Lab 5, Camera Calibration

- Chessboard calibration.
- Projection of 3D points in image with camera model.
- Calibrating your camera.
- External calibration.

5.1 Chessboard calibration

Run and test the file `chessboard.py`. This code detects corners in a chessboard pattern using openCV functions and shows the results of the detection for a series of images. Use the available code to calibrate the camera used in the provided images (`left01.jpg` to `left13.jpg`) using the function calibrateCamera. Help on this function can be found in `https://docs.opencv.org/4.x/d9/d0c/group__calib3d.html`. The last two parameters should be set to none (not using previous information for calibration and not specifying a termination criteria).
You might show in the standard output the calibration results using:

```
print("Intrinsics: ")
print (intrinsics)
print("Distortion : ")
print(distortion)
for i in range(len(tvecs)):
    print ("Translations(%d) : " % i )
    print(tvecs[0])
    print ("Rotation(%d) : " % i )
    print(rvecs[0])
```

Listing 10: Printing of camera parameters

After a successful calibration, save the intrinsic and distortion matrices in a npz file using savez as in the following code.

```
np.savez('camera.npz', intrinsics=intrinsics, distortion=distortion
    )
```

Listing 11: Saving camera parameters to file

Analyze the code for filling the 3D coordinates of the pattern. Imagine that you use another pattern with a different size what should you do to get the distance correctly evaluated?

Optional

You might improve the precision of the corner detection by using the cornerSubPix function after the call to `FindChessboardCorners`.

5.2 Projection of 3D points in the image

Use the function `cvProjectPoints()` to project an orthogonal line (normal) or a wireframe cube in one of the calibration image (the first for example) after the calibration code. Use the correct rotation and translation vectors from the calibration to project the 3D point in the correct positions in the image.
Modify the code to use the camera from your computer to process the chessboard (comment the code for reading the provided images to allow switching between camera and provided images). Calibrate your camera with several chessboard images (use `cvWaitKey()` to move the chessboard tp different position (consider a pre-defined number of images, for example 10, or use ”q” to finish the pattern aquisition). Be careful to check if the available chessboard is the same as the one in the provided images. If not, modify the code accordingly. If you want real metric distances, you need to update the code with the real distances of the used chessboard. Save the calibration parameters to a file.

```
import cv2
capture = cv2.VideoCapture(0)
while (True):
  ret, frame = capture.read()
  cv2.imshow('video', frame)
  if cv2.waitKey(-1) & 0xFF == ord("q"):
    break

capture.release()
cv2.destroyAllWindows()
```

Listing 12: Sample code for accessing camera

5.3 External calibration

Calibrate a camera (using the given images or using your computer camera) and save the camera parameter file with another name. Modify the previous examples to read the intrinsic and distortion parameters from a calibration file and perform only external parameters calibration (using function solvePnP) for a single image with the calibration pattern.

```
with np.load('camera_params.npz') as data:
    intrinsics = data['intrinsics']
    distortion = data['distortion']
print(intrinsics)
print(distortion)
```

Listing 13: code for reading camera parameters

Remember that in this case, the external calibration should be performed for each single image returning its position (rotation and orientation).

Optional

Compute the external calibration parameters for the camera of your computer while seeing a live feed of a pattern and project a cube (or normal vector) on the processed images live on the pattern.

Report

Write a report following the DETI journal template about the experiences done in this class. It should contain an example of the images displayed in each exercise, as well your comments about them. All the exercises must be repeated with images you acquired and the parameters of calibration of the camera you will be using must appear in the report.