Digital Image Processing: Assignment 5

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1 Introduction

Geometric transformations are fundamental techniques in image processing that manipulate the spatial arrangement of pixels in an image. Common transformations include scaling, rotation, shearing, and translation. This report presents a Python implementation of these transformations and showcases their effects on a sample image.

2 Theory

2.1 Scaling

Scaling modifies the size of an image. It can be uniform (same factor for width and height) or non-uniform. The scaling transformation can be represented mathematically as:

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} s_x & 0 \\ 0 & s_y \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

where s_x and s_y are the scaling factors for the x and y dimensions, respectively.

2.2 Rotation

Rotation rotates an image about a specified point. The transformation is given by:

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos(\theta) & -\sin(\theta) \\ \sin(\theta) & \cos(\theta) \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

where θ is the angle of rotation.

2.3 Shearing

Shearing skews the image along the x or y axis. The transformation matrix for shearing can be defined as:

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} 1 & k_x \\ k_y & 1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

where k_x and k_y are the shear factors.

2.4 Translation

Translation shifts an image in the x and y directions. The transformation is defined as:

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & tx \\ 0 & 1 & ty \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

where tx and ty are the translation distances along the x and y axes.

(a) Original Image

(b) Scaled Image

(c) Rotated Image

(d) Sheared Image

(e) Translated Image

Figure 1: Geometric Transformations Applied on the Image

3 Conclusion

This report demonstrates how various geometric transformations can be applied to images using Python. Each transformation modifies the image in distinct ways, enabling various applications in computer vision and image processing.

Code Availability

All the code used in this project is available in a public GitHub repository. You can access it at: https://github.com/Computer-Science-Practicum/DIP-Lab-Assignment.