ELEN-0016 – Computer Vision
Student projects 2024-2025

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Version 1.3

1 Introduction

The aim of the project is to "practice" computer vision with a practical application. To do so, your task is to implement a solution that retrieve the name of each piece on a chessboard at a given position and replace it in augmented reality. The learning objectives are for you to

- handle images/videos,
- design methods,
- understand its components,
- evaluate the quality of the results, and
- be able to comment the solution.

Each group must be composed of 3 students. Please register you group in the following sheet: registration sheet

2 Task 1: Data acquisition

The task consists in the acquisition of video sequences. Each student must record two games (played by the other team members).
For this first task, you are asked to play a game of chess that will be provided to you, starting from the initial position, and record the the ongoing game. In that regard, you should **record two different games**:

- the first with a **fixed** camera, and

- the second with a **moving** camera, where the cameraman moves around the board for at least 180° (on the left side of the player playing white).

When you play your games, you **must substitute all the white pieces by an item and all the black pieces by another item;** you can use anything that you want for the white/black pieces (e.g. bier capsules), but it needs to be the same for all white/black pieces. Each student must record its own two sequences, resulting in 6 games per group.

You will need to send your videos and your annotations following the format given in the notebook.

3 Task 2: Camera calibration

The purpose of this task is to implement and understand the process of camera calibration.

With the acquired sequences (see Task 1), you are asked to perform a camera calibration.

For this calibration, we assume that the system coordinates for the image plane is such that

- $(0, 0)$ is the upper left pixel and $(W - 1, H - 1)$ is the right bottom pixel.
- the real world coordinate system (X, Y, Z) is located in the middle of the a1 square; X moves along the letter, and Y moves along the number of the chessboard.

The steps to be performed are:

1. Detect the two stickers (only to determine the white/black side).
2. Perform a camera calibration (explain which model you are using).
3. Every 100 frames (starting from the first frame numbered 0):
   - provide the four corners of the chessboard (only the internal part, do not include the borders), in the image plane, in the following order: a1, a8, h8, h1 in the text file such that you have, per line:

     ```
     frame_Number (xa1,ya1) (xa8,ya8) (xh8,yh8) (xh1,yh1)
     ```

     for example

     ```
     499 (780,506) (60,504) (80,120) (705,78)
     ```

   - provide a frame named "frame_XXXXXX.png" on top of which you are displaying the polygon defined by the previous four corners.
   - provide the homography matrix.

4 Task 3: Piece recognition based on its motion

The main goal of this project is to retrieve the correct pieces based on the changes of game state. Accordingly, you are asked to update the game state with the correct piece number (see the notebook) when you have correctly predicted its value. Note that you can only rely on the dynamic of the pieces, no external knowledge about the game of chess is accepted.For the evaluation of this task, you are asked to come up and motivate your own evaluation procedure(s).

For this task, you can only use the video as input. The json file containing the true game state can only be used as training/evaluation. The output of your method is a json file with the same content as the one you produced for the Task 1, except that you only save the `game_states` key, with its corresponding `gs` and `frame` keys. When a move is played, you should update the game state with either the correct piece value (if you could correctly determine it), or keep the unknown value.

Hint: try to vary the starting frame/game state to analyze the behavior of your method.

5 Task 4: Augmented reality (bonus)

For this final task, you are asked to replace the determined pieces with their real shape/image on the video stream. You can start with a 2D model of the piece and then go for a 3D model. Note that this part should only be covered when the Task 3 is fully done, and can be seen as a bonus part.

6 Schedule

Date	In short	Description
25/09	**Constitution of groups + description of project**	
9/10	**Task 1**	**You must send your videos and your annotations**
30/10	**Task 2**	**You must send your codes and results**
4/12	**Task 3**	**You must send your codes and results (for Task 3) and a 2 pages report following the template.tex file.**
11/12	**Challenge + Task 4**	**The challenge will be done during the class. You must send your codes and results (for Task 4)**