Task 3 Report

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Course: AIML-A
Subject: Computer Vision
Task: Image Processing Toolkit Submission

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1. Introduction

This project demonstrates the implementation of a **GUI-based Image Processing Toolkit** using Python, OpenCV, NumPy, and Streamlit. The toolkit provides an interactive interface where users can upload an image, apply a wide range of image processing operations, and visualize results side-by-side with the original image.

The objective is to connect theoretical concepts of **image processing** (color conversions, transforms, filtering, edge detection, etc.) with practical implementation in a user-friendly system.

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2. System Design

The GUI is implemented in **Streamlit**, which allows real-time interaction. The layout consists of:

- **Menu Bar (Top Section):** File upload, save, exit
- **Sidebar (Left Panel):** List of image processing operations grouped by category
- **Right Panel:** Displays the original image and processed image
- **Status Bar (Bottom):** Shows properties such as dimensions, channels, file size, and format

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3. Implemented Features

3.1 Image Information

- Resolution, shape, dimensions
- DPI/PPI (where available)
- File format
- Color channels

3.2 Color Conversions

- RGB ↔ BGR
- RGB ↔ HSV
- RGB ↔ YCbCr

- RGB ↔ Grayscale

3.3 Transformations

- Rotation (with adjustable angle)
- Scaling (zoom in/out)
- Translation (shifting)
- Affine transform
- Perspective transform

3.4 Filtering & Morphology

- Gaussian, Mean, Median filters
- Sobel, Laplacian edge filters
- Dilation, Erosion
- Opening, Closing

3.5 Image Enhancement

- Histogram Equalization
- Contrast Stretching
- Sharpening

3.6 Edge Detection

- Sobel
- Canny (with threshold sliders)
- Laplacian

3.7 Compression

- Save in multiple formats (JPG, PNG, BMP)
- Compare file size & quality

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4. Additional Features (Bonus)

- Sliders for kernel size, rotation angle, scaling factor, and edge detection thresholds
- Split-screen comparison mode
- Download processed images
- Option to extend with webcam feed (real-time mode)

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5. Theory Notes

5.1 CMOS vs CCD Sensors

- **CMOS (Complementary Metal-Oxide-Semiconductor):**
    - Lower power consumption
    - Faster readout
    - Integrated processing on-chip
    - More cost-effective
- **CCD (Charge Coupled Device):**
    - High-quality images with low noise
    - Better for low-light conditions
    - More power-hungry and expensive

5.2 Sampling & Quantization

- **Sampling:** Selecting discrete pixel points from a continuous image
- **Quantization:** Mapping continuous intensity values into finite levels (e.g., 8-bit → 256 gray levels)

5.3 Point Spread Function (PSF)

- Defines how a point source of light spreads in the imaging system
- Determines the sharpness and quality of the captured image
- Used in image restoration and deblurring

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6. Results (Add Screenshots Here)

- Example of color conversion (RGB → HSV → Gray)
- Transformation examples (rotation, scaling, affine)
- Filtered images (Gaussian blur, Median filter, Sobel edge detection)
- Histogram equalization result
- Compression comparison (JPG vs PNG size)

