Exercise for MA-INF 2201 Computer Vision WS18/19
07.01.2019
Submission on 13.01.2019

1. **Keypoint Localization:** Using the given set of 14 checkerboard images, each containing 7×10 keypoints, detect and display them in each image using the following commands:

   - findChessboardCorners()
   - cornerSubPix()
   - drawChessboardCorners()

   (4 Points)

2. **Camera Calibration:** Assuming that the top-left keypoint of the checker-board lies at the origin and in z = 0 plane; such that the 3D coordinates of the top-left and the bottom-right keypoints are (0, 0, 0) and (9, 6, 0). Compute and print on console the

   - cameraMatrix and distortionMatrix
   - rotation and translation matrices for each input image

   Use calibrateCamera() and **note** that the cameraMatrix is of type double and size 3×3.
   (4 Points)

3. **Reprojection Error:** In each input image, compute the 3D coordinates of each keypoint. Visualize the 2D location of each keypoint (in green) and their 2D reprojection (in red) by overlaying it on the image. Also, compute and print the reprojection error (ϵ_x, ϵ_y) where

$$\epsilon_i = \frac{1}{NK} \sum_{n=1}^{N} \sum_{k=1}^{K} |p_{nk}^i - \hat{p_{nk}^i}|, \quad i \in \{x, y\} \tag{1}$$

   where N is the total number of images, K is the number of keypoints, p_{nk}^x is the x-coordinate of the k^{th} keypoint in the n^{th} image and $\hat{p}$ refers to the corresponding reprojected keypoint.
   (2 Points)

4. **Image Unidisortion:** Convert each image to grayscale and compensate for lens distortion using undistort(). Display the absolute difference be-tween input-output pair of images.
   (2 Points)

5. **Chessboard Locations:** Display the top view of the position and orientation of image planes (by lines) relative to the camera coordinate system (origin shown by a circle) as shown in the figure below. You may scale and translate coordinates for display purposes.
   (8 Points)

Figure 1: Relative positions and orientations of image planes w.r.t the camera coordinate system