

Design and implement MATLAB or C/C++/.. or Python program for a stereo analysis system involving (A) region-based and (B) feature-based matching methods. Perform multi-resolution matching by matching at each level and using disparity as initialization for the next level. (A) or (B) can be used at any level except at the top level (A) is used. The program should be able to perform multi-resolution stereo analysis, where the number of levels is set by the user, and validity check is performed at every level. The template size and search neighbourhood at each level can be set differently by the user. Details are given below.

## 1. Methods

### A) Region-based analysis

i) User can pick the size of the template and matching window. Template can either be square or rectangular. Matching is done in the x direction.

ii) Provide the following matching scores:

a) Sum of Absolute Differences (SAD)

$$SAD = \sum |I_1 - I_2|$$

b) Sum of Squared Differences (SSD)

$$SSD = \sum (I_1 - I_2)^2$$

c) Normalized Cross-correlation (NCC)

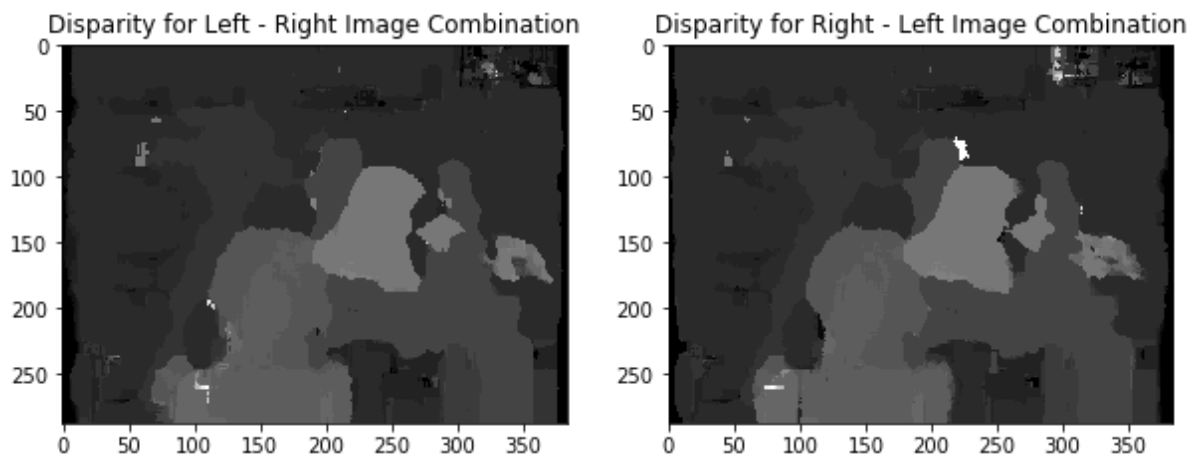
$$NCC = \frac{\sum I_1 I_2}{\sqrt{\sum I_1^2 \sum I_2^2}}$$

### B) Feature-based analysis

Use Harris corners detector for feature extraction, then use the descriptor value for matching (i.e., Harris corner response measure). Also give the user option to choose different matching scores: SAD, SSD, NCC.

## 2. Validity check and filling up gaps in disparity

i. Validity check is then performed wherein if the left-to-right match does not correspond to right-to-left match, a 'zero'(gap) is placed at that location in the disparity. One way to do this is, switch the left image with right image and see if the correspondences match up in both directions. They will not match up, for example, when pixels are under occlusion (see Fua's paper provided). If the correspondences are same in both directions, then consider that the correspondence are valid, otherwise invalid.



ii. Perform averaging in the neighbourhood to fill these gaps (zeroes). The neighbourhood window can be as big as needed (for example, if 3X3 does not provide at least 5 non-zero values, make the window 5X5, and so on). Some may use quadratic fits in this neighbourhood to get the interpolated values in the gaps – I will leave this up to you.

### 3. Data

Please visit below pages for stereo data and evaluation strategies:

<https://vision.middlebury.edu/stereo/data/scenes2001/>

### 4. Notes

\_ You can use region or feature based at any level. However, make sure to use the region based at the top level.

\_ You may end up with sub-pixel values of disparity while interpolating. This is just fine, and good.

\_ Better your stereo analysis results, better it is. So, you may incorporate your own constraints and improve in anyway the accuracy of the algorithm.

\_ Prepare at least 3 results for 5 different stereo pairs, with readme file explaining each result and indicating parameters used; upload the 'zipped' directory in Canvas which includes source code, data used. Include all the necessary files.

\_ You may use built-in corner detector available in Matlab or OpenCV.