COMPUTER VISION

LAB SESSION 3: STEREO VISION

MASTER IN INFORMATION AND HEALTH ENGINEERING

19/20

1 Introduction

In this Lab session we will experiment with some techniques of Stereoscopic Vision. The guideline of the practice contains the following folders and files:

- **Folder 'images'**: this folder contains various subfolders with image examples. In some cases, both Left (L) and Right (R) images are provided whereas in others, just the left one is available.
- **Folder `stereo_toolbox`**: this folder contains a toolbox that implements the stereo matching algorithms between the frames L and R.
- **computeZMap.m**: Function that computes a depth map from two stereo images (L, R).
- **anaglyph.m**: Function that generates and shows an anaglyph image (3D) from the corresponding L and R images.
- **generateFrameR.m**: Function that help users to generate a frame R by providing shifts from a frame L.

In order to know how to invoke the different functions and their parameters, you can type 'help function' in the command line. The folder 'images' contains several images to be used during the practice. In particular, two kinds of examples are included in the folder:

1. Examples with L and R images: 'office', 'mask', 'newspaper', 'harley', 'playtable' and 'toys'.
2. Examples with just the L frame and masks associated to a segmentation of the L image: `cube`, 'familyguy', 'motos', and 'seaview'.

2 Visualize an anaglyph

Run the function 'anaglyph.m' with the example pairs and visualize the results with the glasses. You can convert images to gray-level to improve the results (it is known that the anaglyph works better with gray-level images). Push the Zoom button to check its effect (modelling a zoom motion).

QUESTION 1.- Read the function anaglyph.m to check how we are generating the anaglyph from the pair of images (the answer can be found in the function plotAnaglyph).

QUESTION 2.- By changing the corresponding parameter when calling the function, compare the quality of the visualization of anaglyphs for gray-level and color images. In which images the perception of color is more complicated. Why do we say that, when working with color images, we are losing information?

QUESTION 3.- Use the button `SwapRL' in the GUI. This button exchanges the Left and Right images of the stereoscopic pair. Are you able to still perceive the 3D image? Why?

QUESTION 4.- For some images, you may not properly perceive the 3D representation. Why do you this is happening? Hint: Look at the anaglyph without the glasses and focus on the object borders.

3 Computation of a Depth Map from image pairs

In this section we will simulate a **standard** Stereo System. Our objective is to estimate a Depth Map from a pair of images, a typical task in many robotic systems. As seen in the lectures, a standard Stereo System contains two cameras with parallel axes and known baseline T:

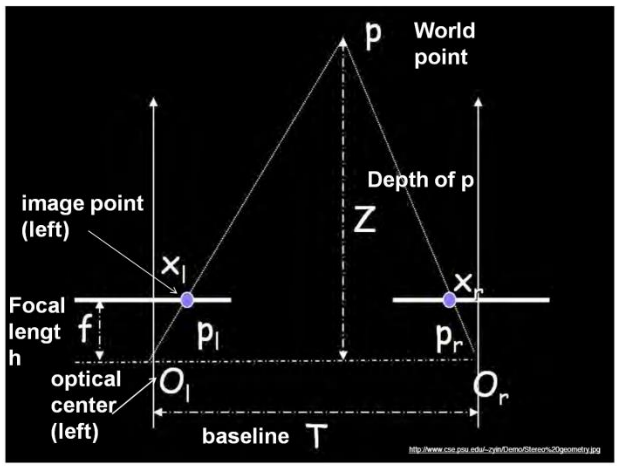

Figure 1 Standard Stereo System

Under the assumption of a standard stereo system, the student is asked to perform the following steps:

1. Read the function ‘computeZMap’ and identify the processing steps.

2. Read the function ‘stereo.m’ in the folder ‘stereo_toolbox’ to understand the stereo matching process between images.

3. Complete the function ‘computeZMap’ to provide a depth map given a pair of stereo images. Inside the file, you will find the instructions to fill the code.

Once the code is finished, run the computeZMap with the available examples (‘office’, ‘mask’, ‘newspaper’, ‘harley’ and ‘toys’) and the next configuration:

- Focal length: 28mm
- Baseline: 10cm
- Sensor Width: 32mm
- Win_size: 8px.

QUESTION 5.- Examine the results and related the resulting Disparity Map and the Z Map. Using the ‘cursor’ control in MATLAB figures, you can check depth values in the Z Map.

NOTE: Check numerical values using the 2D figures; the 3D map has been re-scaled to enhance the visualization and does not contain real numerical values.

QUESTION 6.- Now evaluate the influence of the following parameters in the results:

- **Focal Length**
- **Baseline**
- **Sensor Width**

What will happen if a robot uses wrong values of these parameters when computing the depths (lower or higher than the real ones used by the stereoscopic system that acquires the images)? Will the estimated Z be lower or higher than the real one?

QUESTION 7.- What happens if you change the value of the `win_size` parameter in the function 'stereo.m'? Test some values of this parameter (win_size=2, 4, 8, 16, 32). Can you explain the results?

4 Semi-automatic Generation of a Stereo Image Pair

Now we will experiment with the semi-automatic generation of Stereo Image Pairs from the Left Image. For that end, we have segmented images and provided a set of regions of fixed depth. Hence, the process is now the opposite of that the one in the previous section:

1. For each region in the segmentation, associate an estimated depth in meters.
2. Convert the Depth Map into a Disparity Map in pixels.
3. Apply the disparities to generate the frame R from the frame L.

QUESTION 8.- Read the function 'GenerateFrameR.m' and try to understand the different steps in the processing pipeline.

Now, execute the function 'generateFrameR' over the samples images ('familyguy', 'motos', 'seaview' and 'cube'). Use the following baseline setup:

- Focal length=28mm
- Baseline: 30cm
- Sensor Width=32mm

Once, the frame R is generated, run the function 'anaglyph' and visualize the results.

QUESTION 9.- Evaluate the results and identify when the performance is not acceptable. Can you find visible errors?

QUESTION 10.- What is the influence of the segmentation over the 3D visualization? Can we improve the results with more segments?

QUESTION 11.- Modify the values of the focal length, baseline and sensor width and evaluate their influence over the results.

5 Navigation using stereoscopic systems (optional)

This section is optional and will not be evaluated. Here the student can extend the original algorithm to compute (X,Y) coordinates in addition to the Z, and therefore implement a navigation system for a robot with a stereoscopic system.

6 Evaluation

For the evaluation of this lab session, the student will be asked to answer a test through Aula Global. The test will be available from Tuesday 10 March at 10:00 to Monday 16 of March at 14:00.

IMPORTANT: The student has only ONE attempt to answer the test. This means that once the test is started it has to be finished in the same session. In the undesired event that a network or system failure occurs, please send me an email to check the causes and, consequently, reset the attempt.