

Image Processing Toolkit

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1. Introduction

The Image Processing Toolkit is an interactive Python application built using Streamlit and OpenCV. It allows users to upload images and apply multiple image processing operations, including Grayscale conversion, Color Space conversion, Rotation, and Edge Detection. The toolkit demonstrates practical applications of digital image processing concepts.

2. Tools & Technologies

- Programming Language: Python
- Libraries Used:
 - o Streamlit (for GUI)
 - o OpenCV (for image processing)
 - o NumPy (for numerical operations)
 - o Pillow (for image handling)

Features Implemented:

1. Upload an image (PNG/JPEG)
- . 2. Display original image information (size, format).
3. Apply processing operations such as:
 - O Grayscale conversion
 - o Edge detection (Canny)
 - o Image resizing

- HSV Conversion

2. Theory / Notes

CMOS vs CCD

- **CMOS (Complementary Metal-Oxide-Semiconductor):**
 - Low power consumption
 - Cheaper to manufacture
 - Suitable for mobile devices
- **CCD (Charge-Coupled Device):**
 - Higher image quality
 - Less noisy
 - Used in high-end imaging applications

Sampling & Quantization

- **Sampling:** Converting a continuous image signal into discrete pixels.
- **Quantization:** Assigning discrete intensity values to the sampled pixels.
- Together, sampling and quantization convert analog images into digital form for processing.

Point Spread Functions (PSFs)

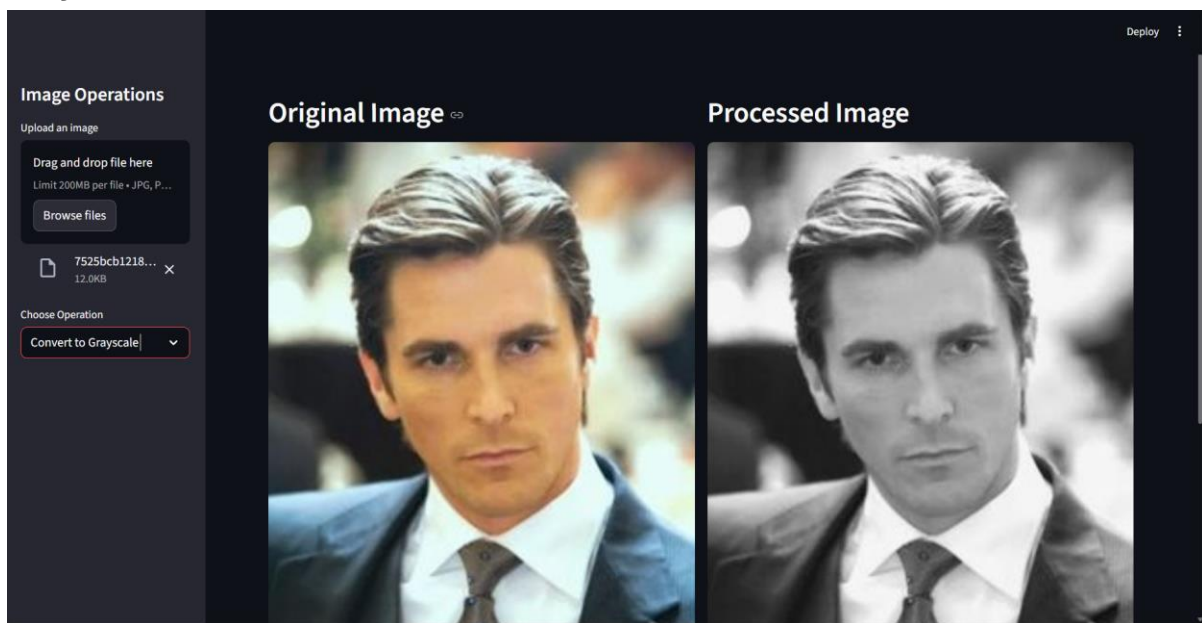
- PSFs describe how a single point of light spreads in an imaging system.
- They explain the blurring effect that occurs in digital images and are essential for understanding image degradation and reconstruction techniques.

