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Efficient Face Recognition in Real Time for Locating Missing Person

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Abstract: This paper presents a web-based application system that utilizes deep learning as the core technology of a Face Recognition System, with the primary objective of enhancing the accuracy and efficiency of locating missing individuals. Every day, a significant number of individuals go missing due to various factors such as old age, mental health issues, or conditions like Alzheimer's. The conventional methods employed for searching for missing persons are typically slow, expensive, and involve protracted physical searches lasting weeks or even months. In contrast, deep learning-based technologies offer a promising solution by rapidly analyzing substantial volumes of data within minutes or hours. By leveraging facial recognition technology, which is an application of deep learning, our proposed system aims to compare images and videos obtained from surveillance cameras with pictures of missing persons to identify potential matches. Specifically, we employ the Resnet deep learning algorithm to examine the images of missing individuals, thereby improving the accuracy and speed of identification and making the process more reliable and efficient. To provide a comprehensive solution, we have developed a user-friendly web-based application system that facilitates the search for missing persons. The application efficiently collects and stores information about missing individuals in a centralized database. Whenever a missing person is identified in a CCTV video stream, our application actively tracks their location. Once the missing person is successfully identified within the video stream, the application promptly sends location details via email to the person's relative.
Keywords: Deep Learning, Facial Recognition Technology, ResNet Algorithm, Surveillance Cameras, Location Tracking.

I. INTRODUCTION

Face Recognition is still a challenging endeavor when it comes to the automatic tracking and locating of individuals. However, recent advancements in deep learning offer new opportunities for more effective ways of locating missing individuals. Deep learning can quickly and accurately process large amounts of data, making it useful for searching for missing persons. This technology has been applied in various aspects of missing person investigation, like recognizing faces, analyzing images, and studying videos.

Face recognition technologies have become more important in recent years, serving as computer applications capable of analyzing digital images or video frames from video sources to recognize or verify individuals.

Face Recognition technology, which uses deep learning, can accurately recognize and verify individuals by analyzing digital images or video frames.

By comparing images and videos from surveillance cameras with pictures of missing persons, facial recognition algorithms can quickly narrow down potential leads. The Resnet architecture has been used in this project, a powerful type of neural network, it improves the accuracy and speed of identification. Resnet has been successful in recognizing images, including faces. By applying Resnet to analyze images of missing persons, the identification process becomes more reliable and efficient, leading to better results in finding missing individuals. To overcome the challenges of traditional methods, we have designed a web-based application system that provides a complete solution.

The system adeptly collects and stores information about missing individuals in a centralized database. Upon identifying a missing person in a CCTV video stream, the application actively tracks their location and promptly sends location details to their relatives and the local police station via email.

This system focuses on security and authentication, and reduces the work for law enforcement, ensuring faster and more effective identification processes. In conclusion, deep learning and facial recognition technologies enhance the accuracy and efficiency of locating missing individuals. The Resnet architecture improves the identification process. The web-based application system contributes to security and authentication, and reduces the workload for law enforcement, resulting in faster and more efficient identification of missing persons.

II. RESEARCH GAPS

There are several alternative algorithms employed in existing systems for locating missing individuals, and one of them is the Haar Cascade algorithm, which is mostly used to detect faces. However, this algorithm has some limitations when it comes to accurately finding missing individuals. It may have trouble correctly recognizing facial features and needs careful training with data updates to be precise. Also, it can be challenging to customize the training, making it less accurate, and it may take a long time to process information. Additionally, the Haar Cascade algorithm can give many false alarms, indicating a missing person is found when they are not actually located. The Haar Cascade algorithm's effectiveness depends on the quality of the data used, and it might not always provide a high level of certainty. Biased or incomplete data can lead to mistakes and wrong identifications, making it less reliable. While the Haar Cascade algorithm is good for detecting objects in videos, it may not be as accurate as other advanced computer vision methods in tracking people's movements over time. Moreover, training the Haar Cascade algorithm requires a lot of data and computer resources, leading to a higher number of false alarms and making it challenging to accurately identify missing individuals.

III. PROPOSED SYSTEM

The proposed system aims to enhance the accuracy and efficiency of identifying missing persons by utilizing the Resnet architecture for image recognition. Resnet is a widely recognized deep convolutional neural network (CNN) architecture that has demonstrated remarkable effectiveness in image classification tasks, owing to its deep structure comprising over 23 million trainable parameters. By integrating Resnet into the system, the objective is to analyze images of missing persons, leading to more precise and efficient identification processes. The proposed system comprises several key components. Firstly, a comprehensive database of missing persons is established, containing essential information such as images, names, email addresses, and descriptive details. CCTV camera technology is utilized to capture images of individuals, and these images are compared with entries in the database.