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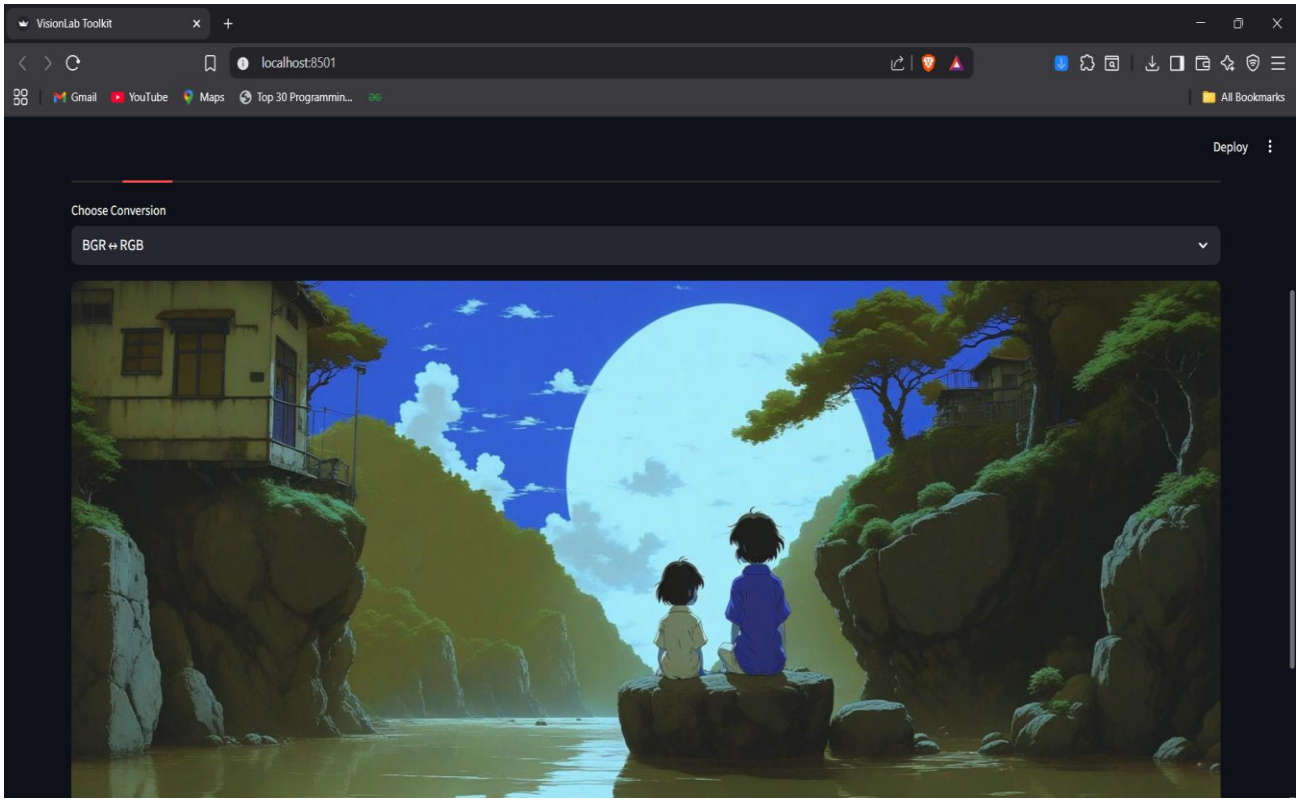
7. Conclusion

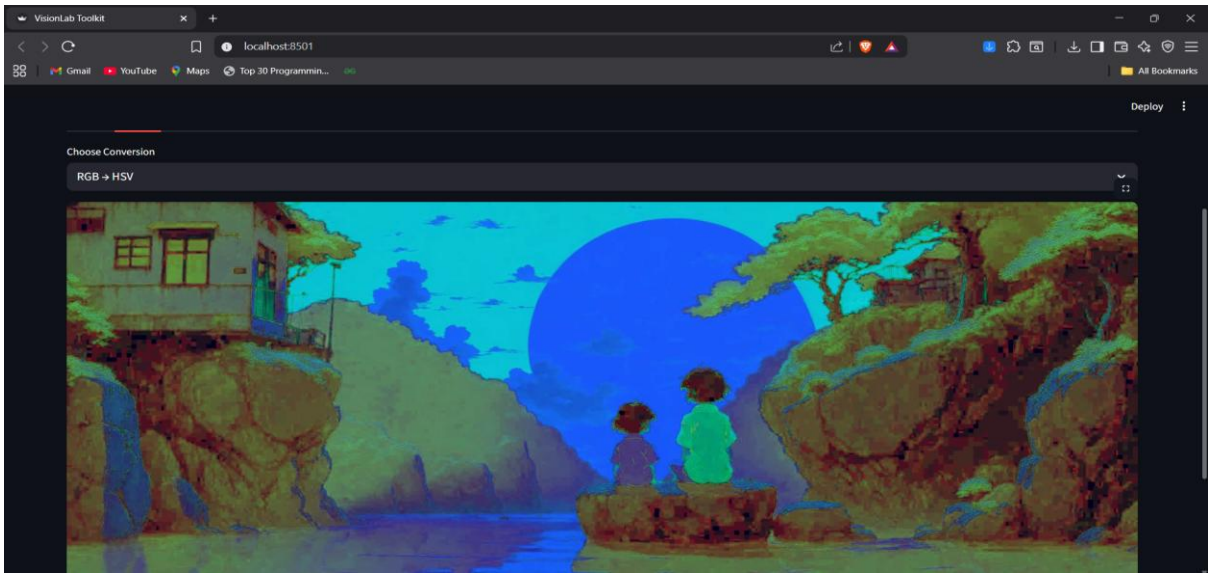
The Image Processing Toolkit successfully integrates theoretical concepts with practical applications. The GUI makes experimentation easier for students to understand how different operations affect an image.

