Main steps of the assignment

The setting is as follows:
Input:

- left and right stereo images of blockswith known world coordinates
- left and right stereo images of blocks with a robot block. The camera is in the same position as in the previous images.
- the arrow on the robot defines the direction of z-axis of robot frame, y-axis of robot frame points up (to the ceiling).
- stereo camera properties (baseline, etc)

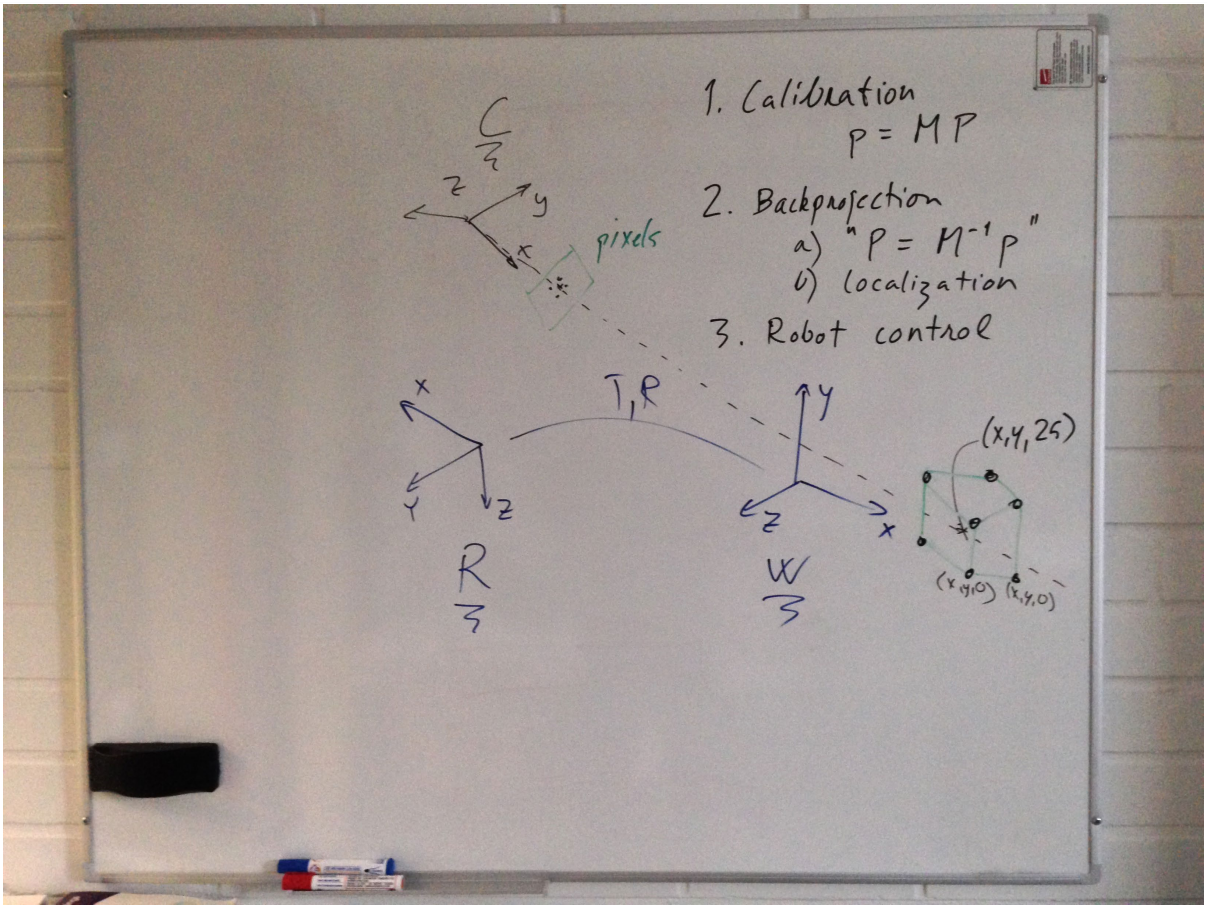
Output:

- A list of cube positions in the **robot frame** coordinates. The order is: red cube, green cube, blue cube, black cube.

You may propose some additional assumptions/simplifications in your initial plan, we will help you shape the algorithm into a more specific form.

For example, using the assumption that all blocks have the same fixed z-coordinate, the algorithm might look like the following:

1. Camera calibration, $\mathbf{p} = \mathbf{MP}$ with world coordinates $\mathbf{P}$ and the corresponding pixel coordinates $\mathbf{p}$ using images with blocks.
2. Back-projection. Find 3D locations of blocks and robot from the second set of images. The options for this are
    1. $" \mathbf{P} = \mathbf{M}^{-1}\mathbf{p} "$. Using the pseudo-inverse of the calibration matrix the locations can be found since one coordinate of the blocks is already known.
    2. Localization of the blocks. See Lecture slide set 12.
3. Robot control. When the locations of the blocks are found, you should also localize the robot and construct its frame. The mapping $[\mathbf{R} \quad \mathbf{T}]$ between the world frame $\mathbf{W}$ (the world coordinates) and the robot frame $\mathbf{R}$ (the robot coordinate space) should be known (measure and define $[\mathbf{R} \quad \mathbf{T}]$ between the two frames).



There are multiple ways for localizing the re-located blocks (Step 2 Back-projection), the setup is visualized in the figure above. One approach as the steps in 2.1 is:

1. Decompose calibration matrix $\mathbf{M}$ (in Matlab: [K R C] = decompose(M);).
2. Take the pseudo-inverse of $\mathbf{M}$ (in Matlab: pinv(M)).
3. Compute the world coordinates $\mathbf{P}$ corresponding to the pixels $\mathbf{p}$.
4. Construct the projection lines using the camera frame origin $\mathbf{C}$ and the coordinates of the points $\mathbf{P}$.
5. Cut the projection lines to the specified level in z-direction in the world frame.

Keep in mind that this is just one possible option! You are not required to make the same assumption. Instead, you can utilize stereo-vision to get additional information about the distance from blocks to the camera. You can use that to localize them instead of using the previous assumption. The less assumptions and simplifications you make, the better!

Last modified: Wednesday, 7 April 2021, 9:25 PM

◄ Description of the assignment.

Jump to...

Uploading the final report and the codes of the assignment. ►