3. Screenshots of Toolkit Results

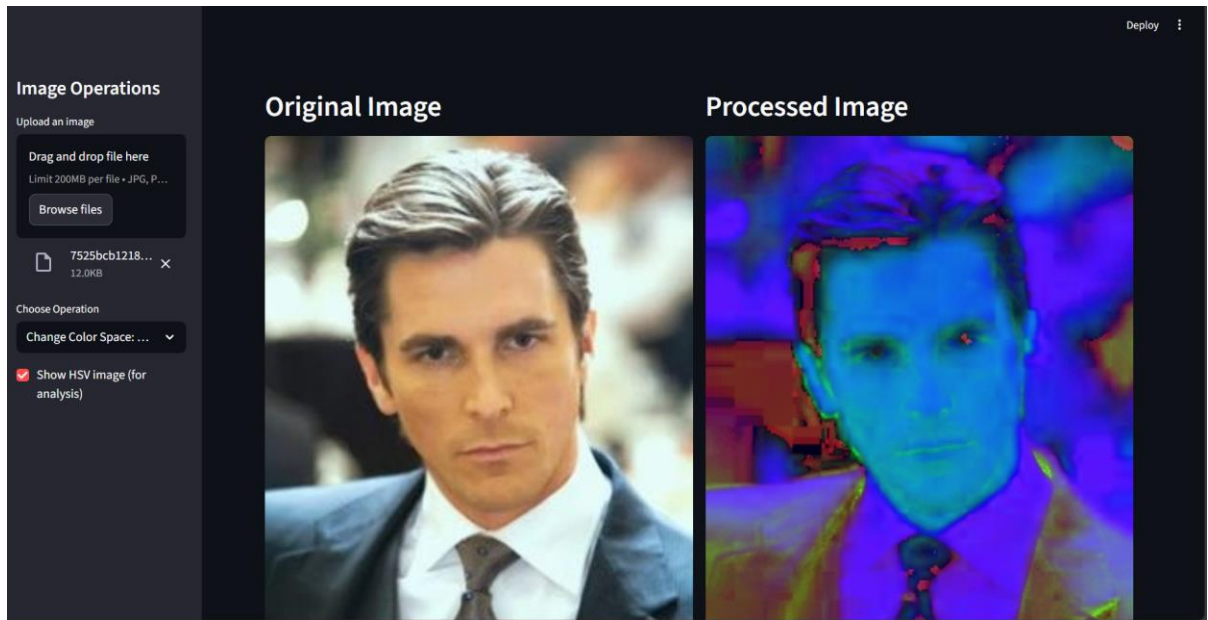
Original Image:



