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Counterfeit Buster: Indian Currency Detection using Generative Adversarial Networks

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Abstract: Counterfeit currency undermines financial trust and economic stability, particularly in cash- dependent regions. As counterfeiters adopt increasingly sophisticated techniques, forged notes can evade visual inspection, rendering traditional detection methods unreliable. Furthermore, existing verification techniques are typically hardware-dependent, expensive, or too complex for general users, making them impractical and inaccessible in real-world applications. To overcome these limitations, we introduce Counterfeit Buster, an Android application that leverages Generative Adversarial Networks (GANs) for real-time detection of counterfeit Indian currency. GANs operate by training two neural networks—a generator that produces synthetic data and a discriminator that learns to distinguish it from real data—thereby enhancing detection accuracy through continuous learning. The app allows users to scan currency using their smartphone camera and receive instant results, offering a portable, affordable, and user-friendly solution. Additional features such as denomination recognition, real-time currency conversion, and voice feedback further improve accessibility and usability, empowering users to effectively combat currency fraud.
Keywords: Counterfeit detection, Generative Adversarial Networks (GANs), Convolutional Neural Networks (CNN), currency recognition, mobile app, currency conversion, voice feedback.

I. INTRODUCTION

Counterfeit currency continues to pose a significant threat to global financial systems, eroding public trust and contributing to substantial economic losses. The widespread availability of advanced printing technologies has empowered counterfeiters to produce forged notes that closely resemble legitimate ones, complicating detection efforts. Given the critical role of currency in daily transactions, ensuring its authenticity is essential for both financial institutions and individuals. However, with the growing sophistication of counterfeiting techniques, traditional safeguards are becoming less effective, necessitating intelligent and adaptive solutions. Conventional counterfeit detection methods typically rely on hardware-based approaches such as ultraviolet light scanning, magnetic ink detection, and watermark analysis. These techniques require specialized equipment and trained personnel, making them impractical for everyday users. Moreover, their limited scalability and mobility hinder adoption in decentralized or resource-constrained environments, reinforcing the need for automated, affordable, and accessible systems.

To address these challenges, Generative Adversarial Networks (GANs) have emerged as a powerful tool in image synthesis and anomaly detection. By training a generator to produce counterfeit currency samples and a discriminator to distinguish them from authentic ones, GANs enable the creation of enriched datasets and improved classification models. When combined with Convolutional Neural Networks (CNNs), the system can detect subtle inconsistencies in counterfeit notes with remarkable accuracy, capturing intricate visual cues and structural patterns. In this paper, we propose a robust and scalable counterfeit detection system that integrates GANs and CNNs into a mobile application for real-time detection of counterfeit Indian currency. The application provides a user-friendly interface and additional features such as denomination recognition, currency conversion, and voice feedback, enhancing accessibility for a wide range of users.

II. LITERATURE REVIEW

The rise in counterfeit currency has prompted the need for efficient, accessible detection systems. Recent advancements in deep learning and image processing enable faster, have fueled the development of automated systems capable of detecting counterfeit notes. Bhushan et al. [1] developed a system that compares the effectiveness of Simple Neural Networks (SNN) and Convolutional Neural Networks (CNN) for counterfeit detection, with CNNs achieving better results due to their strong image classification capabilities. Their work emphasizes the strength of deep learning over traditional manual inspection techniques. Shokeen et al. [2] presented a model that integrates machine learning with image processing, where CNN achieved better accuracy than SVM and Random Forest, while also proving resilient in varying lighting conditions. This highlights how enhancing image preprocessing techniques can significantly impact the detection accuracy.

Wang [3] focused on CNN-based currency recognition across multiple countries and denominations, using a large dataset and data augmentation methods. Despite achieving high test accuracy, challenges such as class imbalance and overfitting were noted, prompting the need for architectural and data improvements. Desai et al. [4] proposed a hybrid approach using CNNs in conjunction with Generative Adversarial Networks (GANs), creating a user-friendly system capable of detecting fake Indian currency and enriching datasets through synthetic image generation. The integration of GANs in such systems demonstrates a novel direction for improving detection accuracy and dataset diversity.
Kumar et al. [5] employed a deep convolutional neural network across multiple denominations like 200rs, 500rs, and 2000rs, with commendable results. However, their system's dependency on image quality, especially for stained or damaged notes, suggests the necessity for more resilient models. Sharan and Kaur [6] approached counterfeit detection through traditional image processing using MATLAB, focusing on visible features like the RBI logo and denomination numerals. While their approach was effective for specific cases, limitations in accuracy and environmental dependency reduce its practical scalability.
These studies highlight the rapid progress in counterfeit detection, with deep learning methods like CNNs and GANs leading due to their strong feature extraction. Despite challenges like dataset limitations and image quality, further research in advanced models and mobile apps promises to improve system effectiveness and usability, aiding in the fight against counterfeit currency.

