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Vorwort

Die vorliegende Arbeit ist während meiner Tätigkeit als Wissenschaftlicher Mitarbeiter am Lehrstuhl für Kommunikationstechnik der Technischen Universität Dortmund entstanden. Die Motivation zu der behandelten Thematik entstammt meiner wissenschaftlichen Arbeit im Rahmen von Forschungs- und Entwicklungsprojekten in Kooperation mit dem European Technology Center der Sony Deutschland GmbH in Stuttgart.

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Contents

1. Introduction	1
1.1. Contributions	3
1.2. Outline	4
2. Selected Basics	5
2.1. Formalism	5
2.2. Block Matching Correspondence Estimation	6
2.2.1. Matching Principle and Criteria	6
2.2.2. Decoupling of Block Grid and Match Block Size	8
2.2.3. Search Strategies	8
2.2.3.1. Hierarchical Search	9
2.2.3.2. Predictive Search	11
2.2.3.3. Combined Hierarchical and Predictive Search	13
2.2.4. Related Work	13
2.3. Differential Correspondence Estimation	15
2.3.1. Optical Flow Constraint	15
2.3.2. Local Estimation (Lucas and Kanade Method)	16
2.3.3. Global Estimation	17
2.3.3.1. Formulation of a Global Energy Functional	17
2.3.3.2. Horn and Schunck Approach	18
2.3.4. Limitations of Basic Differential Methods	19
2.3.5. Related Work	20
2.3.5.1. Data Term Modification	20
2.3.5.2. Prior Term Modification	21
2.3.5.3. Estimation of Large Motions	22
2.3.5.4. Outlier Reduction	23
2.3.5.5. Evaluation	23
2.4. Adaptive Vector Field Filtering	23
2.4.1. Filter Structures	24
2.4.1.1. Weighted Moving Average Filter	24
2.4.1.2. Weighted Median Filter	25
2.4.2. Filter Weights	26
2.4.2.1. Domain Filter Weights	26
2.4.2.2. Color Range Filter Weights	27
2.4.2.3. Vector Range Filter Weights	28
2.4.2.4. Filter Weights from Additional Cues	29

2.4.3.	Related Work	29
2.4.3.1.	Correspondence Vector Field Postprocessing	29
2.4.3.2.	Adaptive Support Weights for Correspondence Estimation Methods	30
3.	Comparison of Block Matching and Differential Correspondence Estimation	33
3.1.	Assumptions on Input Data and Correspondence Vector Fields	33
3.2.	Basic Approaches for Correspondence Estimation	34
3.3.	Optimization Strategies	35
3.4.	Vector Field Resolution and Accuracy	36
3.5.	Local Behavior	37
3.5.1.	Object Boundaries	37
3.5.2.	Homogeneous Regions	38
3.6.	Large Displacements and Independently Moving Objects	39
3.7.	Conclusion	40
4.	Adaptive Correspondence Estimation	43
4.1.	Adaptive Spatio-Temporally Predictive Hierarchical Block Matching	43
4.1.1.	Hierarchical Multi-Scale Estimation Framework	44
4.1.2.	Image Preprocessing	45
4.1.3.	Vector Projection	47
4.1.4.	Adaptive Predictive Block Matching	49
4.1.4.1.	Predictor Selection	49
4.1.4.2.	Update Star Search	51
4.1.4.3.	Integration of Adaptive Weights	52
4.2.	Adaptive Differential Correspondence Estimation for Refinement of Block Matching Results	57
4.2.1.	Basic System	57
4.2.1.1.	Discrete Realization	58
4.2.1.2.	Gradient Computation	59
4.2.1.3.	Mean Flow Computation	59
4.2.1.4.	Flow Update Computation	60
4.2.1.5.	Flow Computation	60
4.2.2.	Warping Based Estimation	60
4.2.3.	Input Image Transformation	62
4.2.4.	Integration of Adaptive Weights	62
4.2.5.	Final System	66
4.2.6.	Multi Scale Framework	68
4.2.7.	Two Stage Estimation Concept for Refinement of Block Matching Results	70
4.3.	Conclusion	71

