APISAT 2021
Asia-Pacific International Symposium on Aerospace Technology 2021

A Comparison of Deep Learning-based Monocular Visual Odometry Algorithms

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Motivation

▲Source: Dilly Drive Robot, BAEMIN

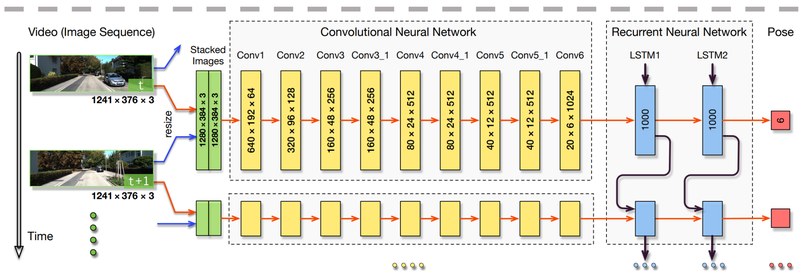
- Development of **indoor/outdoor service robots**
- **Difficulties** of deployment in **challenging real-world** environments

Contributions

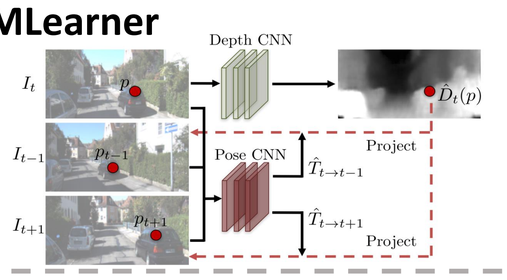
- Identify **the most robust VO Algorithm** in **real-life challenging** environments
- The results and conclusions provide insight for research **in expanding the types of environments** where autonomous robots can traverse

Pipelines of DL-based VO Algorithms

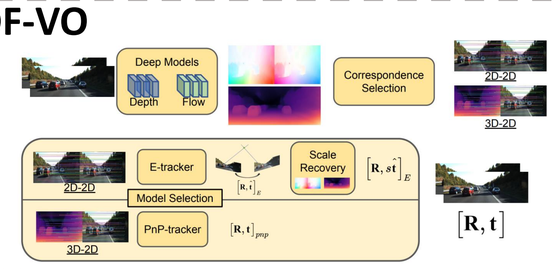
DeepVO



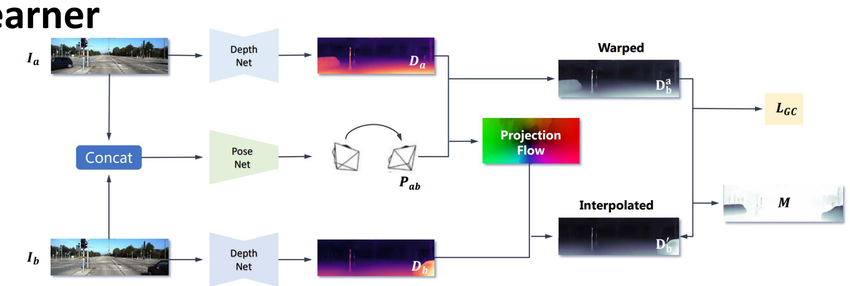
SfMLearner



DF-VO



SC-SfMLearner



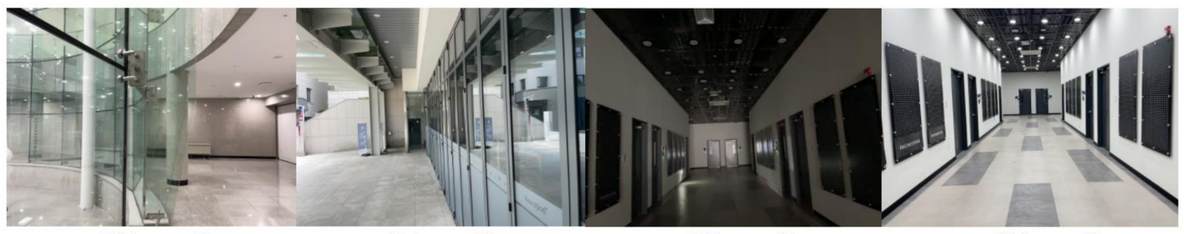
Algorithm \ Learning	Supervised	Unsupervised	Self-supervised
Deep learning-based: DeepVO [10]	✓		
Deep learning-based: SfMLearner [12]		✓	
Deep learning-based: SC-SfMLearner [1]		✓	
Deep learning and geometry-based: DF-VO [11]			✓

