iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 **Issue:** V **Month of publication:** May 2024

DOI: https://doi.org/10.22214/ijraset.2024.62184

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue V May 2024- Available at www.ijraset.com

Advanced Tactical Helmet for Military Use

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Abstract: ***Advanced features on a tactical helmet designed for military use. Soldiers in today's military operations must have improved situational awareness, strong communication skills, and superior protection when fighting. A new generation of tactical helmets with enhanced features is required because the standard helmets now in use do not adequately fulfil these criteria. To improve army performance and survivability The helmet has several extra features in addition to its extensive ESP32 CAM for real-time data visualization, communication systems for seamless inter-squad communication, and improved ballistic protection materials. Among these characteristics include the incorporation of a helmet camera's First-Person-View (FPV) live video feed into a base station, along with the base station's face detection capabilities for enhanced identification. SolidWorks was used in the design process to produce a unique 3D-printed helmet, while ESP32 and ESP8266 were used to power a custom mainboard that effectively controlled the helmet's functions. this creative solution aims to significantly improve military operations, increase survivability, and ensure the safety of soldiers on the battlefield.***

Keywords: Military, Smart Helmet, IoT, Monitoring System, Audio Communication, Environmental monitoring, Centralized monitoring and control, Intelligent battlefield support.

I. INTRODUCTION

An inventive and adaptable helmet, the Proposed System for Advanced Military Applications is intended to greatly improve the capabilities and security of military personnel in the field. It combines a wide range of modern technologies to offer a complete solution for mobile network communication, environmental monitoring, object detection, motion sensing, accurate location determination, seamless wireless communication, effective audio capabilities, and image/video processing.

Improving soldiers' situational awareness, communication, and decision-making in demanding and dynamic environments is the main goal of the helmet. This intelligent tactical helmet includes innovative features that address important areas of military operations. Tactical equipment. With the addition of an audio amplifier and condenser microphone, audio capabilities further improve communication by facilitating voice communication, clear and dependable audio transmission, and audio recordings for documentation and analysis.

II. RELATED WORK

Various researches are going on the field of smart helmet system for portable health monitoring, reliable system and cost-effective solution for various applications some researches involve: An IoT enabled approach for Smart Data Logging Helmet which ensures the vehicle drivers safety. It monitors the speed, accident status also location of the driver using GPS module, MPU6050, and Hall Effect sensor [1]. Smart Helmet for accident avoidance which combines various features like alcohol detection, if person is wearing or not helmet, GPS sensor for live location tracking [2]. SMS alert-based mechanism system for road accident using Smart Helmet with accident detection using Tilt sensor, and Vibration sensor with GPRS module [3]. This paper suggests augmented reality model to display battlefield related information on screen and live video transmission using Pi camera module [4]. Development of smart helmet for construction workers involves the fall detection of worker using accelerometer and gyroscope sensors also the health is continuously monitored using GSM module via SMS alert [5].

A study on using 5G technology for military applications a comparative based study approach for using 5G military and civil applications involves the transmission requirements [6]. A study on the use of Internet of Things for military application for weapon and various equipment management, health monitoring, logistic support etc. were evaluated [7]. Military training tracking system based on the Immersive Audio Environment system involves simulating the real-world battle environment using audio effects to test and evaluate the accuracy [8]. Alcohol detection and Safety driving smart helmet prototype using IR sensor and Alcohol sensor and GSM based alert system [9]. The authors explore the explore the benefits and challenges of utilizing 5G technology for military purposes [10]. The authors investigate the application of MIoT in their paper presented at ICCWAMTIP 2020.

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They focus on researching the potential uses of MIoT and its implications for military operations, shedding light on its significance in modern warfare [11]. In this paper presented at IEMCON 2020. The system integrates IoT technology to enhance road safety by detecting accidents and sending alerts in real-time. The research provides valuable insights into the design and implementation of smart helmets with potential applications in improving road safety and minimizing accident risks [12]. The capacitive sensor serves as a crucial input, ensuring the helmet's basic safety functions are activated only when properly worn and locked. The integration of SW-420 vibration sensors and GPS module enables real-time accident detection and emergency response, allowing for location-based SMS alerts through the GSM module. This comprehensive system showcases advancements in IoT technology applied to helmet construction, emphasizing the importance of road safety awareness for riders [13]. The paper by Fernández-Caramés and Fraga-Lamas provides a review on IoT wearables and intelligent e-textiles, exploring the advancements in smart clothing and their integration with IoT technologies. It highlights the potential of connected e-textiles in enhancing user experience, health monitoring, and interactive functionalities, serving as a valuable resource for IoT and wearable technology research [14]. This study by Lo et al. focuses on the application of wearable assistive technology to enhance soldiers' effectiveness. Investigating the use of such technology, the paper explores its potential impact on improving soldier performance and safety. The research provides valuable insights into the integration of wearable devices for defence and safety purposes, contributing to the advancement of human factors and mechanical engineering in military contexts.[15].