When a missing person is identified in the CCTV video stream, a "Match found" message is displayed, and an automated email notification, containing a snapshot of the identified person's face and current location, is sent to the person who reported the missing individual. On the other hand, if the captured person is not recognized as a missing person, a "Match not found" message is displayed. The system is designed with user-friendliness in mind, ensuring accessibility for search teams, higher authorities, and the families involved in the search for missing persons.

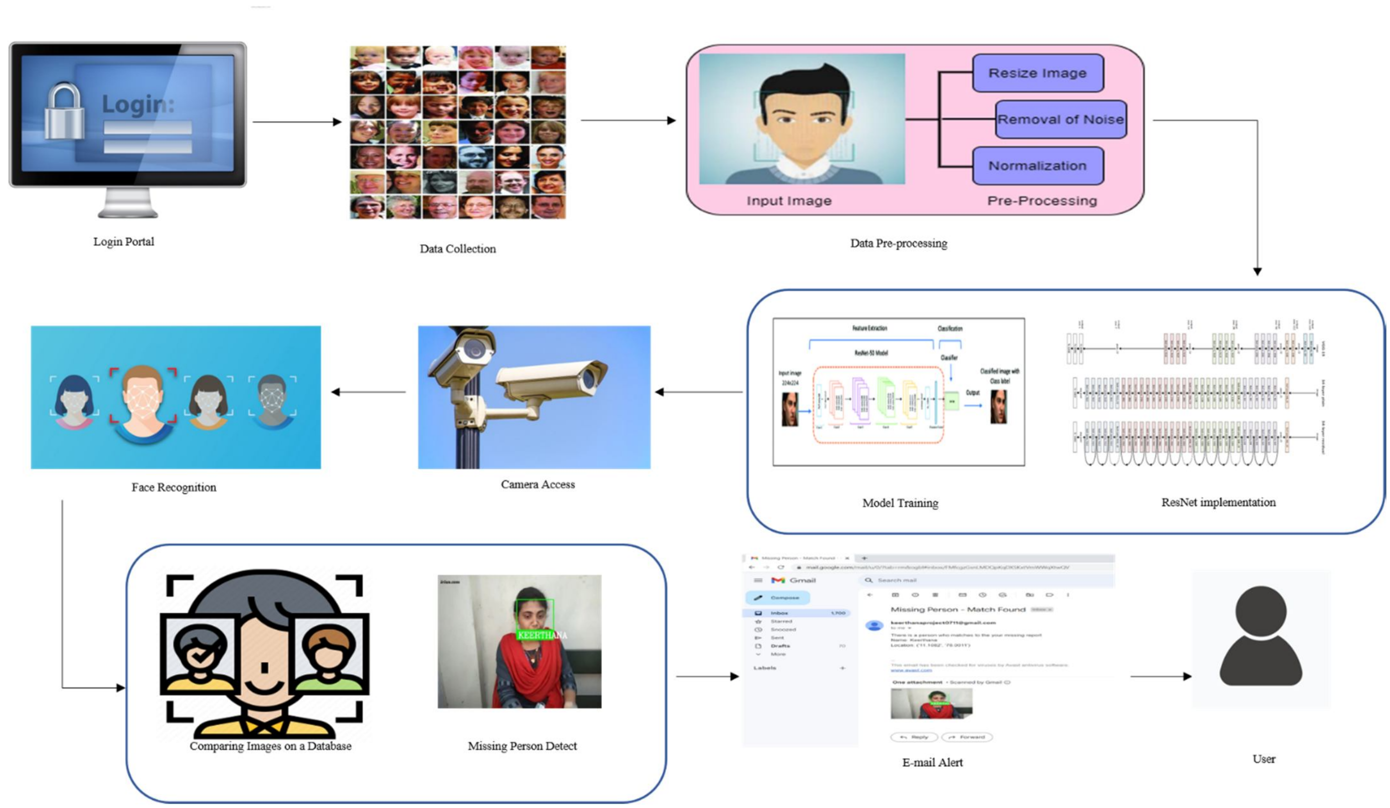

Fig 1. Workflow Diagram

IV. METHODS

A. Data Collection

Data collection is the process of gathering information from different sources. In the context of finding missing persons, it involves collecting relevant details about the individuals such as their physical appearances, last seen locations, dates of disappearance, and photographs. This information is crucial for conducting an effective search. There are various ways to collect this data, including talking to the missing person's family or friends, working with law enforcement agencies, conducting interviews, accessing public records, or using social media platforms to gather publicly available information.

