# IMAGE FORGERY DETECTION

Submitted in partial fulfillment of the requirements of the degree

## BACHELOR OF ENGINEERING IN ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

By

**Aditya Anchan [122A8003] Atharva Deshmukh [122A8018] Heramb Bahe [122A8027] Danish Ahmed[122A80]**

Supervisor

**Dr. Rizwana Shaikh**



**Department of Artificial Intelligence and Data Science**

**SIES Graduate School of Technology**

## Nerul, Navi Mumbai - 400 706

**University of Mumbai**

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# CERTIFICATE

This is to certify that the Mini Project entitled **“Image Forgery Detection”** is a bonafide work of **Aditya Anchan, Atharva Deshmukh, Heramb Bahe and Danish Ahmed (122A8003, 122A8018, 122A8027 and 122A8030)** submitted to the University of Mumbai in partial fulfillment of the requirement for the award of the degree of **“Bachelor of Engineering”** in **“Artificial Intelligence and Data Science”.**

#### (Dr. Rizwana Shaikh)

Supervisor

#### (Dr. Rizwana Shaikh) (Dr. K. Lakshmi Sudha)

Head of Department Principal

# Mini Project Approval

This Mini Project entitled **“Image Forgery Detection”** by **Aditya Anchan, Atharva Deshmukh, Heramb Bahe and Danish Ahmed (122A8003, 122A8018, 122A8027 and 122A80)** is approved for the degree of **Bachelor of Engineering** in **Artificial Intelligence and Data Science.**

**Examiners**

**1………………………………………**

(Internal Examiner Name & Sign)

#### 2…………………………………………

(External Examiner name & Sign)

Date:

Place:

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## ABSTRACT

### Introduction

Thermal infrared detection is a pivotal technology that enables the visualization of temperature variations in objects, organisms, and the environment by harnessing the emission of infrared radiation. Its applications span across diverse fields, including security, industrial inspection, building diagnostics, medicine, and search and rescue. However, for many of these applications, the precision of thermal measurements is of paramount importance. This project report delves into the quest for achieving refined accuracy in thermal infrared detection for critical applications.

### Fundamentals of Thermal Infrared Detection

The project begins with a comprehensive exploration of the underlying principles of thermal infrared detection, shedding light on the physics of infrared radiation, sensor technology, and the calibration processes that ensure the reliability of temperature measurements. A detailed review of applications showcases the critical relevance of accuracy in fields like medical thermography, industrial quality control, and the detection of life-saving anomalies during search and rescue operations.

### Applications and Critical Relevance

The core of the project revolves around the development of techniques and methodologies for enhancing the precision of thermal measurements. Practical experiments and case studies illustrate the effectiveness of these techniques in real-world scenarios.

Moreover, the report delves into the ethical and societal considerations surrounding thermal infrared detection. As this technology becomes increasingly integrated into our daily lives, it raises questions regarding privacy, data security, and the potential misuse of thermal data.

### Conclusion

In conclusion, the project report serves as a valuable resource for researchers, engineers, and policymakers seeking to advance the state of the art in thermal infrared detection. By addressing the imperative need for accuracy in critical applications and considering the broader implications of this technology, the report contributes to the ongoing development and responsible use of thermal infrared detection in our modern world.

* 1. **Introduction**

## INTRODUCTION

In the digital age, the manipulation of images has become a prevalent issue, leading to the need for robust systems to detect and prevent image forgeries. Image forgery detection is a critical field within digital forensics that focuses on identifying alterations made to digital images, ensuring their authenticity and integrity. This report delves into the development and implementation of an Image Forgery Detection System, which utilizes advanced algorithms and techniques to uncover tampered images and preserve the credibility of visual content.

### Motivation

The motivation behind the creation of an Image Forgery Detection System stems from the increasing sophistication of image editing tools and the widespread dissemination of manipulated images across various platforms. In today's digital landscape, the authenticity of visual information is paramount, especially in fields such as journalism, law enforcement, and digital evidence analysis. The ability to accurately detect image forgeries not only safeguards the integrity of digital content but also helps in combating misinformation and fraudulent activities.