References	Functionality	Published Year
K Ramesh, SB Lamani	To introduce the technological remedy for the communication issues cochlear implant users have.	2017
P Shah, A Faza,	The effectiveness and quality of military training programs can be improved by integrating tracking technologies like infrared and inertial tracking.	2012
RK Sharma, G Kumar	The prototype was created with motorcycle riders in mind to improve riding safety. This implies an emphasis on enhancing traffic safety.	2020
M Uniyal, H Rawat	Device connectivity as well as data gathering, transfer, and analysis are made possible via the Internet of Things.	2018
A Jesudoss, R Vybhavi	The paper might discuss the physical design of the helmet, considering factors like comfort, visibility, and user-friendliness.	2019

Table 1 Comparative Study of Literature

III. METHODOLOGY

Among these characteristics include the incorporation of a helmet camera's First-Person-View (FPV) live video feed into a base station,. SolidWorks was used in the design process to produce a unique 3D-printed helmet, while ESP32 and ESP8266 were used to power a custom mainboard that effectively controlled the helmet's functions. To ensure that the Tactical Helmet with these cutting-edge capabilities is reliable and effective in combat situations, it will go through a rigorous testing and evaluation process. By providing soldiers with a cutting-edge helmet that improves their skills, this creative solution aims to significantly improve military operations, increase survivability, and ensure the safety of soldiers on the battlefield.

A. Environmental Monitoring

The system's primary goal is to simplify the process of keeping an eye on the nearby surroundings in real time. The seamless integration of specialised sensors allows for the measurement of the following significant environmental parameters:

1) *Air Quality Sensing:* The helmet is equipped with specialised sensors that allow for continuous monitoring of the air quality, allowing for the early identification of dangerous gases and pollutants that may pose a threat to the soldiers' safety.
2) *Temperature and Humidity Sensing:* The helmet has sensors to track the temperature and humidity levels, giving soldiers critical information about their operating environment. Decision-making and situational awareness are enhanced by these metrics.

B. Communication System

The suggested system includes a robust communication infrastructure crucial for facilitating efficient team coordination and communication. It features a Bluetooth-enabled transmission and reception system for live audio communication. This allows seamless integration with mobile phones or PCs, enabling team members to access and exchange data in real-time. In emergency scenarios, this approach streamlines decision-making processes and fosters improved teamwork dynamics.

C. Live Video Streaming Functionality

Among the smart tactical helmet's sophisticated capabilities is the ability to stream live video.
Live Video Feeds: Using the built-in camera on their helmet, soldiers can broadcast live video from their point of view. On the field, this real-time visual stream helps with informed decision-making by improving situational awareness.

D. Live Tracking

In addition to a robust communication system, the suggested smart helmet integrates a GPS sensor for tracking longitude and latitude coordinates. This feature allows for precise location monitoring of team members, enhancing situational awareness and enabling swift response in emergency scenarios. The GPS data can be transmitted to mobile phones or PCs via Bluetooth, providing real-time updates on the whereabouts of each team member. This integration of GPS technology further strengthens team coordination and communication, ultimately improving overall operational efficiency and safety.

E. G-force for accidental monitoring

In addition to a robust communication system, the suggested smart helmet integrates a G-force sensor to measure and monitor acceleration forces experienced by team members. This sensor provides valuable data on sudden impacts or movements, alerting the team to potential accidents or injuries in real-time. The G-force sensor data enhances safety measures and ensures prompt intervention in critical situations, further strengthening team coordination and communication for improved operational efficiency.

F. Face Detection on Base Station

Advanced face detection technology is installed in the base station to further improve the capabilities of the system:

1) *Face Recognition System:* On the base station, a reliable facial detection algorithm is put into place. In order to recognise and detect faces in the field of view, it processes the live video stream from the helmet's camera feed.
2) *Enhanced Identification:* By differentiating between friendly personnel and possible threats, the facial detection capabilities helps identify people in the field. On the battlefield, this helps to enhance situational awareness and decision-making.

