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Real - Time Animal Detection in Forest Areas Using VGG-19 and BI - LSTM Techniques

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Abstract: Rural populations and forestry workers face significant safety risks due to inadequate surveillance methods for detecting animal types and movements. To address this challenge, this project introduces a hybrid VGG-19 and Bi-LSTM network aimed at enhancing safety monitoring in forested areas. The VGG-19 model excels in feature extraction, while the Bi-LSTM network specializes in learning sequential data, collectively enabling precise detection of animal types and behaviours. This integrated approach not only improves accuracy in identifying wild animals but also provides a cost-effective alternative to traditional surveillance techniques. The primary objectives of this project include improving the accuracy of animal detection and activity classification in forested regions by leveraging the strengths of VGG-19 and Bi-LSTM algorithms. Furthermore, the project seeks to mitigate the high computational expenses associated with existing surveillance methods through model optimization, ensuring both cost-effectiveness and superior detection performance. The efficiency and accuracy of the proposed VGG-19 + Bi-LSTM model is rigorously evaluated against traditional Convolutional Neural Network (CNN) approaches, offering valuable insights into the advancements and benefits of the new methodology.

By incorporating advanced deep learning techniques, the proposed system ensures comprehensive monitoring of forest animal activity, enhancing safety measures. Through meticulous comparison with existing CNN models, the system identifies the most effective method for real-time animal activity detection, facilitating optimized surveillance implementation. This project aims to ensure the safety of individuals in rural and forested areas, delivering improved safety measures and peace of mind through accurate and reliable animal detection.

Index Terms: VGG-19, Bi-LSTM, CNN, GRU, Feature extraction, Image feature optimization, Deep learning models.

I. INTRODUCTION

Detecting animal activities in real-time presents significant challenges due to the continuous influx of data and the complexity of natural environments. Wildlife encompasses a vast range of species, each with unique physical characteristics, making detection and classification in video sequences highly demanding. Processing extensive feature maps requires a robust framework capable of handling large-scale video datasets and leveraging high-performance GPU-based computing resources. Intelligent data processing techniques are essential to ensure accurate and efficient results. Developing such models is crucial for monitoring wildlife in forest regions, helping to prevent sudden animal attacks and facilitating rapid response through automated alerts with location details for forest officials. These systems enhance surveillance by tracking animal movements, identifying activities, and detecting illegal hunting or threats to wildlife. However, the integration of these tasks - tracking, activity recognition, and real-time alert generation - poses substantial challenges in deep learning. Research in this domain focuses on advancing video analysis techniques and exploring sophisticated neural network architectures. While deep learning has shown remarkable success in image recognition, classification, and generation, further advancements are required to build more reliable and effective models for real-time animal activity detection.

A. Objective

This paper introduces a Hybrid VGG-19 + Bi-LSTM neural network for efficient detection of wild animals through surveillance cameras and drones, sending SMS alerts to safeguard rural populations and forestry workers. Achieving a 98% classification accuracy, 77.2% mAP, and 170 FPS, the model outperforms existing approaches. Additionally, integrating Bidirectional GRU further enhances accuracy by optimizing image features compared to LSTM, making it a reliable solution for real-time animal activity monitoring.

B. Problem Statement

Rural communities and forestry workers face a growing threat from wild animal attacks. Existing animal detection methods using surveillance technology are often expensive and complex, hindering satisfactory results. This study addresses the need for an efficient model, introducing a Hybrid VGG-19 + Bi-LSTM network to accurately detect and monitor wild animal activity, ensuring the safety of people and foresters.

II. EXISTING SYSTEM

The existing system for monitoring animal activities in forest areas relies on cameras and deep learning, but it faces challenges of high computing costs and insufficient detection accuracy. The prevailing technique lacks cost-effectiveness and struggles to provide accurate results. Surveillance efforts often employ existing CNN algorithms, which, while widely used, may not adequately address the specific demands of accurate animal movement detection. The absence of a robust system for efficient alerting and subsequent intervention poses a risk to human and animal safety. Additionally, the computational demands of the current approach contribute to its financial impracticality.

