CPSC 535
Assignment 5: 3D Computer Vision: Follow the Bouncing Ball

The goal of this assignment is to plot the trajectory of a bouncing ball using the images captured from two calibrated cameras.

Section 11.4 of Sonka, Hlavac and Boyle covers triangulation of scene points from multiple camera views.

1 Method

To collect the data for this assignment, we did the following.

1. Found some open space in the computer vision lab.
2. Arranged two video cameras to view that space such that the two cameras are aimed approximately perpendicular to each other.
3. Feed the signal from each camera into a *video quad*. A video quad is a device that takes the video from up to four individual cameras and displays the images simultaneously in the four quadrants of a single video signal. These are commonly used in video surveillance systems. This allows us to capture the video from the two cameras simultaneously.
4. We place a calibration target in the center of the space in the lab and capture a frame of video from the quad.
5. We remove the calibration target and capture several frames of video from the quad showing a bouncing tennis ball.
6. We finish by transferring the frames of video from a digital video tape to the computer such that each frame of the video sequence is in its own image file.

2 The Data

To get the data provided for this assignment we took the images for the quad video frames and extracted them into two images per quad frame, one for each of the two cameras. The result is as follows.

1. **ballA-??.ppm** contains images of the bouncing ball from camera A.
2. **ballB-??.ppm** contains images of the bouncing ball from camera B.
3. **calibrateA.ppm** is an image of the calibration target from camera A.
4. **calibrateB.ppm** is an image of the calibration target from camera B.

3 GUI Calibration Tool

The material provided for this lab includes a GUI calibration tool designed specifically for use with the calibration target. The tools allows you to select the approximate view that you have of the target, and then by using the mouse select correspondences between dots on the target and position in the image. This builds a table of world coordinate versus screen coordinate correspondences that is the input to an algorithm that computes a camera calibration matrix. The output of the calibration process is a three-by-four matrix that relates world coordinates to screen coordinates. See the course text for more detail.

4 What You Do

1. Use the GUI calibration tool to calibrate both cameras.
2. Extract the coordinates of the ball in each of the sequences either manually (tedious) or by writing a program that can identify the center of the yellow tennis ball in each frame (more challenging and less tedious).
3. Use the camera calibration matrix and the ball centroids in the image plane to triangulate the position of the ball in world coordinates for each frame.

5 Hand In

1. Your code that extracts the ball positions and does the triangulation.
2. A plot of the ball position in 3D (gnuplot can do this once you have the 3D coordinates).
3. A brief description of your implementation.
4. Any salient observations that you have.

6 Acknowledgments

Krista Spence wrote the GUI calibration tool and collected the data for this assignment.