-CAM → User
- Live video streaming.
- Camera Module → ESP32-CAM • Video data input.
- ESP32-CAM → Car Hardware
- Motor and movement control signals.

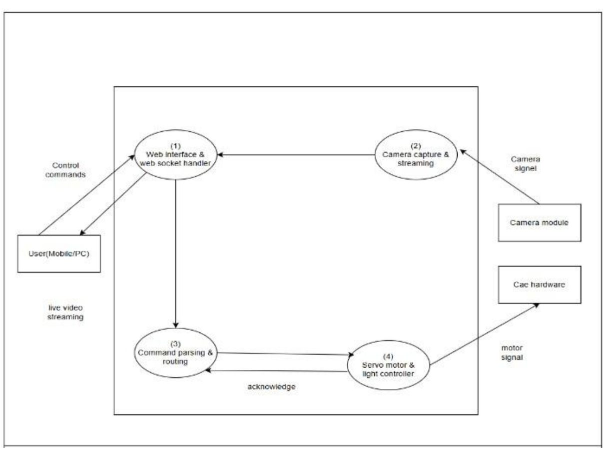

Fig. 20 Level 1 DFD

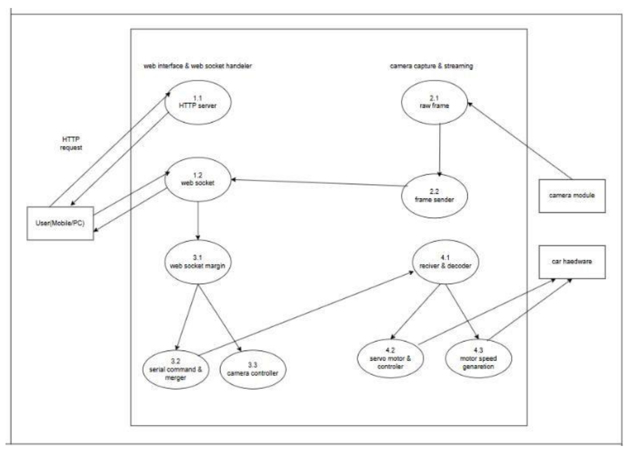

Fig. 21 Level 2 DFD

Fig. 20 is a Level-1 Data Flow Diagram (DFD) of the ESP32-CAM car control system, showing the internal processes.

1. Web Interface & WebSocket Handler
   Receives control commands from the user (mobile/PC) and sends live video stream back to the user.

2. Camera Capture & Streaming
   Takes camera signals from the camera module, processes them, and sends video data to the web interface for live streaming.
3. Command Parsing & Routing
   Interprets user commands and converts them into serial control commands.
4. Servo Motor & Light Controller
   Executes commands by generating motor and light signals to control the car hardware and sends acknowledgements back.

F. Overall flow

User commands → web interface → command processing → motor control → car hardware, while camera data → streaming → user.

Fig. 21 shows the Level-2 Data Flow Diagram (DFD) of the ESP32-CAM car control system, explaining detailed internal processes.

- User (Mobile/PC):

Sends HTTP requests to access the control page, receives HTML page, and views live video stream.

- (1.1) HTTP Server:

Handles HTTP requests and serves the web interface to the user.

- (1.2) WebSocket (Camera):

Maintains real-time communication for video streaming and control data.

- Camera Capture & Streaming:
- (2.1) Raw Frame (ESP32-CAM): Captures raw images from the camera module.
- (2.2) Frame Sender: Sends video frames to the WebSocket for live streaming.
- Command Handling:
- (3.1) WebSocket Merging: Combines camera and control data.
- (3.2) Serial Commands & Router: Routes parsed commands to hardware controllers.
- (3.3) Camera Controller: Controls camera settings like rotation or quality.
- Motor & Light Control:
- (4.1) Receiver & Decoder: Decodes control commands.
- (4.2) Servo Motor Controller: Controls steering or camera pan/tilt.
- (4.3) Motor Speed Generation: Generates speed signals for motors and lights.
- This dataflow diagram is designed to work equally well on both the lower part and upper part

VII. FUTURE SCOPE

Our future aim of the project is to enhanced with intelligent decision-making abilities such as automatic threat identification, object tracking and path planning using AI based models and machine learning. We have to add vision at night, and distance measurement and temperature. Instead of Wi-Fi, advanced communication systems such as LoRa or satellite connectivity can be used to control the robot over very long distances without signal loss. Solar panels or hybrid battery systems will increase the working time of the robot and it will be used in long missions. Video streams and mission data can Be stored in secured cloud servers for real time analysis, logging and mission planning.

