ECEn 631 3D Reconstruction and Trajectory Estimation

Objectives:

- Learn to obtain 3D information of points of interest.
- Learn to track the baseball location in the image accurately.
- Learn to obtain 3D information of the baseball.
- Use the detected x, y, and z coordinates of the baseball to estimate ball trajectory

Instructions:

- Use the **baseball catcher system in Room 250 B34** to complete this assignment.
- This assignment will help prepare you for your baseball catcher team project. Save your code and reuse it later.
- Write your own code to read in the images to perform the tasks for this assignment.
- All team members can use the same images for this assignment.
- You will lose 20 points if any of the following requirements is not met:
  - Generate a PDF file that includes (with proper headings) a pair of stereo images and X, Y, and Z coordinates for all selected points (Task 1), five stereo image pairs with ball location highlighted (Task 2), and data points and trajectories in two graphs (Task 3).
  - Submit your PDF file and source code file(s) in one zip file without the folder or directory.
  - Use your first name and last name (e.g., justinsmith.zip) as the file name.
- Login to myBYU and submit your work through BYU Learning Suite online submission.

Image Acquisition:

- Click "Grab" and check "Update Image" to show the live video on the image display screens.
- Uncheck "Update Image" so the system can capture images as fast as the camera framerate allows.
- Have one of your team members feed a baseball in the pitching machine.
- Click "Capture Images" button immediately after the baseball leave the pitching machine.
- Change the delay time back to 30 mSec and click "Replay Images" to examine the images. Repeat until you are satisfied with the image quality.
- Click "Save Images" to save the images. Type in the file name in the "File Name" box. You need to select the folder and type in the file name (e.g., C:\Projects\BaseballCatcher - team#\Images).
- The program will automatically add a letter "L" or "R" and a sequential number to each file. You will get 32 images for the left camera (ImgL0.bmp ... ImgL31.bmp) and 32 images for the right camera ((ImgR0.bmp ... ImgR31.bmp) in the folder you select.
- Copy these images to your thumb drive and remove them from the computer hard drive (**empty the recycle bin**).

Task 1: 3D Measurement 30 points

- Select one pair of chessboard images from your stereo calibration image pairs from the Stereo Calibration and Rectification assignment for this task.
- Use OpenCV function findChessboardCorners() to find chessboard internal corners.
- Use OpenCV function cornerSubPix() to refine corner locations.
- Use undistortPoints() and your calibration parameters to undistort AND rectify the 4 outermost corner points.
- Use perspectiveTransform() and your calibration parameters to calculate the 3D information of the 4 outermost corner points.
- This is a good exercise for you to check if your code works correctly.
- Include the stereo image pair with the four outermost corner points circled and their 3D (X, Y, and Z) information measured from both the left and right cameras in your PDF file and explain why you believe your result is correct.
- Submit your code for this task.

Task 2: Baseball Tracking 20 points

- Use the baseball image sequence you have captured for this task.
- Estimate and process the region of interest of each image frame to reduce processing time.
- Detect and track the baseball in your left and right image sequences.
- Include the first, fifth, tenth, fifteenth, and twentieth frames (starting when the baseball is detectable) from both sequences with the ball location highlighted in your PDF file.
- Submit your code for this task.

Task 3: Baseball Trajectory Estimation 50 points

- Convert the ball location in pixels in each image pair to 3D location in inches with respect to the left camera.
- Convert the reconstructed 3D points into the catcher's coordinates (center of the catcher is 0,0,0)
- Plot one graph of the ball location with the x and z coordinates and one graph of the ball location with the y and z coordinates.
- Show all data points in both graphs as well as their estimated trajectories and locations when z is zero.
- Explain how you estimate the ball trajectory.
- Include these graphs in your PDF file.
- Submit your code for this task.

Congratulations! You are ready to start your baseball project. It is suggested that you integrate the code you have developed for this and the previous assignments into your team's baseball project so that your team can calibrate the stereo system easily and whenever it is needed. It is important that you are able to write your calibration parameters into a file after you calibrate the system and read them back into your program every time you start your program.