G. Power Management

Efficient power management is a crucial aspect of the proposed system's design:

1) *12V Battery:* The energy source for the system is a 12V battery, chosen for its balance of energy capacity and weight, ensuring optimal portability.
2) *Step-Down DC-DC Converter:* The system regulates the supply voltage to different modules. This converter ensures consistent and suitable operating voltages for the various components within the helmet.

H. Modular Design and Customization

The smart tactical helmet features a modular design that allows for easy customization based on mission requirements and individual soldier preferences. Soldiers can easily swap out components such as sensors, cameras, and communication modules to tailor the helmet to specific operational needs. This flexibility enhances versatility and ensures that the helmet remains adaptable to evolving combat scenarios.

I. Integration with Command-and-Control Systems

The smart tactical helmet seamlessly integrates with existing command and control systems, providing commanders with a comprehensive view of the battlefield in real-time. Data collected by the helmet's sensors, including environmental conditions, soldier locations, and live video feeds, are transmitted directly to command centers for centralized monitoring and analysis. This integration streamlines communication and coordination between frontline units and headquarters, enabling rapid response to changing situations and maximizing mission success.

1) Proposed System

The proposed system integrates a suite of advanced components to enhance situational awareness, communication, and data collection capabilities for military operations. Utilizing temperature measurement sensors, GPS tracking modules, motion sensors, live video streaming devices, air quality sensors, and Bluetooth communication interfaces, the system offers a comprehensive solution tailored to meet the demands of modern warfare. These sensors play a pivotal role in providing crucial data insights and facilitating informed decision-making on the battlefield.

The temperature measurement sensors, such as the MLX90614, enable precise monitoring of environmental temperatures without direct contact with objects. This functionality is vital for assessing thermal conditions in the operational environment, identifying potential temperature extremes that may affect personnel performance or equipment functionality. By continuously monitoring temperature variations, the system can preemptively alert personnel to potential heatstroke risks or equipment malfunctions, ensuring operational continuity and personnel safety.

The GPS tracking modules, exemplified by the GPS NEO 6M, provide accurate geolocation data, enabling real-time tracking of personnel positions in the field. This capability enhances situational awareness by providing commanders with a comprehensive understanding of troop movements and deployments. Additionally, GPS tracking facilitates rapid response to emergencies, enabling swift extraction of personnel from hazardous situations or deployment of reinforcements to critical locations.

Motion sensors, such as the MPU 6050 module, detect and measure acceleration forces experienced by personnel. This functionality is essential for assessing personnel safety and identifying potential threats or hazardous conditions. By monitoring G-force values, the system can detect sudden impacts or movements indicative of accidents or hostile actions, triggering immediate response protocols to mitigate risks and ensure personnel safety.

Live video streaming devices, such as the ESP32 CAM, enable real-time transmission of visual data from the field to command centers or designated recipients. This capability provides commanders with actionable intelligence, enabling them to assess operational conditions, evaluate tactical situations, and make informed decisions. Live video feeds enhance situational awareness by providing personnel with visual cues and context, facilitating better coordination and response strategies.

Air quality sensors, represented by the MQ135 sensor, monitor atmospheric conditions and detect the presence of dangerous gases or pollutants. This functionality is critical for assessing environmental hazards and protecting personnel from respiratory risks. By continuously monitoring air quality parameters, the system can detect the presence of toxic gases or pollutants, enabling personnel to take appropriate precautions or evacuate affected areas to ensure their safety and well-being.

Bluetooth communication interfaces, such as the HC-05 module, facilitate wireless data transmission between system components and external devices, such as smartphones or tablets. This capability enables seamless integration with software applications, such as the Android app used for displaying sensor data. By leveraging Bluetooth connectivity, personnel can access real-time sensor data on their mobile devices, enhancing situational awareness and enabling timely decision-making in the field.

In conjunction with the hardware components, the proposed system utilizes an Android application for displaying sensor data such as coordinates and temperature. This application serves as a user-friendly interface, providing real-time access to critical information for personnel in the field. Additionally, for live video streaming, the system generates an IP address, enabling seamless transmission of visual data from the battlefield to designated recipients. By leveraging these software solutions, the system enhances communication, situational awareness, and decision-making capabilities, empowering military personnel to effectively navigate complex operational environments and execute missions with precision and efficiency.