III.EXISTING SYSTEM

Conventional counterfeit detection systems are predominantly hardware-based and commonly found in banks, retail chains, or government facilities. These systems utilize UV/IR sensors, magnetic ink detectors, and watermark or microprint analysis to verify the authenticity of currency. In some cases, manual verification by trained personnel is also employed. Despite being reliable in controlled environments, these systems present several limitations:

1) High Cost and Infrastructure Needs: Deployment is restricted to areas with proper setup and maintenance capabilities.
2) Limited Portability: Devices are non-mobile, preventing usage in field scenarios or remote locations.
3) Inaccessibility to General Public: Shopkeepers, vendors, and rural users typically lack access to such machines.
4) No Mobile Integration: The absence of smartphone-based solutions limits real-time, on-the-go validation.

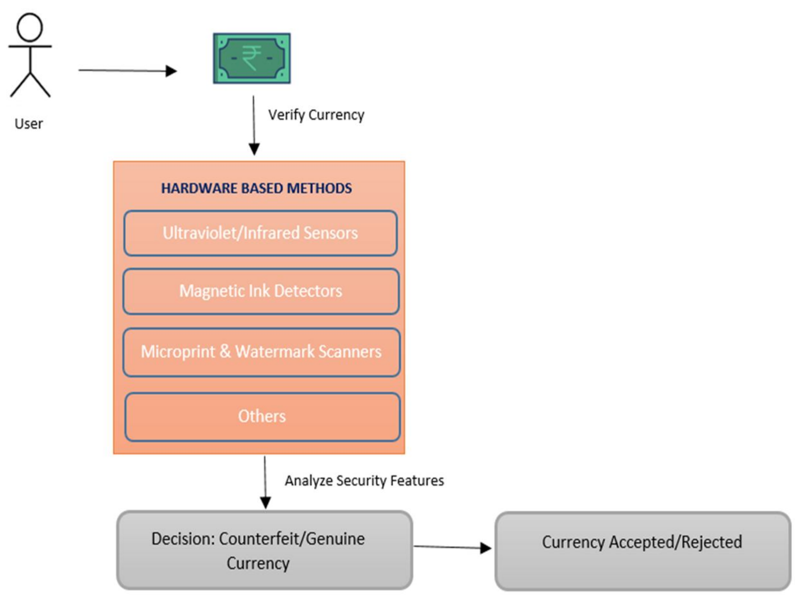

Fig. 1. Existing System

Given the limitations of conventional counterfeit detection systems there is a clear need for a mobile application-based solution. These hardware-dependent setups are impractical for everyday users like shopkeepers, delivery agents, and people in rural areas. A smartphone app can offer instant, on-the-go validation using just a camera, eliminating the need for bulky machines or trained personnel. It ensures widespread usability, adaptability to evolving threats, and convenience in real-time scenarios. Thus, mobile integration is essential to make counterfeit detection accessible, scalable, and efficient for the general public.

IV. PROPOSED SYSTEM

Counterfeit Buster is an Android application designed to help users easily verify the authenticity of Indian currency notes. It aims to provide an intuitive and user-friendly solution for the general public to distinguish between real and counterfeit ₹100, ₹200, and ₹500 notes using their smartphones. The app allows users to either click a photo or upload an image of a currency note. Once the image is submitted, the app processes it through advanced algorithms that identify key features of the note, enabling quick verification. The app uses cutting-edge technology to analyze the submitted image, providing immediate feedback to the user. Along with visual feedback on the authenticity of the note, the app also provides voice feedback, making it accessible to individuals with visual impairments.

A. Key Features

1) Currency Authentication: The primary function of the app is counterfeit detection. After a user uploads an image, the app processes it and immediately displays whether the note is real or fake. This feature helps prevent financial losses from counterfeit notes.
2) Currency Recognition: The app features an intelligent currency recognition system that automatically identifies the denomination of the currency note. This eliminates the need for users to manually select the note type, ensuring a seamless experience.
3) Currency Conversion: Counterfeit Buster also includes a currency conversion tool. Users can input an amount in Indian Rupees, and the app will instantly calculate its equivalent in various global currencies based on real-time exchange rates. This makes the app useful for travelers or anyone needing quick currency conversion.
4) Voice and Text Feedback: To enhance usability and accessibility, the app provides results in both on-screen text and voice feedback. The voice feedback is particularly helpful for users who prefer hands-free interaction or those with visual impairments.