B. Data Pre-Processing

Data Pre-Processing is an important step before analyzing data. It means getting the raw data ready for study. For images, this includes resizing and adjusting the colors. It helps us understand the data better and make more accurate predictions. It also makes it easier to compare and combine information. It converts categories into numbers for analysis. Pre-processing improves the data quality and helps deal with missing or unusual data. The following measures have been selected as our primary focus for the dataset.
Cropping the Images: Cropping images is essential for face recognition tasks as it enhances accurate identification and analysis. By isolating the facial region and removing unnecessary background, cropping improves model focus and efficiency. It also standardizes face image size and orientation, enabling consistent analysis and comparison. Facial landmarks and boundary detection help achieve precise cropping, significantly improving the speed and accuracy of face recognition systems for effective identification and authentication. The Python Imaging Library(PIL) provides essential tools, such as the PIL.Image.crop() method, for extracting rectangular image sections.
Syntax: PIL.Image.crop(box=none)
The “crop” function in the Python Imaging Library(PIL) allows you to extract a rectangular region from an image using a 4-tuple called “box”. The 4-tuple defines the left, upper, right, and bottom pixel coordinates of the region to be cropped. The function returns an instance of the image class, which represents the cropped rectangular region as a tuple containing the left, upper, right, and bottom sides.

TABLE I
SYNTAX USED IN DATA PREPROESING

Syntax	PIL.Image.crop(box=none)
Box	4-tuple: (left, upper, right, bottom)
Return Image	Type: Image
Returns	An Instance of the Image class

1) *Resizing the Images:* Resizing images is crucial for face recognition systems, ensuring consistent dimensions for effective analysis and comparison. It reduces biases, improves computational efficiency, and aligns facial landmarks for precise matching. The Python Imaging Library(PIL) offers the image.resize() function to resize images, enhancing accuracy and reliability in face identification and verification.

The function takes into consideration the following parameters:
Size: Represented as a 2-tuple, indicating the intended size of the image in pixels (Length, Width).
Resample: An optional resampling filter that can be chosen from PIL.Image.NEAREST (nearest neighbor), PIL.Image.BILINEAR (linear interpolation), PIL.Image.BICUBIC (cubic spline interpolation), and PIL.Image.LANCZOS (high-quality downsampling filter). If this parameter is omitted or set to "1" or "P," the default resampling filter is PIL.Image.NEAREST.
The function returns an object of type Image after performing the necessary processing.

C. Splitting the Dataset

Partitioning a dataset for face recognition into training, validation, and testing subsets is crucial for accurate and reliable model development. It aids in preventing overfitting, ensuring exposure to diverse face images, and enabling unbiased evaluation. Techniques like cross-validation and stratification further enhance evaluation reliability. Temporal splitting assesses the model's ability to handle variations over time, such as aging and changing appearances. This approach is particularly important for face recognition systems used in continuous monitoring or surveillance scenarios. Meticulous dataset partitioning enables the creation of robust face recognition systems proficient in real-world identification and verification tasks.

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D. Model Training using ResNet 50

