COMPUTER VISION

I. Affine Transformations

Using the homogeneous coordinate system, projecting a ladder onto a walkway to reflect perspective transformation. Then performing the affine transformations such as rotations, translation, reflection, and others on the projected ladder.

INTRODUCTION:

Affine transformations are a type of geometric transformations that preserve parallel lines and ratios of distances between points. These transformations include rotation, translation, scaling, and shearing. An affine transformation can be represented by a matrix multiplication of a point in a coordinate system and a transformation matrix. The transformation matrix consists of a combination of rotation, scaling, and shearing matrices, along with a translation vector

The homogeneous coordinate system is a mathematical approach to represent geometric transformations in a homogeneous way. One of the main benefits of using the homogeneous coordinate system is that it enables perspective transformations, which simulate the way objects appear smaller as they move away from the viewer.

In this context, we can project a ladder onto a walkway by applying a perspective transformation to its vertices using homogeneous coordinates. This will allow us to create a realistic representation of how the ladder would appear in real life, taking into account the viewer's position and the geometry of the environment.

FORMULAS & PROCEDURE:

The formulas for some common affine transformations are as follows:

1. Translation:
    - x' = x + tx
    - y' = y + ty

2. Rotation:
    - x' = x * cos(theta) - y * sin(theta)
    - y' = x * sin(theta) + y * cos(theta)

3. Reflection:
    - x' = -x (reflection about y-axis)
    - y' = -y (reflection about x-axis)

PERSPECTIVE TRANSFORMATIONS:

Perspective transformation is a type of transformation that is used to project a 3D object onto a 2D surface with the effects of depth and distance. The formula for perspective transformation is given by:

x' = (x * d) / (z + d)

y' = (y * d) / (z + d)

where (x, y, z) are the coordinates of a 3D point, (x', y') are the coordinates of the corresponding 2D point after the projection, and d is the distance between the camera and the projection plane.

In homogeneous coordinates, the perspective transformation can be represented by a 3x3 matrix called the projection matrix:

P = [1 0 0]
[0 1 0]
[0 0 1/d]

where P is the projection matrix and d is the distance between the camera and the projection plane. The perspective projection of a point (x, y, z) can be obtained by multiplying the homogeneous coordinate of the point with the projection matrix, i.e.,