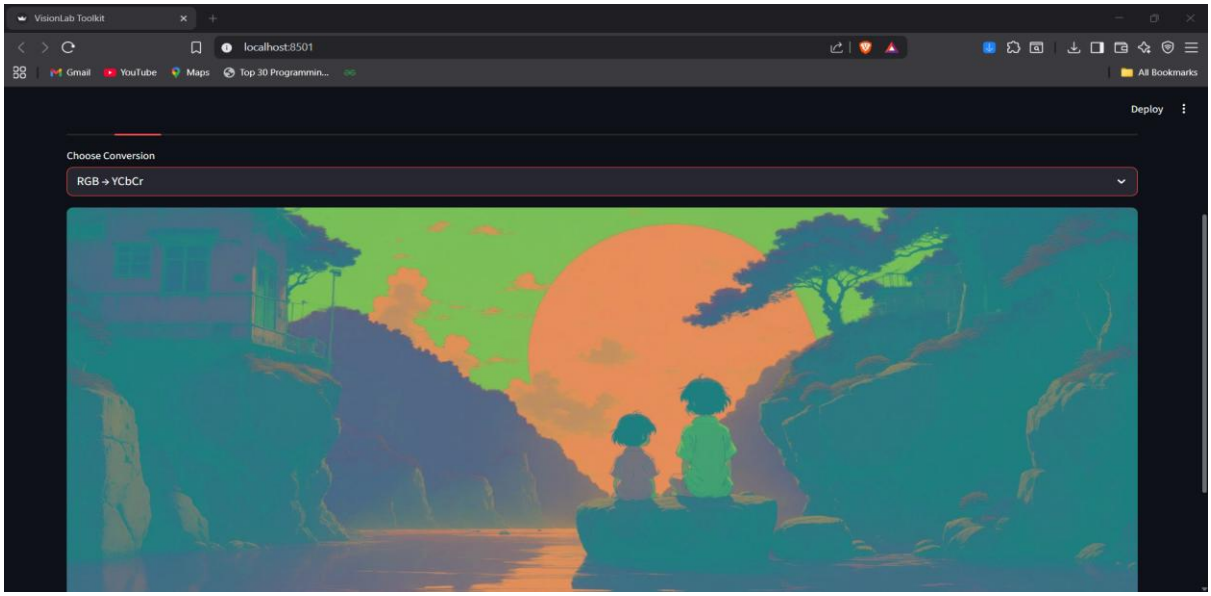
This project can be extended further by:

- Adding real-time video processing

- Integrating machine learning for object detection/classification
- Supporting batch image processing