Flow Chart

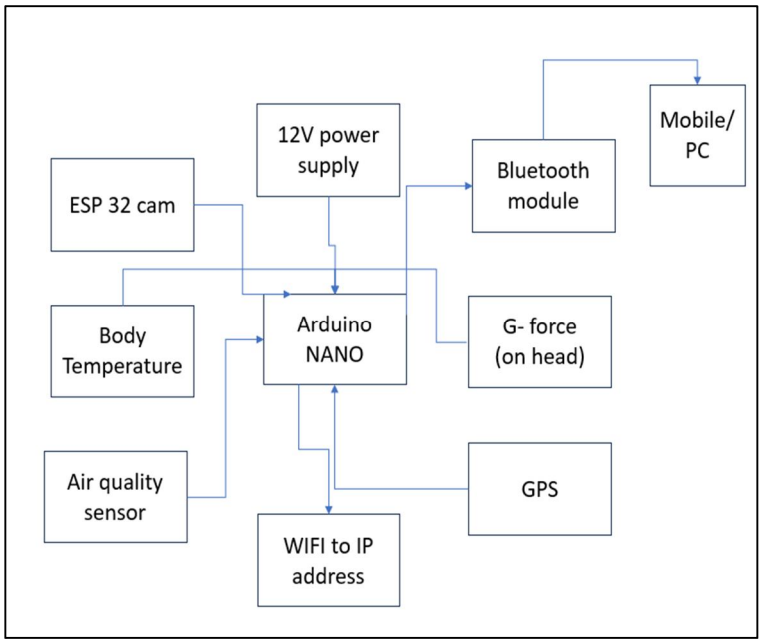


Fig. 1 Block diagram of Smart Helmet

IV. TOOLS AND TECHNOLOGY USED

The proposed system uses the following tools and technology

1) MLX90614
2) Arduino nano
3) GPS NEO 6M
4) MPU 6050
5) ESP 32 CAM
6) MQ135
7) HC-05

A. Applications

- Useful in Communication and Situational Awareness.
- Useful in Environmental Monitoring
- Useful in Industrial Area like Mining, Construction
- Target Acquisition and Tracking

