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1 Large Displacement Optical Flow: Descriptor Matching in Variational Motion Estimation

Authors: Thomas Bronx, Jitendra Malik
Conference: TPAMI 2010

Summary:
This paper presents an approach of integrating descriptor matching into variational framework for optical flow. Traditional variational model for optical flow is formulated as the following energy functional minimization problem:

$$E(\mathbf{w}) = E_{color} + \gamma E_{gradient} + \alpha E_{smooth} \tag{1}$$

The terms correspond to color constancy, gradient constancy and regularization (smoothness) constraints. Solution is by obtained by local minima corresponding to where the first variants (derivatives) become zero. For initializing a coarse-to-fine strategy is followed. Hence, solutions with larger structures are favoured due to initializations. The result of this is that finer and faster motions are not captured. On the other hand, feature descriptors can produce large number of correct displacement correspondences. However, unlike variational model autorthey can not produce dense motion fields. To get the best out of both worlds, two descriptor based terms are added to the variational formulation.

$$E(\mathbf{w}) = E_{color}(\mathbf{w}) + \gamma E_{gradient}(\mathbf{w}) + \alpha E_{smooth}(\mathbf{w}) + \beta E_{match}(\mathbf{w}, \mathbf{w_1}) + E_{desc}(\mathbf{w_1}) \tag{2}$$

The function is non-convex, so we need good approximations. The paper shows how the properties of descriptor matching and continuation method can be exploited to simplify the optimization problem.

Key Idea:
Combining discrete descriptor matching into the variational framework.

Positives: Handles large displacements in optical flow.

Limitations: Non-convex formulation

2 DeepFlow: large displacement optical flow with deep learning

Authors: Philippe Weinzaepfel, Jerome Revaud, Zaid Harchoui, Cordelia Schmid

Conference: ICCV 2013

Summary: This paper extends the idea of Bronx and Malik. They improve the descriptor matching by adding dense correspondences matching and self smoothed matching. They introduce a multi-stage architecture for descriptor matching with about six layers, interleaving convolutions and max pooling. The construction has been inspired by deep convolutional networks. This allows them to get denser descriptor matches, as hierarchical model can provide for matches at coarser or finer level. They also allow for warping of the descriptors and subdivide the SIFT descriptor into smaller (4×4) patches and allowing flexibility in the matches within appropriate limits. Thus non-rigid deformations can be handled by this method.

Key Idea:
Convolutional net like structure and handling of non-rigid deformations.

Advantages:
Denser correspondences and non-rigid deformations

Disadvantages:
Complexity