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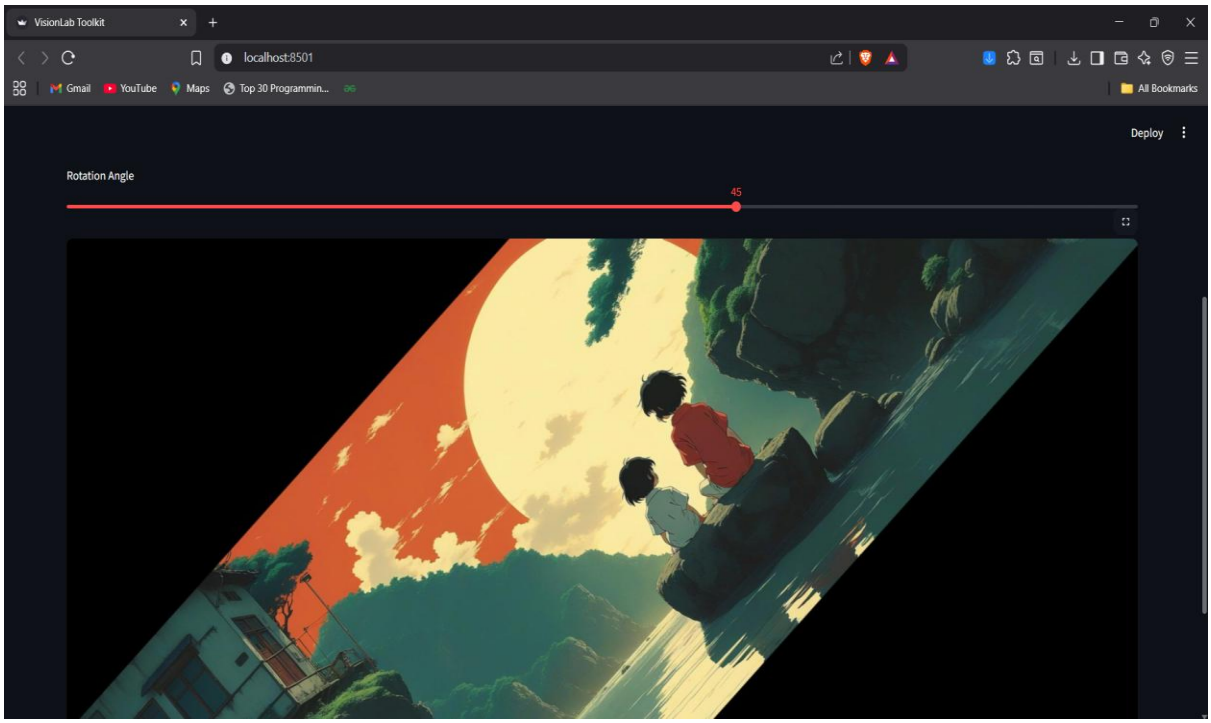
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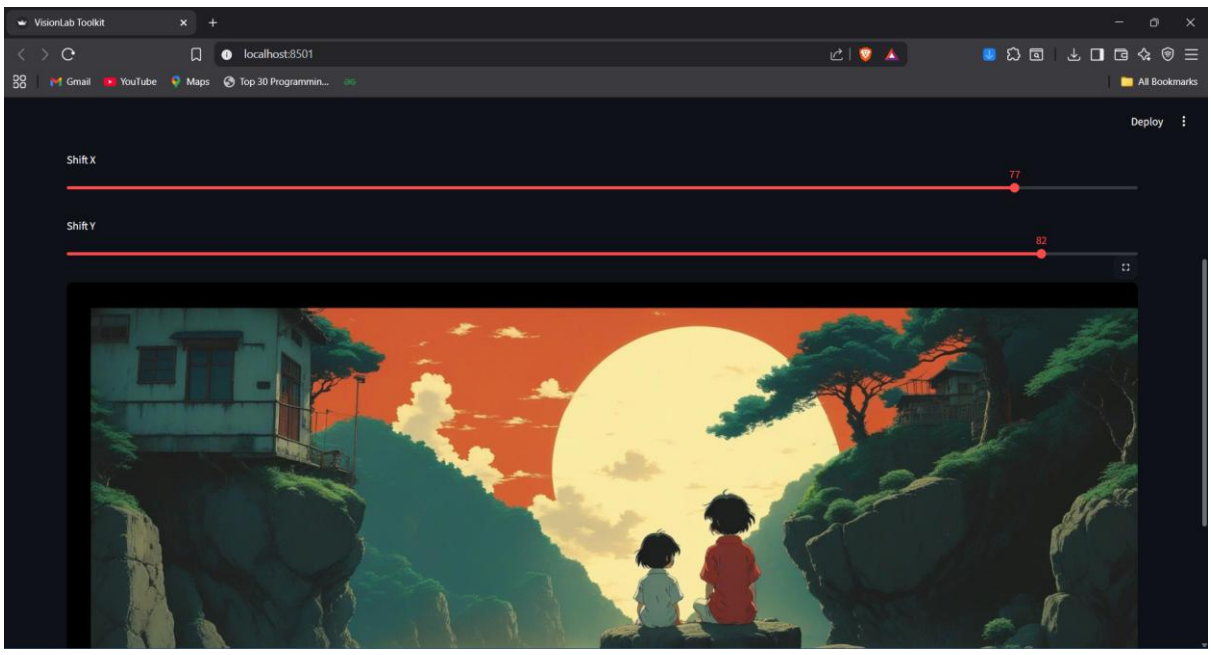
