Activity 12 Stereometry

Introduction

Multiple 2D views allow the computation of depth information. In this activity we use two identical cameras to capture and reconstruct a 3D object. Images are essentially 3D objects projected onto a 2D frame. From object points at (x,y,z), an image is reduced to (x,y) with z projected as a function of x and y and camera-object geometry. In applications such as microscopy or terrain imaging, it is sometimes more informative to preserve the depth information z. In this way, the 3D image may be inspected at different view angles.

Stereo imaging is the technique we will use in this experiment and it is inspired by how our two eyes allow us to discriminate depth. In Figure 1 consider two identical cameras positioned such that the lens centers are placed a traverse distance *b* apart. Let the object point *P* lie at the axial distance *z*. It is this *z* that we wish to recover. The image planes of each camera are at a distance f from the camera lens. In the image plane, *P* appears at a traverse distance x_1 and x_2 from the centers of the left and right cameras respectively. From similar triangles, we see that

$$\frac{x_1}{f}=\frac{X}{z} \qquad (1)$$

$$\frac{x_2}{f}=\frac{X-b}{z} \qquad (2)$$

Solving for *z* we find that

$$z=\frac{bf}{x_2-x_1} \qquad (3)$$

If done for several points on the object, we can reconstruct its 3D shape.

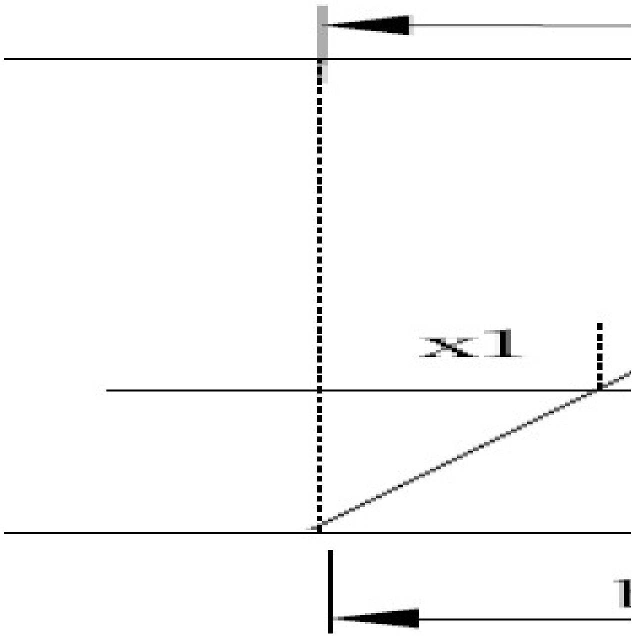

Figure 1: Imaging geometry for stereometry using two views.

Procedure

1. Capture an image of your Tsai grid with your PiCam then move your camera a short horizontal distance b millimeters and then capture another image of your Tsai grid at this position.

2. Open both images in an imaging software. With one image as a reference, translate the other image up or down such that corresponding points align along the horizontal.

3. Assuming their y-coordinates coincide after adjustment in Step 2, get x-coordinates of

corresponding vertices in the two images. Gather as many points as possible to get a smooth fit. From known lengths in the image, convert pixel position x into distance with units of mm.

4. Compute for z using equation (3). The focal length f of the PiCam is given in https://www.raspberrypi.org/documentation/hardware/camera/. Plot the surface of your object. Since the points are unevenly sampled, you will need to interpolate between points to get a smooth surface. In python check out **scipy.interpolate.griddata**. In Matlab, use **griddata**. In Scilab, use **splin2d**, read the help file and follow closely **Example 2 different interpolation functions on random datas**.

5. Assess the quality of your 3D reconstruction.