The Counterfeit Buster app aims to be a valuable tool for anyone needing to verify currency authenticity, offering a simple, efficient, and accessible solution.

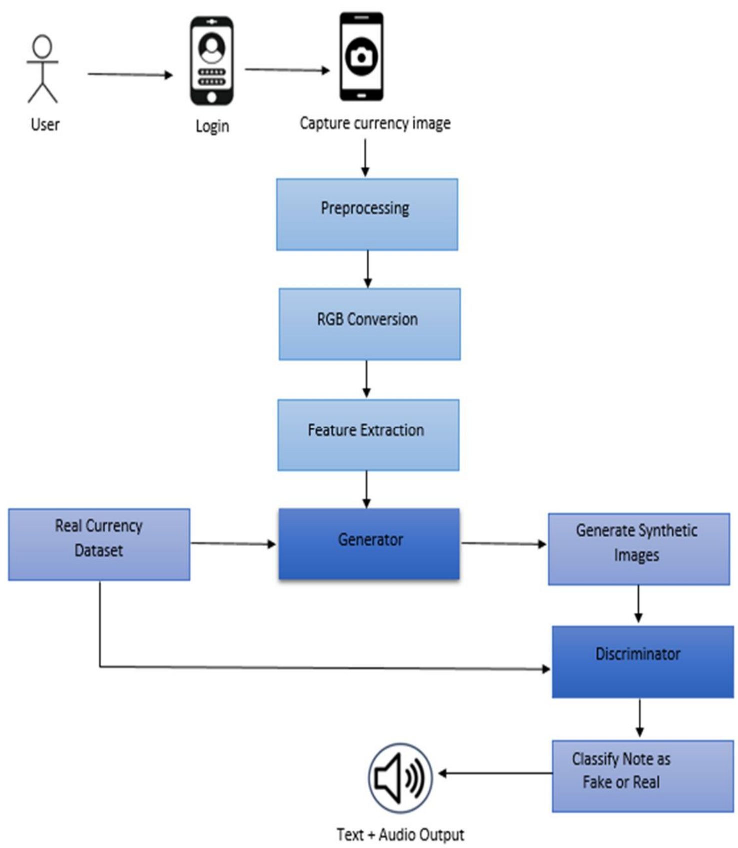

Fig. 2. Proposed System

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V. GAN ARCHITECTURE

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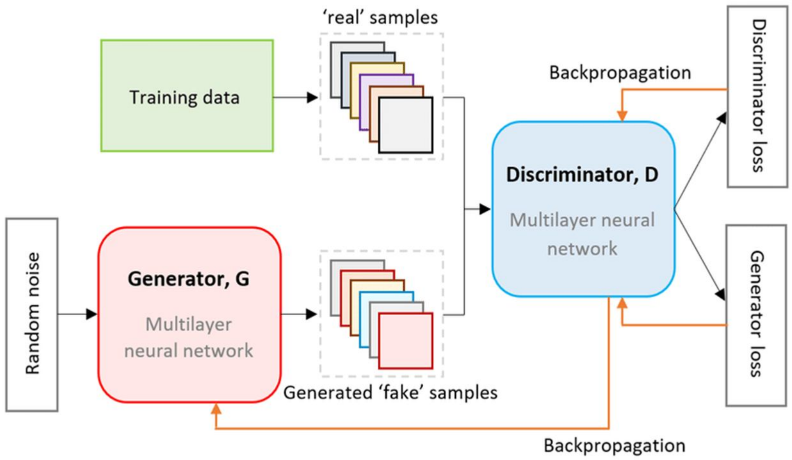

Fig. 3. Architecture of Generative Adversarial Networks(GAN)

Generative Adversarial Networks (GANs) consist of two main components — the Generator and the Discriminator — that are trained simultaneously in an adversarial process. The Generator learns to create realistic counterfeit images of Indian currency, while the Discriminator learns to distinguish between genuine and counterfeit images. The training of both networks is interdependent and iterative, forming the foundation of adversarial learning.

The process involves the following steps:

1) Input features or noise vectors are provided to the Generator, which creates synthetic images of currency notes.
2) These synthetic images are combined with genuine currency images and passed to the Discriminator.
3) The Discriminator attempts to correctly classify each image as either "real" or "fake."
4) Based on the Discriminator's performance, loss functions are computed:
   - Generator loss increases if the Discriminator correctly identifies the fake images.
   - Discriminator loss increases if it fails to classify fake and real images accurately.
5) Backpropagation is used to update the weights of both networks accordingly.
6) The Generator and Discriminator are trained in alternating cycles, allowing them to improve iteratively over multiple epochs.

