Pipeline step 2: triangulation

For the second step of your pipeline, you will reconstruct the scene in 3D from three different perspectives. To perform triangulation, you will need to know the locations of objects in the cameras, as well as the locations of these objects in the real world. Since we have the exact model of the lockbox, we can use detection of the lockbox in the cameras to reconstruct the scene in 3D.

The lockbox model

A 3D model of the lockbox is shown in Fig. 1. Six different locations are marked and their corresponding coordinates are given in Table 1. Since we are free to choose our own coordinate system, location "0" is selected as the origin.

Note that these coordinates apply only to the lockbox in its fully closed state. Therefore, to perform triangulation, you can only use frames in which the lockbox is fully closed. If there were many videos that needed to be processed, you would ideally detect the closed state of the lockbox based on the pixel coordinates of the cameras. However, since for this project we only analyze two trials, you can alternatively manually label which frames are eligible for triangulation.
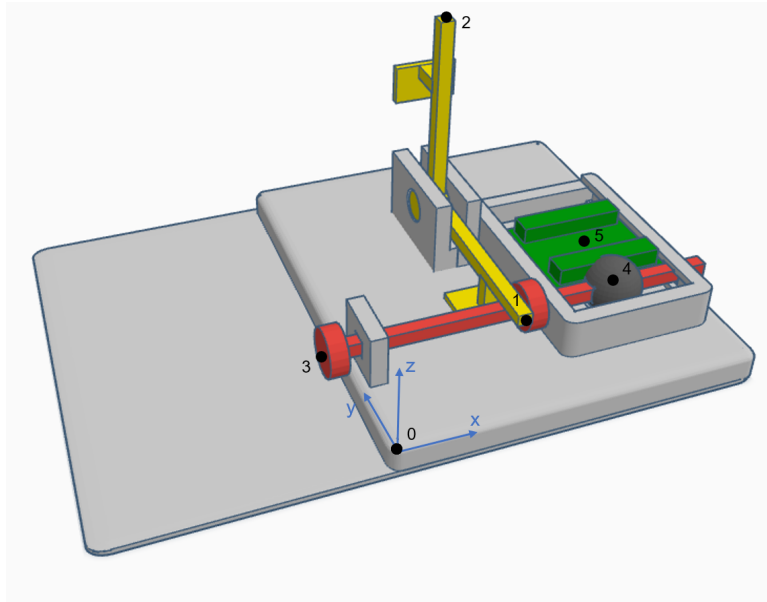

Figure 1: 3D model of the lockbox with labeled coordinates (0: corner of the elevated plateau, 1: tip of the lever, 2: other tip of the lever, 3: stick head, 4: center of the ball, 5: middle of the sliding door).

Coordinate	x	y	z
0: origin	0	0	0
1: lever tip	49	24	15
2: upper lever tip	49	87	82
3: stick head	-9	35	9
4: ball	86	34	15
5: sliding door	86	67	10

Table 1: 3D coordinates of lockbox locations (in mm).

The 3D model shown in Fig. 1 is available on ISIS. You are free to use different and/or more points for your triangulation procedure. If you decide to do so, you will need to determine the 3D coordinates of the lockbox yourself, using the available 3D model. An easy and user-friendly way to do this is by loading the 3D model into a program such as Tinkercad (`https://www.tinkercad.com`). If you want to use Tinkercad will need to make a free account, create a new project, and import the "lockbox_model.stl" file.

To define new 3D point on the model, you will need to select a point as origin (such as the origin that was picked in Fig. 1) and measure the distances of your selected points with respect to that origin. Keep in mind to select points that are visible in all three camera perspectives. This is not strictly necessary, but it saves you time as you don't need to define unique points per perspective.

Triangulation for your project

In the lecture on triangulation, we explored the principles of 3D reconstruction. We also discussed several advanced techniques that can improve the accuracy of the reconstruction process. For your project, the essential requirement is to reconstruct the scene in 3D. While incorporating additional steps to refine the accuracy of your pipeline is highly encouraged, it is not mandatory.