Report

Assignment 3 – Image Processing Toolkit with GUI

Module: Module 1 – Image Processing Fundamentals & Computer Vision

Submitted by:

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Abstract

This project demonstrates a Graphical User Interface (GUI)-based Image Processing Toolkit developed in Python using Streamlit and OpenCV. The toolkit allows users to upload images, apply fundamental image processing operations, and visualize results interactively. The operations include color conversions, transformations, filtering, morphology, enhancement, edge detection, and compression. The GUI is designed for beginners and intermediate learners to understand computer vision fundamentals with hands-on practice.

Introduction

Image Processing is a vital domain of Artificial Intelligence and Computer Vision. It involves enhancing images, extracting useful information, and preparing data for advanced machine learning models. This toolkit integrates theoretical concepts such as filters, transforms, and histogram equalization with a practical Streamlit-based GUI.

Objectives

- To design a Streamlit GUI for real-time image processing.
- To implement fundamental OpenCV operations.
- To allow side-by-side visualization of original and processed images.
- To compare image formats and compression efficiency.
- To provide a beginner-friendly platform for AIML students.

System Design

GUI Layout (Streamlit):
- Menu Bar: Upload, Save, Exit
- Sidebar: Operations Menu (Info, Conversions, Transformations, Filtering, Enhancement, Edge Detection, Compression)
- Main Display Area: Original (left) vs Processed (right) images
- Status Bar: Dynamic info – resolution, format, size

Modules Implemented:
1. Image Info: Resolution, format, channels
2. Color Conversions: RGB ↔ HSV, RGB ↔ YCbCr, RGB ↔ Gray
3. Transformations: Rotate, Scale, Translate, Affine, Perspective
4. Filtering & Morphology: Gaussian, Median, Sobel, Laplacian, Dilation, Erosion
5. Enhancement: Histogram Equalization, Contrast Stretching, Sharpening
6. Edge Detection: Canny, Sobel, Laplacian
7. Compression: JPG, PNG, BMP with file size comparison

Implementation Details

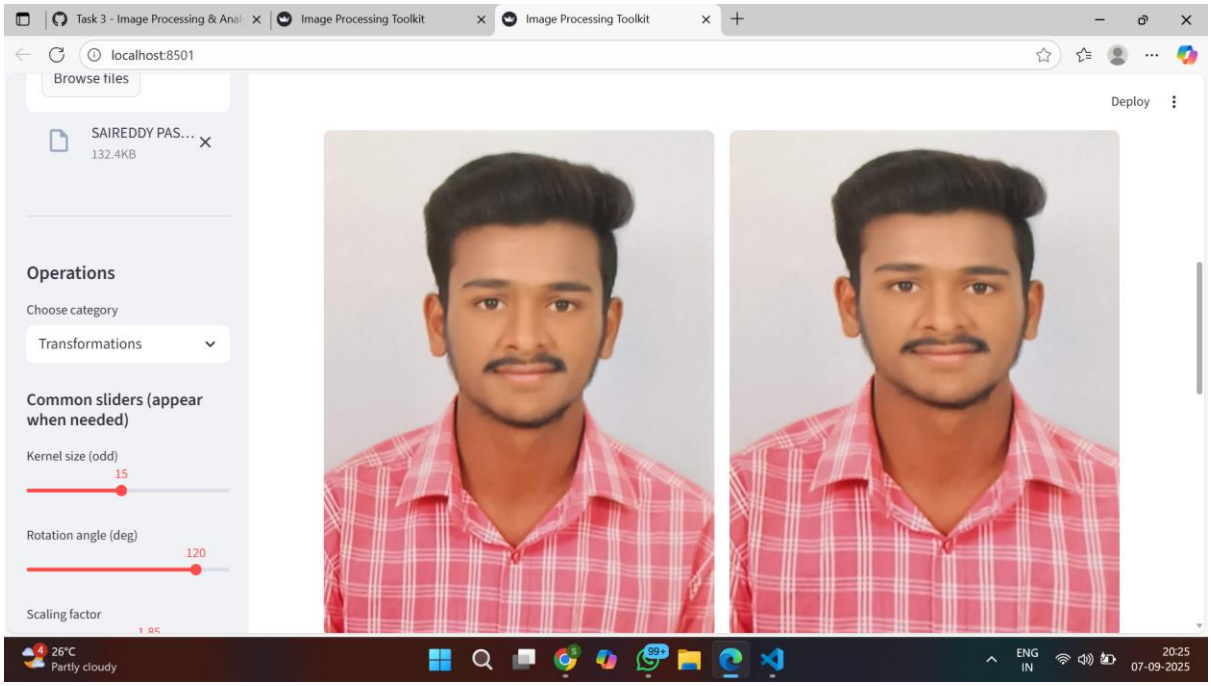
Language: Python 3
Libraries: Streamlit, OpenCV, NumPy, Pillow, Matplotlib
Environment: VS Code, Virtual Environment (venv)
Workflow:
1. Upload image
2. Select operation from sidebar
3. Process using OpenCV
4. Display results
5. Save processed image

Algorithms & Techniques Used

- Color Conversions: OpenCV cv2.cvtColor() for RGB, HSV, YCbCr, Grayscale.
- Transformations: Rotation, Scaling, Translation, Perspective using OpenCV functions.
- Filtering: Gaussian, Median, Mean smoothing filters.
- Morphology: Dilation, Erosion, Opening, Closing using cv2.morphologyEx().
- Enhancement: Histogram Equalization, Contrast Stretching, Sharpening filters.
- Edge Detection: Sobel, Laplacian, Canny algorithms.
- Compression: Saving in JPG, PNG, BMP and comparing file sizes.

