Image Processing Toolkit – Assignment Report

Submitted by: G Surya Kiran
Course: B.Tech – AIML
Subject: Computer Vision
Assignment Title: GUI-Based Image Processing Application Using OpenCV and Streamlit

1. Introduction

This project focuses on developing an interactive Image Processing Toolkit using Python libraries like OpenCV, NumPy, and Streamlit. The toolkit provides users with an easy-to-use graphical interface where they can upload images, apply a variety of processing techniques, and visualize the results side-by-side.

The application is designed not only as a practical tool but also as an educational platform where users can experiment with image transformations, filtering, edge detection, enhancement, and compression techniques.

2. Objective

The objectives of this assignment are:

- To create a user-friendly interface for image processing tasks using Streamlit.
- To implement essential image operations such as color conversion, transformations, filtering, enhancement, and edge detection.
- To display image properties dynamically after each operation.
- To provide real-time parameter adjustments through sliders and selection menus.
- To enable users to download processed images in different formats.

3. Theory

📌 CMOS vs CCD Sensors

- **CCD (Charge-Coupled Device):** High sensitivity and low noise, but more power consumption.
- **CMOS (Complementary Metal-Oxide-Semiconductor):** Used in most modern devices due to low power consumption and faster processing.

📌 Sampling & Quantization

- **Sampling:** Converts a continuous image into pixels at discrete intervals.
- **Quantization:** Maps continuous intensity values into finite levels, which may introduce noise or artifacts.

📌 Point Spread Function (PSF)

PSF represents how a point source of light is spread in an imaging system. It helps understand distortions, blur, and other artifacts introduced by the system.

4. Technologies Used

- **Python 3.x** – Main programming language.
- **OpenCV** – Used for image manipulation, filtering, transformations, and analysis.
- **NumPy** – Utilized for efficient numerical computations and matrix operations.
- **Streamlit** – Provides the graphical user interface and interactivity.
- **Pillow (PIL)** – Assists in handling image file formats and enabling downloads.

5. Features Implemented

📁 **Image Info**

- Displays resolution, color channels, format, and file size.

🌈 **Color Conversions**

- RGB ⟷ BGR
- RGB ⟷ HSV
- RGB ⟷ YCbCr
- RGB ⟷ Grayscale

🔄 **Transformations**

- Rotation
- Scaling
- Translation
- Affine Transformation
- Perspective Transformation

🖌️ **Filtering**

- Gaussian Filter
- Mean Filter
- Median Filter

⚙ **Morphology**

- Dilation

- Erosion
- Opening
- Closing

✨ **Enhancement**

- Histogram Equalization
- Contrast Stretching
- Sharpening

🔍 **Edge Detection**

- Sobel
- Laplacian
- Canny

📦 **Compression**

- Supports JPG, PNG, BMP formats
- Shows compressed file size compared to original

6. User Interface Design

The app interface is designed with simplicity and interactivity in mind:

✓ Sidebar menus are grouped into expandable sections.
✓ Operations like rotation, scaling, or edge detection display relevant sliders only when selected.
✓ Two columns display original and processed images side by side for direct comparison.
✓ Image properties are shown dynamically after every operation.
✓ Users can download the processed image in various formats with a single click.

This design ensures that users can experiment without confusion and see results immediately.

7. Implementation Details

The toolkit is built using Streamlit for the front-end and OpenCV for image processing. Operations are applied in real-time, allowing users to interact with images easily.

Core Features Implemented:

- Image upload and download
- Dynamic interface with expandable menus

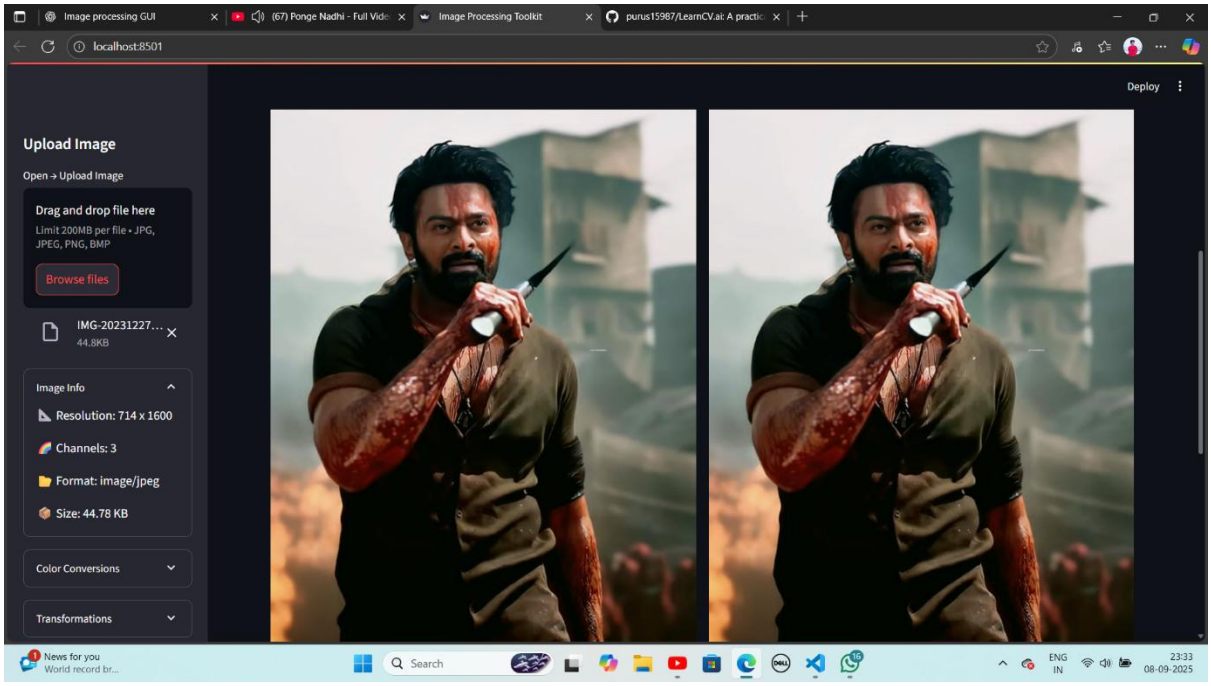
- Real-time application of transformations and filters
- Adjustable parameters using sliders
- Support for multiple image formats

The modular structure allows easy extension for future enhancements like video processing or machine learning-based filters.

8. Observations and Results

✓ The image processing operations were applied smoothly and results were visually noticeable.
✓ The dynamic sliders made parameter tuning intuitive.
✓ Compression feedback helped users understand file size trade-offs.
✓ Edge detection algorithms produced clear contours suitable for further analysis.
✓ Enhancement methods significantly improved contrast and sharpness.