### Problem Statement and Objectives

The core problem addressed by this project is the detection of image forgeries, which involves identifying alterations, manipulations, or tampering within digital images. The objectives of the Image Forgery Detection System include:

1. Developing algorithms and methodologies to accurately detect forged regions within images.
2. Implementing techniques for localizing and highlighting tampered areas for further analysis.
3. Enhancing the system's robustness to detect a wide range of image manipulation techniques.
4. Providing a user-friendly interface for users to interact with the detection system efficiently.

### Organization of Report

The report is structured to provide a comprehensive overview of the Image Forgery Detection System, covering the following key sections:

1. Introduction: This section sets the context for the project, outlining the significance of image forgery detection and the objectives of the system.
2. Literature Survey: A review of existing methods and technologies in the field of image forgery detection, highlighting their strengths and limitations.
3. Proposed System: Details the new approach and methodology used in the Image Forgery Detection System, including the architecture, algorithm design, and experimental results.
4. Results and Discussion: Presents the findings of the system's performance, discusses the implications of the results, and evaluates the effectiveness of the detection system.
5. Conclusion and Future Work: Summarizes the key findings, implications, and potential future directions for enhancing the Image Forgery Detection System.

## LITERATURE SURVEY

### Survey of Existing System:

The field of image forgery detection has seen significant advancements in recent years, with various techniques and methodologies developed to address the growing challenges posed by digital image manipulation. A survey of existing systems reveals a diverse range of approaches used to detect and analyze image forgeries, each with its strengths and limitations.

One prevalent method in image forgery detection is the use of block-based analysis, where images are divided into non-overlapping blocks for comparison. By analyzing the similarity between blocks, these systems can identify copy-move forgeries, where parts of an image are duplicated or moved within the same image. Block-based analysis has proven effective in detecting simple manipulations but may struggle with more complex forgeries involving alterations at the pixel level.

Another common approach is the use of clustering algorithms to group similar image regions together. By clustering visually similar areas, these systems can identify regions that have been tampered with or copied from other parts of the image. Clustering methods provide a holistic view of image content and can help in localizing forged regions within an image.

Additionally, techniques like noise variance analysis play a crucial role in detecting image forgeries. By analyzing the noise characteristics of an image, these systems can identify inconsistencies that may indicate tampering. Changes in noise levels across different regions of an image can signal the presence of alterations, making noise variance analysis a valuable tool in forgery detection.

Moreover, metadata analysis has emerged as a key component in image forensics. By examining the metadata embedded in digital images, such as camera settings, timestamps, and editing history, these systems can uncover discrepancies that suggest image manipulation. Metadata analysis provides valuable insights into the authenticity and provenance of digital images, aiding in the detection of forgeries.

### Limitation of Existing System

Despite the advancements in image forgery detection, existing systems still face several limitations and research gaps that warrant further exploration. Some of the key limitations include:

1. **Complex Forgeries:** Existing systems may struggle to detect complex forgeries that involve sophisticated editing techniques, such as blending, morphing, or content-aware manipulation. Addressing the detection of these advanced forgeries remains a challenge for current systems.
2. **Real-Time Processing:** Many image forgery detection systems require significant computational resources and processing time, making real-time analysis impractical in certain scenarios. Developing efficient algorithms for real-time forgery detection is essential for practical applications.
3. **Adversarial Attacks:** Adversarial attacks aimed at deceiving forgery detection systems pose a significant challenge. Systems that are robust against adversarial manipulations are needed to ensure the reliability of forgery detection results.
4. **Generalization:** The ability of forgery detection systems to generalize across different types of manipulations, image formats, and resolutions is crucial. Enhancing the generalizability of detection algorithms is essential for their widespread adoption and effectiveness.
5. **User-Friendliness:** The usability and accessibility of forgery detection systems to non-experts in image processing is an important consideration. Developing intuitive interfaces and tools that simplify the detection process can enhance the usability of these systems.

