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3D Computer Vision

Assignment 4: Semi-Global Matching

Submission Deadline:

In this assignment, you will be working on stereo matching using semi-global matching. You will develop and test your code against images from the Middlebury 2005 dataset [1], which consists of rectified image pairs.

Privacy Note: Please note that you are not allowed to publish the solutions to any of the exercises publicly.

Part 1 - Data Term and SGM in 1D

- Q1 [3 Points] Implement computing the data term in `task1.ipynb`.
- Q2 [1 Point] Compute the data term for the given images and find the disparities according to the minimum cost (this corresponds to block matching). Visualize your result in `task1.ipynb`. See the example result in Figure 1.
- Q3 [10 Points] Find the optimum disparities for a 1D horizontal line across the image at the given y location in `task1.ipynb` and visualize your results.

Part 2 - SGM in 2D

Please note: the following task is to be done in C++ and gives 30 points in total. If you are not able to do it in C++, you may implement the code in Python and receive a maximum of 20 points.

- Q1 [20 Points] Implement sending the messages in all directions in `sgm.cpp`. Use `task2.ipynb` to debug and visualize your results.
- Q2 [5 Points] Implement aggregating the cost for all messages for each pixel in `sgm.cpp`.
- Q3 [5 Points] Select the best disparity for each pixel according to the minimum cost in `sgm.cpp`. Visualize your result in `task2.ipynb`.

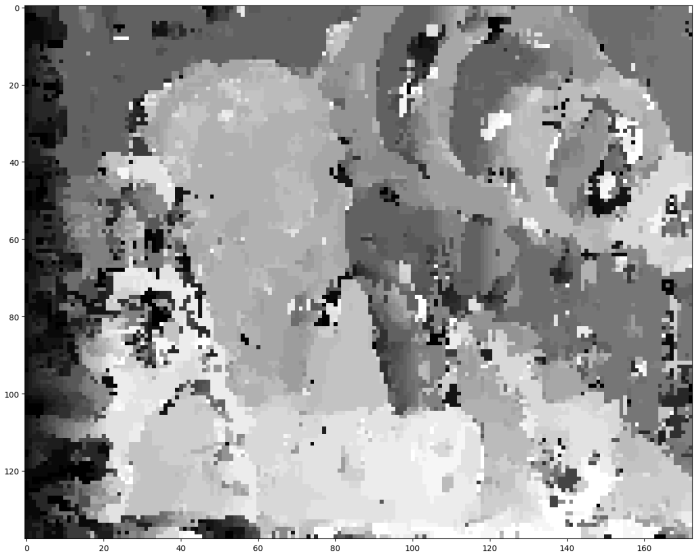

Figure 1: Example result from block matching with 5×5 patches.

Part 3 - Bonus

Please create a new Python notebook called `bonus.ipynb`.

- Q1 [10 Points] Use the supplied Middlebury images and disparity ground truths to do a grid search for different values of $P1$, $P2$ and the patch size. To evaluate the error, use the mean absolute distance $\frac{1}{N} \sum_{\mathbf{p}} |d_{\mathbf{p}} - d_{\mathbf{p}}^{GT}|$ to the ground truths.
- Q2 [10 points] Use different data terms from the lecture and literature and compare the results qualitatively. Provide a table with the numerical results in the Python notebook.

Best of Luck!

References

[1] Daniel Scharstein and Chris Pal. Learning conditional random fields for stereo. In *2007 IEEE Conference on Computer Vision and Pattern Recognition*, pages 1–8, 2007.