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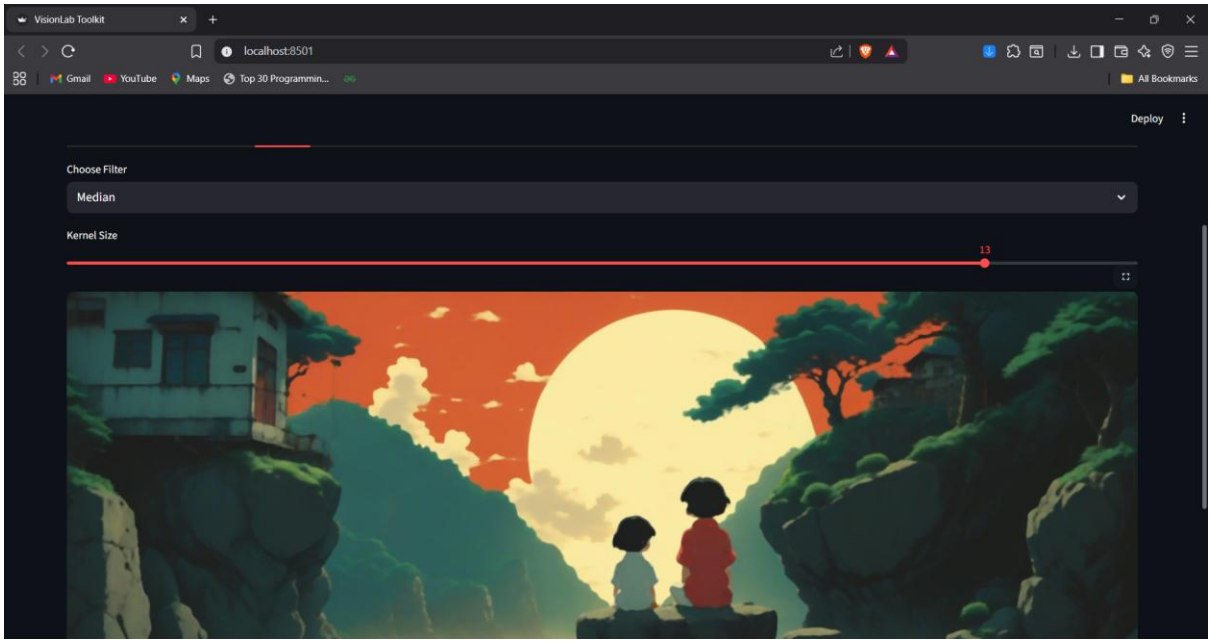
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Kernel Size
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