VIII. CONCLUSION

This project demonstrates the significant potential of robotics and IoT to enhance military defense systems. The robot-car with ESP32-based controls, 360° rotating camera, radar detection and Wi-Fi-enabled control interface, enhances the Indian Army's ability to carry out secret missions securely.

It can traverse challenging terrain, identify threats in real time, and neutralize danger without endangering human lives. There are some challenges such as Wi-Fi range and vulnerability to heavy weaponry, but the system can be made even more reliable with future enhancements including advanced radar systems, long-range communication modules and more robust components. This project, overall, is a step toward modernizing defense operations with innovation, automation and safety at its core.

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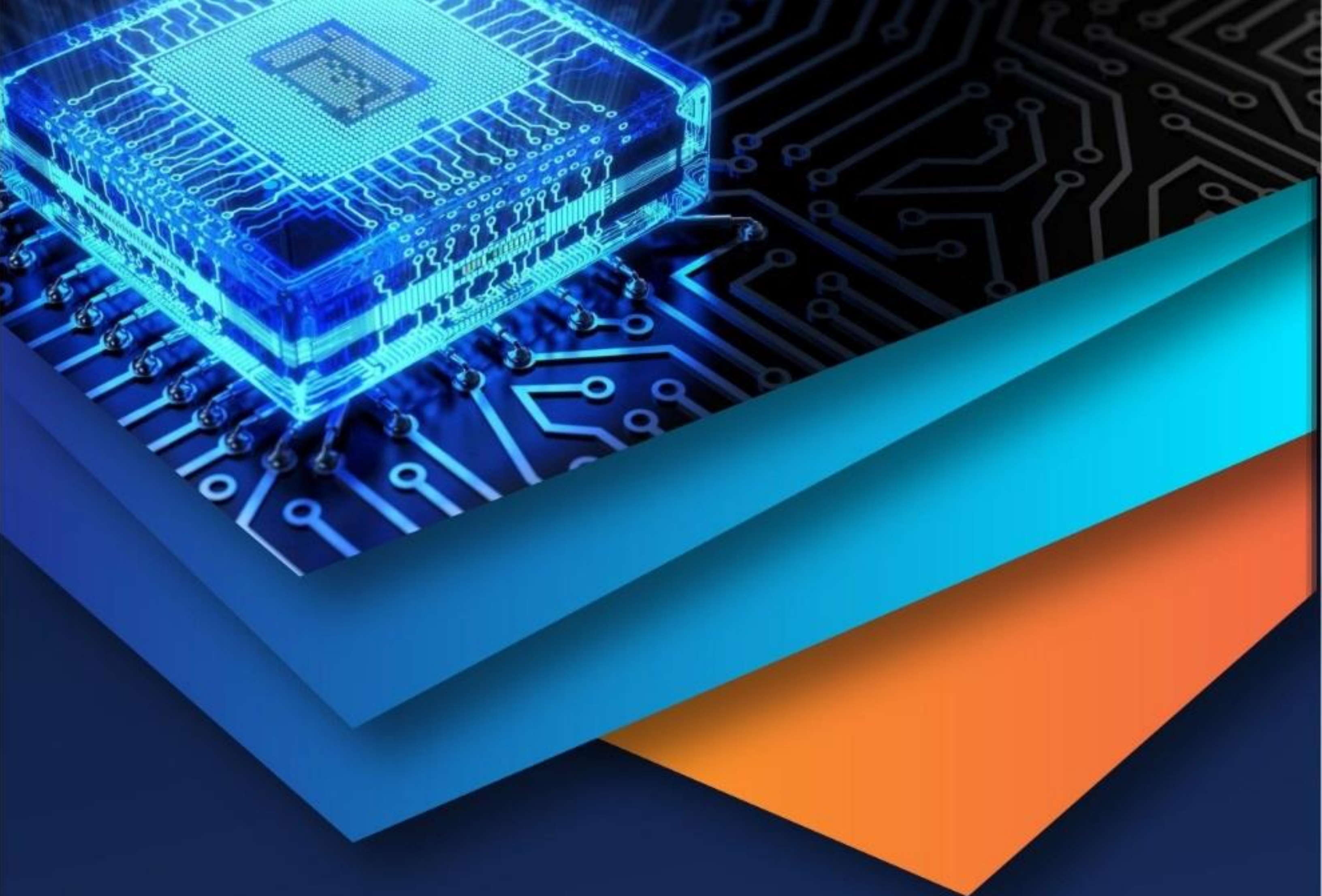

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