Motion segmentation with pairwise matches and unknown number of motions

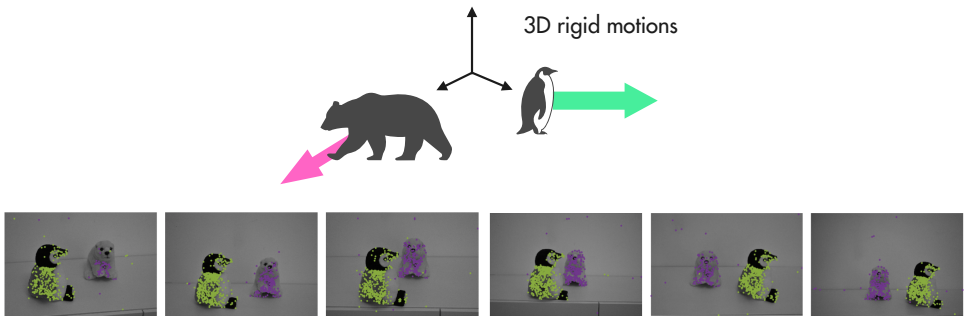
Federica Arrigoni[1], Luca Magri[2] and Tomas Pajdla[3]

[1]DISI, University of Trento (Italy) – federica.arrigoni@unitn.it
[2]DEIB, Politecnico di Milano (Italy) – luca.magri@polimi.it
[3]CIIRC, CTU in Prague (Czech Republic) – pajdla@cvut.cz

ICPR Online, 10-15 January 2021

Introduction

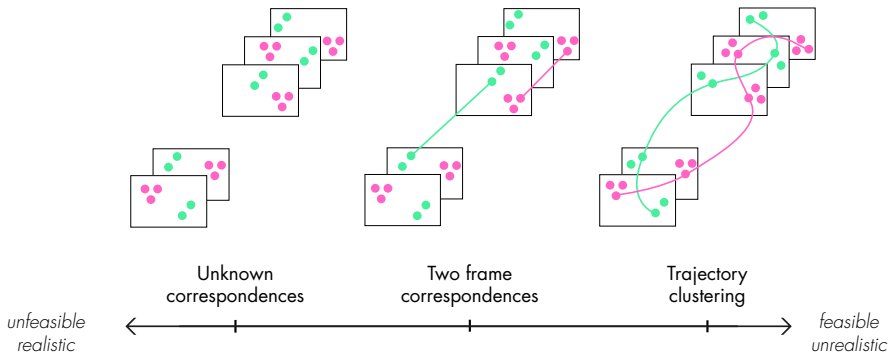
Motion segmentation: the goal is to classify points in multiple images based on the moving object they belong to.



Assumption: the number of motions is **unknown**.

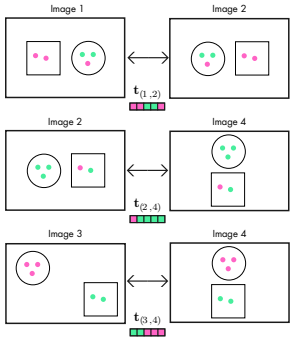
Introduction

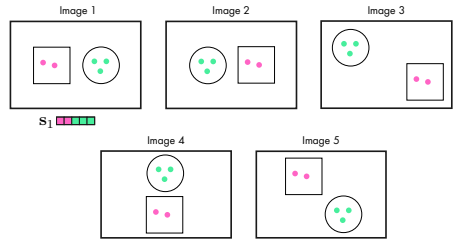
Scenario: two-frame correspondences are available



Contribution

In this paper we propose a segmentation approach that combines local/partial results independently obtained from pairs of images.





We extend a recent work to the case of an **unknown** number of motions.

F. Arrigoni and T. Pajdla Robust motion segmentation from pairwise matches ICCV (2019)

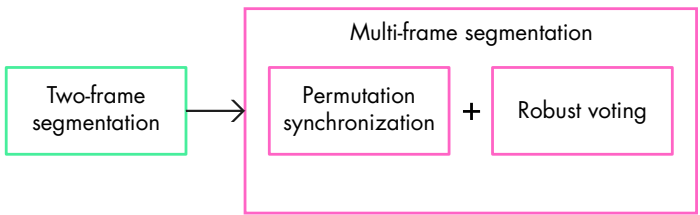
Proposed Method

1. Motion segmentation is solved independently on different image pairs, by fitting an **unknown** number of **fundamental matrices** to correspondences.

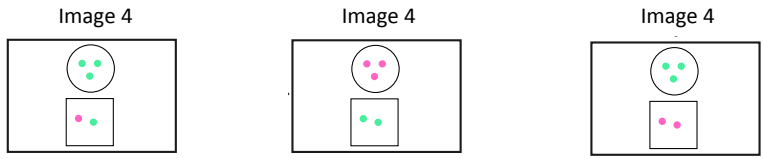
   L. Magri and A. Fusiello T-Linkage: a continuous relaxation of J- Linkage for multi-model fitting CVPR (2014)

2. Such partial results are combined in order to get a multi-frame segmentation.



Proposed Method

Idea: all the two-frame segmentations involving a fixed image provide an estimate for the segmentation of that image.