1) *Face Detection:* Face detection is a crucial computer vision task that involves identifying and locating human faces in images or videos. It is used in various applications like face recognition, emotion analysis, video surveillance, and augmented reality. The main objective is to accurately detect and locate faces in input images or video frames, enabling further feature extraction and potential matching. Algorithms use different facial characteristics like color, texture, shape, and spatial relationships between facial components to distinguish between face and non-face regions.
2) *Face Alignment:* Face alignment is a crucial step in face recognition as it standardizes the pose of detected faces, reducing variations in expressions, head orientation, and lighting. Techniques like facial landmark detection or affine transformations are used for this process. It involves locating and normalizing facial landmarks to ensure consistent spatial relationships among faces. By mitigating pose and scale variations, face alignment improves face recognition accuracy and robustness. Its objective is to transform the face image so that specific facial landmarks occupy predefined positions using shape prediction algorithms.
3) *Feature Extraction:* Feature extraction is a crucial step in facial recognition, using deep learning models like ResNet to extract high-level features from aligned facial images. These features capture important facial attributes such as shape, texture, and color, transforming raw images into compact and distinctive representations called feature vectors. Local feature descriptors capture unique patterns and key points, providing additional appearance and texture information. Various techniques, including traditional and deep learning-based methods like Convolutional Neural Networks (CNN), extract discriminative information for facial recognition.
4) *Face Recognition:* Face recognition compares extracted features of an individual's face with a database to find potential matches. Techniques like Euclidean distance or cosine similarity determine similarity scores, identifying highly similar matches. Deep learning-based methods, such as deep convolutional neural networks (CNNs), are effective for training face recognition algorithms. Face recognition algorithms extract distinctive features from facial images, generating unique representations for each individual. By comparing the facial features of unidentified individuals with known missing persons in databases, face recognition significantly contributes to locating missing individuals, aiding family reunification, and resolving missing person cases.
5) *Result Analysis:* In the final step, results are analyzed to identify potential matches of missing individuals. A similarity score threshold is set to filter out matches below it. Further scrutiny is applied to remaining matches, considering factors like age, gender, and ethnicity for improved identification accuracy. Performance metrics such as TPR, FPR, TNR, and FNR assess the face recognition system. A confusion matrix provides a detailed breakdown of recognition outcomes, including true positives, true negatives, false positives, and false negatives. Precision, recall, and F1 score can be derived from the confusion matrix to evaluate system performance.

E. Model Evaluation

1) *Accuracy Testing*: Accuracy testing involves evaluating the facial recognition system's correctness in identifying individuals. Metrics like precision, recall, and F1 score measure accuracy. True Positive Rate (TRR) or Recall represents the system's ability to correctly recognize and match faces. False Positive Rate (FPR) indicates the percentage of false positive matches. True Negative Rate (TNR) measures the system's ability to reject non-matching false. False Negative Rate (FNR) is the percentage of falsely rejected faces.
2) *Performance Testing:* Performance testing in facial recognition evaluates system robustness to real-world variations (lighting, pose, expression). It measures efficiency, speed, and response time for single-face and bulk processing scenarios. Scalability is tested with increasing workloads, ensuring no performance degradation. Real-time applications are assessed for quick and continuous face recognition.
3) *False Positive/Negative Testing:* It evaluates a face recognition system's reliability. It assesses the system's ability to correctly classify matching and non-matching faces. False positive testing verifies if the system mistakenly identifies a person as a match when it shouldn't. False negative testing focuses on cases where the system fails to recognize a person who should be a match. The purpose is to identify and rectify such errors in the system.

F. Email Alert

1) *Configuring Email Settings:* Configuring the email module with accurate server settings and user credentials is crucial for sending alert emails. Obtain the necessary details like server name, port number, login credentials, and recipient's email address. Store the settings securely, and the module can transmit alert emails promptly and effectively, ensuring efficient communication.

2) *Formatting the Alert Email:* The module composes an email with essential details about the missing person's detection, including date, time, location, and visually represented image enclosed within a bounding box for emphasis. HTML formatting improves the email's presentation, making it visually appealing and informative.
3) *Sending the Email Alert:* After finalizing the email formatting, the module uses the smtplib library to send the email to the recipient's address. The email is available in plain text or HTML with embedded images for visual content. It includes a hyperlink directing the recipient to a web portal with comprehensive information about the located person, facilitating convenient access to detailed identification and current location data.