Results & Screenshots

(Add toolkit screenshots here: original vs processed images for sample operations)
Example: Grayscale conversion, Gaussian blur, Canny edge detection, Compression comparison.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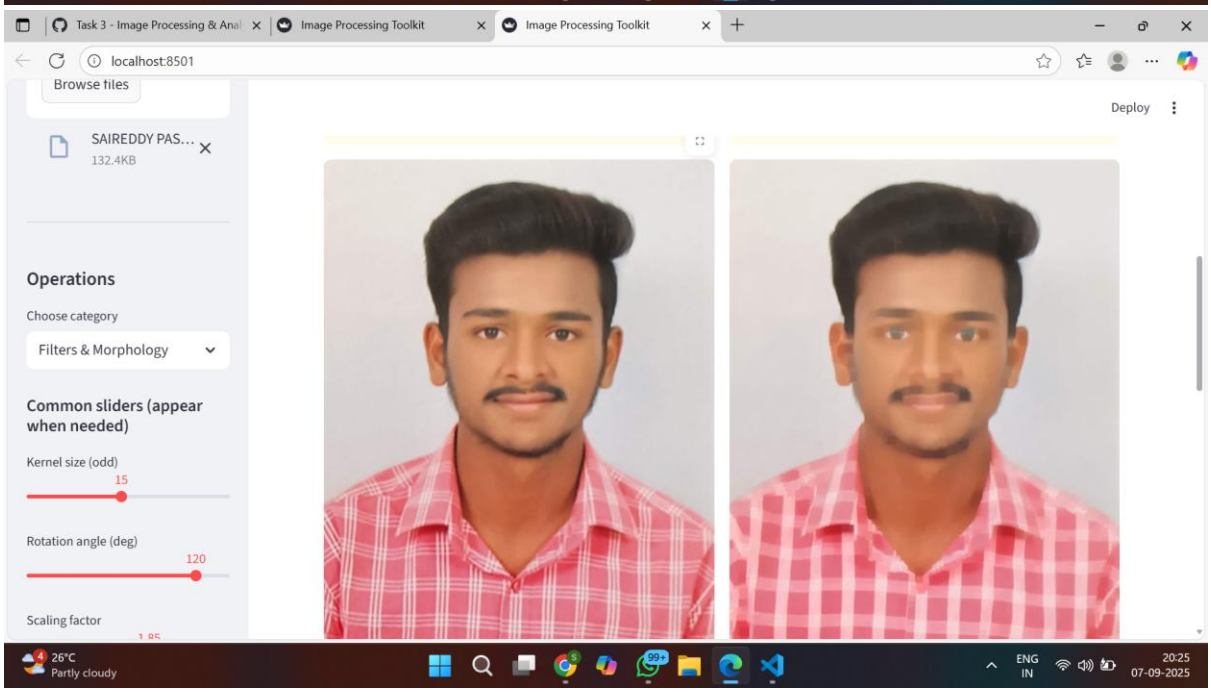