III. PROPOSED SYSTEM

This paper presents an innovative approach to address the challenges of cost and accuracy in detecting animal activities in forest areas. The proposed five-phase system integrates VGG19 and BI-LSTM algorithms for efficient animal detection and classification. Initial phases involve dataset image preprocessing and object detection, followed by the application of VGG19 and BI-LSTM for precise animal classification. The fourth phase generates SMS alerts with location details for forest officers, while the fifth phase involves on-ground intervention. Due to cost limitations in an academic setting, the last two phases are excluded. The proposed system is implemented alongside existing CNN algorithms, utilizing the 'Wild Animal Dataset' from Kaggle.

A. Algorithms

1) VGG19 + Bi-LSTM: The VGG19 + Bi-LSTM model begins with the VGG19 convolutional neural network for feature extraction. The output is then fed into a Bidirectional Long Short-Term Memory (Bi-LSTM) layer, capturing sequential dependencies. This hybrid architecture enables the model to discern animal types, monitor movement, and provide location information. Alerts are generated based on detected activity, and Short Message Service (SMS) notifications are sent for immediate response.
2) CNN + BiGRU: The CNN + BiGRU model utilizes a Convolutional Neural Network (CNN) for initial feature extraction from input images. The extracted features are then passed through a Bidirectional Gated Recurrent Unit (BiGRU) layer, optimizing image features efficiently. This combination enhances accuracy in detecting wild animal activity. The model proves effective in real-time surveillance, outperforming traditional approaches by leveraging the strengths of both CNN and BiGRU architectures.

IV. SOFTWARE REQUIREMENTS

Software requirements outline the necessary software resources and prerequisites that must be installed on a system to ensure the optimal functionality of an application. These requirements are typically not included in the software installation package and must be installed separately beforehand.

1) Platform – In computing, a platform serves as a foundation, either in terms of hardware or software, that enables an application to run efficiently. Platforms may include a computer's architecture, operating system, or programming languages along with their runtime libraries.
2) Operating System – One of the primary requirements when defining system specifications is the operating system. Some software may not be compatible with different versions of the same OS, though backward compatibility is often considered. For instance, applications designed for Microsoft Windows XP may not function properly on Windows 98, while the reverse may sometimes be possible. Similarly, software developed with newer features of Linux Kernel v2.6 may not compile or execute correctly on distributions using Kernel v2.2 or v2.4.
3) APIs and Drivers – Software that relies on specialized hardware, such as advanced graphics cards, often requires specific APIs or updated device drivers. An example is DirectX, a set of APIs primarily used for multimedia and game development on Microsoft platforms.

4) Web Browser – Many web applications and software solutions that utilize internet technologies depend on the system's default browser. For example, applications running on Microsoft Windows often leverage Internet Explorer due to its support for ActiveX controls, despite known security concerns.

A. *Technical Stack*

- Software: Anaconda
- Primary Language: Python
- Frontend Framework: Flask
- Backend Framework: Jupyter Notebook
- Database: SQLite3
- Frontend Technologies: HTML, CSS, JavaScript, Bootstrap 4

V. HARDWARE REQUIREMENTS

Hardware requirements specify the physical system resources necessary for running an operating system or software application efficiently. A hardware requirements list is often accompanied by a Hardware Compatibility List (HCL), particularly for operating systems. The HCL provides details about tested and compatible hardware, as well as any known incompatibilities. The key hardware components are discussed below:

1) Architecture – Computer operating systems are designed for specific hardware architectures. Most software applications are built for specific operating systems running on designated architectures. Although some OS and applications are architecture-independent, they often need recompilation for compatibility with new architectures.
2) Processing Power – The CPU plays a crucial role in determining a system's capability to run software efficiently. Processing power is often specified in terms of model and clock speed, though additional factors such as bus speed, cache, and MIPS can also influence performance. While Intel Pentium and AMD Athlon processors with similar clock speeds may have varying performance, Intel Pentium CPUs remain a widely recognized standard.
3) Memory (RAM) – When software runs, it occupies space in the system's random access memory (RAM). The required memory capacity is determined by factors such as the application's demand, the operating system, supporting software, and other background processes. Optimal RAM allocation ensures smooth multitasking and prevents performance issues.
4) Storage (Hard Disk) – Hard drive space is influenced by software installation size, temporary files created during installation or execution, and potential swap space usage in cases where RAM is insufficient.
5) Graphics Processing (Display Adapter) – Applications requiring high-end graphics, such as video editing software and advanced gaming applications, may necessitate dedicated graphics cards for optimal performance.
6) Peripherals – Some applications require specific peripherals for enhanced functionality. These may include CD-ROM drives, network adapters, keyboards, pointing devices, or other specialized hardware components.