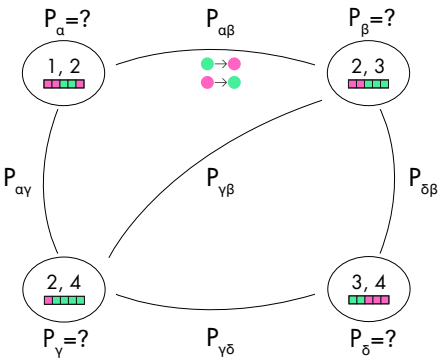


Two challenges have to be addressed:

- **ambiguity** – each two-frame segmentation considers its own labelling of the motions;
- **noise** – each two-frame segmentation may contain some errors.

Proposed Method

Graph: each vertex corresponds to one image pair; an edge is drawn between two vertices each time the associated pairs have one image in common.



- For each edge a permutation is computed via a **linear assignment problem**.

  H. W. Kuhn The Hungarian method for the assignment problem Naval Research Logistics Quarterly 2 (1955)

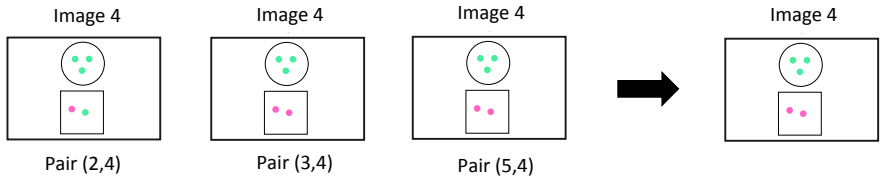
- Permutations for all the nodes are computed by **permutation synchronization** with **unknown** number of motions.

  E. Maset, F. Arrigoni, and A. Fusiello Practical and efficient multi-view matching ICCV (2017)

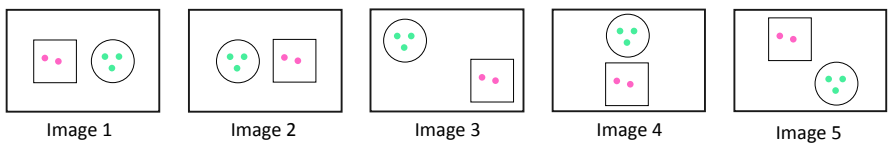
  R. Tron, X. Zhou, C. Esteves, and K. Daniilidis Fast multi-image matching via density-based clustering ICCV (2017)

Proposed Method

For each point in a given image, several putative labels are available: the most frequent label (**mode**) is chosen. Outlier/missing labels are ignored.



This procedure is repeated for all the images in order to produce the output segmentation.



Experiments

					Our Method		Mode		Synch	
Dataset	d	n	p	$\widehat{d}$	Error[%]	Points[%]	Error[%]	Points[%]	Error[%]	Points[%]
Pen	2	6	4550	2	1.55	89.08	**0.58**	80.07	0.82	83.23
Pouch	2	6	4971	2	**1.39**	60.79	3.79	65.34	4.15	69.89
Needlecraft	2	6	6617	2	1.80	67.07	**0.83**	72.81	1.04	76.76
Biscuits	2	6	13158	2	1.12	90.42	**0.47**	84.47	0.51	87.28
Cups	2	10	14664	2	2.05	71.31	**0.56**	65.42	1.01	69.82
Tea	2	10	32612	2	0.69	85.21	**0.29**	81.70	28.12	52.21
Food	2	10	36723	2	0.78	82.34	**0.36**	76.19	0.56	80.66
Penguin	2	6	5865	2	1.36	66.60	**0.76**	69.17	44.21	46.97
Flowers	2	6	7743	2	1.51	75.50	**1.23**	73.65	1.62	77.28
Pencils	2	6	2982	2	**3.09**	51.01	3.80	65.33	27.53	40.44
Bag	2	7	6114	2	2.78	52.91	**1.52**	57.95	25.92	54.27
Bears	3	10	15888	3	**3.48**	68.21	4.82	73.65	38.95	74.59

[Dataset] https://github.com/federica-arrigoni/ICCV_19

[Mode] F. Arrigoni and T. Pajdla Robust motion segmentation from pairwise matches ICCV (2019)

[Synch] F. Arrigoni and T. Pajdla Motion segmentation via synchronization ICCV Workshops (2019)

Conclusion

- We presented a novel solution to motion segmentation with two-frame correspondences, which is a poorly studied task.
- Differently from previous works considering the same assumptions, our approach can handle an **unknown** number of motions, hence it is more general and practical.
- Our method achieves comparable or better accuracy than its competitors on existing datasets, while correctly estimating the number of moving objects in every scene.

Thank you for your attention!