B. Advantages

- Simple Operation
- Minimal Energy Usage
- Intelligent Information Recording

V. RESULTS AND ANALYSIS

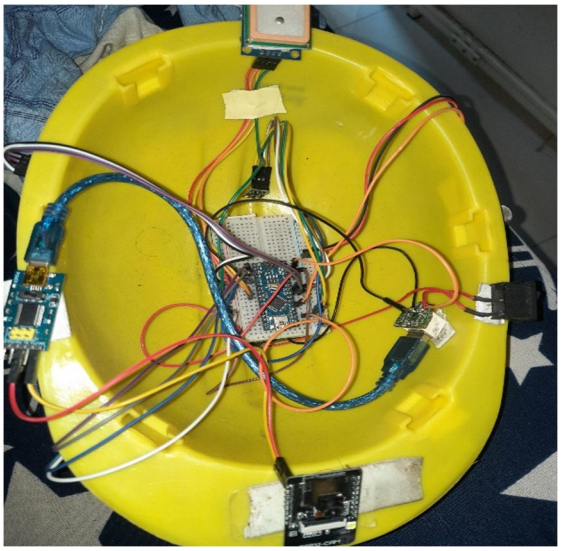


Fig5 Testing of system

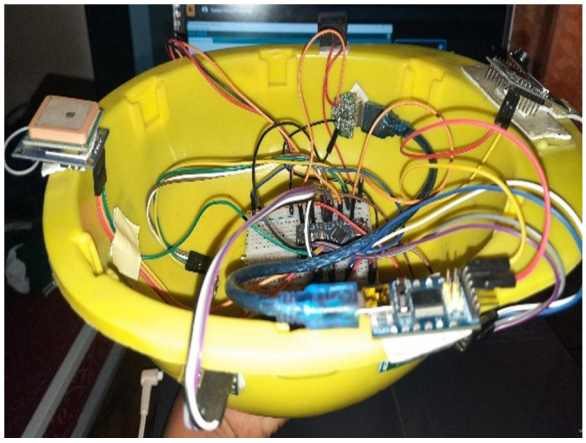


Fig6 Testing of system

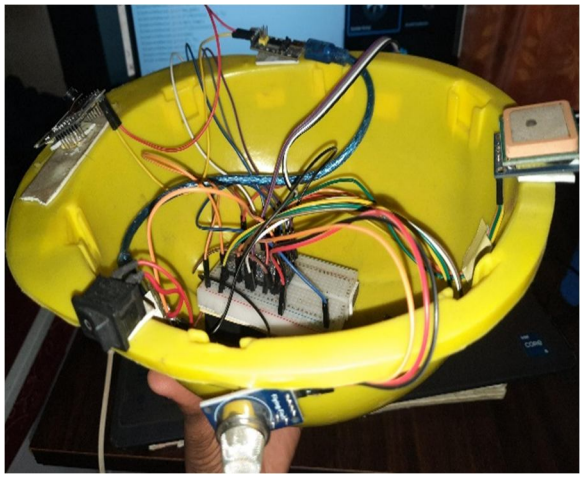


Fig7 Testing of system

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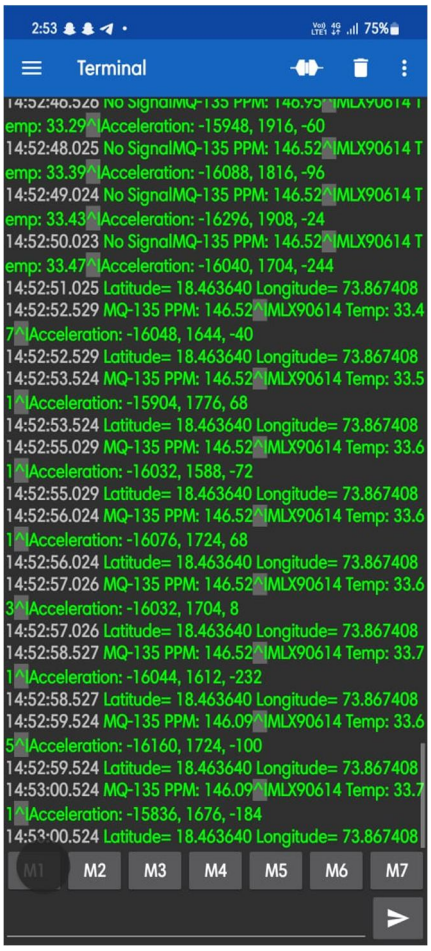
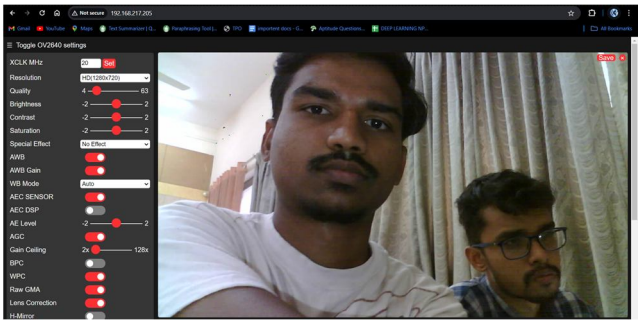
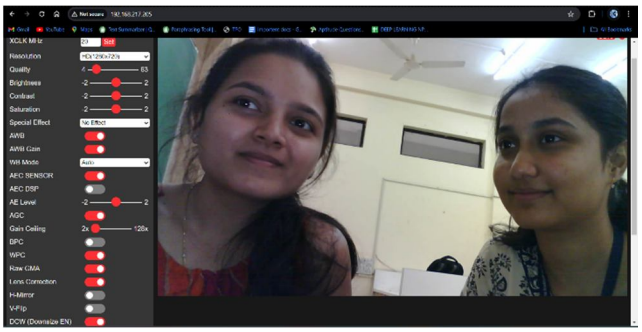


Fig .7 Application Dashboard


Fig 8 ESP32 CAM


Fig 9 ESP32 CAM

The proposed system successfully integrates various components and technologies to enhance military application. The system includes the Arduino nano pro mini for data processing, the audio amplifier and condense microphone for audio capabilities, proximity IR sensor for object detection, MPU6050 for motion sensing, ESP8266 for connectivity, GPS module 6m is used for precise location determination, Wi-Fi pod for communication via mobile. network or two provide internet for various boards like esp32, esp8266. Also tested the live video feed and face detection on base station side.

