Robotics:Perception Assignment 1
Dolly Zoom

1 Introduction

In this programming assignment, we will implement Dolly Zoom effect used by film-makers to create a sensation of vertigo, a "falling-away-from-oneself feeling". It keeps the size of an object of interests constant in the image, while making the foreground and background objects appear larger or smaller by adjusting focal length and moving the camera. You will simulate the Dolly Zoom effect with a synthetic scene as shown in Figure 1, which illustrates two cubes and one pyramid seen from the top view. Please find an example of the Dolly Zoom simulation from here: `http://cis.upenn.edu/~cis580/Spring2016/Projects/output.avi`

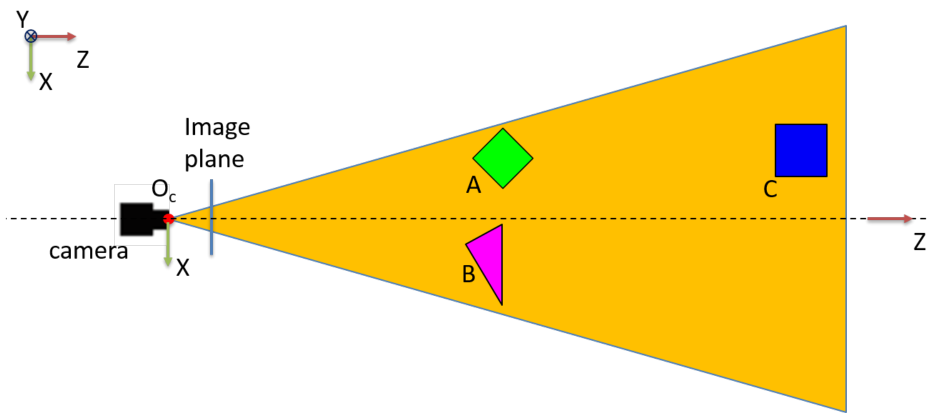

Figure 1: Top view of the synthetic scene.

2 Technical Details

The MATLAB script **run_dolly_zoom.m** will be the main script to run this assignment. Given 3D coordinates of vertices, we will complete two functions: **compute_focal_length** and **compute_f_pos**. **compute_focal_length** finds focal length such that the height of the object A remains constant while the camera moves along with Z axis. The reference depth, reference focal length and height of the object A and the camera movement will be given. **compute_f_pos** computes the focal length and the camera movement such that the height of the background object C becomes twice smaller than the foreground object A (while the height of the object A remains constant) as shown in Figure 4. We will use this function to visualize the Dolly Zoom effect using **project_objects**.

Robotics:Perception Assignment 1
Dolly Zoom

3 Dolly Zoom

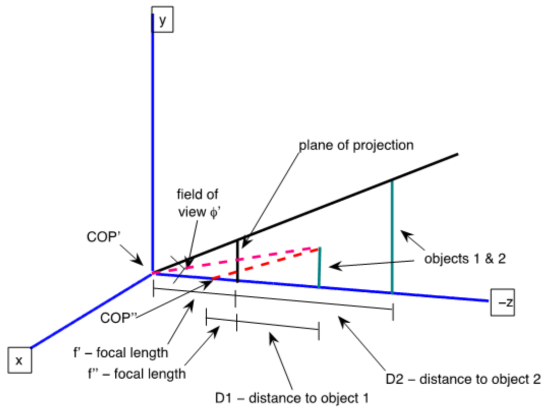

Figure 2: Image projection

A point in 3D is projected onto the image plane through the pinhole (COP) as shown in Figure 2:

$$u = f\frac{X}{Z}, \qquad v = f\frac{Y}{Z}, \tag{1}$$

where (u, v) is the image coordinate of the projection, (X, Y, Z) is the 3D point, and f is the focal length of the camera.