V. FINDING THE MISSING PERSON

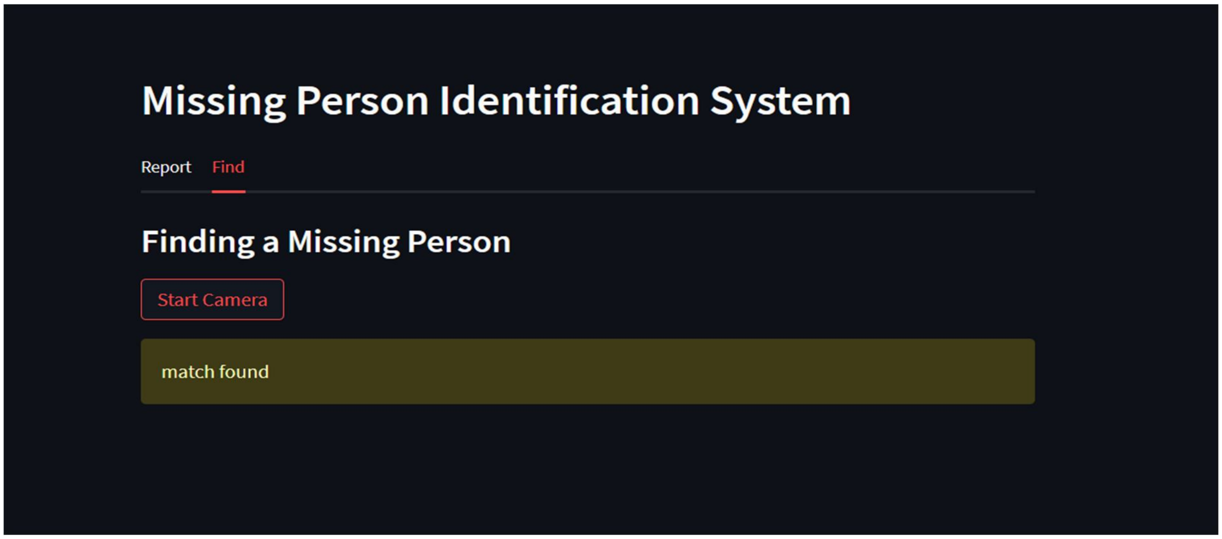

Fig 2. Match Found

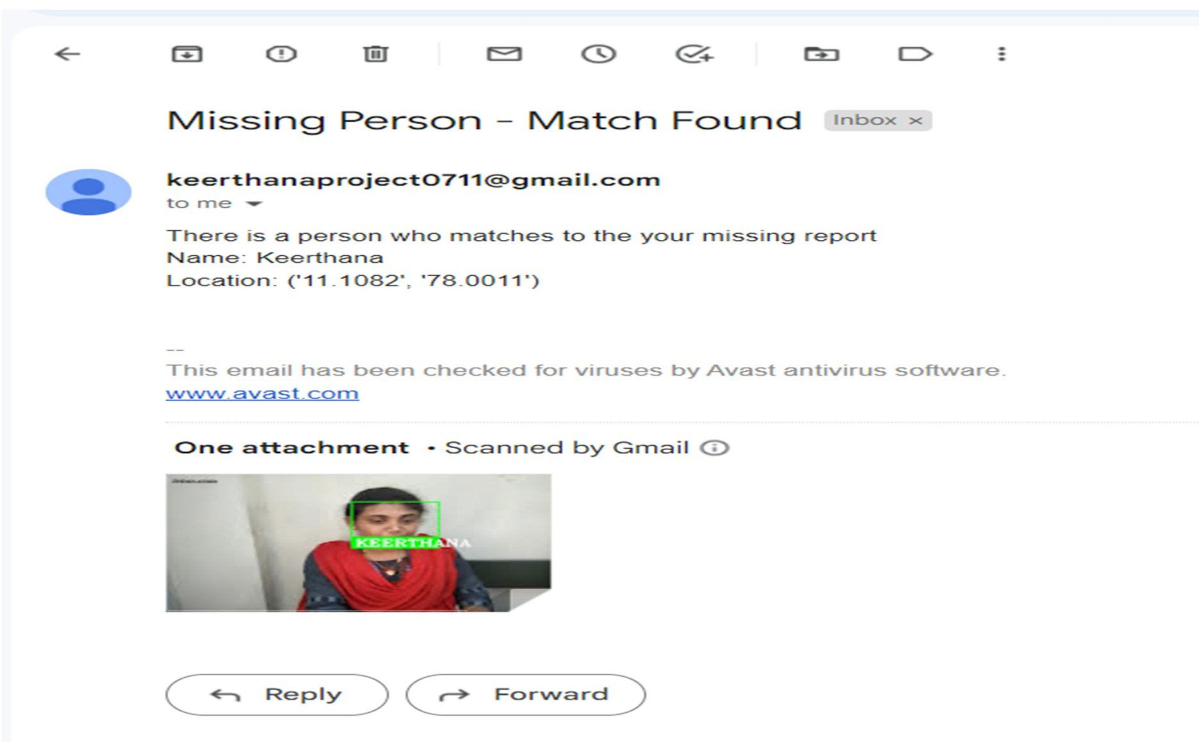

Fig 3. Email Alert

VI. CONCLUSION AND FUTURE WORK

The project "Efficient face recognition in real-time for locating missing person" enhances public safety by using facial recognition and deep learning algorithms to locate missing individuals. An up-to-date database and user-friendly interface improve the search process's accuracy and efficiency. System administrators efficiently manage operations.