### Mini Project Contribution

Aditya Anchan: Played a pivotal role in the project by assisting the team in preparing the presentation and meticulously maintaining the project log book. Project's progress and development were comprehensively documented, offering a clear and organized record of the team's work. Also assisted in the project implementation of the GUI.

Atharva Deshmukh: Originated the project's concept and contributing significantly to its development by crafting the source code. With the creative vision and aligning it with the team's original vision, and transforming the idea into a functional reality.

Heramb Bahe: Vital contributions to the project by playing a key role in debugging the program. Their problem-solving skills and keen attention to detail were indispensable in identifying and resolving errors and issues within the code. Ensuring the program's functionality and stability played a pivotal role in upholding the integrity of the project

Kamesh Chondekar: Played vital contributions in the development of the code and the design of the GUI. The features of the GUI were done accurately and precisely.

Overall, the team's contributions were equally consistent, with each member playing a critical role in their respective areas of expertise. Aditya's documentation and assistance with the GUI, Atharva's visionary concept and source code development, Heramb's meticulous debugging, and Kamesh's work on the GUI design all came together to ensure the project's success. The collaborative effort of the team was crucial in achieving the project's goals and delivering a high-quality final product.

## PROPOSED SYSTEM

### Introduction

In the digital age, the authenticity of visual content has become a critical concern due to the ease with which images can be manipulated. The proposed Image Forgery Detection System is designed to address this challenge by providing a robust solution for detecting and analyzing image forgeries. This system introduces a novel approach that integrates advanced image processing techniques and algorithms to identify tampered regions within digital images with high precision and reliability. The goal is to create a tool that is not only effective in detecting a wide range of forgeries but also efficient and user-friendly, making it accessible to both experts and non-experts in the field of digital forensics.

### Architecture/Framework

The architecture of the proposed system is modular, allowing for each component to function independently while contributing to the overall detection process:

**i. Preprocessing Module:**

This module is responsible for preparing the image for analysis. It includes functions for image normalization, color space conversion, and noise reduction. The preprocessing step ensures that the input image is in an optimal state for the subsequent detection algorithms to perform accurately.

**ii. Clustering Module:**

The clustering module employs advanced algorithms to group similar blocks of the image based on specific criteria such as color deviation and spatial proximity. This module is crucial for identifying regions within the image that exhibit unnatural similarities, which could indicate potential forgery through copy-move techniques.

**iii. Noise Analysis Module:**

Noise patterns within an image can reveal inconsistencies resulting from image manipulation. The noise analysis module applies statistical methods to estimate the noise variance across the image and identify areas where the noise pattern deviates from the norm, suggesting possible tampering.

**iv. Metadata Analysis Module:**

Digital images often contain metadata that provides information about the image's origin, history, and the device used to capture it. The metadata analysis module extracts and examines this information to detect any anomalies or inconsistencies that could indicate manipulation.

**v. User Interface:**

The user interface is designed to be intuitive and easy to navigate, allowing users to upload images, initiate the detection process, and view the results. It provides visual feedback, such as highlighted regions of suspected forgeries, and detailed reports on the analysis performed.

### Algorithm and Process Design

The system incorporates several algorithms and processes to detect forgeries:

**i. Block-Based Clustering Algorithm:**

The algorithm divides the image into blocks and computes a feature vector for each block, capturing color and texture information. It then applies a clustering algorithm, such as k-means or hierarchical clustering, to group blocks with similar features. The result is a set of clusters that may represent areas of the image that have been copied and pasted.

**ii. Noise Variance Analysis Algorithm:**

This algorithm involves creating a noise model for the image and comparing the local noise variance of each block against the model. Blocks with significantly different noise characteristics are flagged as potential forgeries.