Through this adversarial process, the Generator progressively learns to produce increasingly realistic counterfeit images, while the Discriminator becomes more adept at identifying fake images. This balanced competition ultimately results in a robust system for counterfeit currency detection.

VI. TECHNOLOGY STACK

This project integrates multiple technologies from both machine learning and mobile development to build and deploy a counterfeit currency detection application.

1) Python: Python is the primary programming language used for model development, offering simplicity and a rich ecosystem for AI, image processing, and data visualization.
2) NumPy: NumPy Provides powerful support for numerical operations, especially for handling large matrices and performing efficient computations during data preprocessing.
3) TensorFlow: TensorFlow is an open-source deep learning framework used to build and train the GAN model efficiently with GPU acceleration support. It simplifies the deployment of trained models in both cloud and edge environments.
4) Matplotlib: Matplotlib is a visualization library that helps plot training metrics like accuracy and loss over epochs. It helps identify trends and model behavior throughout the training phase.
5) Android Studio: Android Studio acts as the official IDE for Android app development, offering tools for UI design, testing, and debugging. It was used to create a clean, responsive interface for real-time currency verification.
6) Java: Java is used for implementing core functionalities of the Android application, including handling user input and UI logic.
7) Google Colab: Google Colab offers a cloud-based development environment with GPU support for training CNNs and GANs faster without needing local computational power.

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8) TensorFlow Lite (TFLite): TensorFlow Lite converts TensorFlow models into a lightweight format optimized for mobile devices. This is ideal for running the GAN model directly on Android without needing a server.