5. Combined Block Matching and Differential Correspondence Estimation in a Hierarchical Multi-Scale Framework	75
5.1. Hierarchical Scaling Pyramid Framework	75
5.2. Low-Scale Differential Vector Field Initialization	78
5.3. Predictive Block Matching	79
5.4. Consistency Check	81
5.5. Adaptive Vector Field Histogram Filter for Block Matching Outlier Removal	82
5.6. Differential Refinement	85
5.7. Border Occlusion Detection and Filling	86
5.8. Adaptive Flooding of Occlusion Areas	87
5.9. Conclusion	90
6. Evaluation of the Developed Adaptive Correspondence Estimation Method	91
6.1. Evaluation Criteria	92
6.1.1. Quantitative Measures	92
6.1.1.1. Angular Error	92
6.1.1.2. Endpoint Error	93
6.1.1.3. Interpolation Error	94
6.1.1.4. Normalized Interpolation Error	94
6.1.2. Qualitative Measures	95
6.1.2.1. General Accuracy	95
6.1.2.2. Vector Field Homogeneity	96
6.1.2.3. Steepness of Vector Field Transitions at Motion Boundaries	96
6.1.2.4. Precision at Motion Boundaries	96
6.1.2.5. Sensitivity to Motion of Small Structures	96
6.1.2.6. Tracking of IMOs	97
6.1.2.7. Motion Projection into Homogeneous Regions	97
6.1.2.8. Susceptibility to Local Minima and Image Noise	97
6.2. Evaluation and Comparison to State-of-the-Art Methods	98
6.2.1. Compared SoA Methods	98
6.2.2. Qualitative Local Comparison of Selected Results	99
6.2.2.1. Selection of Sequences	100
6.2.2.2. RubberWhale	101
6.2.2.3. Grove3	103
6.2.2.4. Urban3	105
6.2.2.5. Beanbags	106
6.2.2.6. Qualitative Evaluation	108
6.2.3. Quantitative Comparison	109
6.2.3.1. Middlebury Training Dataset	110
6.2.3.2. Middlebury Evaluation Dataset	112
6.3. Conclusion	116

7. Summary, Conclusion and Outlook	119
7.1. Summary and Conclusion	119
7.2. Outlook	122
A. Appendix	123
A.1. Correspondence Vector Field Visualization	123
A.2. Parameter Settings for Evaluated System	124
A.3. Estimation Results of the Proposed Systems	126
A.3.1. RubberWhale	126
A.3.2. Grove3	127
A.3.3. Urban3	128
A.3.4. Beanbags	129
List of Abbreviations	131
List of Operators, Functions and Symbols	133
Bibliography	141
Author's Publications	151
Author's Supervised and Relevant Theses	153
Curriculum Vitae	155

Abstract

Dense correspondence estimation is widely used for many image processing applications. For example, it is applicable in video signal processing for the computation of the motion field used for temporal de-interlacing, motion compensated frame-rate conversion or temporal super-resolution. In computer vision it is predominantly used for scene understanding. For instance, estimated correspondence vectors are used to reconstruct observed 3D objects and motions or to detect and track moving objects. In these two fields of image processing, two different estimation approaches which were independently developed are used. In video signal processing, block matching motion estimation, a discrete search for small similar patches in adjacent frames, is usually used. In contrast, in computer vision differential optical flow estimation is used in most applications that require dense correspondence fields. This latter approach has a strong mathematical background and tries to find pixel-wise correspondence vectors that optimize an image model based global energy functional.

In this thesis, the characteristics of the two correspondence estimation concepts - block matching and differential optical flow - are analyzed and compared, and specific strengths and weaknesses are outlined. Both approaches have specific advantages for applications they were designed for, but also drawbacks that limit their applicability for advanced scenarios. The two approaches show complementary strengths, such that a combination of the two concepts seems to be a promising approach to achieve correspondence vector fields that meet the requirements of advanced applications. Both methods show weaknesses when it comes to estimation of precise vector fields with steep transitions at motion boundaries. This thesis proposes to increase the adaptivity of block matching and optical flow method and to combine the two approaches in a common framework that will exploit their complementary advantages. Two separate methods for block matching and differential estimation are developed with respect to enabling a combination of the two methods. Weights known from adaptive vector field filtering are integrated into each developed method, such that both approaches show high adaptivity to image structures and motion boundaries. Afterwards, a concept for combining the two methods in a common multi-scale framework is proposed. The two methods are alternately applied over multiple scales, such that the estimation results are increasingly refined with each processing step. Adaptive vector field postprocessing steps

are then further integrated into the framework to reduce remaining outliers and achieve an even higher precision at motion boundaries. In this context, a histogram-based method for jointly filtering horizontal and vertical vector field component is proposed. Resulting vector fields of the proposed concept are qualitatively and quantitatively evaluated and compared to current state-of-the-art methods. The proposed method achieves high ranks in a current benchmark for optical flow methods.