WM-SBA: Weighted Multibody Sparse Bundle Adjustment Kai Cordes • Mark Hockner • Hanno Ackermann • Bodo Rosenhahn • Jörn Ostermann

# **Multibody Extension to Bundle Adjustment**

Sparse Bundle Adjustment (SBA)

 $\min_{\mathbf{a_j},\mathbf{b_i}} \sum_{i=1}^n \sum_{j=1}^m ||Q(\mathbf{a_j},\mathbf{b_i}) - \mathbf{x_{ij}}||^2$ 

: 2D feature points X<sub>ii</sub>  $Q(\mathbf{a_i}, \mathbf{b_i})$ : Projection function

- Minimizes reprojection error
- Optimization exploits sparse structure of Jacobian matrix [1]

- Multibody Bundle Adjustment
  - Given: trajectory clustering
  - Joint optimization of multiple motion models [2]



## Contribution

- Incorporate identical intrinsic camera parameters for static background and moving object(s)
- Weighting of different motion models
- Sparse structure of Jacobian preserved
- Evaluation:
  - Well represented MAIN motion model
  - Poor represented OBJ motion model
  - Set weights to emphasize OBJ motion model

### **Synthetic Experiments**

- Two motion models, 500 runs
- > Varying noise  $\sigma$  on 2D points
- Mean error in focal length:  $\epsilon_f$





Separated vs. joint optimization

Different weights

#### **Natural Experiments**

- Harris/KLT features, manually grouped
- MAIN: many features
- ► OBJ: few features
- Constant intrinsics, but: assume varying intrinsics





Wrong results: OBJ ref-SBA

Identical: WM-SBA  $10^2, 10^4, 10^6$ 



Wrong results: OBJ ref-SBA Identical: WM-SBA  $10^4, 10^6$ 

#### **Conclusions**

- New multibody bundle adjustment approach uses weighting for different motion models
- Appropriate weighting leads to more accurate results

#### Dependency on motion model representation

Application demonstrates superior performance in automotive scenario

Computation of optimal weighting factor under examination

[1] M. A. Lourakis, A. Argyros: "SBA: a software package for generic sparse bundle adjustment", ACM Trans. Math. Software 2009 [2] A. W. Fitzgibbon, A. Zisserman: "Multibody structure and motion: 3-D reconstruction of independently moving objects", ECCV 2000