VI. CONCLUSION

Finally, the proposal for a system shows how to successfully integrate different components together with an innovative solution that is specifically geared towards national defense needs. The developed smart helmet enhances situational awareness, improves communication channels, and provides crucial information for well-informed and efficient decision-making on the battlefield by seamlessly integrating wireless communication, audio prowess, object detection, motion sensing, connectivity, precise location determination, mobile network communication, environmental monitoring, and image/video processing. The successful completion of this project highlights the practicality and effectiveness of combining these complex technologies into a single helmet system. The achieved functionalities surpass theoretical domains and significantly improve military personnel's safety, effectiveness, and efficiency in a variety of scenarios and environments. In the future, potential improvements might include more thorough integration with external systems, like command centers or surveillance networks. By enabling real-time data sharing, this extension may spark cooperative operations and increase overall operational effectiveness. Moreover, the helmet's capabilities can be strengthened through the ongoing development of sensor technology, communication protocols, and data processing algorithms, which expands the helmet's potential applications and highlights its importance in contemporary military operations. This project's innovative journey opens the door to a constantly developing defense-tech synergy, which will have a significant impact on military engagement in the future.

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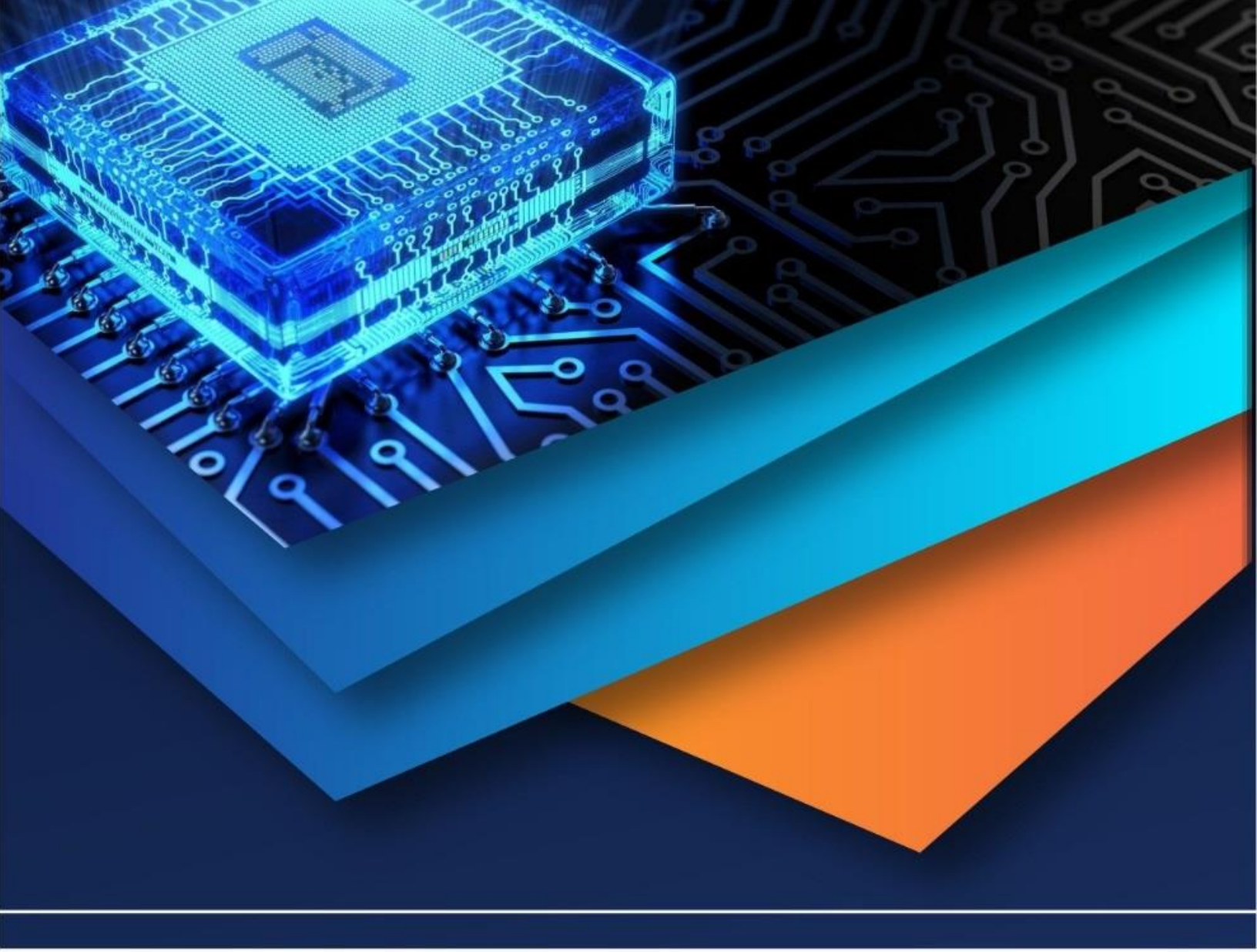
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