When the camera moves along with its Z-axis, the depth, Z, changes and therefore, the projection, (u, v), changes. This projection change produced by the depth change can be compensated by adjusting focal length:

$$u = f_{\text{ref}}\frac{X}{Z_{\text{ref}}} = f'\frac{X}{Z_{\text{ref}} - \Delta C}, \tag{2}$$

where ΔC is the movement of the camera along its Z axis (+ direction indicates approaching to objects) and f' is the modified focal length. f_{ref} and Z_{ref} are the focal length and depth of an object in the original image, respectively. Dolly zoom effect exploits the compensation between depth and focal length, which produces depth sensation.

Figure 3 illustrates the focal length/depth compensation: the camera moves away from the object while changing its focal length such that the height of the object A, $h_1 = 400$, in both original and moved images remains constant. Note that the heights of the other background objects are changed due to this effect.

Robotics:Perception Assignment 1
Dolly Zoom

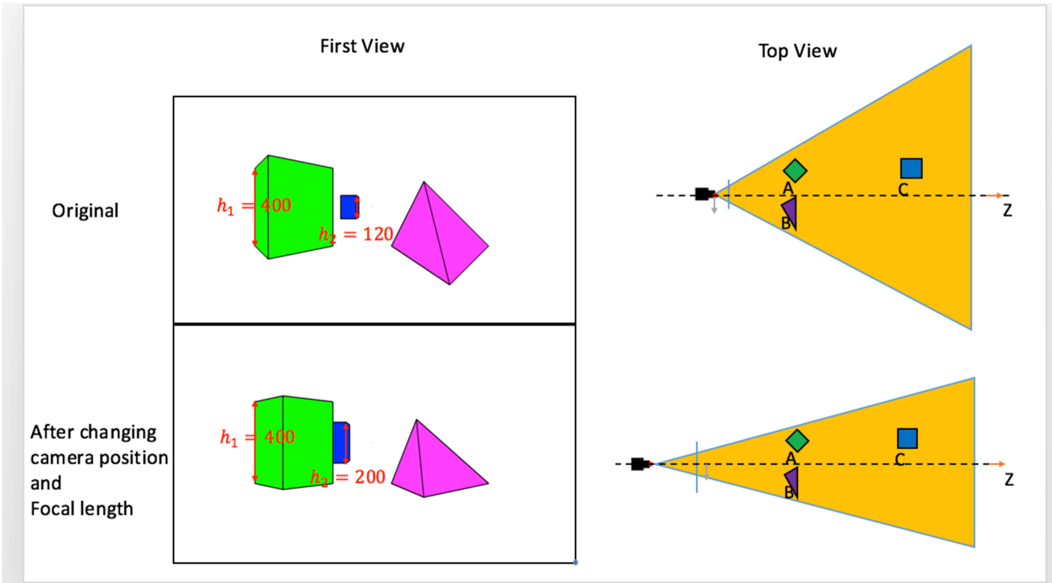

Figure 3: compute_focal_length

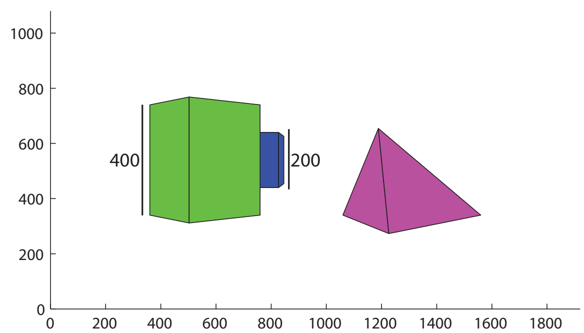

Figure 4: compute_f_pos

4 Visualizing Results

We can visualize the Dolly zoom effect using **project_objects(f, pos, points, fid)** where **f** is the focal length, **pos** is the camera position, **points** is 3D coordinates for vertice on polygons, and **fid** is the figure display ID.

5 Submitting

To submit your results, run the **submit** script, which will test your **compute_focal_length** and **compute_f_pos** functions. This script will generate a mat file called RoboticsPerceptionWeek1Submission.mat. Upload this file onto the assignment page, and you should receive your score immediately.