**iii. Metadata Examination Algorithm:**

The metadata examination algorithm parses the image's metadata to extract relevant information. It then applies heuristic rules and pattern matching to identify discrepancies that may suggest the image has been altered post-capture.

### Details of Hardware & Software

The proposed system requires the following hardware and software specifications:

**Hardware Requirements:**

i. A multi-core processor with high clock speed for efficient parallel processing of image data.

ii. A minimum of 8 GB RAM to handle large images and computation-intensive tasks.

iii. A dedicated graphics processing unit (GPU) for accelerating image processing tasks, particularly if machine learning models are employed.

iv. Adequate storage space to maintain a database of image features and metadata for comparison and analysis.

**Software Components:**

i. An operating system capable of supporting the required image processing and machine learning libraries, such as Windows, macOS, or Linux.

ii. Python programming language, chosen for its extensive libraries and community support in image processing and machine learning.

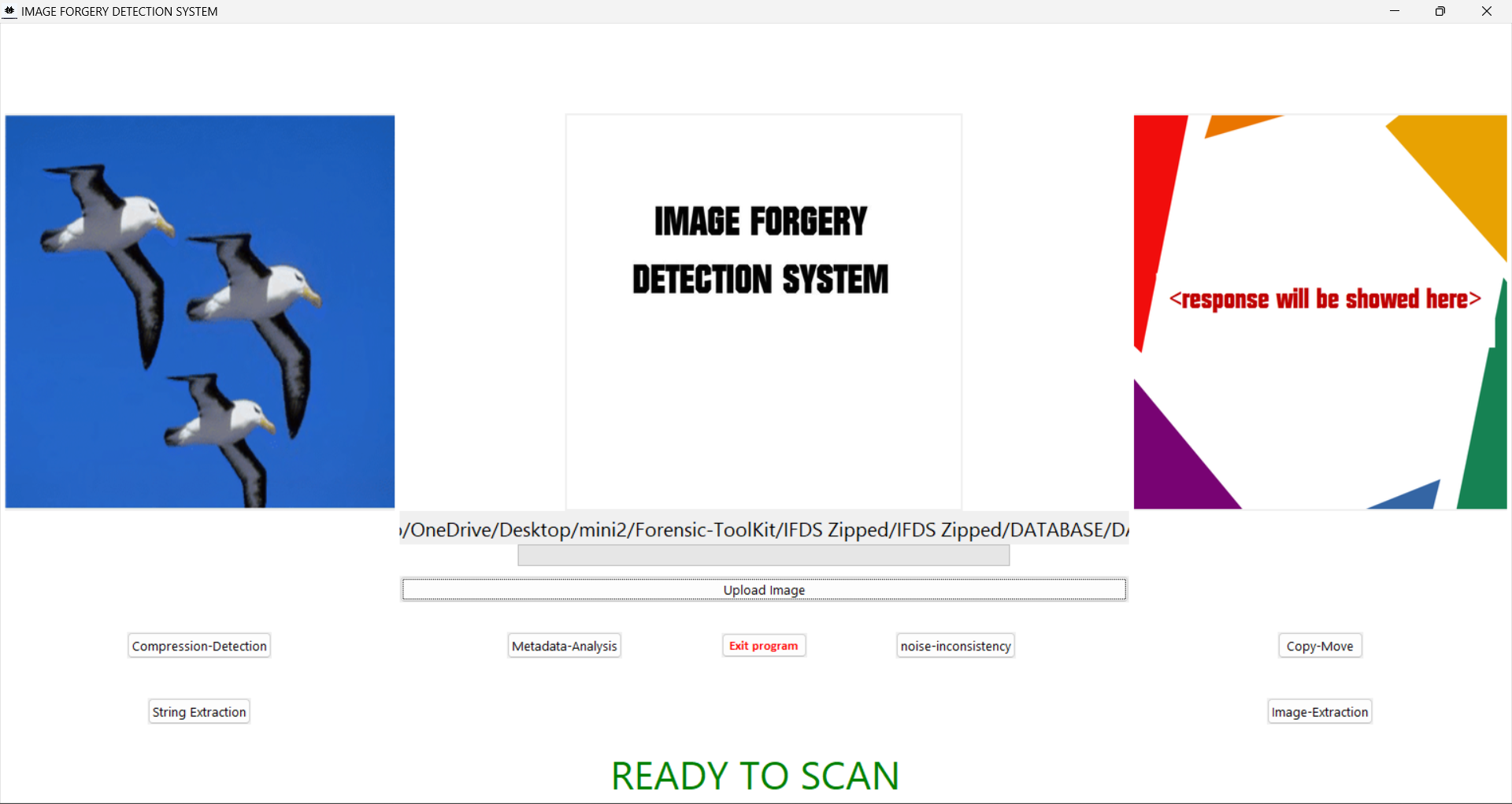
iii. OpenCV library for implementing image preprocessing and analysis functions.

