Spatiotemporal Bundle Adjustment for Dynamic 3D Reconstruction

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Motivation

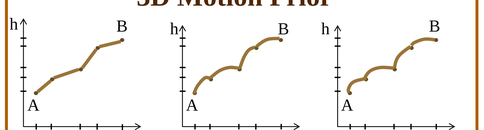
Insight: Solve four sub-problems jointly

1. Camera intrinsics and extrinsics
2. 3D location of static points
3. Relative camera temporal alignment
4. 3D trajectory of dynamic points

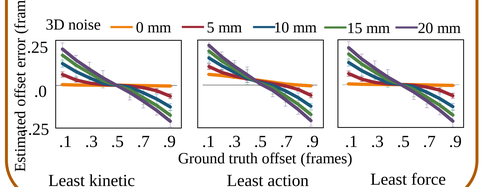
Key Ideas

1. Physics-based motion prior for dynamic trajectory triangulation
2. Incremental alignment and reconstruction algorithm to strictly enforce motion prior constraint.

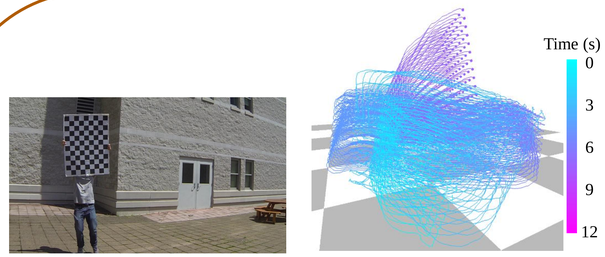
3D Motion Prior



Evaluation of 3D Motion Prior



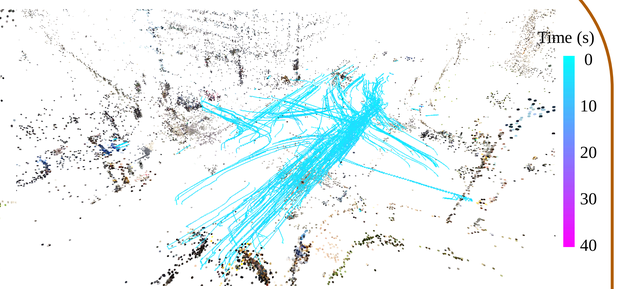
Qualitative Results



(a) Frame from 1 of 7 video cameras (b) The 3D trajectory of the checkerboard corners

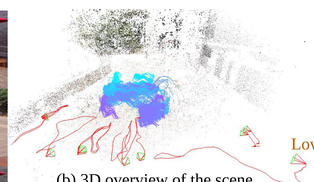
(a) Original unaligned video images

(b) Motion prior based @60fps (Top view)

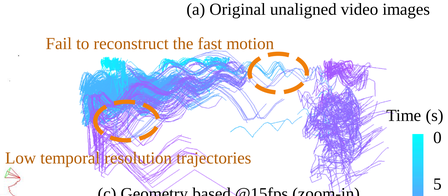


(c) Motion prior based @60fps (Side view)

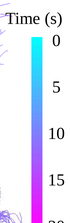
(a)Original unaligned video images

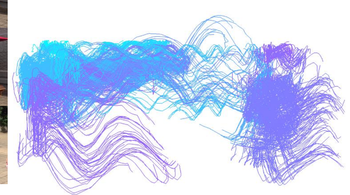


(b) 3D overview of the scene



(c) Geometry based @15fps (zoom-in)

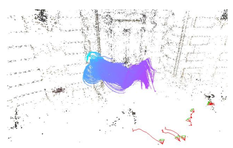




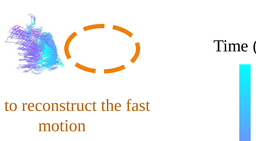
(d) Motion prior based @15fps (zoom-in)

(e) Geometry based @60fps (zoom-in)

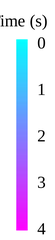
(a) Original unaligned video images



(b) 3D overview of the scene



(c) Geometry based @30fps (zoom-in)



(d) Motion prior based @30fps (zoom-in)

(e) Geometry based @120fps (zoom-in)

Quantitative Results

	Geometry based method				Motion Prior					
	#Trajectory	Avg samples per trajectory	RMSE (pixels) Static	- Dynamic	#Trajectory	Avg samples per trajectory	RMSE (pixels)* Static	- Dynamic	RMSE (pixels)** Static	- Dynamic
Checkerboard	88	179.8	0.67	6.59	88	1023.0	0.67	1.21	0.65	1.15
Jump	717	36.4	0.59	1.91	3231	127.8	0.59	1.34	0.6	1.26
Dance	677	22.3	0.82	5.23	4105	216.4	0.82	2.12	0.85	1.71
Synthetic Ballet	31	53	3.31	24.3	31	534	3.31	1.49	2.65	0.82

Discussion

1. Joint spatiotemporal bundle adjustment and correspondences estimation
2. Shape triangulation from multiple calibrated cameras

Acknowledgement

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