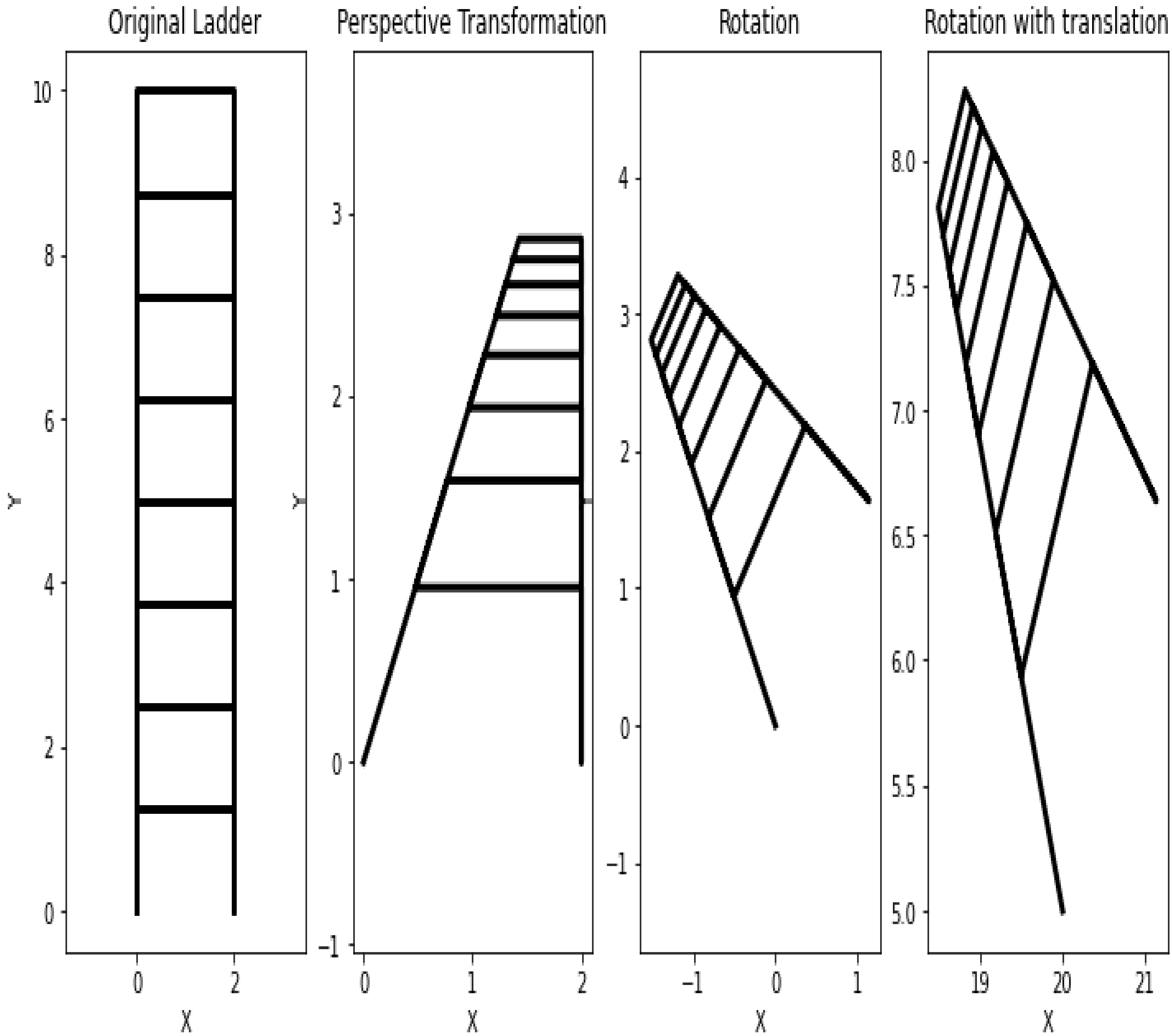
[x', y', z', 1] = [x, y, z, 1] x P

After obtaining the homogeneous coordinates of the projected points, we can obtain their 2D coordinates by dividing the first two elements by the third element, i.e.,

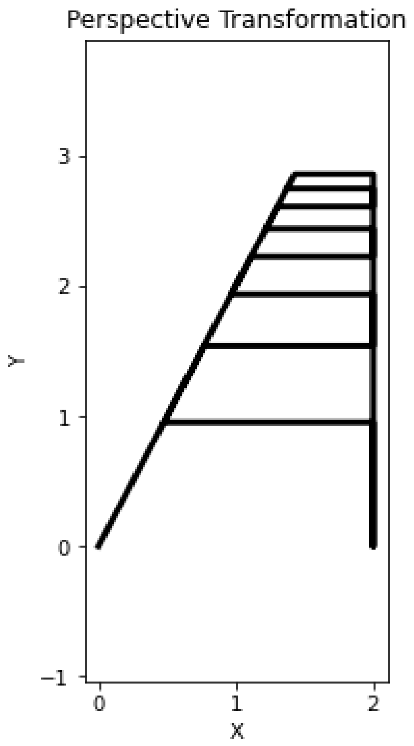
x' = x'' / z''
y' = y'' / z''

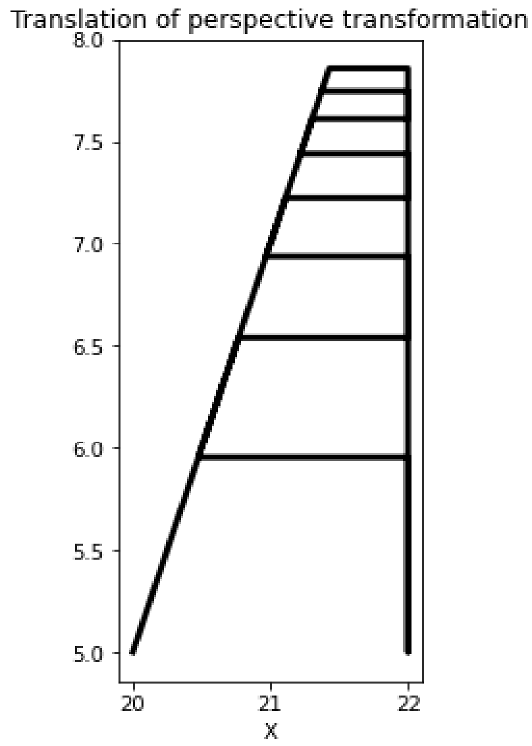
RESULTS:

The first image is the original ladder.
The second image is the ladder with **PERSPECTIVE TRANSFORMATION**.
The third image is the ladder **ROTATION** of 55 degrees
The fourth image is the rotated with **TRANSLATION**.
(Feel free to change the numericals in the code for different views.)

