Image Processing Using NumPy and Matplotlib

A Project Report  
  
submitted in partial fulfillment of the requirements  
  
of  
  
Image Processing Track  
  
  
by  
  
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# ABSTRACT

This project explores foundational image processing operations using Python's NumPy and Matplotlib libraries. The core objective is to demonstrate how image data, represented as multidimensional arrays, can be manipulated programmatically. The project performs tasks such as grayscale conversion, flipping, rotation, color channel separation, and edge detection using the Sobel operator. All transformations were implemented using NumPy without relying on high-level image processing libraries, making it a hands-on learning experience in pixel-level computation. The results successfully highlight how core mathematical techniques can be used for computer vision applications. This project lays the groundwork for more advanced computer vision and deep learning tasks.

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# CHAPTER 1 Introduction

## Problem Statement

To perform fundamental image processing tasks using Python, focusing on matrix manipulations through NumPy and basic visualization with Matplotlib.

## Motivation

With the increasing demand for image and video-based applications, this project was chosen to understand core processing methods before applying deep learning techniques.

## Objectives

- Load and display images  
- Convert images to grayscale  
- Flip and rotate images  
- Separate RGB channels  
- Detect edges using convolution

## Scope of the Project

The project focuses on basic manipulations using only Python, NumPy, and Matplotlib. It avoids using high-level libraries like OpenCV to reinforce low-level understanding.

# CHAPTER 2 Literature Survey

Image processing is a foundational concept in computer vision. Previous work has explored edge detection, filtering, and transformations using various techniques. This project builds on those ideas by re-implementing them using NumPy for educational purposes.

# CHAPTER 3 Proposed Methodology

The methodology includes:  
1. Loading the image using PIL  
2. Converting to grayscale using NumPy  
3. Applying transformations like flipping and rotation  
4. Separating RGB channels from the 3D array  
5. Performing edge detection using Sobel filters via convolution

Modules Used:  
- NumPy  
- PIL (Pillow)  
- Matplotlib

# CHAPTER 4 Implementation and Results

Images processed and saved:  
- Grayscale Image  
- Flipped Image  
- Rotated Image  
- Red, Green, Blue Channels  
- Edge Detected Image  
  
Each output verifies the success of the image transformation using NumPy-based operations.

# CHAPTER 5 Discussion and Conclusion

## Key Findings

This project demonstrates how fundamental image operations can be performed using matrix manipulation in NumPy.

## GitHub Link of the Project

https://github.com/bioluminance/Image-Processing/tree/main

## Video Recording of Project Demonstration

[Coming Soon]

## Limitations

The project is limited to basic image processing and doesn't include advanced operations like filtering or object detection.

## Future Work

Future enhancements could include OpenCV-based extensions or deep learning approaches for image classification.

## Conclusion

This capstone project provides hands-on experience with image processing, bridging mathematical concepts with visual computing.

# REFERENCES

Ming-Hsuan Yang, David J. Kriegman, Narendra Ahuja, “Detecting Faces in Images: A Survey”, IEEE Transactions on Pattern Analysis and Machine Intelligence, Volume. 24, No. 1, 2002.