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LSDM: Long-Short Diffeomorphic Motion for Weakly-Supervised Ultrasound Landmark Tracking

Full Paper

Find Zhihua here

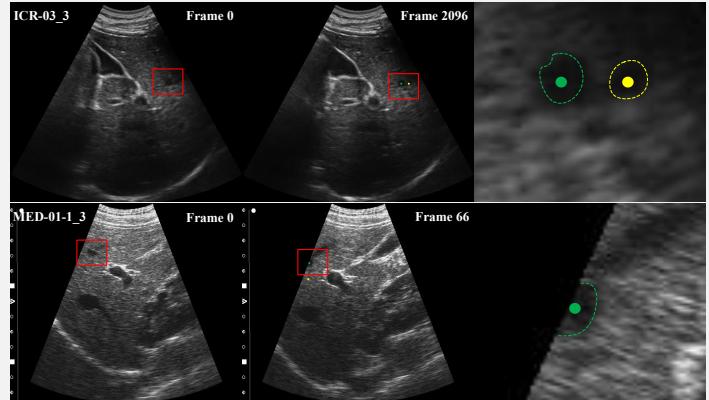
Zhihua Liu, Bin Yang, Xuejun Ni, Yan Shen, Huiyu Zhou



Ultrasound Landmark Tracking

What: The goal is to locate the same landmark provided by the exemplar frame in the follow-up image sequences.

Why: Delivers landmark localization and movement estimation information in temporal-spatial domains, which provides clinicians a measurable therapy margin around clinical and surgical target to increase the chance of tumor control.

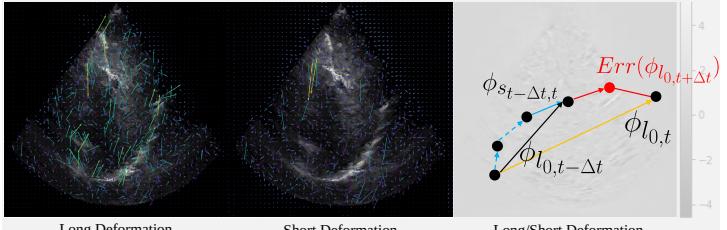


Tracking with Novel Motion Representation

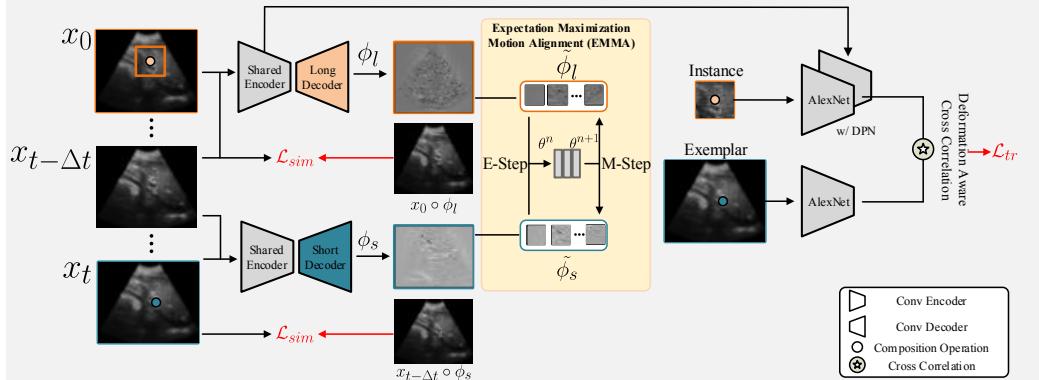
★**Multi-Task:** A novel landmark tracking network by multi-tasking both tracking and motion learning.

★**Long-Short Representation:** A new representation design containing diffeomorphism in both long and short intervals.

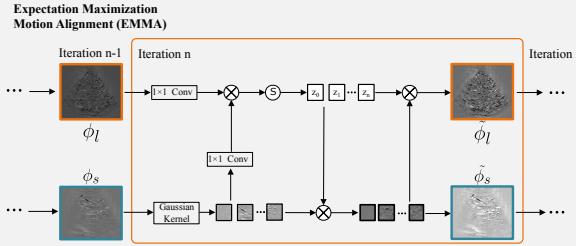
★**Weakly-Supervised:** Only few landmark annotations for tracking and zero annotation for motion learning.