A. *Minimum Hardware Specifications*

- Operating System: Windows (Only)
- Processor: Intel i5 or higher
- RAM: 8GB or more
- Storage: 25GB of free space on the local drive

	ML Model	Accuracy	Precision	Recall	F1_score
0	Existing CNN	0.943	0.946	0.943	0.943
1	VGG19 + BiLSTM	0.837	0.841	0.837	0.834
2	CNN + GRU	1.000	1.000	1.000	1.000

VI. RESULT

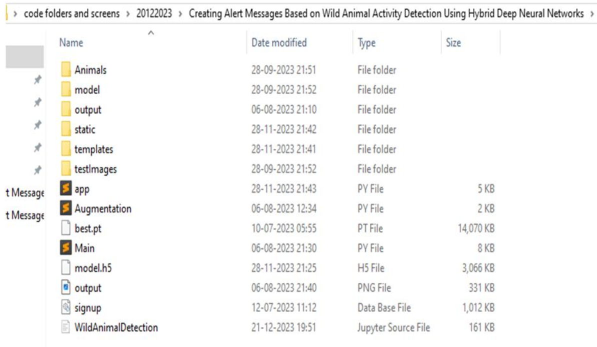

Fig 1: Folder

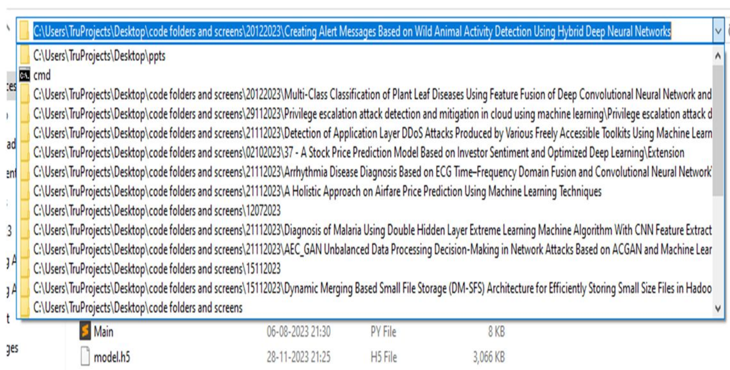

Fig 2: Copying the folder location

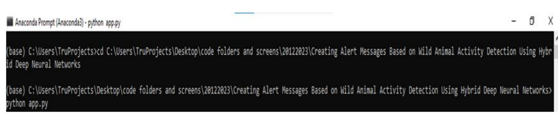

Fig 3: Paste copied location in Anaconda prompt