VII. RESULT ANALYSIS

Fig. 4. Splash screen of app

Fig. 5. Features dashboard of app

Fig. 6. Real currency detection

Fig. 7. Fake currency detection

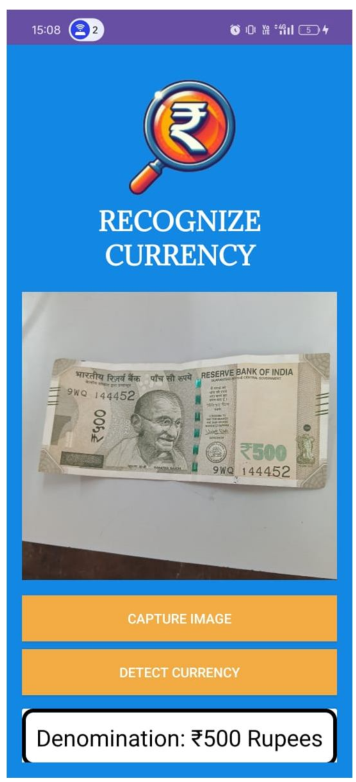

Fig. 8. Recognize currency

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Fig. 8. Convert currency

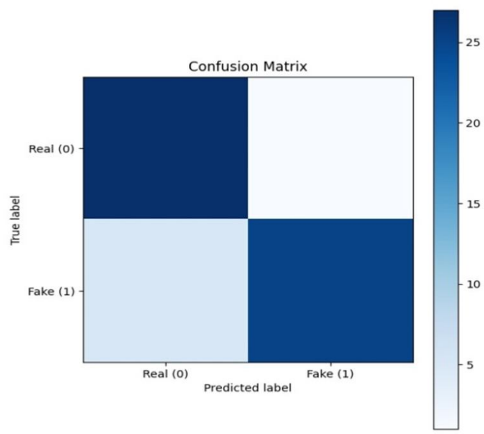

Fig. 9. Confusion Matrix

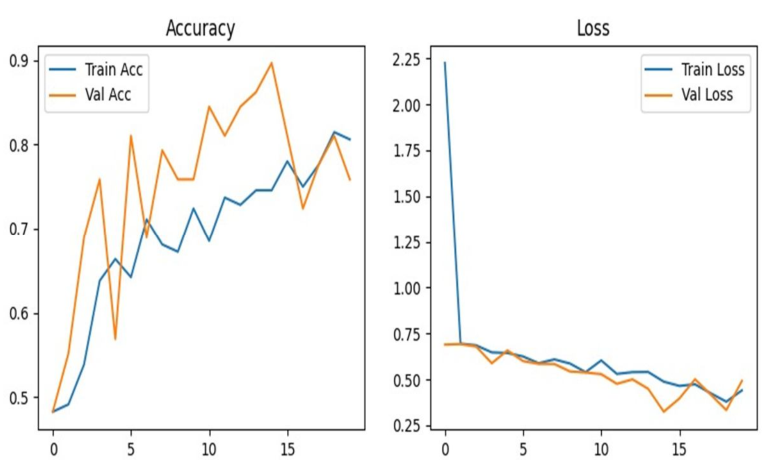

Fig. 10. Training accuracy and Loss graph

VIII. CONCLUSION

Counterfeit Buster delivers a practical and inclusive solution for detecting counterfeit Indian currency by leveraging the power of Generative Adversarial Networks alongside deep learning techniques. Designed as an Android application, it ensures wide accessibility for the general public while offering reliable currency validation through a combination of visual recognition and audio feedback. Its added capabilities of recognizing denominations and converting currency values enhance its utility beyond simple detection. With further refinements, such as support for additional denominations and real-time exchange updates, Counterfeit Buster has the potential to become an essential tool for individuals and small businesses in safeguarding against currency fraud.

IX. ACKNOWLEDGMENT

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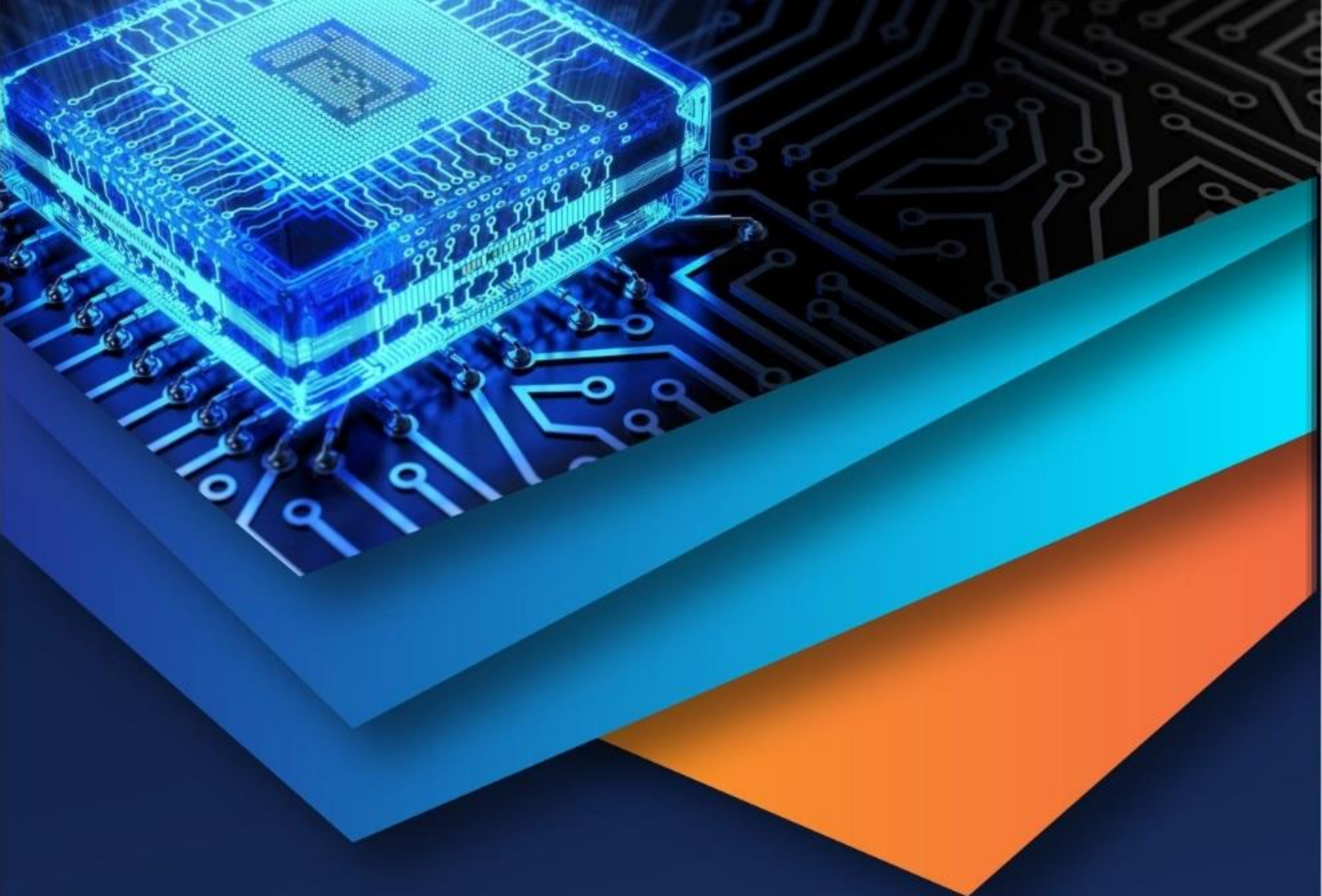

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