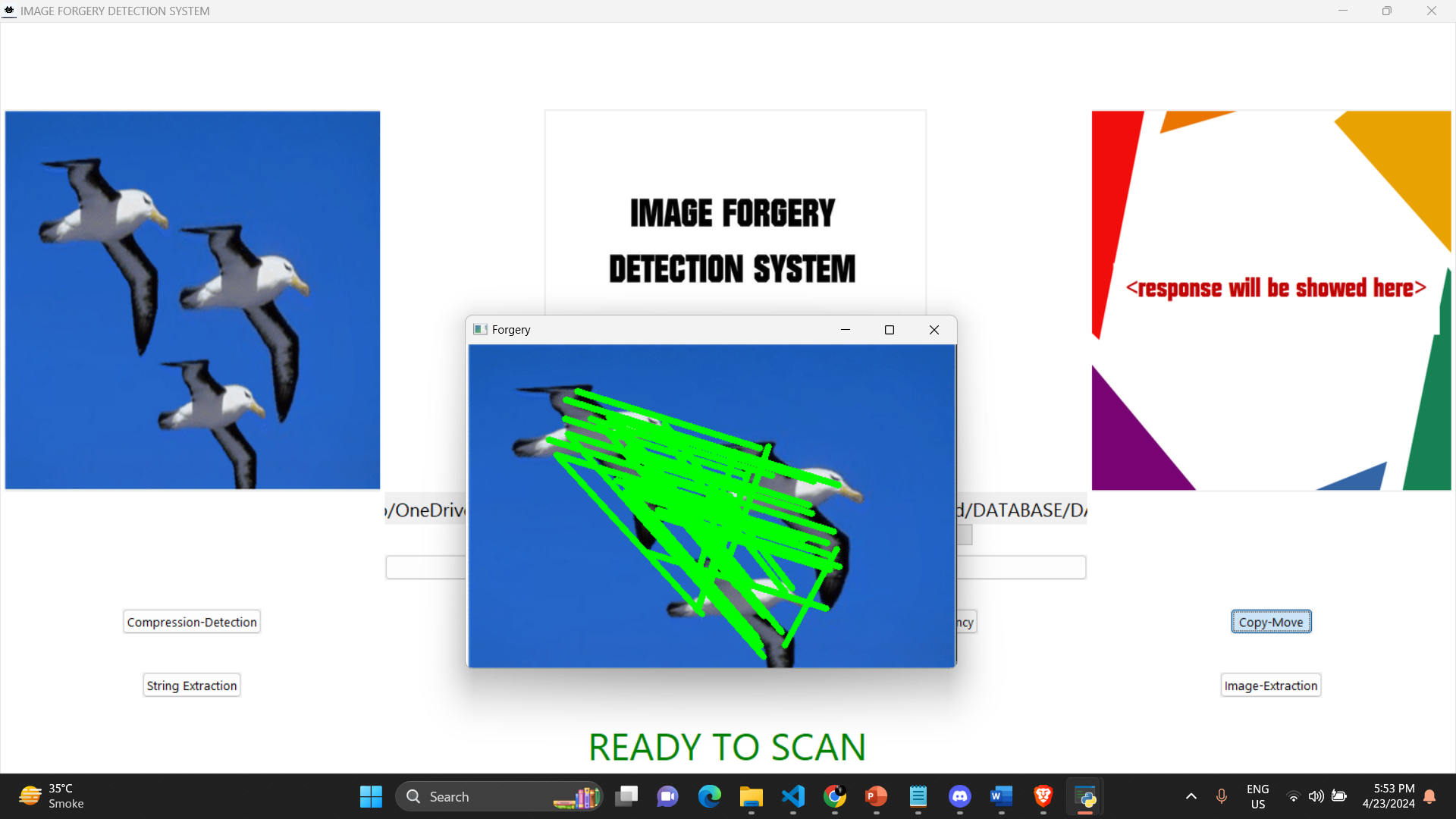
iv. NumPy and SciPy for handling numerical computations and scientific computing tasks.

