EE-608 Digital Image Processing
Lab Assignment 3

Link for sample Images: Sample Images

AIM 1: Write a function to apply geometric transformations on a given image i.e., scaling, rotation, shearing and translation.

1) Translation

Translation shifts the image by a certain distance along the x and y axes.
It can be represented as:

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & T_x \\ 0 & 1 & T_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

where:
(x,y): are the original coordinates,
(x′,y′) are the transformed coordinates,
Tx and Ty are the translation distances along the x and y axes.

2) Scaling

Scaling changes the size of the image. It is represented by a matrix that multiplies the coordinates by scale factors Sx and Sy.

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} S_x & 0 & 0 \\ 0 & S_y & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

3) Rotation

Rotation rotates the image by an angle θ around the origin.

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

4) Shearing

Shearing skews the image along the x or y axis. It can be represented by two types of matrices:

a) Horizontal Shear (Skew along x-axis)

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

b) Vertical Shear (Skew along y-axis)

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