9. Screenshots



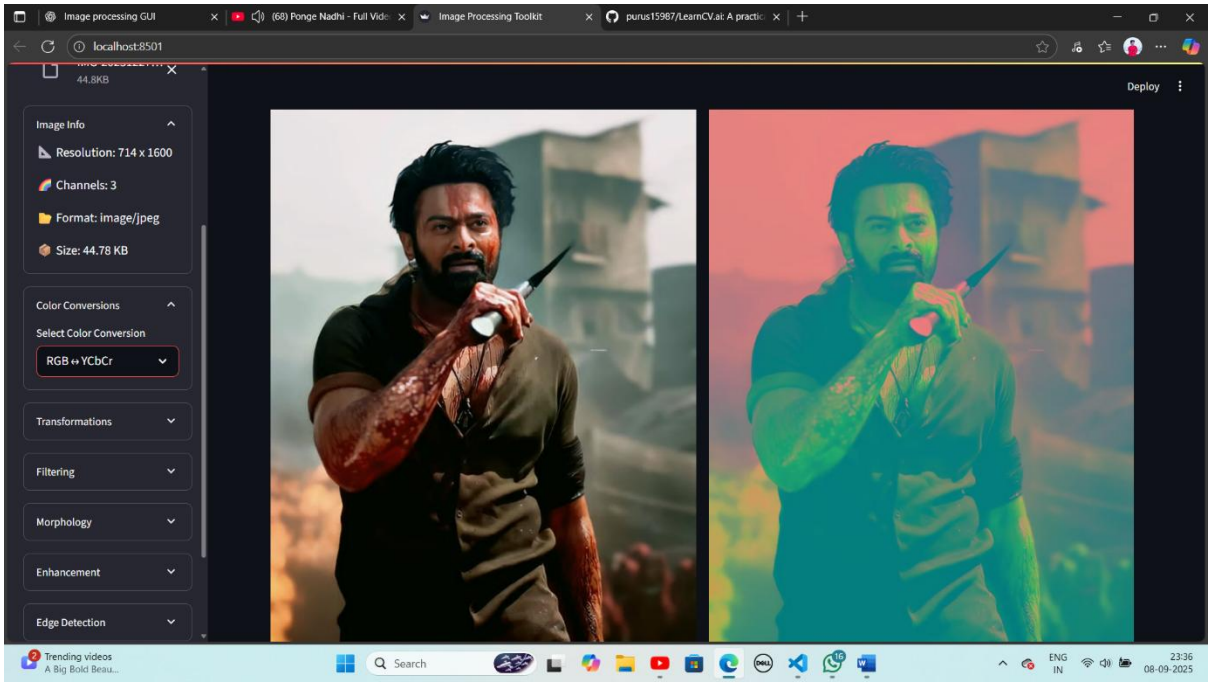


Image processing GUI
(68) Ponge Nadhi - Full Vide
Image Processing Toolkit
purus15987/LearnCV.ai: A practic
localhost:8501
44.8KB
Deploy
Image Info
Resolution: 714 x 1600
Channels: 3
Format: image/jpeg
Size: 44.78 KB
Color Conversions
Select Color Conversion
RGB ↔ YCbCr
Transformations
Filtering
Morphology
Enhancement
Edge Detection
Trending videos
A Big Bold Beau...
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08-09-2025