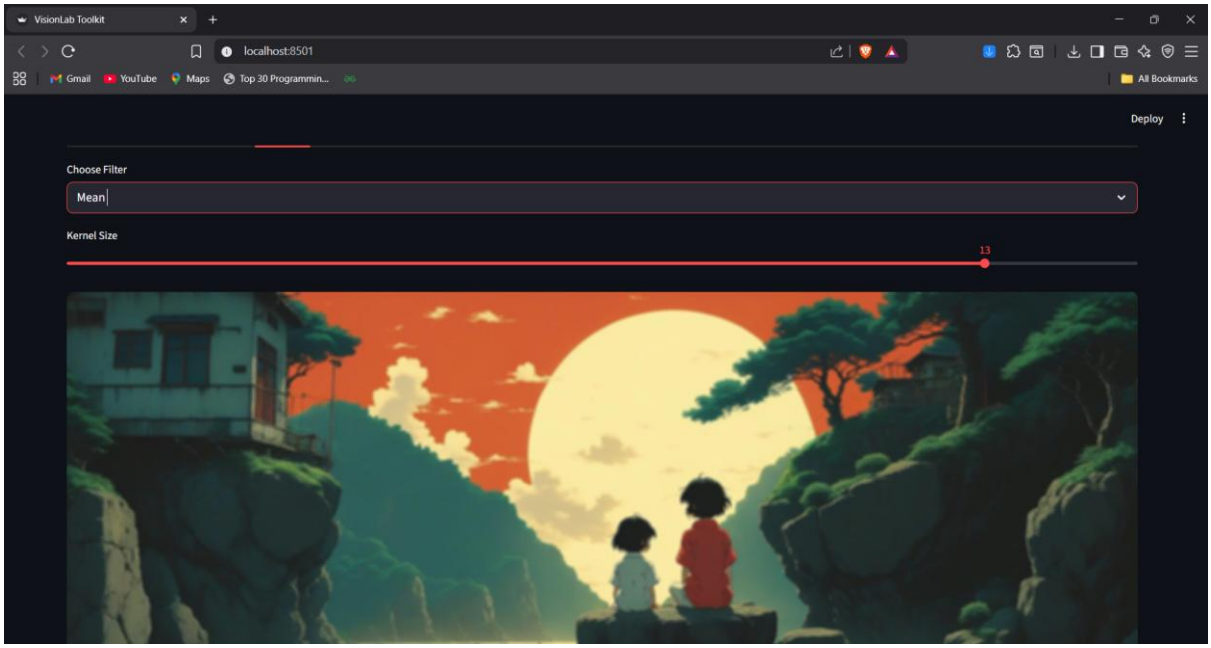
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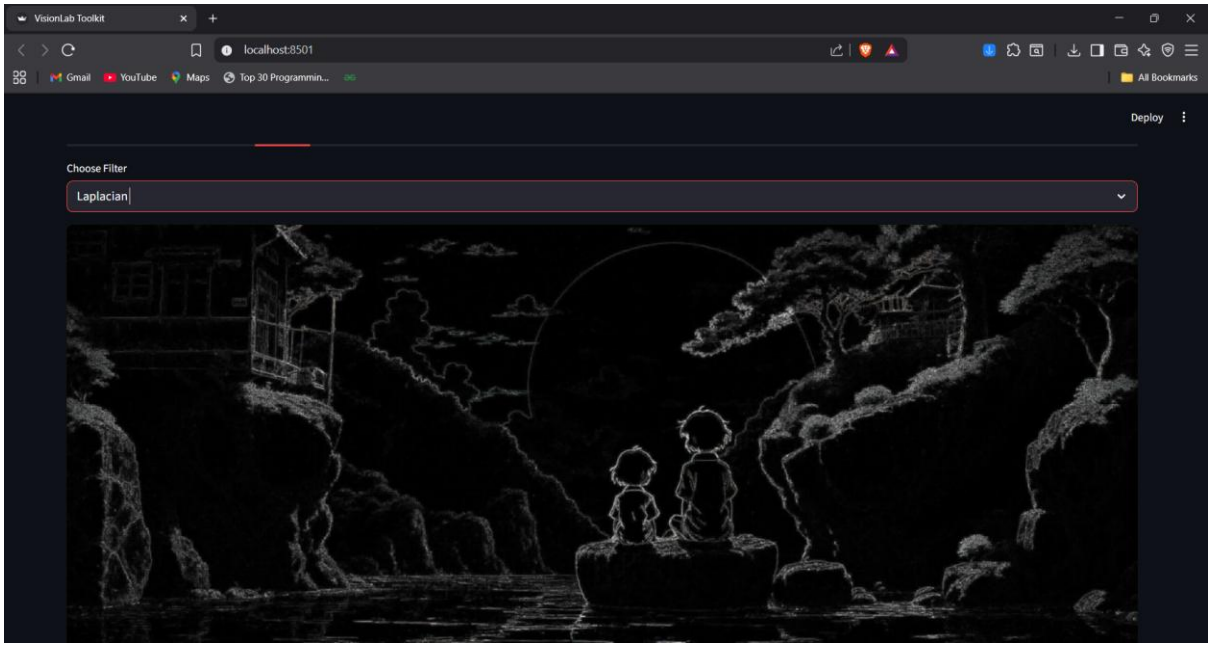
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