Project Documentation: Image Processing Application

# Introduction

This project is developed using Python and focuses on implementing multiple image processing modules. It uses libraries like OpenCV, PIL (Pillow), and rembg (for background removal). The project aims to provide a combination of lightweight, practical, and visually attractive image processing techniques that are both useful in real-world applications and engaging for users.

# Technologies Used

* Python 3.x
* OpenCV (cv2) - for image processing operations
* Pillow (PIL) - for image handling and resizing
* rembg - for background removal using deep learning
* NumPy - for numerical operations
* Matplotlib - for visualizing processing steps

# System Requirements

* Operating System: Windows/Linux/Mac
* Python 3.8 or above
* RAM: Minimum 4GB (8GB recommended for rembg background removal)
* Libraries: OpenCV, Pillow, rembg, NumPy, Matplotlib

# Modules Documentation

## Image → Sketch Converter

This module converts an image into a pencil sketch effect.  
Steps:  
1. Convert image to grayscale.  
2. Invert the grayscale image.  
3. Apply Gaussian Blur to the inverted image.  
4. Divide grayscale image by blurred inverted image.  
Advantages: Lightweight, simple, produces a classic sketch effect.

## Image Size Reducer

This module reduces the size of images for optimization.  
Steps:  
1. Load the image.  
2. Resize the image using scale factor or fixed dimensions.  
3. Save the reduced image.  
Advantages: Saves storage, faster uploads, real-world usability.

## Cartoonifier

This module converts an image into a cartoon-like effect.  
Steps:  
1. Apply bilateral filter to smooth image while preserving edges.  
2. Convert to grayscale and apply median blur.  
3. Detect edges using adaptive thresholding.  
4. Combine smoothed image with edges to create cartoon effect.  
Advantages: Fun, visually appealing, suitable for creative apps.

## Filters + Background Remover

This module applies various filters and removes background using rembg.  
Steps:  
1. Load image and apply filters (sepia, grayscale, sharpen, brightness/contrast).   
2. Use rembg to remove background with AI.  
3. Merge filtered image with transparent/solid/new background.  
Advantages: Flexible, modern, integrates AI for advanced results.

# Workflow of the Project

The workflow of the application follows these steps:  
1. User uploads an image.  
2. The user selects one of the available modules (Sketch, Resize, Cartoonify, Filters + Background Removal).  
3. The corresponding algorithm is applied using Python libraries.  
4. Processed image is displayed and saved for download.  
5. For visualization, intermediate steps (like grayscale, edges, blurred images) are also shown using Matplotlib.

# Conclusion

This project demonstrates the power of Python in handling image processing tasks. By integrating classical computer vision techniques with modern AI-based background removal, it provides a versatile toolset that is practical and engaging.