Generating 3D Trajectory Data and Motion Metrics

Introduction

This document describes how to generate 3D instrument trajectory data and motion metrics from UGT tracking data files. A Matlab script named **TrajectoryEst_script.m** is used to do this. The 3D trajectory data is saved to an .xlsx file that also contains motion metric data. A tracking file (.mat) corresponding to the left and right camera and a stereo calibration file (.mat) are needed to run the script. The tracking files should have been generated using the Matlab application UGT (User Guided Tracking). They should correspond to the same instrument over the same frame subset within a video. The calibration file should have be generated using the Camera Calibration Toolbox.

Procedure

1) Open Matlab Script

   Open Matlab and set the current folder to the directory containing the Matlab routines used for video based tracking. Typically these files are located at

   C:\Simulated_Surgery_Software\Matlab

   For example, this can be done by typing the following into the command line

   ```
   cd C:\Simulated_Surgery_Software\Matlab\
   ```

   Type the following into command line and press enter

   ```
   pathScrip
   ```

   This will setup the Matlab path to access any needed functions. A message should appear indicating that folders are being added to the Matlab path. The script used to generated 3D data is named **TrajectoryEst_script.** It should be located at .\TrajectoryEstimation. This folder should be on the path. The script can be opened by typing the following into the command line and pressing enter

   ```
   open TrajectoryEst_script.m
   ```

   The script will open in editor.

2) Setup the Script

You need to set file related variables prior to running the script. The top of the file contains comments describing the script. Below these comments are six variables that you must set appropriately prior to running the script. The lines of code you should modify are given below :

```matlab
%% Script Setup
disp('------------------------------------------------------------------');
disp('TrajectoryEst_script.m');
% Calibration File
% The location of the cameraCalibrationToolbox generated stereo calibration
% file.
camCalFile = 'C:\Data\Calib_Results_stereo.mat';

% UGT Tracking data files
% Tracking data files generated from the left and right video for the same
% surgical instrument over the same video frame subset.  These files
% contain feature data (estimated midline and track point) that is used to
% estimate 3D instrument position at each frame.
leftTrackFile = 'C:\Data\capture_2\F_G2_L.mat';
rightTrackFile = 'C:\Data\capture_2\F_G2_R.mat';

% Frame Drop/Failed Grab Arrays
% Frames that were dropped or unsuccessfully grabbed during video
% acquisition.  As of 12/15/2011 this data is saved in a .txt file along
% with the video files.  Enter the dropped frames numbers into the array.
% If no frames were dropped set the variable equal to an empty array [].
missingFrames_L = [];
missingFrames_R = [150,500];

% Plot Flag
% Controls if the 3D position is plotted in a new figure window when the
% script is run.
plotFlag = 1;
```

The *camCalFile* variable should be set to the location of the stereo camera calibration file. The *leftTrackFile* and *rightTrackFile* variables should be set to the location of the left and right tracking file. Note that file locations are set as strings. For example, if the camera calibration file was located at C:\Data\Calib_Results_stereo.mat you should set *camCalFile* as

```matlab
camCalFile = 'C:\Data\Calib_Results_stereo.mat';
```

Additionally, you must set the *missingFrames_L* and *missingFrames_R* variables. These variables should be set to arrays indicating frames that were dropped when

acquiring the left and right video respectively. Beyond 12/15/2011 frames dropped during acquisition are written to a .txt file that is saved along with the video files when using *vidCaptureGUI*. If no frames were dropped, set the variable to an empty array. For example, if frame 150 and 500 were dropped in the right video you would set *missingFrames_R* as

```
missingFrames_R = [150,500];
```

If no frames were dropped in the left file you would set *missingFrames_L* as

```
missingFrames_L = [];
```

The variable *plotFlag* controls if the 3D data is plotted after it is generated. When set to 1 data is plotted, when set to 0 data is not plotted. Set this variable to zero if you plan to run this function several times in a row to avoid closing the figure window after every run.

3) Run the Script

   Press F5 to run the script. The command window will update as the script progresses.

4) Save the data to an Excel File

   You will be prompted to save an Excel file. Save it to a desired location. This file contains the instrument's 3D trajectory (X,Y,Z position) and motion metrics computed using the 3D position data. Note that X,Y,Z refers to coordinate frame of the left camera.