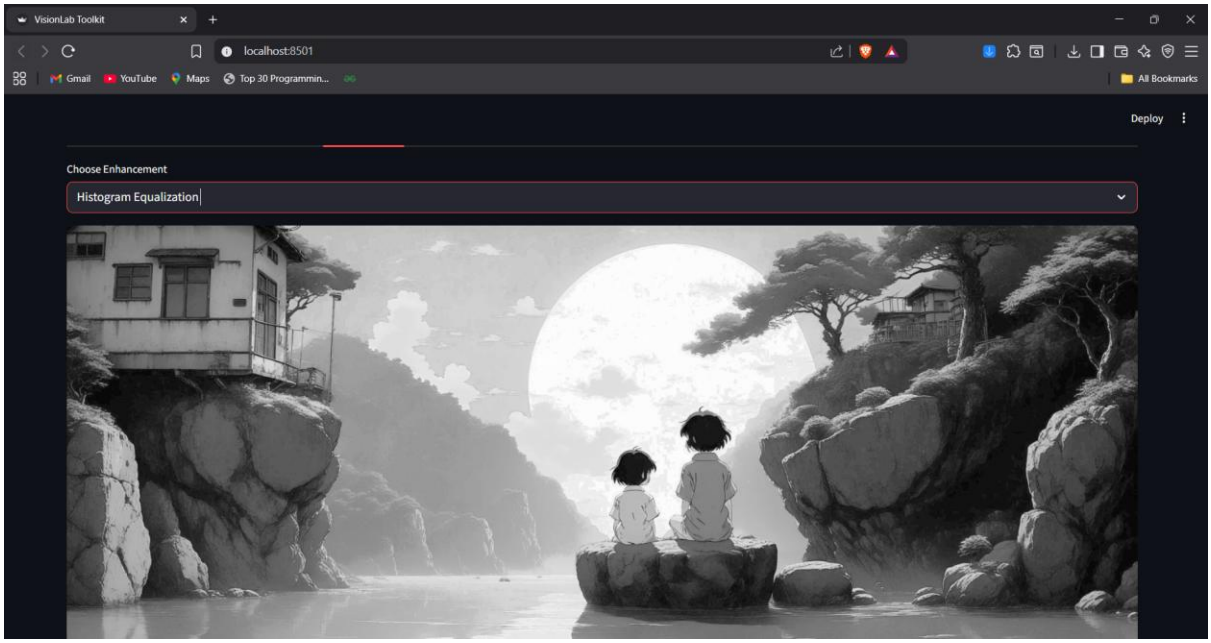
Choose Filter
Laplacian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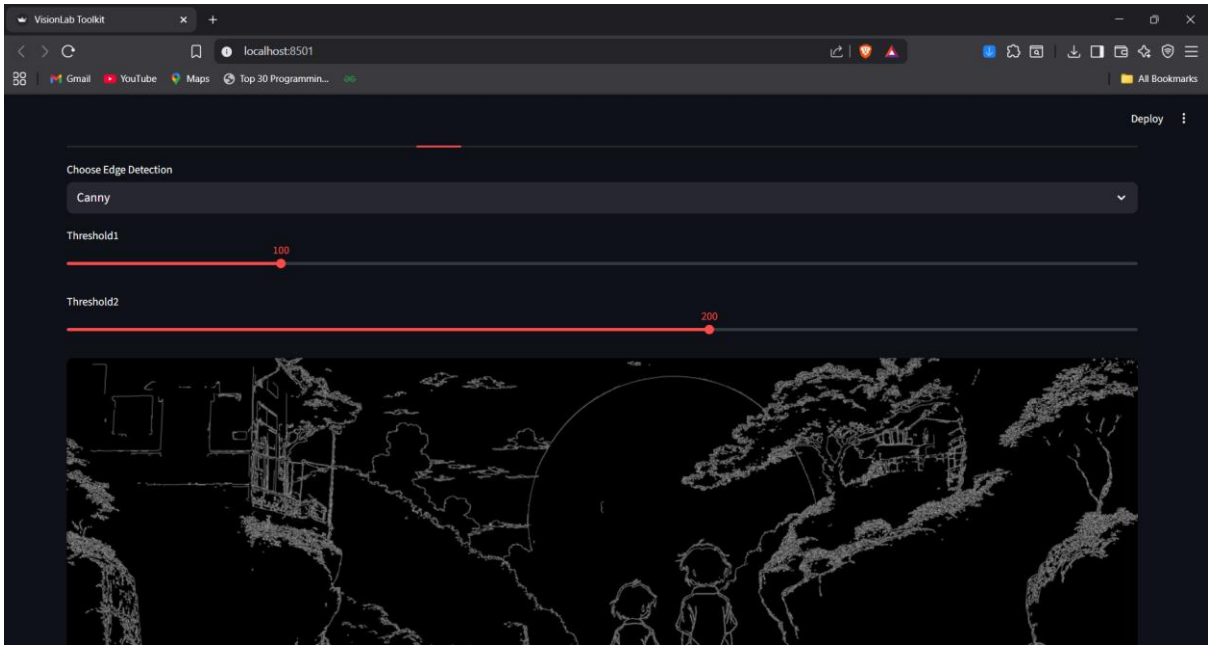
Choose Enhancement
