ECEN 631 – Robotic Vision

Baseball Catcher Project Guide

February 8, 2016

Project Scope:

This project is one of the three focuses of this robotic vision course. It is designed to introduce stereovision theory and its implementation to the student through a fun real-time vision project. This team project focuses on using a stereovision system to estimate the 3-D trajectory of the baseball and control the catcher (x-y stage) to catch it. The baseball will be pitched by a baseball pitching machine at approximately 60 mph. The distance between the pitching machine and the catcher is roughly 40 feet. It takes approximately 300 mSec for the baseball to travel the entire distance. The delay and maximum travel time of the catcher is roughly 150 mSec depending on the distance the catcher has to travel. Using a pair of Firewire cameras running at 60 frames per second, this vision system has to capture and process 15 to 20 image pairs, estimate the baseball trajectory, and control the catcher, all in about 150 mSec.

Project Requirements:

- Students will work as a team to complete this project.
- The team should use the best stereovision calibration code from the team members.
- Two Firewire color camera (only use grayscale in order to achieve 60 frames per second) are mounted on the catcher to capture stereo image pair for processing.
- Students will use the obtained 3D information to estimate baseball trajectory and catch the baseball.
- Each team gets 20 shots and receives 4 points per catch.
- Prepare and submit an unedited video of all 20 shots, catch or miss.

Software Package:

A Visual Studio 2013 project (called BaseballCatcher) using OpenCV 3.0.0 C++ functions for Windows 7 64-bit has been prepared for students to implement their algorithms. Image acquisition portion is included in this project. The team is responsible for the development and implementation of the stereovision and trajectory estimation algorithms. Follow the following steps to use this software.

- The zip file of this project is posted on the class website. Students can download a copy and get familiar with the project.
- Students can login the baseball catcher project computer using account: "ecestudents" and password: "circuit"
- Each team should create a project folder (C:\Projects\BaseballCatcher - #) and work on files only in its own folder.
- Change the application folder in the Hardware.h file to the folder the project is copied into. Below is an example of using C:\Projects\ BaseballCatcher – 1 for Team #1

#define APP_DIRECTORY "C:\\Projects\\BaseballCatcher - 1\\"

- Comment out the line #define PTGREY in the hardware.h file if PointGrey cameras are not available. Comment out the line #define USE_STAGE in the BoboteqWrapper.h file if the motor controller board is not available.
- Create your OpenCV folder and put your OpenCV library in C:\\Program Files\\OpenCV-3.0.0 or change your library link directory in Project Property.
- Only three files need to be modified.
  - Hardware.h is a header file for a class called CTCSys. CTCSys is a base class of the main class BaseballCatcherDlg.
  - Hardware.cpp implements all member functions of the CTCSys class.
  - BaseballCatcherDlg.cpp is the main program that handles Windows messages.

You may need to perform stereovision calibration multiple times. It is wise to implement an easy way to read in the calibration parameters.

The chessboard square size is 3.88636" x 3.88636"

Hardware Instruction:

- There are two Firewire cables that are connected to the computer system. Do not move the computer system. Moving the computer could damage the Firewire connectors.
- Stereovision system has been adjusted to be very close to canonical configuration. Do not touch the camera lenses or camera mounting fixture.
- There are two limit switches for homing the catcher and some wiring for motor controller. Do not remove the boards that protect them.
- Do not move the catcher. It is aligned to the baseball pitching machine
- Motor parameters are stored in the memory of the motor controller board. You may have to reset the motor controller board by clicking the "Set Default" button if the catcher does not work properly.
- In case the motor stalls, shutdown the power supply to release the motors to avoid overheating the motor.
- You only need to home the catcher once at the beginning of your two-hour work period. To avoid the wear or accidently damaging the catcher hardware, you should only do homing when the catcher does not return to the center.

Software Instruction:

Capture and Save Images:

- Create a folder called "Images" to store your images.
- Click "Update Image" and "grab" to see the live video.

- Uncheck “Update Image” so the system can capture images as fast as the camera framerate allows.
- Click “Capture Images” at the same time as the baseball is pitched to capture an image sequence.
  - The system will capture 32 pairs of images (L00~L31 and R00~R31) for offline processing.
- Click “Save Images” to store these captured 32 pairs.
- Click “Load Images” to load the saved images back to the memory for replay.

Replay Images:

- Stored images can be replayed by clicking the “Replay Images” button.
- The speed of reply can be controlled by setting the delay time (in mSec).

Catcher Operation:

- Click “Reset Catcher” to home the catcher when power up the system. The catcher will move to the right and down to obtain home position and then move to the center. This doesn’t have to be done very often.
- Perform homing only when the catcher does not return to the center when click “Center Catcher”.
- The catcher is limited to move between +/-9” horizontally and +/-8” vertically.
- Type in the location and click “Move Catcher” to move the catcher.
- Uncheck “Update Image” so the system can capture images as fast as the camera framerate allows.
- Click “Catch Ball” when you are ready to have some fun.