

## Task 3 Report

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**Course:** AIML-A

**Subject:** Computer Vision

**Task:** Image Processing Toolkit Submission

### 1. Introduction

The project **Image Processing Toolkit** is a web-based application built using **Streamlit**, **OpenCV**, **NumPy**, and **PIL**. The main objective of this application is to provide an interactive platform for applying various **image processing operations** such as color conversions, transformations, filtering, morphological operations, enhancement, edge detection, and compression.

This toolkit helps users visualize the effects of different image processing techniques in real-time, making it a useful learning and experimentation tool for students, researchers, and developers.

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### 2. Technologies Used

- **Python:** Core programming language.
- **Streamlit:** For creating an interactive web-based user interface.
- **OpenCV (cv2):** For image processing operations.
- **NumPy:** For handling numerical operations on arrays and matrices.
- **PIL (Python Imaging Library):** For saving and compressing images in different formats.
- **Matplotlib:** For visualization support (if extended).

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### 3. Features of the Toolkit

The toolkit supports the following functionalities:

#### A. File Handling

- Upload images in formats such as .jpg, .jpeg, .png, .bmp.
- Display **original image details** such as dimensions, channels, file size, and format.

#### B. Image Operations

##### 1. Color Conversions

- RGB ↔ BGR
- RGB ↔ HSV

- RGB ↔ YCbCr
- RGB → Grayscale

## 2. Transformations

- Rotation (custom angle)
- Scaling (zoom in/out)
- Translation (move along X and Y axes)

## 3. Filtering & Morphological Operations

- Gaussian Blur
- Median Blur
- Mean Blur
- Sobel Edge Detection
- Laplacian Edge Detection
- Dilation, Erosion, Opening, Closing

## 4. Enhancement

- Histogram Equalization
- Contrast Stretching
- Image Sharpening

## 5. Edge Detection

- Canny Edge Detection (with adjustable thresholds)

## 6. Compression

- Save images with compression in **JPEG, PNG, and BMP** formats.
- Adjustable **JPEG quality** and **PNG compression level**.

## C. User Interaction

- Side panel to select operation category and parameters.
- Real-time image display with both **Original** and **Processed images** side by side.
- Download option for saving processed images.
- Status bar showing current image details and operations applied.

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## 4. Workflow of the Application

### 1. Image Upload:

User uploads an image file → Application reads and stores the image in session state.

## 2. Operation Selection:

User selects an operation category and specific transformation from the sidebar.

## 3. Parameter Adjustment:

Sliders and input controls allow adjustment of parameters like kernel size, angle, scale, thresholds, etc.

## 4. Apply Operation:

On clicking **Apply Operation**, the image is processed using OpenCV functions.

## 5. Output Display:

- Original image and Processed image are displayed side by side.
  - Detailed image information is shown for both.
  - Option to download the processed image is provided.
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## 5. Advantages

- Easy-to-use graphical interface.
  - Real-time visualization of image processing effects.
  - Supports multiple operations in a single platform.
  - Downloadable outputs for further use.
  - Educational value for learning image processing techniques.
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## 6. Possible Extensions

- Add support for **video processing**.
  - Implement **region of interest (ROI) selection**.
  - Provide **batch processing** for multiple images.
  - Include **machine learning-based filters** (e.g., super-resolution, style transfer).
  - Add **histogram and intensity plots** for deeper analysis.
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## 7. Conclusion

The **Image Processing Toolkit** provides a comprehensive and user-friendly environment for experimenting with various image processing operations. It combines the power of **OpenCV** with the simplicity of **Streamlit**, making it suitable for both academic learning and practical applications.

This project demonstrates the integration of **Python libraries** into a functional web application and can serve as a base for more advanced image processing and computer vision projects.