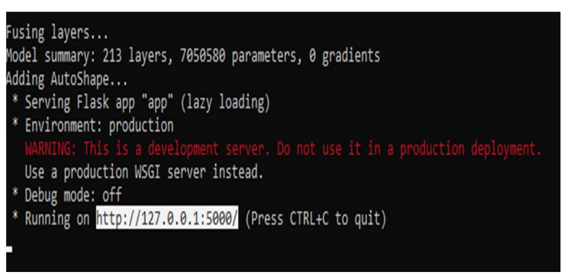

Fig 4: Initializing Flask and IP Address

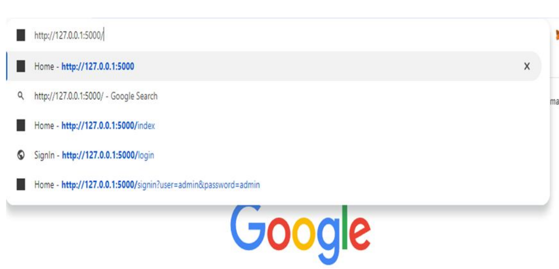

Fig 5: Paste IP Address in browser

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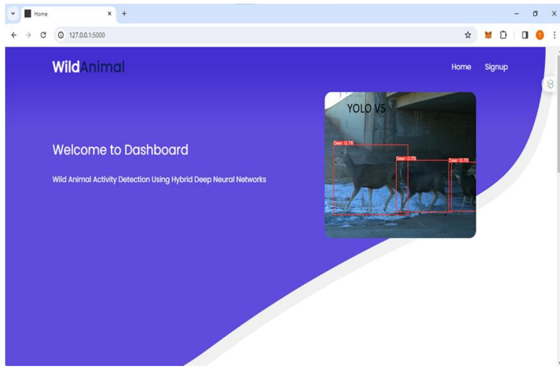

Fig 6: Home page

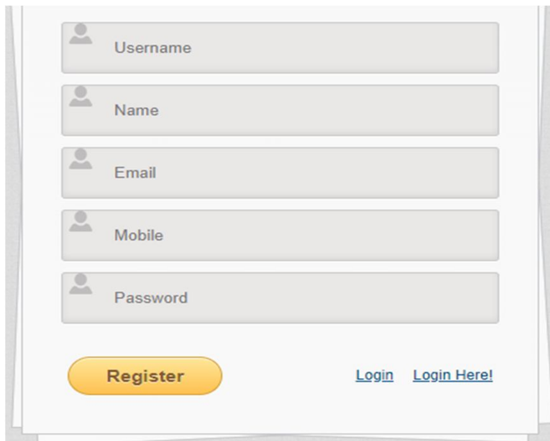

Fig 7: Registration Form

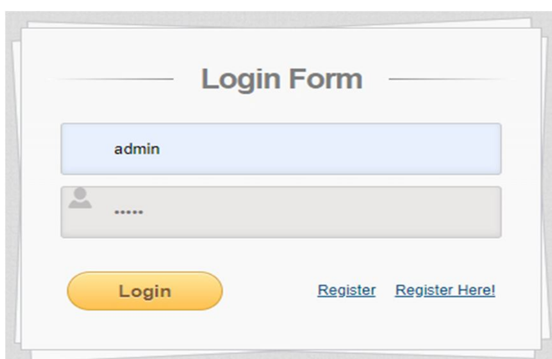

Fig 8: Login Form

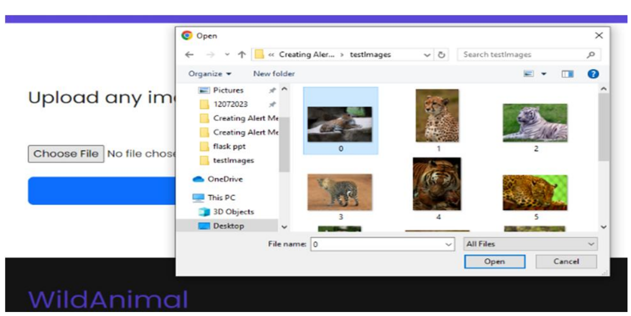

Fig 9: Select image for detection

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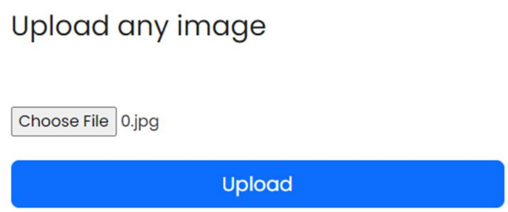