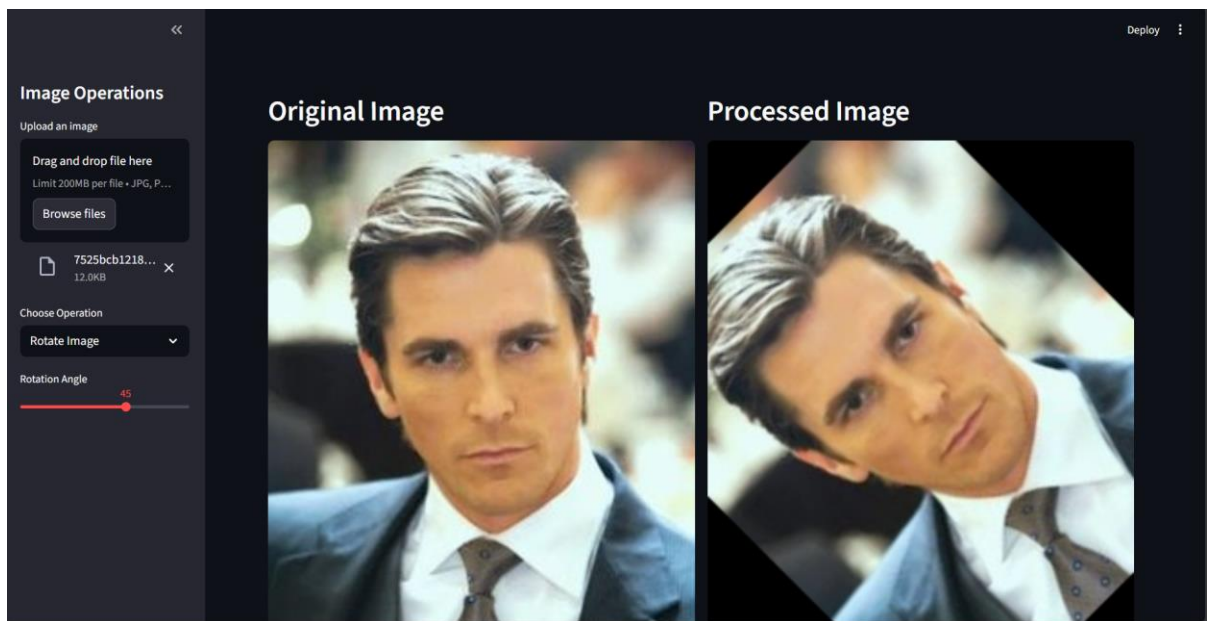
Grayscale Conversion



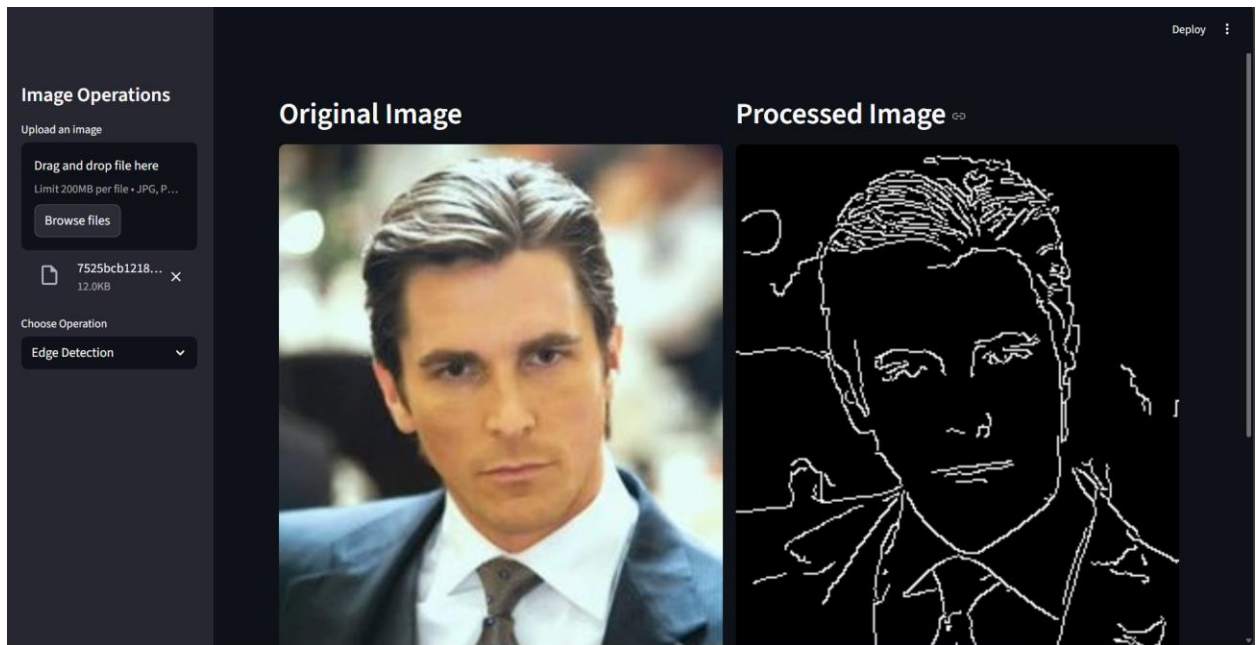
HSV Conversion:



- **Rotation (e.g., 45°):**



Edge Detection (Canny):



4. Explanation of Algorithms

1. Grayscale Conversion

- a. Converts a color (RGB) image into shades of gray using pixel intensity averaging or weighted sums.

2. HSV Conversion

- a. Transforms the image from RGB color space to HSV (Hue, Saturation, Value) for analysis of color properties.

3. Rotation

- a. Uses an **affine transformation matrix** to rotate the image around its center by a specified angle.

4. Edge Detection

- a. Uses the **Canny algorithm** to detect edges by calculating intensity gradients in the image and applying thresholds.

5. Final Demo

The Streamlit GUI is fully interactive. Users can:

- Upload an image from their device

- Select an image processing operation from a sidebar menu
- Adjust parameters where applicable (e.g., rotation angle, HSV display toggle)
- View the **original and processed images side by side** in real-time

This interactive environment allows easy experimentation with digital image processing concepts and visualizes their effects instantly.

4. Results

- The toolkit successfully loads and processes different types of images.
- Processed images are displayed side-by-side with the original.
- Users can easily save processed images.