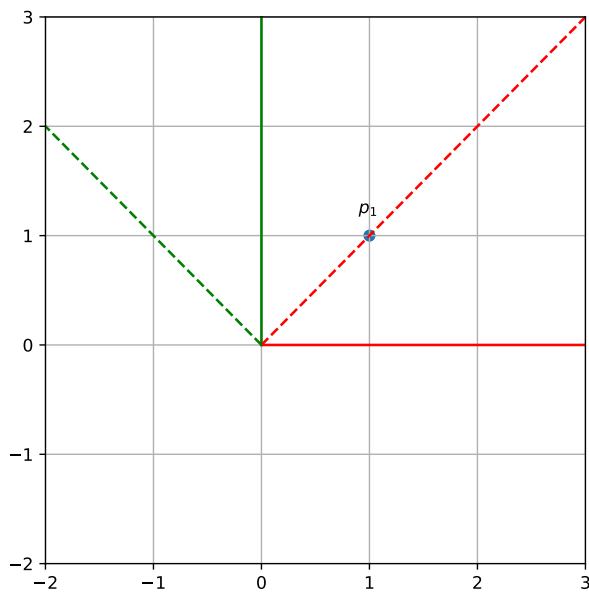
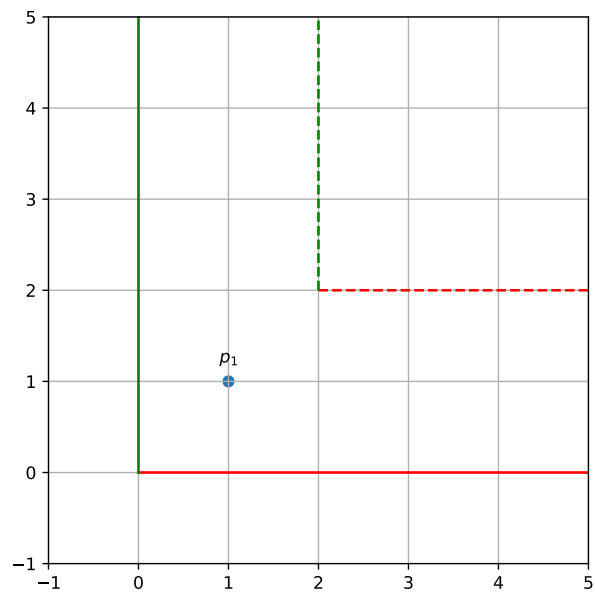