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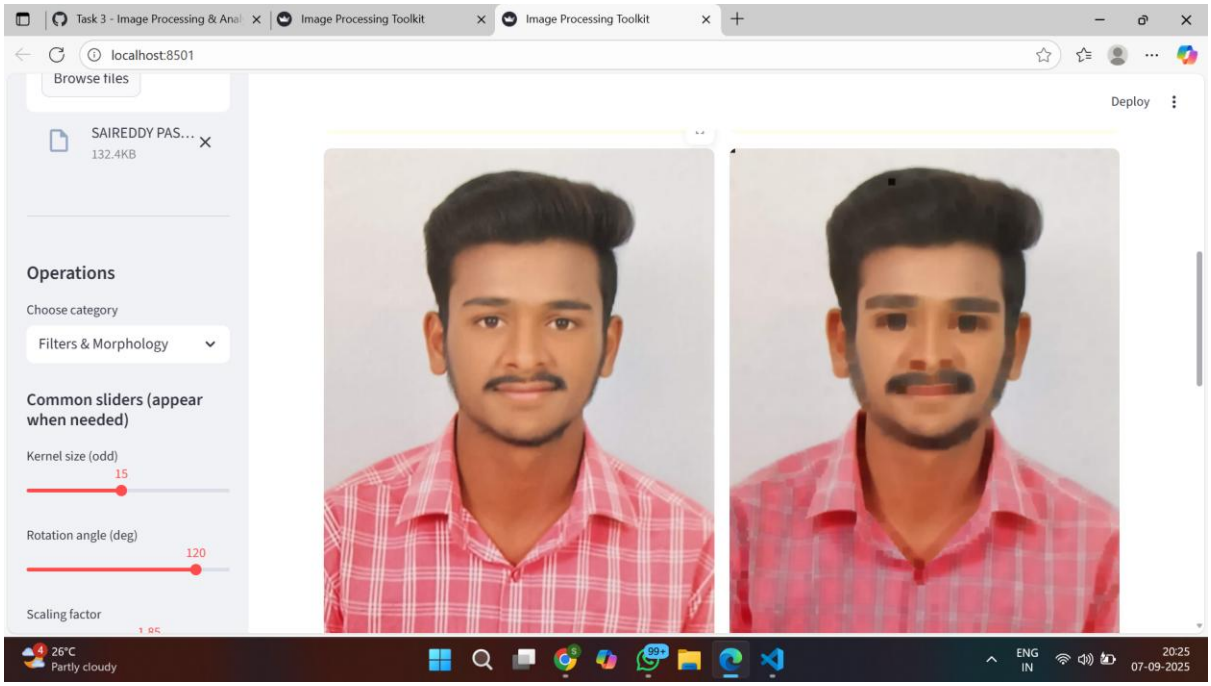
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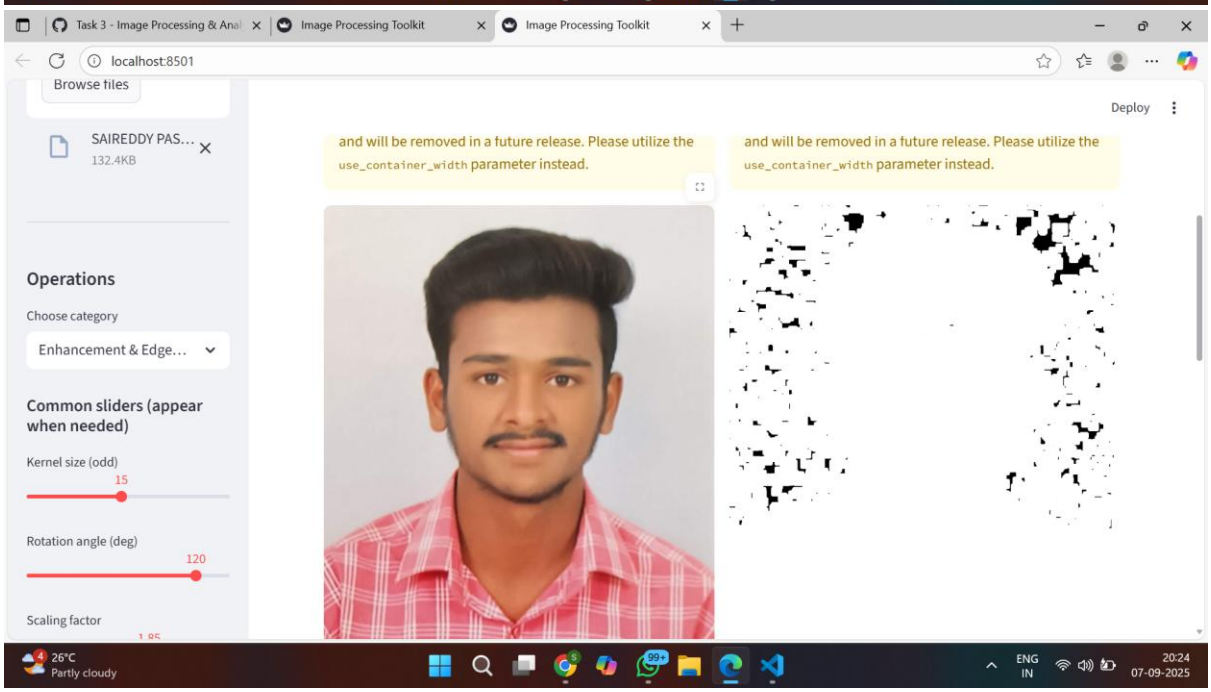
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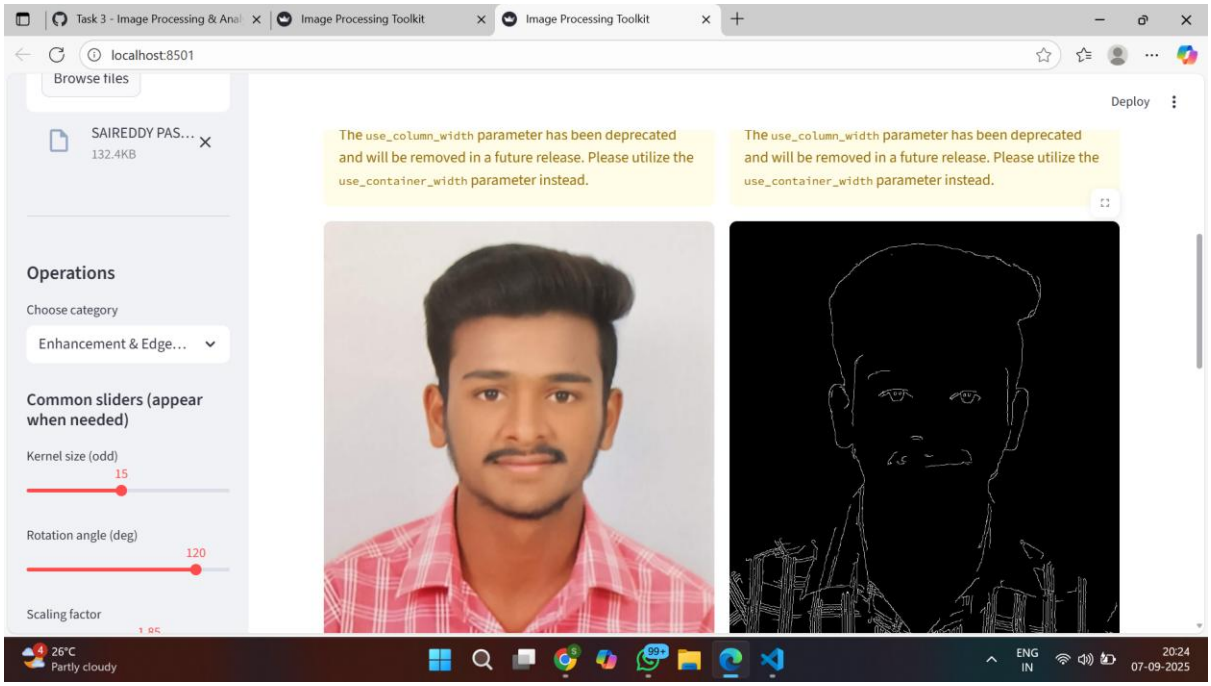