Fig 10: Image uploaded successfully

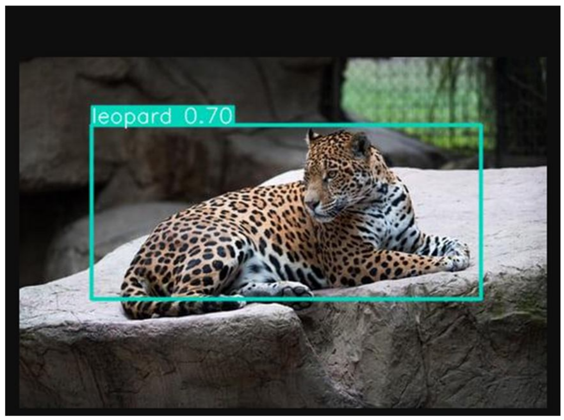

Fig 11: Detected name and giving beep sound

VII. COMPARISON GRAPHS

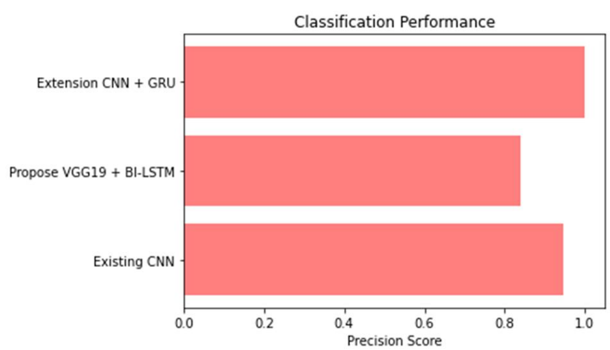

Fig 12: Precision Score

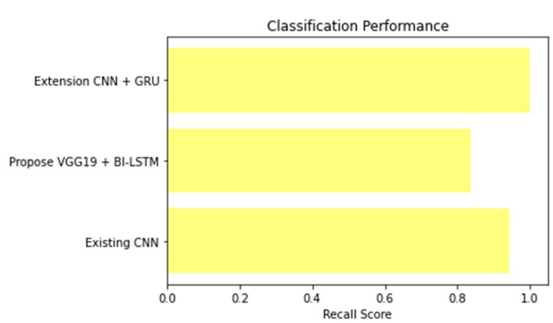

Fig 13: Recall Score

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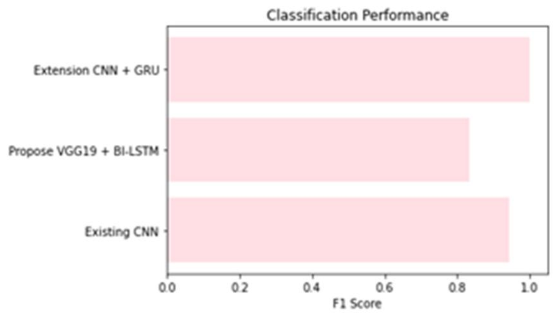

Fig 14: F1 Score

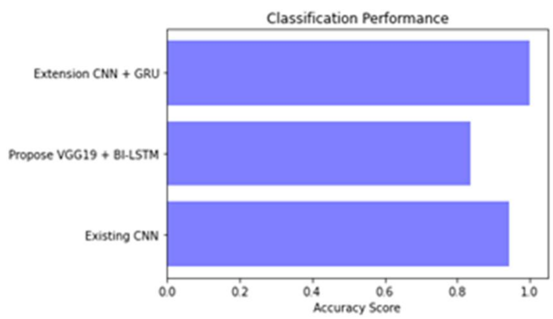

Fig 15: Accuracy Score

VIII. FUTURE SCOPE

Future research could focus on exploring additional datasets that encompass a wider range of animal species and environmental conditions, allowing for a more comprehensive assessment of the model's performance in diverse scenarios. Real-world deployment of the hybrid VGG-19+Bi-LSTM model in collaboration with wildlife conservation authorities could significantly aid in mitigating human-wildlife conflicts and enhancing wildlife protection efforts in forested areas. Continuous refinement and optimization of the model architecture, incorporating advancements in deep learning techniques and algorithms, would further improve its accuracy and efficiency. Additionally, investigating the integration of sensor technologies such as acoustic sensors and thermal imaging cameras could enhance the model's capability to detect and monitor wild animal activity in real time. Ethical considerations must also be addressed by ensuring that the model’s training data is free from biases, thereby promoting fair and responsible wildlife management practices.

IX. CONCLUSION

This paper presents a hybrid framework combining VGG-19 and Bi-LSTM for wild animal detection and activity monitoring. The proposed approach plays a crucial role in safeguarding both wildlife from poaching and humans from unexpected animal encounters by sending automated alerts to forest authorities. This model introduces innovative methods to enhance the efficiency of deep learning techniques for broader real-time applications. To assess its effectiveness, the model has been tested on four benchmark datasets, including the Camera Trap Dataset, Wild Animal Dataset, Hoofed Animal Dataset, and CDnet Dataset. Experimental evaluations demonstrate superior performance across multiple quality metrics. The hybrid VGG-19+Bi-LSTM model achieves an impressive 98% average classification accuracy, surpassing previous approaches while maintaining lower computational complexity.