Histogram Equalization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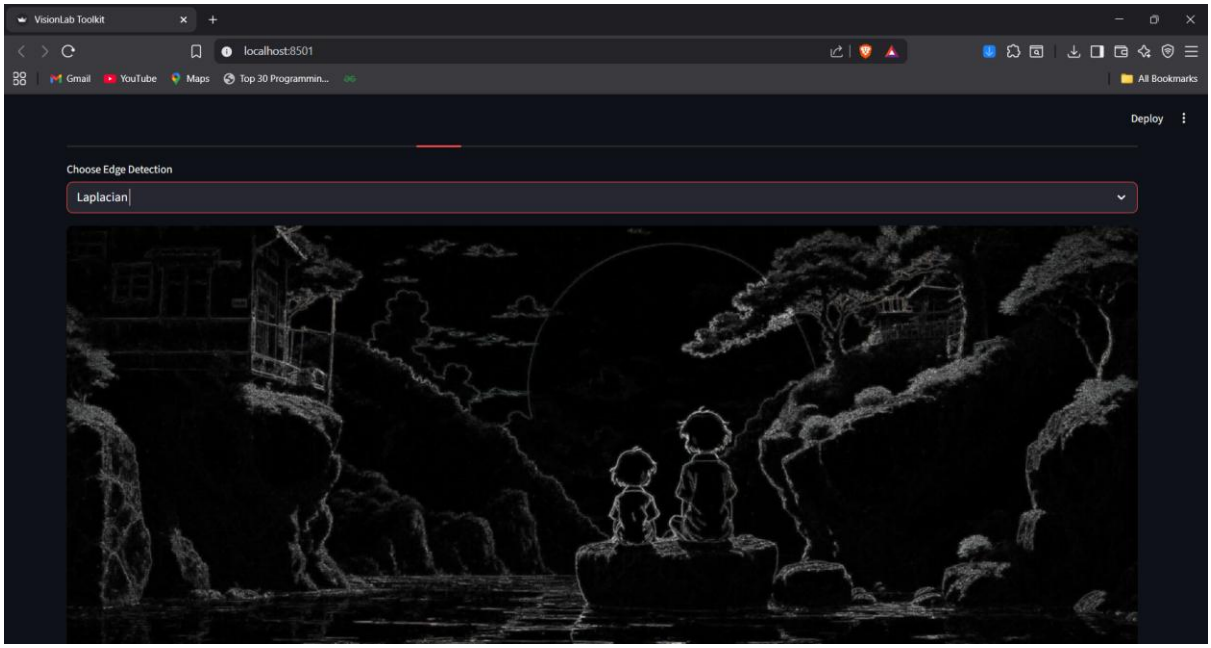
Canny
Threshold1
100
Threshold2
200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