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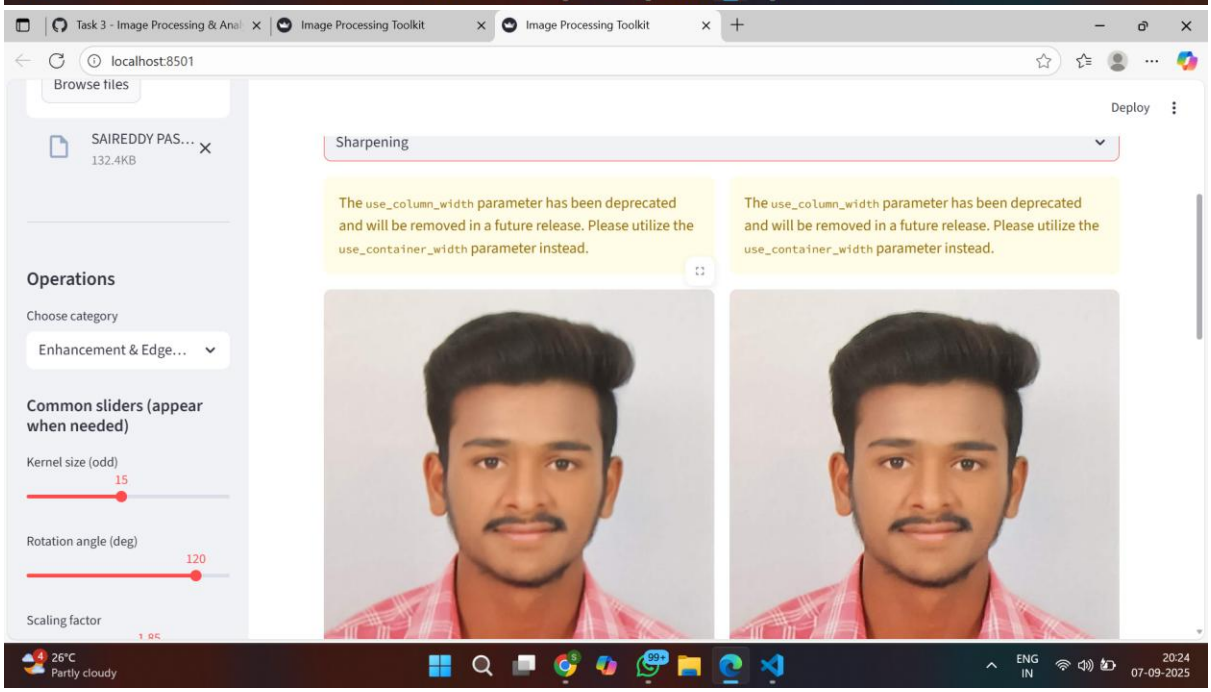
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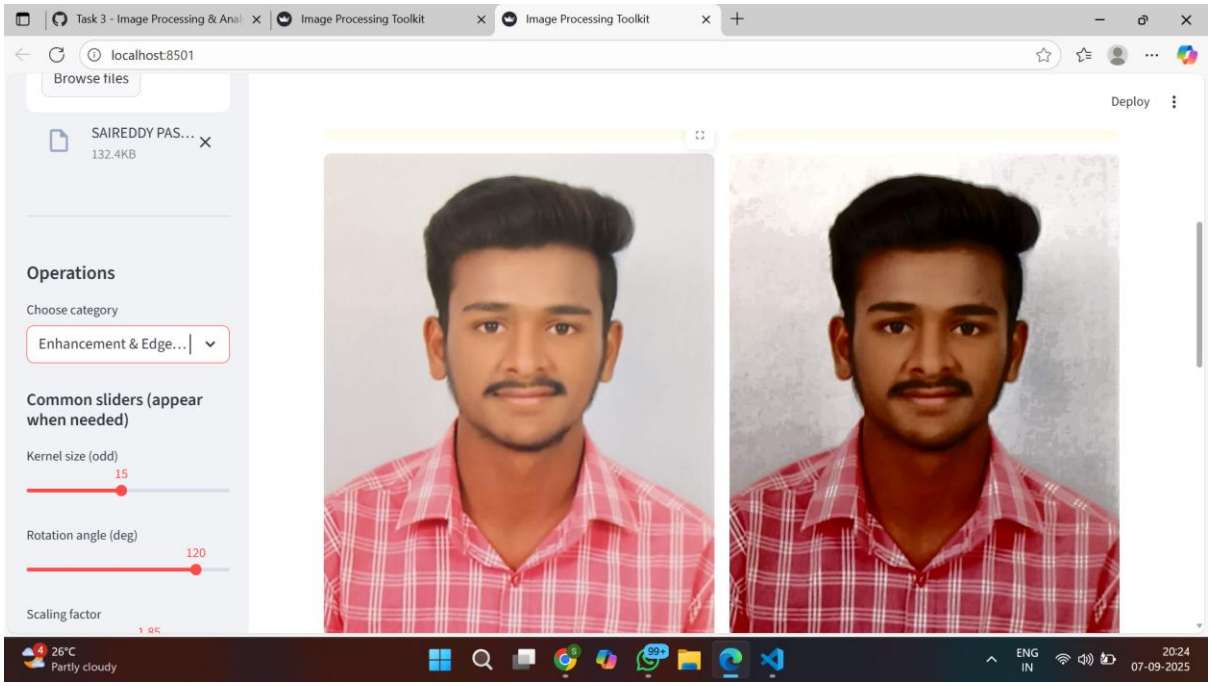
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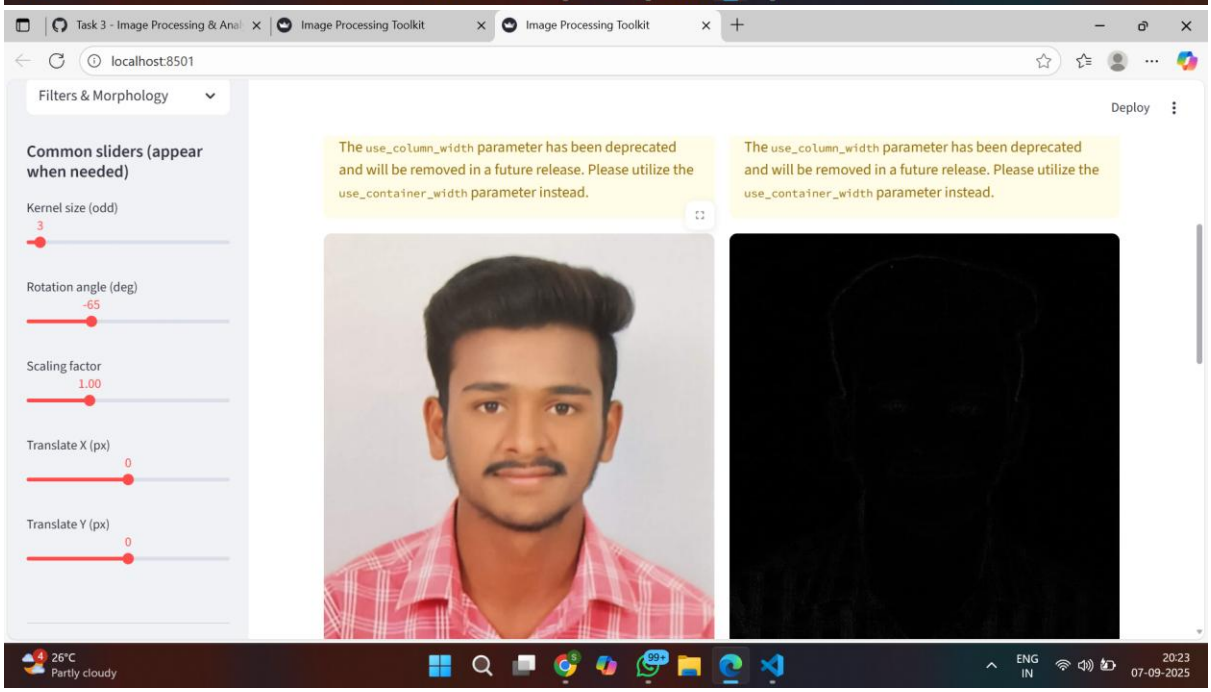