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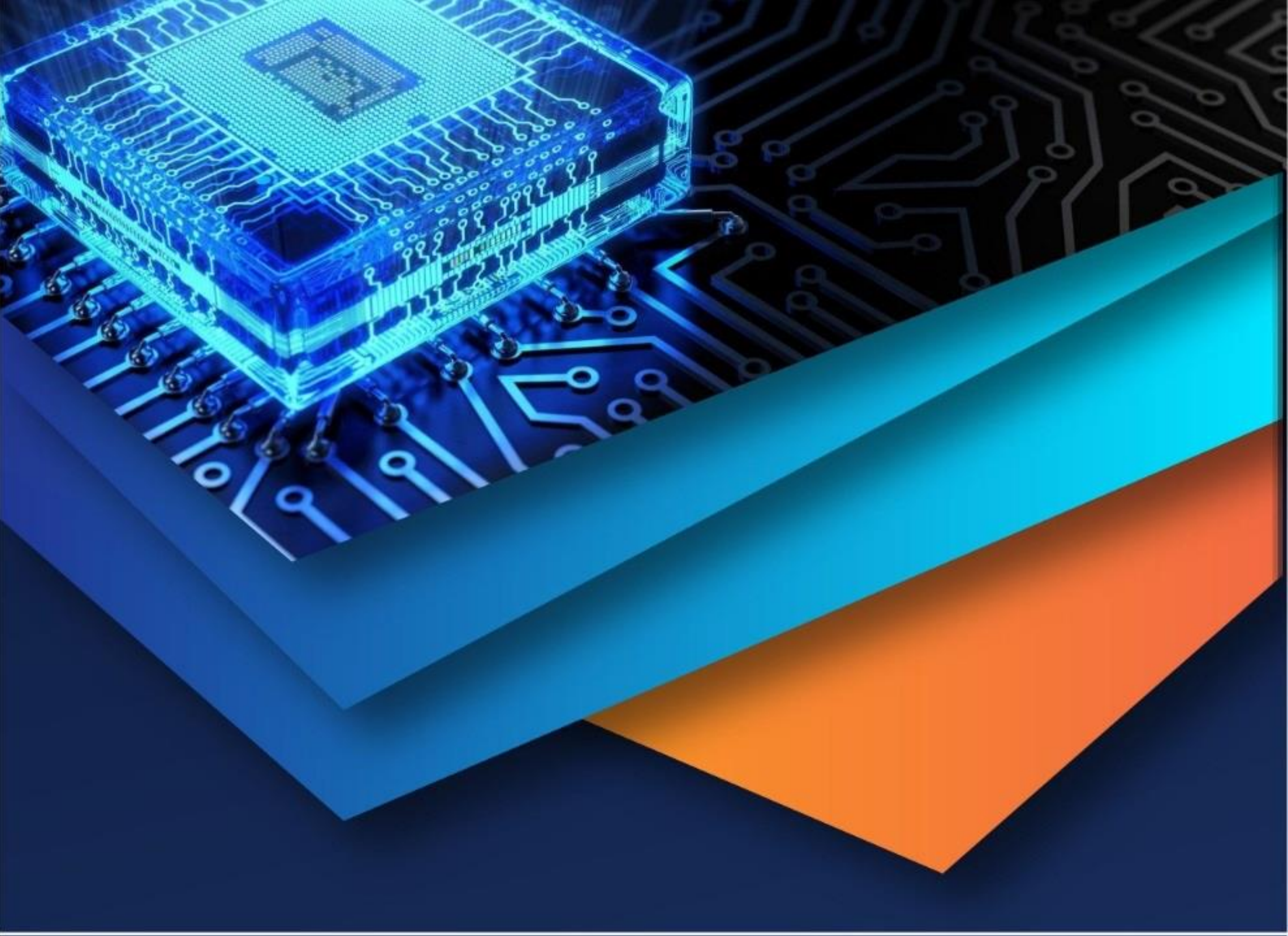

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