CS4243 AY18/19 Project Instructions

1. Background

This project is about deriving the 3D trajectory of a table tennis ball based on three cameras that are synchronized.

The effort comprises two parts: manual labeling of table tennis ball in images for ground truthing; computation and visualization of 3D trajectory.

2. Manual labelling of ping pong ball position in images

The data and instructions had been posted in IVLE on 8th Oct 2018. The deadline is 21st Oct Sunday 2359hrs.

3. 3D table tennis balls trajectory

We will give you sets of 3 sequences taken from three different stationary cameras of the same scene.

We provide you with the camera orientation and camera position of all the 3 cameras i.e. 3x3 matrix **R**, and the translation i.e. 3x1 vector **t** (see Section 4).

We also provide you with the camera calibration matrices (see Section 4).

Your task is as follows:

- Devise and implement a table tennis ball tracking algorithm in Matlab.
- Using the **R** and **t** for the 3 cameras, compute the 3D trajectory of the table tennis balls. Implement your algorithm in Matlab.
    - You may use the automatic tracking algorithm that you have implemented. You may also use the hand annotated table tennis positions provided by you and your classmates.
- Design and implement a visualization software to view the 3D trajectory (in any language of your choice).

4. Camera extrinsic and intrinsic parameters

<u>The following are the extrinsic parameters (i.e. **R** and **t**) for each of the 3 cameras:</u>

Camera 1

$$R_1 = \begin{pmatrix} 9.6428667991264605\text{e}-01 & -2.6484969138677328\text{e}-01 & -2.4165916859785336\text{e}-03 \\ -8.9795446022112396\text{e}-02 & -3.1832382771611223\text{e}-01 & -9.4371961862719200\text{e}-01 \\ 2.4917459103354755\text{e}-01 & 9.1023325674273947\text{e}-01 & -3.3073772313234923\text{e}-01 \end{pmatrix}$$

$$t_1 = \begin{pmatrix} 1.3305621037591506\text{e}-01 \\ -2.5319578738559911\text{e}-01 \\ 2.2444637695699150\text{e}+00 \end{pmatrix}$$

Camera 2

$$R_2 = \begin{pmatrix} 9.4962278945631540\text{e}-01 & 3.1338395965783683e-01 & -2.6554800661627576\text{e}-03 \\ 1.1546856489995427\text{e}-01 & -3.5774736713426591\text{e}-01 & -9.2665194751235791\text{e}-01 \\ -2.9134784753821596\text{e}-01 & 8.7966318277945221\text{e}-01 & -3.7591104878304971e-01 \end{pmatrix}$$

$$t_2 = \begin{pmatrix} -4.2633372670025989e-02 \\ -3.5441906393933242e-01 \\ 2.2750378317324982e+00 \end{pmatrix}$$

Camera 3

$$R_3 = \begin{pmatrix} -9.9541881789113029\text{e}-01 & 3.8473906154401757\text{e}-02 & -8.7527912881817604\text{e}-02 \\ 9.1201836523849486\text{e}-02 & 6.5687400820094410\text{e}-01 & -7.4846426926387233\text{e}-01 \\ 2.8698466908561492\text{e}-02 & -7.5301812454631367\text{e}-01 & -6.5737363964632056\text{e}-01 \end{pmatrix}$$

$$t_3 = \begin{pmatrix} -6.0451734755080713e-02 \\ -3.9533167111966377e-01 \\ 2.2979640654841407e+00 \end{pmatrix}$$

The following are the intrinsic parameters (i.e. camera resolution and camera calibration matrices) of the 3 cameras:

Camera 1:

Camera resolution: 1920 1080

Calibration calibration matrix:

$$\begin{pmatrix} 8.7014531487461625e+02 & 0 & 9.4942001822880479e+02 \\ 0 & 8.7014531487461625e+02 & 4.8720049852775117e+02 \\ 0 & 0 & 1 \end{pmatrix}$$

Camera 2:

Camera resolution: 1920 1080

Camera calibration matrix:

$$\begin{pmatrix} 8.9334367240024267e+02 & 0 & 9.4996816131377727e+02 \\ 0 & 8.9334367240024267e+02 & 5.4679562177577259e+02 \\ 0 & 0 & 1 \end{pmatrix}$$

Camera 3:

Camera resolution: 1920 1080

Camera calibration matrix:

$$\begin{pmatrix} 8.7290852997159800e+02 & 0 & 9.4445161471037636e+02 \\ 0 & 8.7290852997159800e+02 & 5.6447334036925656e+02 \\ 0 & 0 & 1 \end{pmatrix}$$

5. Submission instructions:

a. Submit the following soft copy to IVLE by 16th Nov:

- Tracking software
- Table tennis ball 3D trajectory computation software
- Video clip of the 3D trajectory (pick 5 best sequences)

b. Put all the above files in a folder and zip it before submission. Name your folder using the following format:

- ProjectGroupNumber_Student1_Student2_Student3_Student4. For example, if Tom, Peter, Harry and John are in group 12, the folder will be Gp12_Tom_Peter_Harry_John