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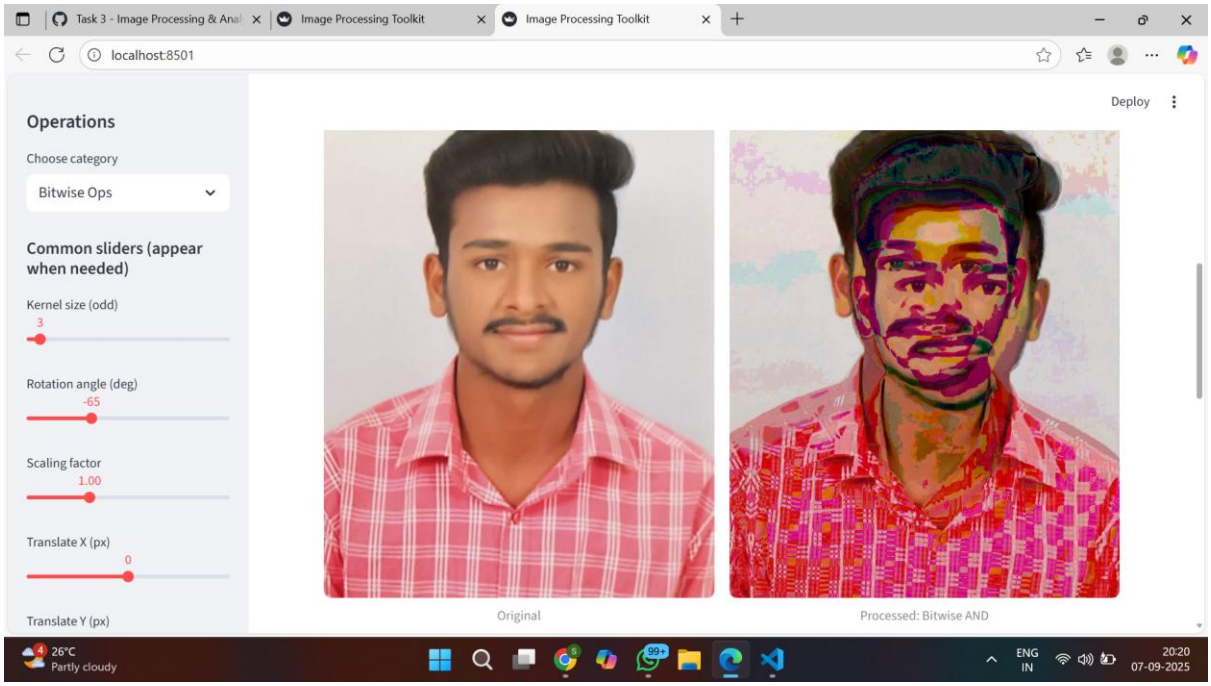
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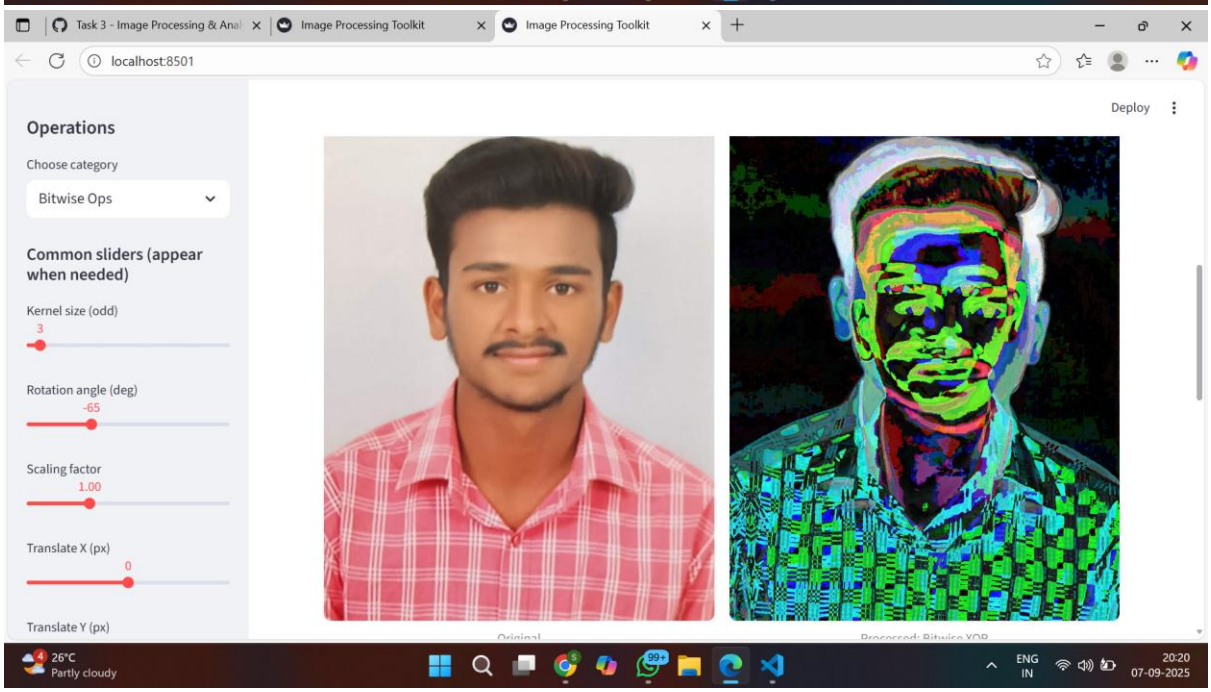
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