Exercises in Tracking & Detection

Task 1 Transformations in 2D Plane



(a) Rotated Coordinate System

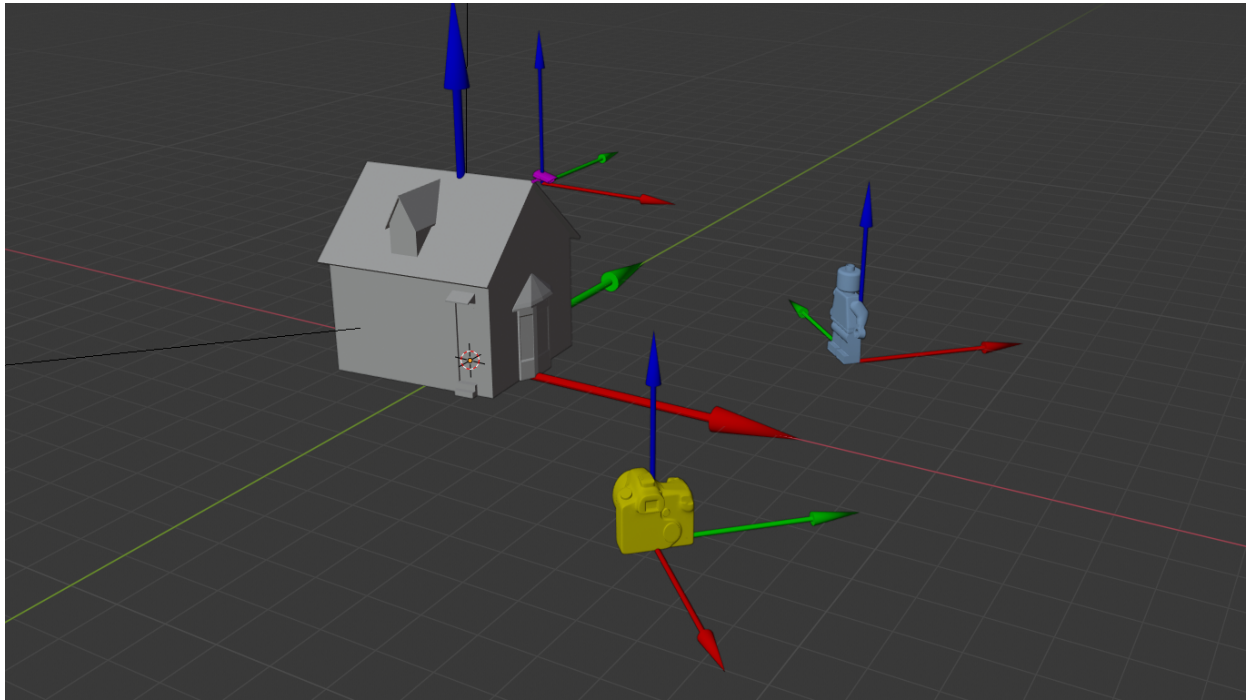


(b) Translated Coordinate System

Figure 1: The above figure shows three coordinate systems: the world coordinate system (solid line in both sub-figures), a rotated coordinate system (Left; counterclockwise 45 degrees), a translated coordinate system (Right). The world coordinate is shown by the non-dashed lines in both graphs. The red lines refer to the X-Axis. The green lines refer to the Y-Axis. Point p_1 is defined as $(1,1)$ in the world coordinate system.

- Write the transformation from the world coordinate system to the local coordinate system at Figure 1a. Re-compute the point p_1 in the local coordinate system (i.e. the rotated one).
- Write the transformation from the world coordinate system to the local coordinate system at Figure 1b. Re-compute the point p_1 in the local coordinate system (i.e. the translated one).

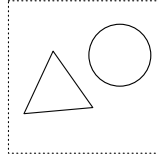
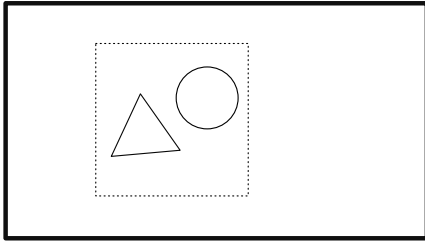
Task 2 House Robber: Transformations in 3D



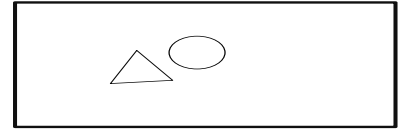
In the above figure, we have the following objects: House, CCTV Camera on top of the house, a robber (i.e. the robot) and a neighbor's camera (the orange camera). The scene assumes a right-handed coordinate system. The red and green lines correspond to the X- and Y-Axes, respectively. The Z-axis (not shown in graph) is orthogonal to the X- and Y-Axes. The robot is on the positive side of the X- and Y-Axes. The house center lies in the origin of the world coordinate system (i.e. look at the red circle).

- What is the transformation (i.e. pose) of the CCTV camera relative to the house? The house dimensions are 2m, 2m and 4m along the X-, Y- and Z-Axes. Assume that the X-Axis and the Y-Axis divide the house into symmetrical halves.
- What is the transformation of the robot (i.e. its pose) relative to the house? The robot is translated 6m on the positive direction of the X-Axis and 5m on the positive direction of the Y-Axis in the world coordinates. The default object model (for the robot 3D model) is designed to look at the negative X-Axis (when no rotation is applied). In order for it to face the house, we rotate it 45 degrees around the Z-Axis.
- What is the robot transformation (i.e. its pose) relative to the CCTV camera?
- What is the neighbor's camera pose relative to the house? The neighbor's camera is translated 8.5m in the positive X-Axis direction, 7.5m in the negative Y-Axis directions, and 2m in the positive direction of the Z-Axis (in the world coordinate system). Like the robot, the object model for the camera is designed to look at the negative X-Axis direction (when no rotation is applied). In order for it to point at the house, we rotate it -45 degrees around the Z-Axis.
- What is the robot transformation (i.e. its pose) relative to the neighbor's camera?

Task 3 Camera Intrinsics



a)



b)

You are given an image of size (x : 3680, y : 2456) taken from a camera with known intrinsics matrix K .

$$K = \begin{bmatrix} 2960 & 0 & 1841 \\ 0 & 2960 & 1235 \\ 0 & 0 & 1 \end{bmatrix}$$

Find the new intrinsic matrix for the following cases:

- a) A cropped image defined with the (width: 1000, height: 1000) and the center (x : 1500; y : 750) in respect of the original image.
- b) A downscaled image of size (x : 1840, y : 614)