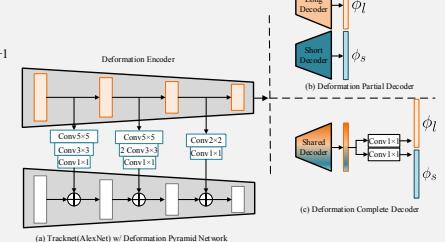
Long-Short Diffeomorphic Motion Network (LSDM)



With EM-Based Motion Alignment (EMMA):



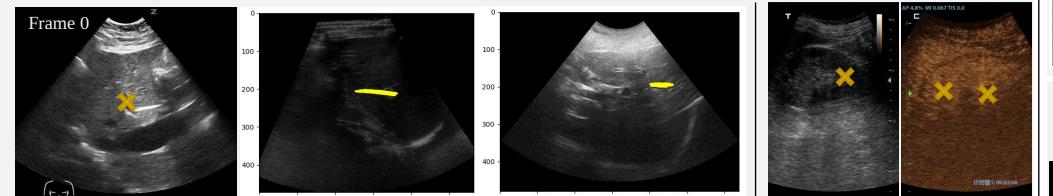
Deformation Pyramid Network boost Tracking Net



No significant performance difference between Partial (Right-Top) and Complete (Bottom-Right).

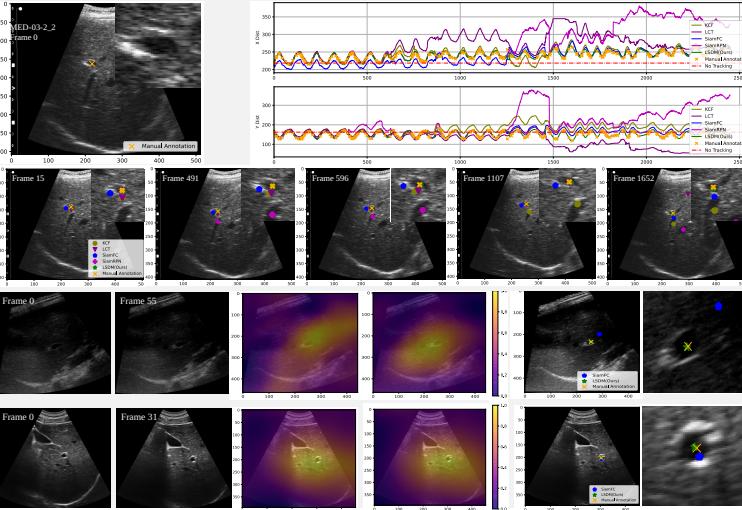
Datasets

Public: CLUST2D(Liver) **Private:** Affiliated Hospital of Nantong University(Kidney)



V. De Luca, et al., "Evaluation of 2d and 3d ultrasound tracking algorithms and impact on ultrasound-guided liver radiotherapy margins," Medical Physics, vol. 45, no. 11, pp. 4986–5003, 2018
<https://clust.ethz.ch/data.html>

Tracking Visualization



Ablation Study

	Components				Metrics
	Complete	Partial	EMMA	DPN	
Deformation Prior	✓				2.63 +/- 2.11
EMMA		✓	✓		2.69 +/- 2.87
DPN	✓		✓	✓	1.21 +/- 2.19
					1.56 +/- 1.73
					0.92 +/- 0.76
					0.81 +/- 0.98

In-House Test

Test sequence from a specific scanner is hidden during training.

In-House Partition	Mean		Std		95th		Scanner Type
	SiamFC	LSDM	SiamFC	LSDM	SiamFC	LSDM	
CIL	2.01	1.82	3.47	1.63	11.49	3.81	Ultrasonix MDP
ETH	5.33	1.98	10.16	1.21	17.3	4.67	Siemens Antares
ICR	1.09	2.19	3.22	1.76	5.64	3.76	Elekta Clarity-Ultronix
MEDI	3.17	1.35	2.46	1.9	7.71	2.91	Zonare.zone
MED2	4.93	3.19	9.27	1.31	19.15	5.18	DiPhas Fraunhofer

Failure Cases