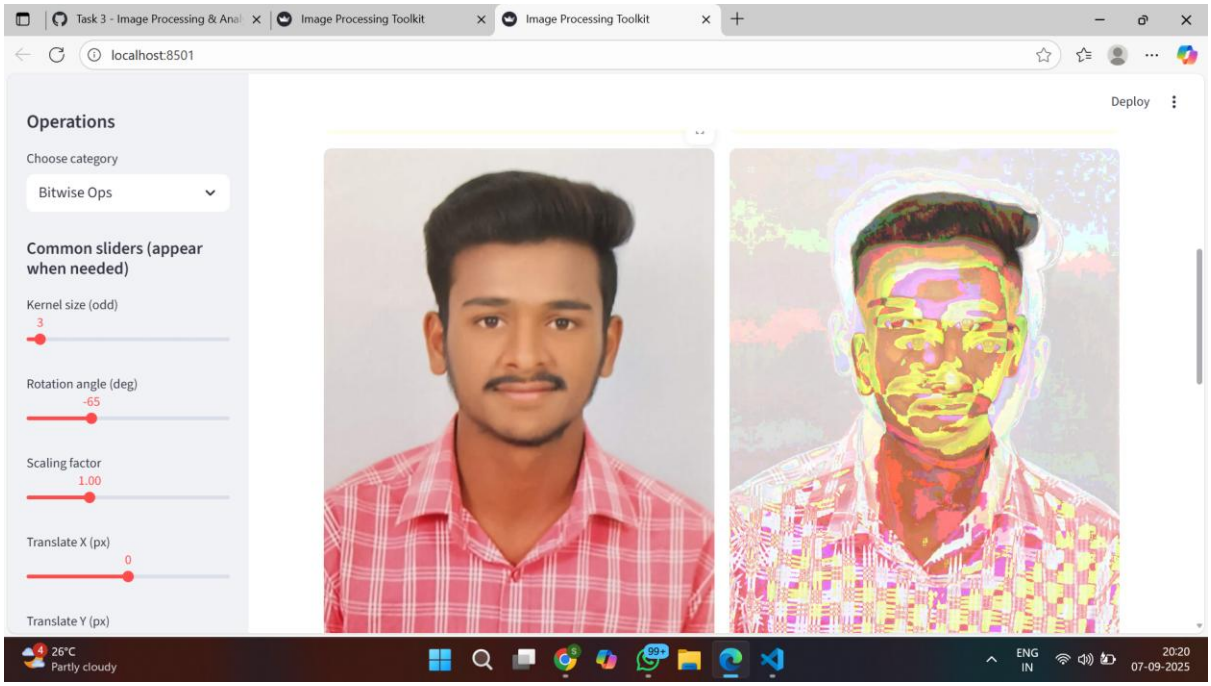
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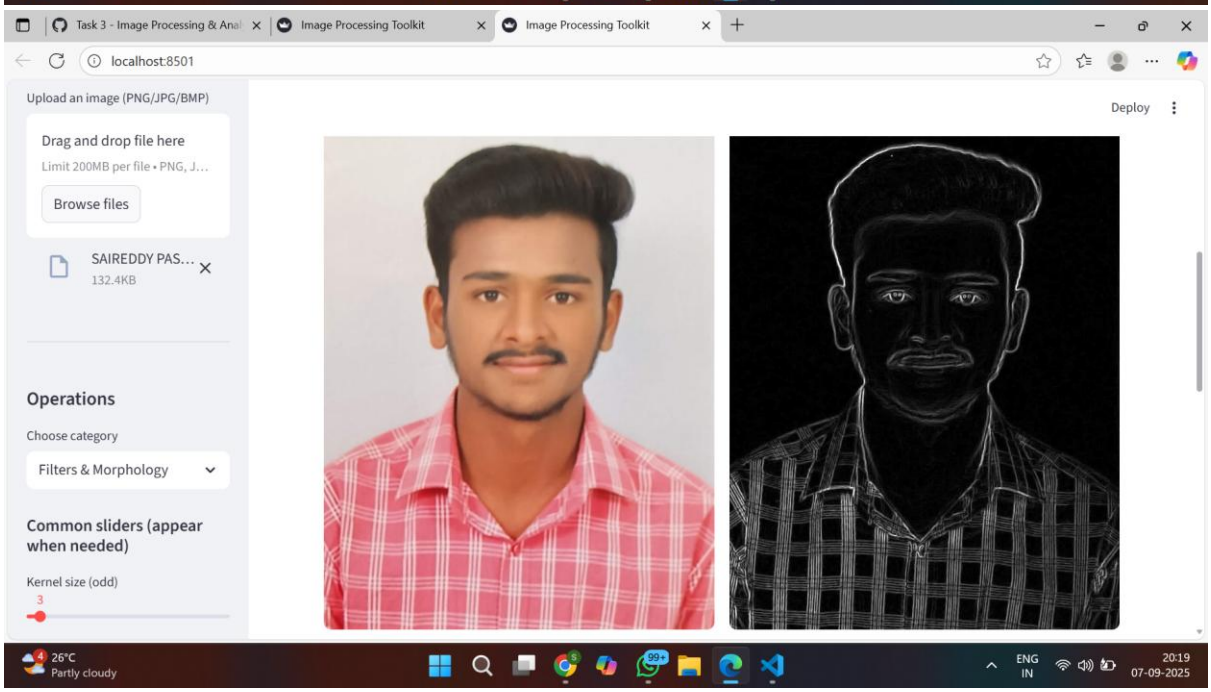
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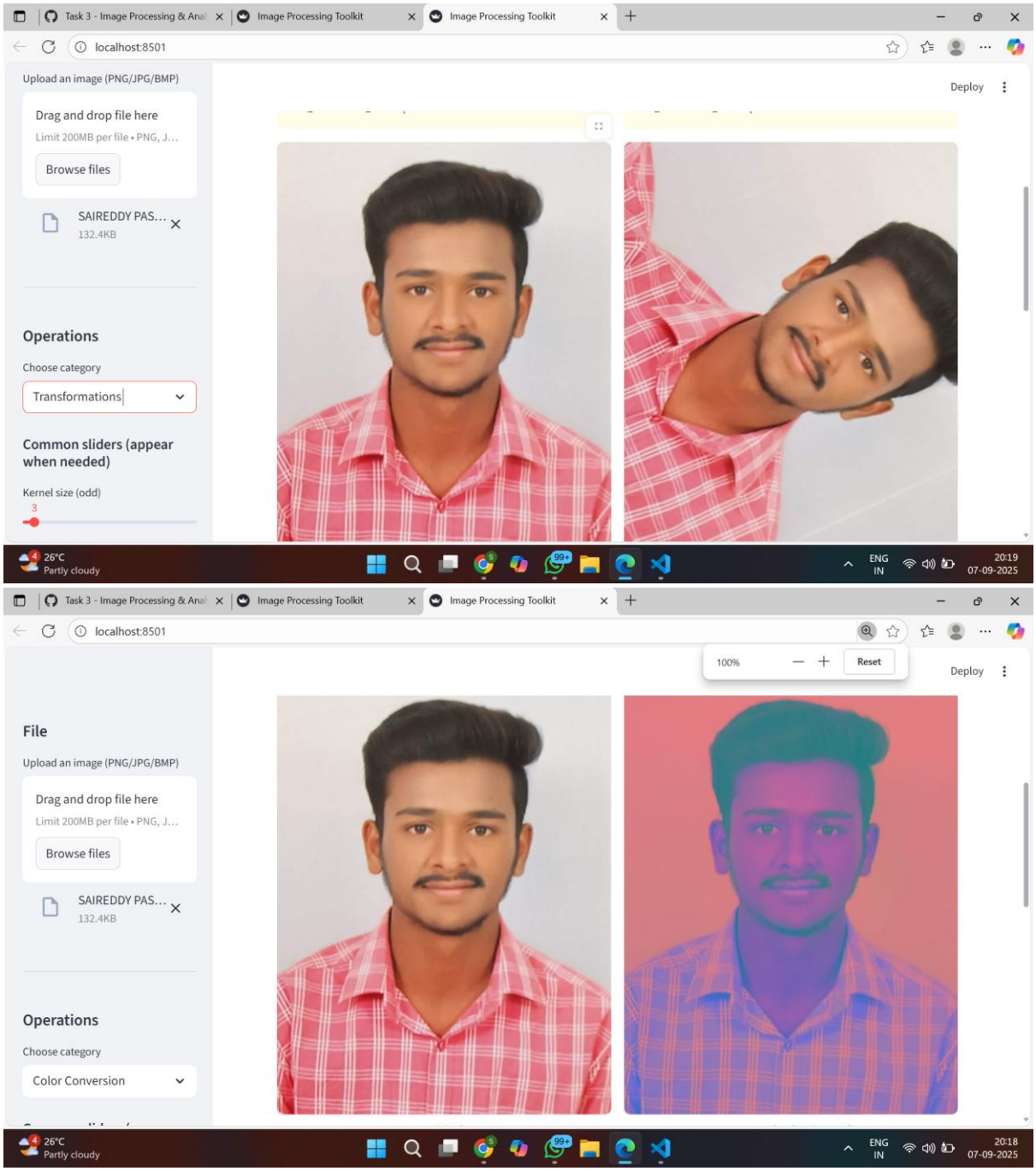

Conclusion & Future Scope

The project successfully demonstrates fundamental image processing techniques with an easy-to-use GUI. It enhances learning by providing hands-on practice of OpenCV concepts.

Future Scope:
- Real-time video stream processing
- Deep Learning-based filters (style transfer, super-resolution)
- Integration with cloud storage for image saving
- Multi-image batch processing

References

1. OpenCV Documentation – https://docs.opencv.org
2. Streamlit Documentation – https://docs.streamlit.io
3. Digital Image Processing – Rafael C. Gonzalez, Richard E. Woods