Principles of Robot Autonomy I
Homework 3 SOLUTIONS

Problem 1

(i) Solutions in code.

(ii) It can reduce the accuracy of detected corners because the algorithm (Harris Detection) is built on contrastive thresholding within a small window around a pixel. Techniques to denoise, undistort images can help and the function to improve subpixel accuracy. A direct function to use in OpenCV is `cv2.cornerSubPix()`

Note: Do not need exact words but students need to be in the right direction or use elements of the reference page linked in HW handout).

(iii) The computed values of $\mathbf{R}$ and $\mathbf{t}$ are:

$$\mathbf{R} = \begin{bmatrix} 0.84 & 0.024 & 0.54 \\ 0.046 & 0.98 & -0.12 \\ -0.54 & 0.12 & 0.83 \end{bmatrix} \quad \mathbf{t} = \begin{bmatrix} -0.068 \\ -0.062 \\ -0.28 \end{bmatrix} \tag{1}$$

(iv) If pinhole camera parameters estimated (like: fx, fy, distortion coefficients, cx, cy and skew s) have noise or not precise enough, it will change the pose of the camera and essentially how 3D points are projected to the focal plane and then to the image. The ways to validate the parameters are using:

1. Computing Reprojection Error
2. Using multiple images at known relative orientations or distances (or bundle adjustment)
3. Back projecting to 3D and comparing with physical size of checkerboard/object

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Problem 2

(ii) No bounding boxes are drawn because none of the bounding boxes have 1.0 probability.

(iii) Many bounding boxes are drawn, and some of them are incorrectly labelled. This is because the confidence threshold is low so even the low probability outputs are drawn.