The project's effectiveness is measured by its capacity to locate missing individuals and reunite them with their families. It signifies a notable advancement in leveraging technology for public safety, saving lives, and bringing comfort to affected families.

Collaborating with social media platforms enhances the project's facial recognition capabilities and access to extensive user databases. It allows the use of publicly available information to identify potential matches or gather additional details about missing individuals. Automating data removal reduces manual clearance time while incorporating temporal information improves identification accuracy over time.

VII. ACKNOWLEDGEMENT

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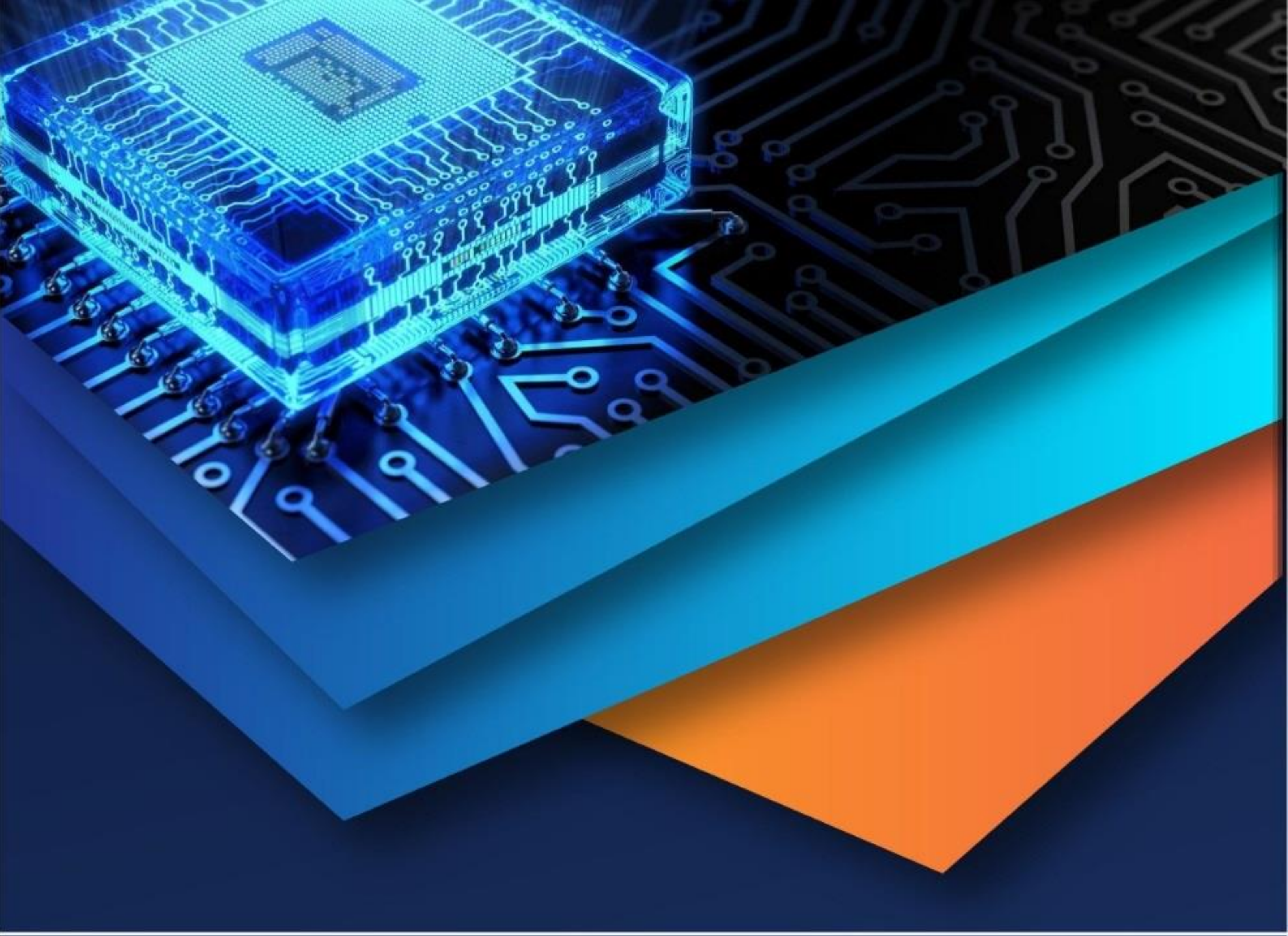

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