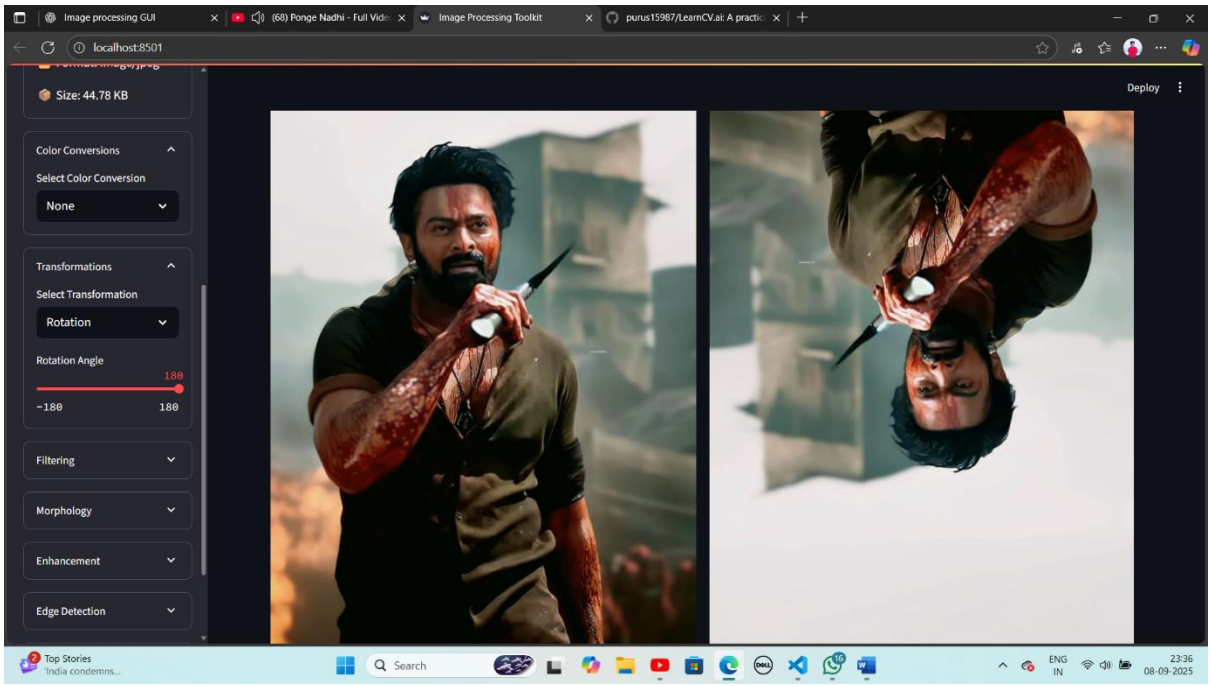
Image processing GUI
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localhost:8501
Size: 44.78 KB
Deploy
Color Conversions
Select Color Conversion
None
Transformations
Select Transformation
Rotation
Rotation Angle
180
-180
180
Filtering
Morphology
Enhancement
Edge Detection
Top Stories
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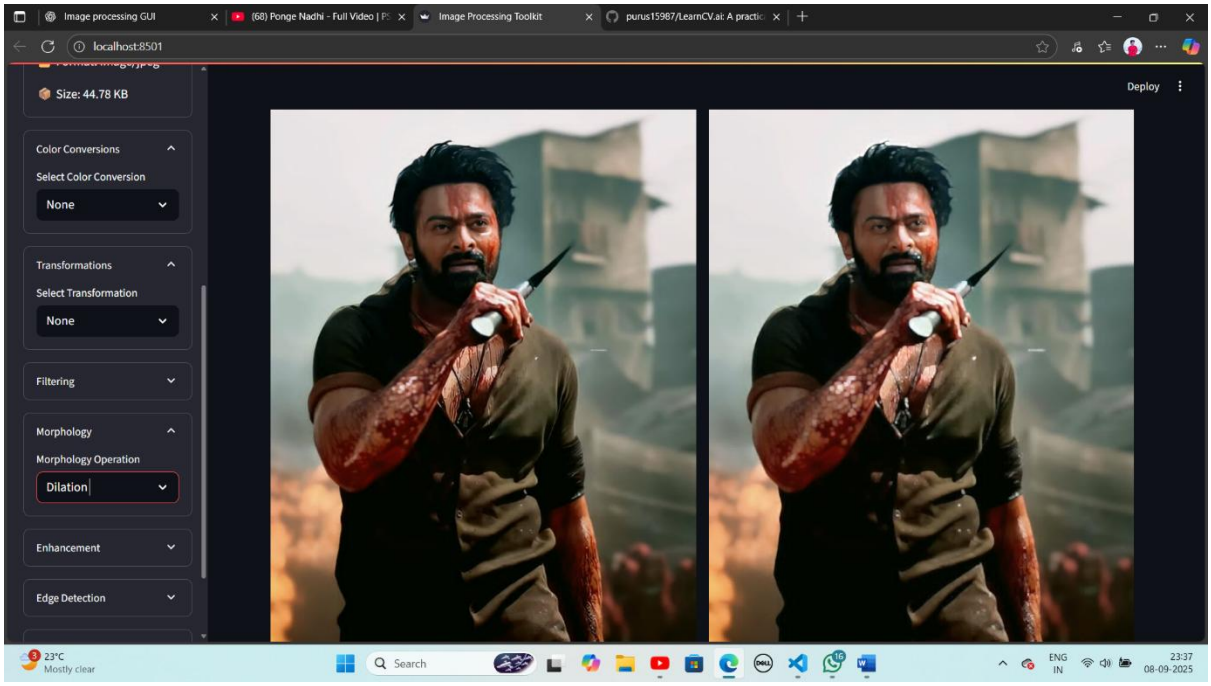
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Image Processing Toolkit
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localhost:8501
Size: 44.78 KB
Deploy
Color Conversions
Select Color Conversion
None
Transformations
Select Transformation
None
Filtering
Morphology
Morphology Operation
Dilation
Enhancement
Edge Detection
23°C
Mostly clear
Search
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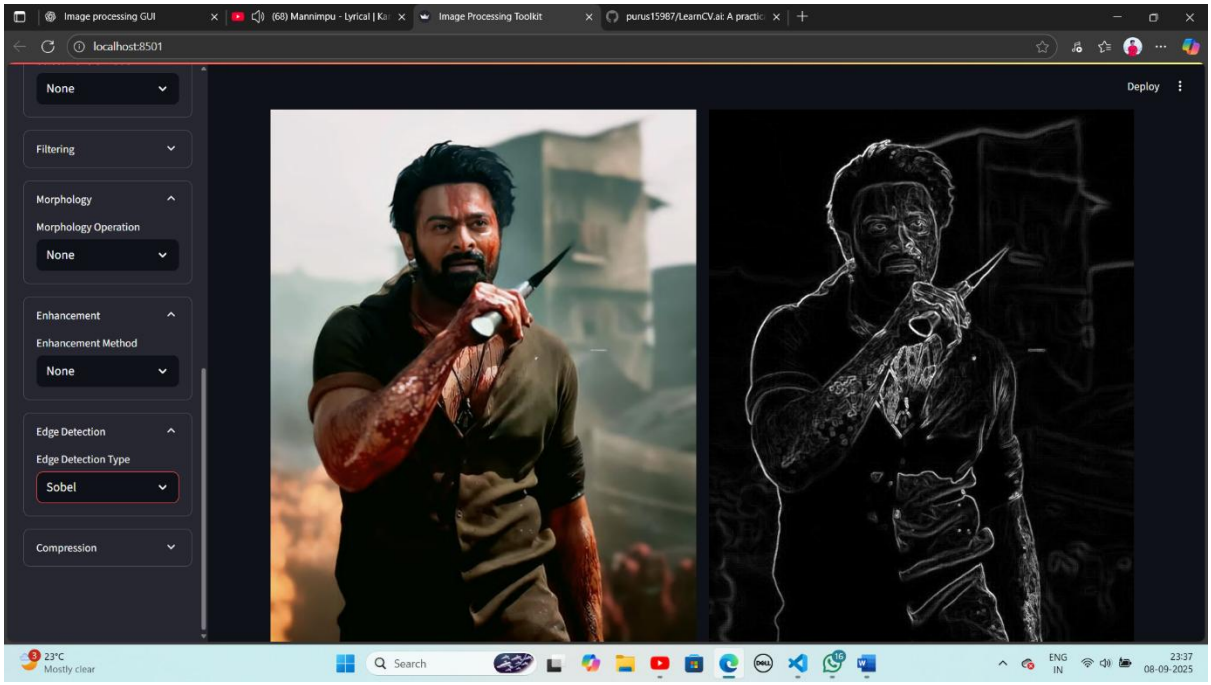
