Supplementary Material for Submission: "PatchMatch Stereo - Stereo Matching with Slanted Support Windows"

BMVC 2011 Submission # 289

The Global Algorithm

In Section 2.4 of the paper we have described how to build a cost volume using our slanted adaptive support weight windows that can be used by global stereo methods. We embed this cost volume into a global algorithm whose details are described here.

The global algorithm searches a disparity map D that assigns each pixel of both views to a discrete disparity and minimizes the energy defined as

$$E(D) = E_{data}(D) + \lambda E_{smooth}(D). \tag{1}$$

Here, λ is a parameter that balances the influence of data and smoothness terms. We take the data term from [3] which accomplishes symmetrical occlusion handling and is defined as

$$E_{data}(D) = \sum_{p \in \mathscr{I}} \begin{cases} c(p, d_p) & : d_p = d_{p'} \\ \lambda_{occ} & : d_p < d_{p'} \\ \infty & : \text{otherwise} \end{cases} \tag{2}$$

where $\mathscr{I}$ denotes all pixels of both views. We write p' to denote p's matching point according to p's disparity in D. The function $c(p, d_p)$ looks up the costs for matching pixel p at disparity d_p in our cost volume and the parameter λ_{occ} puts a penalty on occluded pixels. As a smoothness term, we use the second order term of [4] that puts a penalty on disparity curvature:

$$E_{smooth}(D) = \sum_{<p,q,r> \in \mathscr{N}} \min(|d_p - 2d_q + d_r)|, \tau_{smooth}) \tag{3}$$

Here, $\mathscr{N}$ denotes the set of all 3×1 and 1×3 patches in left and right images. The parameter τ_{smooth} truncates the smoothness costs in order to allow for sharp jumps in disparity at depth discontinuities. This smoothness term is a natural choice for our algorithm, since it overcomes the bias towards fronto-parallel surfaces that competing terms suffer from (e.g., truncated linear model).

For optimization we use the α-expansion algorithm [1]. Note that the graph used to compute an optimal α-expansion can contain non-submodular edges. We use QPBO [2] to derive a potentially incomplete binary labelling of pixels where label 0 means that the old disparity is kept and label 1 means that disparity α is taken. Unlabelled pixels are set to label 0, i.e., we apply QPBOF.

References

[1] Y. Boykov, O. Veksler, and R. Zabih. Fast approximate energy minimization via graph cuts. *PAMI*, 23(11):1222–1239, 2001.

[2] V. Kolmogorov and C. Rother. Minimizing non-submodular functions with graph cuts - a review. *PAMI*, 29(7):1274–1279, 2007.

[3] V. Kolmogorov and R. Zabih. Multi-camera scene reconstruction via graph cuts. In *ECCV*, 2002.

[4] O. Woodford, P. Torr, I. Reid, and A. Fitzgibbon. Global stereo reconstruction under second order smoothness priors. In *CVPR*, 2008.