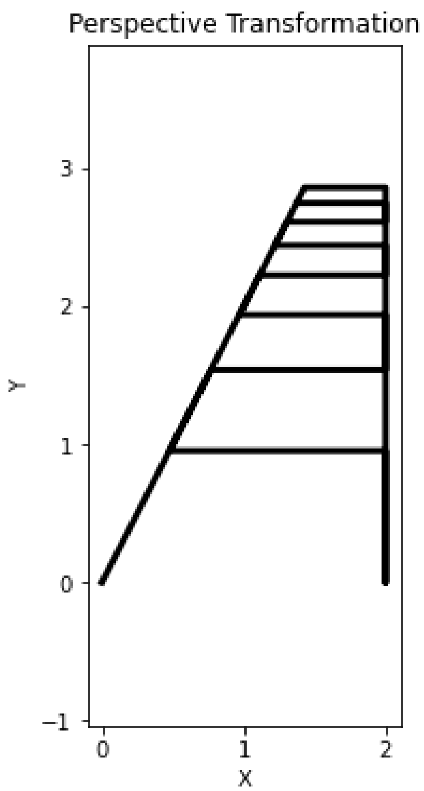


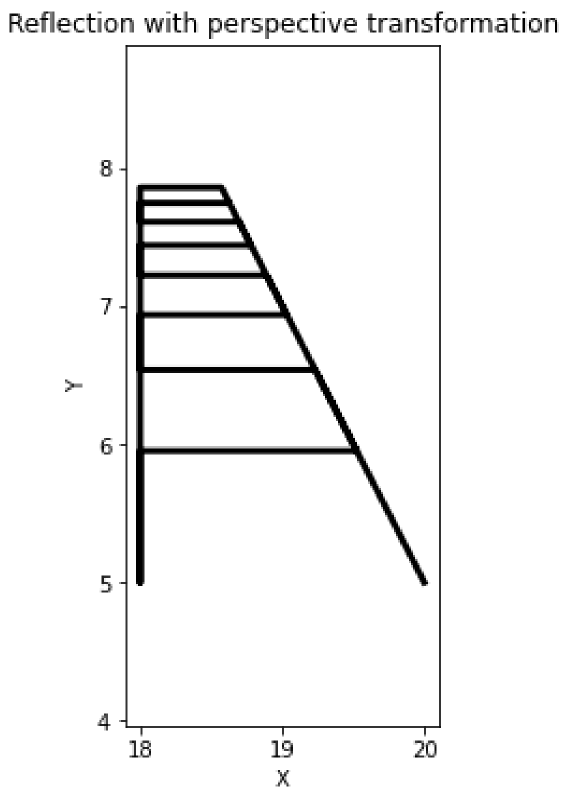
The below left image is the perspective transformation of the original ladder.
The second image in the right is the **TRANSLATION** of the Perspective Transformation



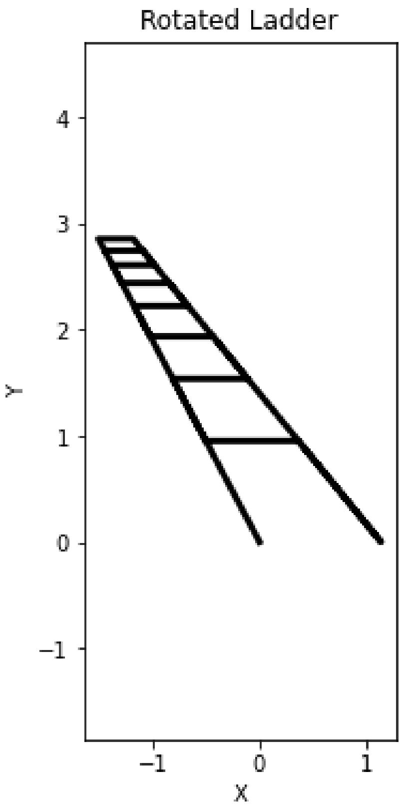


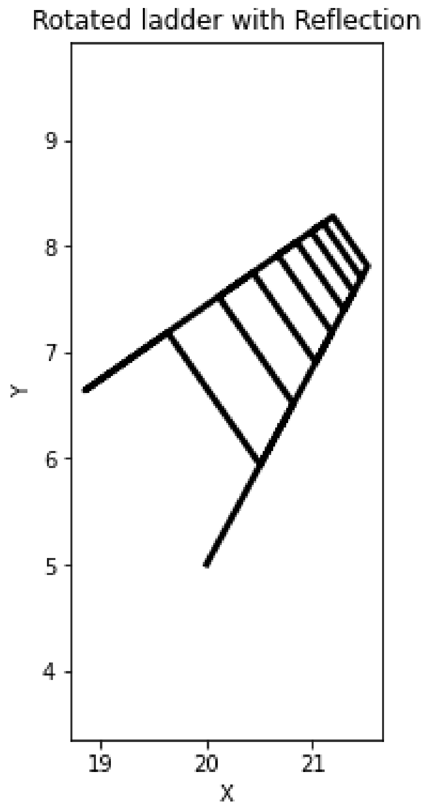
The below left image is the perspective transformation of the original ladder.
The below right image is the **REFLECTION** of the left image.





The below left image is the Rotated ladder.
The below right image is the **REFLECTION** of the rotated ladder.





<u>DISCUSSION & CONCLUSION:</u>

Affine transformations are commonly used in computer graphics, image processing, and computer vision to manipulate images or objects in 2D or 3D space.

I have applied the Perspective transformations for the original ladder.

And next I have applied rotation to the perspective transformation.

And for that result I have applied translation to the rotated perspective transformation.

So in the right most image of the first figure it contains perspective transformation, rotation and also translation.

In the last figure, the right image contains the rotation and reflection.

I was very thrilled and Seeing the perspective transformation and the combinations of affine transformations work so well is really satisfying.