Datasets

1. KITTI Datasets

▲Outdoor Urban Environments

2. Author-Collected Datasets



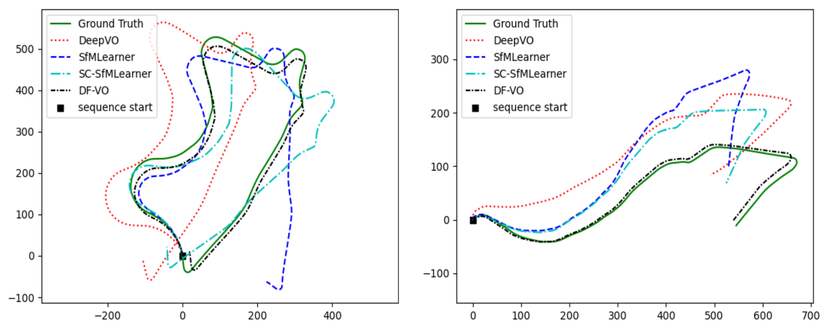
(A) Sequence 00 (B) Sequence 01 (C) Sequence 02 (D) Sequence 03

(E) Sequence 04 (F) Sequence 05 (G) Sequence 06

▲ Challenging Real World Environments
(Glass Wall, Illumination Change, Dynamic Objects)

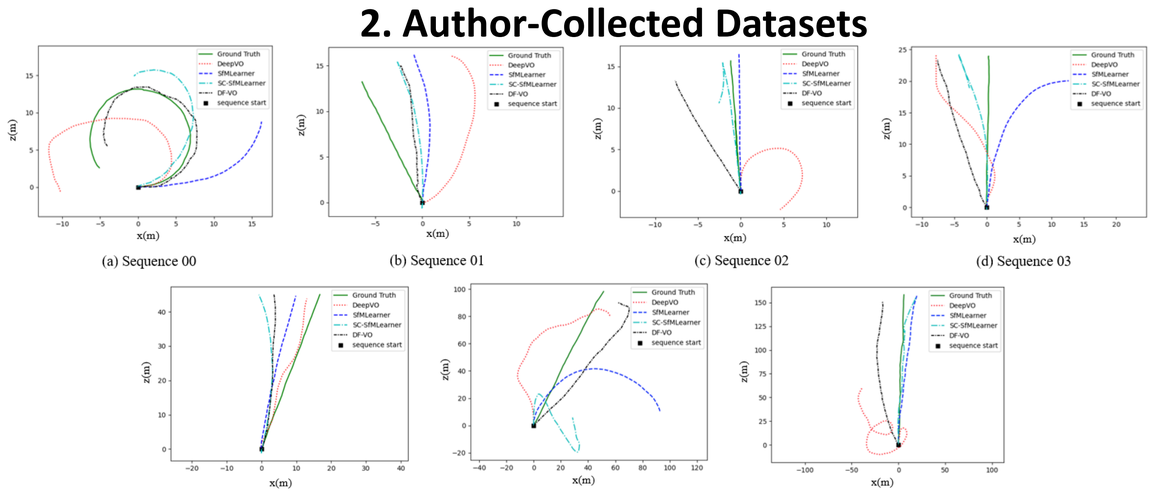
Evaluation

1. KITTI Datasets



Algorithm	Error	KITTI dataset sequence 09	KITTI dataset sequence 10	Avg
DeepVO [10]	ATE (m)	30.70	22.76	26.73
	RPE (m/s)	0.831	1.002	0.917
	Runtime (s)	299.886	223.522	261.704
SfMLearner [12]	ATE (m)	61.69	**4.38**	33.04
	RPE (m/s)	0.215	0.069	0.142
	Runtime (s)	173.502	135.301	154.402
SC-SfMLearner [1]	ATE (m)	22.75	12.00	17.38
	RPE (m/s)	0.190	0.115	0.153
	Runtime (s)	66.022	58.946	62.484
DF-VO [11]	ATE (m)	**7.91**	**4.38**	**6.15**
	RPE (m/s)	**0.093**	**0.048**	**0.071**
	Runtime (s)	278.091	207.790	242.941

2. Author-Collected Datasets



(a) Sequence 00 (b) Sequence 01 (c) Sequence 02 (d) Sequence 03

(e) Sequence 04 (f) Sequence 05 (g) Sequence 06

Algorithm	Error	Glass 00	Glass 01	Illumination 02	Illumination 03	Dynamic 04	Dynamic 05	Dynamic 06	Avg
DeepVO [10]	ATE (m)	1.80	0.95	3.01	1.69	0.83	10.79	30.67	6.99
	RPE (m/s)	0.028	0.033	0.036	0.024	0.071	0.042	0.083	0.045
SfMLearner [12]	ATE (m)	4.03	**0.52**	**1.35**	1.87	**0.59**	11.70	**2.45**	3.22
	RPE (m/s)	**0.026**	0.022	**0.023**	**0.016**	0.060	0.040	**0.015**	0.029
SC-SfMLearner [1]	ATE (m)	2.63	0.60	1.62	1.35	2.35	25.32	7.89	5.97
	RPE (m/s)	0.027	0.026	0.029	0.018	0.058	0.030	0.026	0.031
DF-VO [11]	ATE (m)	**1.66**	0.55	1.53	**0.71**	1.24	**4.71**	4.99	**2.20**
	RPE (m/s)	0.034	**0.016**	0.026	0.021	**0.022**	**0.021**	0.022	**0.023**