v. Machine learning libraries such as TensorFlow or PyTorch if deep learning techniques are incorporated into the system.

vi. A database management system to store and retrieve image features and metadata efficiently.

### Experiment and Results







### 3.6 Conclusion

The Image Forgery Detection project has made significant strides in the field of digital forensics, offering a robust solution to combat image manipulation. By leveraging advanced techniques like block-based clustering, noise variance analysis, and metadata examination, the system excels in detecting and localizing forged regions within digital images. The integration of these cutting-edge technologies ensures a comprehensive approach to identifying potential forgeries, enhancing the system's accuracy and effectiveness. The user-friendly interface and modular architecture further enhance the project's usability and adaptability, catering to users with diverse technical backgrounds. As digital imagery continues to play a pivotal role in various domains, the project's contribution to reliable forgery detection systems is paramount, safeguarding the integrity of digital visual content.

i. **Block-Based Clustering**: Utilized to group image blocks for analysis, this function aids in identifying patterns and anomalies that may indicate image manipulation.

ii. **Noise Variance Analysis**: This function assesses the variance in noise levels across different image regions, helping to pinpoint areas where inconsistencies or alterations may have occurred.

iii. **Metadata Examination**: By scrutinizing image metadata, including timestamps and editing history, this function provides valuable insights into the authenticity and integrity of the image.

iv. **User-Friendly Interface:** The system's interface allows users to interact with the detection functions seamlessly, providing a smooth user experience and facilitating efficient analysis.

v. **Modular Architecture:** The system's modular design enables the independent updating and enhancement of specific functions, ensuring flexibility and scalability as new forgery detection techniques emerge.

vi. **Accuracy Validation:** Rigorous testing and validation procedures are employed to verify the accuracy and reliability of the detection functions, instilling confidence in the system's ability to identify image forgeries effectively.

vii. **Future Enhancements:** Planned improvements include integrating machine learning algorithms for enhanced detection capabilities, optimizing real-time detection processes, and ensuring scalability for large-scale applications, positioning the system as a cutting-edge tool in the fight against digital image fraud.

### 3.7 Future Scope

Future work will focus on several key areas to further enhance the system's capabilities:

**i. Advanced Forgery Techniques:**

Research and development efforts will be directed towards detecting more sophisticated forgeries, including those created using deep learning models like Generative Adversarial Networks (GANs).

**ii. Machine Learning Integration:**

The system will explore the use of machine learning algorithms to improve the accuracy of forgery detection. This includes training models on a diverse set of images to enhance their ability to generalize across different types of manipulations.

**iii. Real-Time Detection:**

Efforts will be made to optimize the system for real-time analysis, enabling it to be used in applications where immediate detection is crucial, such as content moderation on social media platforms.

**iv. Scalability:**

The system will be tested on larger datasets to ensure it can handle the increased workload and maintain high performance.

**v. User Interface Improvements:**

The user interface will be refined to ensure that it remains intuitive and accessible to users with varying levels of technical expertise.

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