Robot Vision MATLAB tutorial

February 1-8, 2021

Instructions

This tutorial is optional and contains two parts. In part 1, you will perform basic digital image processing tasks via MATLAB. In part 2, you will calibrate a perspective camera using the camera calibration toolbox of MATLAB. The tutorial is designed for students who have little MATLAB experience or would like to practice simple image manipulation in MATLAB.

All the assignments of this course are designed to be written in MATLAB programming language. It is required that the students who wish to attend this tutorial to **install MATLAB before the session**. MATLAB can be obtained for student installation on a personal computer via the MathWorks website. For those who find the following tasks too advance we recommend going through the following tutorial: `https://www.cyclismo.org/tutorial/matlab/`.

Part 1

This section will introduce you to basic image processing in MATLAB via some tasks involving loading and manipulating an image.

The questions in this section are designed to be answered in numerical order.

Hint: MATLAB performs calculations involving numbers stored as integer data types, such as uint8, differently to calculations involving numbers stored as floating point data types, such as double. For example, $7 \div 5 \neq 7.0 \div 5.0$. You may wish to examine your use of data types if your calculations are producing unexpected results.

Question 1.1 *Load the* ***Writing desk.jpg*** *image file using the* `imread` *function and display it using the* `imshow` *function. Add a title to the figure using the* `title` *function.*

Question 1.2 *Extract separate rectangular image regions containing the painting, vase, and statuettes, and display them using the* `imshow` *function with a title.*

Hints:

1) You may find it useful to display the whole image using the `image` function to find object positions.

2) Portions of matrices can be extracted by using the following syntax:
matrixName (subscriptsDimension1, subscriptsDimension2, subscriptsDimension3) where matrixName is the name of the matrix, and the subscripts give the coordinates in each dimension to keep.

Question 1.3 *Extract the separate colour channels for the rectangular image region containing the statuettes and display them individually using the* `imshow` *function with a title for each colour.*

Hint: The different colour channels can be accessed using the third dimension of the image matrix.

Question 1.4 *Combine the red, green, and blue image channels for the rectangular image region containing the statuettes into a single greyscale image and display the image using the* `imshow` *function with a title. Do this without a colour map by creating a separate greyscale image. Also display the same image using the jet, and hsv colour maps individually by using the*

`colormap` *function. Hint: You may find it useful to convert the colour channels into a different data type when combining them.*

Question 1.5 *Create a new version of the painting where the colour channels are remapped so that what was red becomes blue, green becomes red, and blue becomes green, and display the resulting image using the* `imshow` *function with a title.*

Part 2

In this task, you will have to use the calibration toolbox of MATLAB. With these exercises you will learn how to add and use a toolbox in MATLAB and how to calibrate a perspective camera. This part is mandatory.

Task 2.1 *Use the camera calibration toolbox from this website. Run MATLAB and add the location of the folder TOOLBOX_calib to the main MATLAB path. (Home>Environment>Set path>Add folder with subfolders and save). Run the main MATLAB calibration function* `calib` *and choose the standard calibration method.*

Task 2.2 *Use the* ***calibration images provided by us*** *and follow the calibration instructions of this website. Save the calibration results into a text file (****username_assignment1_1.txt****). Save the extrinsic parameters as* ***username_assignment1_2.fig****.*

Task 2.3 *Calculate the reprojection error for every image. The reprojection error is also shown in the form of color-coded crosses, save this figure as* ***username_assignment1_3.fig****. What is the reprojection error?*

Task 2.4 *Terminate the calibration and open the automatically generated* ***Calib_results.m*** *file. Construct and save the camera intrinsic matrix based on the result and analyse the accuracy of the calibration (****username_assignment1_4.mat****).*