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localhost:8501
Deploy
None
Filtering
Morphology
Morphology Operation
None
Enhancement
Enhancement Method
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Edge Detection
Edge Detection Type
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Compression
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Mostly clear
Search
ENG
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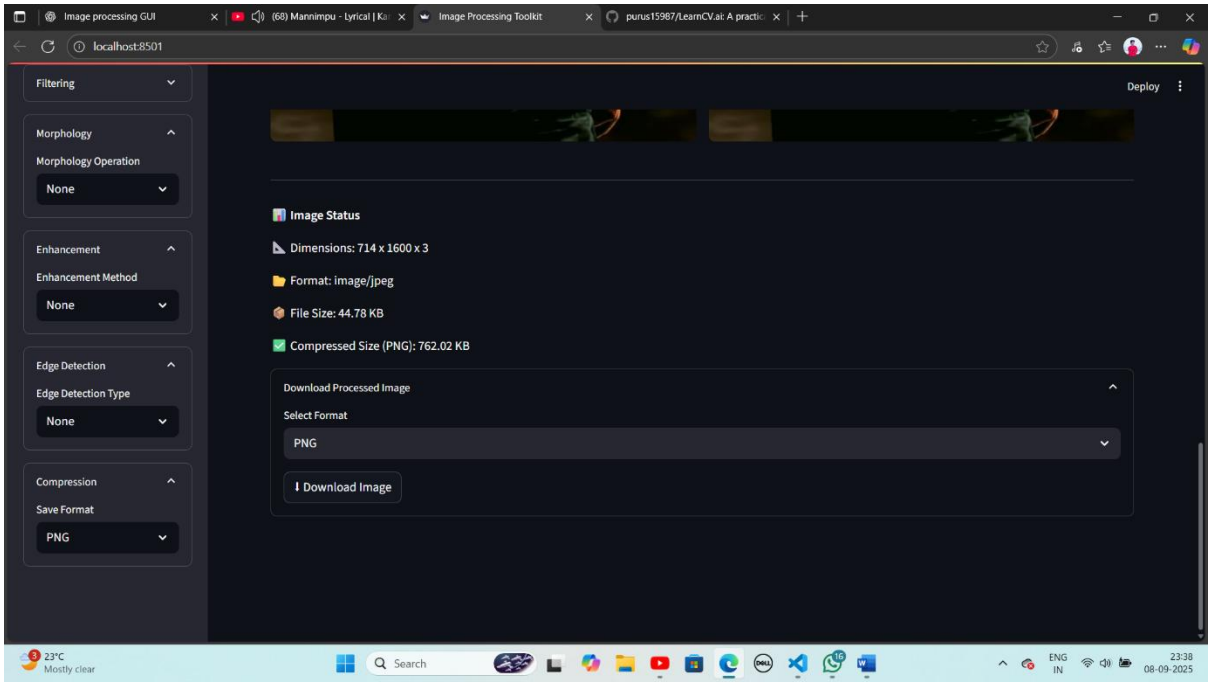
08-09-2025



✅ 10. Conclusion

The Image Processing Toolkit successfully integrates theoretical concepts of image manipulation with practical, hands-on experience. The intuitive interface allows users to experiment and learn by doing.

This application serves as both an educational tool and a demonstration of key image processing techniques.