Temporally coherent 4D reconstruction of complex dynamic scenes

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Motivation and Contributions

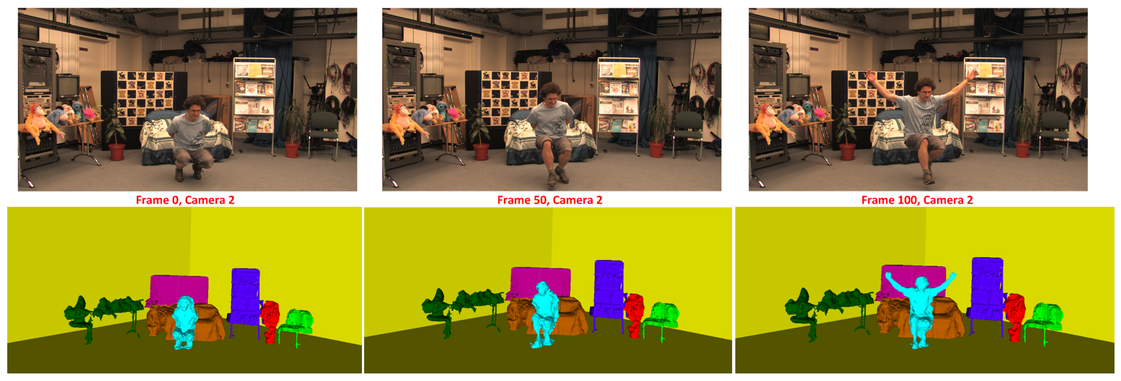
Existing techniques for 4D dynamic scene reconstruction from multiple wide-baseline cameras suffer from following limitations:

1. They work in controlled environments, fixed and calibrated cameras;
2. Assumption of known background appearance and structure;
3. Per frame reconstruction incoherent in time.

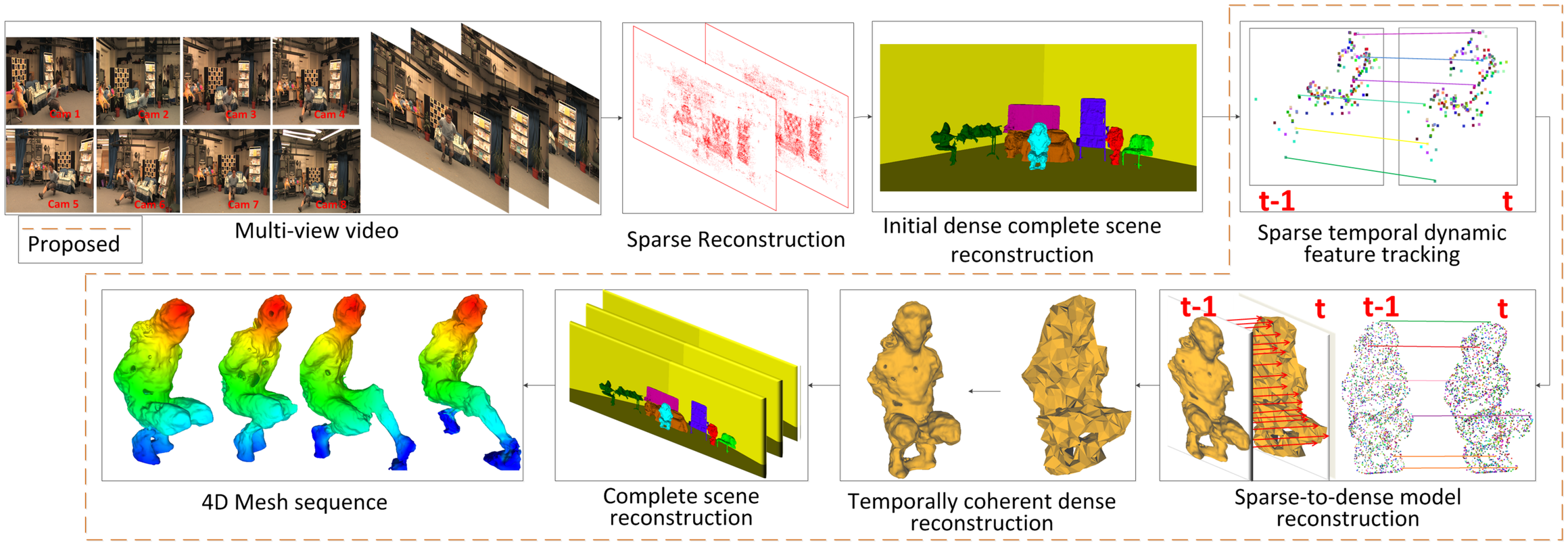
Contributions of this work:

1. Temporally coherent reconstruction of complex dynamic scenes;
2. Optimisation of reconstruction using geodesic star convexity;
3. Space-time sparse-to-dense segmentation and reconstruction.

Proposed approach



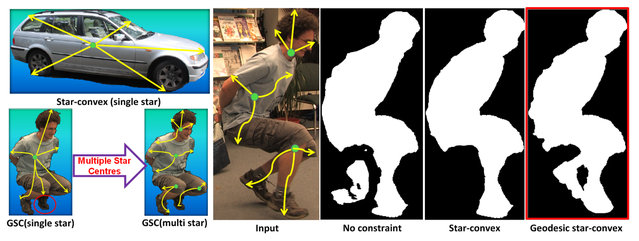
Framework for proposed general 4D scene reconstruction



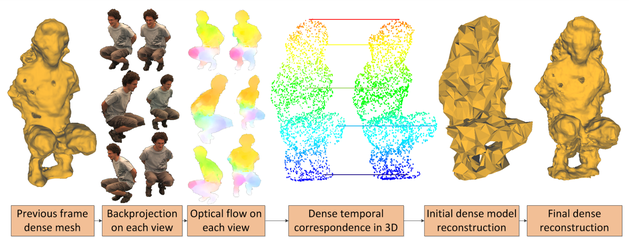
Joint segmentation and reconstruction

$$E(l,d) = \alpha E_{data}(d) + \beta E_{smooth}(l) + \gamma E_{color}(l) + \eta E_{contrast}(l,d)$$

Geodesic star-convexity



Sparse-to-dense framework



Results and Evaluation

Dataset	Furukawa (ms)	Guillemaut (ms)	Mustafa (ms)	Ours (ms)
Dance1	326	493	295	254
Magician	311	608	377	325
Odzemok	381	598	394	363
Office	339	533	347	291
Juggler	394	634	411	378
Dance2	312	432	323	278

Computation time

Summary:

1. The proposed approach allows unsupervised 4D reconstruction without prior information on scene appearance or structure.
2. Temporal coherence and geodesic star-convexity constraint improved the segmentation and reconstruction accuracy over previous methods.
3. Tests on challenging datasets demonstrate improvements in quality of reconstruction and segmentation compared to state-of-the-art methods.

References

[1] Y. Furukawa, J. Ponce. Accurate, dense, and robust multiview stereopsis in *PAMI*, 2010.
[2] J. Y. Guillemaut, A. Hilton. Space-time joint multi-layer segmentation and depth estimation in *3DIMPVT*, 2012
[3] A. Mustafa, H. Kim, J. Y. Guillemaut, A. Hilton. General scene reconstruction from multi-view video in *ICCV*, 2015

Acknowledgement

The researh was supported by European Commission, FP7 Intelligent Management Platform for Advanced Real-time Media Processes project (grant 316564).