







Log in

home setup stereo flow sceneflow depth odometry object tracking road semantics raw data submit results

Visual Odometry / SLAM Evaluation 2012

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trajectories for training and 11 sequences (11-21) without ground truth for evaluation. For this benchmark you may provide results using monocular or stereo visual odometry, laser-based SLAM or algorithms that combine visual and LIDAR information. The only restriction we impose is that your method is fully automatic (e.g., no manual loop-closure tagging is allowed) and that the same parameter set is used for all sequences. A development kit provides details about the data format. Download odometry data set (grayscale, 22 GB) Download odometry data set (color, 65 GB)

- Download odometry data set (velodyne laser data, 80 GB) Download odometry data set (calibration files, 1 MB)
- Download odometry ground truth poses (4 MB) Download odometry development kit (1 MB)
- Lee Clement and his group (University of Toronto) have written some python tools for loading and parsing the KITTI raw and odometry datasets
- From all test sequences, our evaluation computes translational and rotational errors for all possible subsequences of length (100,...,800) meters. The evaluation table below ranks methods according to the average of those values, where errors are measured in percent (for translation) and in

underneath. Note: On 03.10.2013 we have changed the evaluated sequence lengths from (5,10,50,100,...,400) to (100,200,...,800) due to the fact that the GPS/OXTS ground truth error for very small sub-sequences was large and hence biased the evaluation results. Now the averages below take into account longer sequences and provide a better indication of the true performance. Please consider reporting these number for all future submissions. The last leaderboard right before the changes can be found here! Important Policy Update: As more and more non-published work and re-implementations of

degrees per meter (for rotation). A more detailed comparison for different trajectory lengths and driving speeds can be found in the plots

		existing value submission or journal are not a policy is targeted months conferent bibliogra	work is ons with all are a allowed adopted venue old but inces, 6 phy inf	submitted to h significant in a signific	o KITTI, we have eshovelty that are lear modifications of emust be evaluated must detail their stration. Furthermore ymous or do not haugh to determine if r longer review cyclitional informations left and right (steep duses point clouds tion: This method	tablished a pading to a pexisting algon a split on a spaper for a paper for a paper hables, you need to be split on a spl		
	Method	Setting			Rotation	Runtime	Environment	Compare
1	SOFT2	88		0.53 %	0.0009 [deg/m]	0.1 s	4 cores @ 2.5 Ghz (C/C++)	Compare
I. Cvišić, I.	. Marković and I. Petrović	: Enhanced ca	alibration	of camera setups f	for high-performance visua	al odometry. Ro	ne Metric. IEEE Transactions on Robotics 2022. botics and Autonomous Systems 2022. European Conference on Mobile Robots (ECMR) 2021.	
2 J. Zhang a	V-LOAM  nd S. Singh: Visual-lidar (	Odometry and	Mapping:	0.54 %	0.0013 [deg/m]	0.1 s	2 cores @ 2.5 Ghz (C/C++) on Robotics and Automation(ICRA) 2015.	
3	LOAM	***		0.55 %	0.0013 [deg/m]	0.1 s	2 cores @ 2.5 Ghz (C/C++)	
J. Zhang a	nd S. Singh: <u>LOAM: Lidar</u> <u>TVL-SLAM+</u>	Odometry and	d Mapping	0.56 %	ootics: Science and System  0.0015 [deg/m]	s Conference (F	1 core @ 3.0 Ghz (C/C++)	
C. Chou an	nd C. Chou: <u>Efficient and</u> <u>Traj-LIO</u>	Accurate Tigh	<u>ntly-Coupl</u>	ed Visual-Lidar SLA		ntelligent Trans	portation Systems 2021.  4 cores @ 2.5 Ghz (C/C++)	
(. Zheng a	nd J. Zhu: <u>Traj-LIO: A Re</u>	esilient Multi-L		.:L ti-IMU State Estima	itor Through Sparse Gaussi	an Process. arX	iv preprint arXiv:2402.09189 2024.	
6 Dellenb	CT-ICP2 ach, J. Deschaud, B. Jaco	quet and F. Go	<u>code</u> oulette: <u>C</u>	0.58 %	0.0012 [deg/m]  lastic LiDAR Odometry wit	0.06 s h Loop Closure	1 core @ 3.5 Ghz (C/C++)  . 2022 International Conference on Robotics and Automation (ICRA	) 2022.
7 C. Zheng a	<u>Traj-LO</u> ind J. Zhu: <u>Traj-LO: In De</u>	efense of LiDA	<u>code</u> R-Only Od	0.58 % lometry Using an E	0.0014 [deg/m]	0.1 s <u>Trajectory</u> . IEEE	4 cores @ 3.5 Ghz (C/C++) E Robotics and Automation Letters 2024.	
8	GLIM	***		0.59 %	0.0015 [deg/m]	0.1 s	GPU @ 2.5 Ghz (C/C++)	
6. Koide, <i>N</i>	M. Yokozuka, S. Oishi and Universal-SLAM	A. Banno: Glo	opally Cor	0.59 %	Napping with GPU-accelera 0.0014 [deg/m]	0.04 s	ning Cost Factors. IEEE Robotics and Automation Letters 2021.  1 cores @ 2.5 Ghz (C/C++)	
10	<u>CT-ICP</u>	***	<u>code</u>	0.59 %	0.0014 [deg/m]	0.06 s	1 core @ 3.5 Ghz (C/C++)	
. Dellenba	ach, J. Deschaud, B. Jaco <u>DG-LIO</u>	quet and F. Go	oulette: <u>C</u>	T-ICP: Real-time E	lastic LiDAR Odometry wit 0.0014 [deg/m]	h Loop Closure.	2022 International Conference on Robotics and Automation (ICRA 4 cores @ >3.5 Ghz (C/C++)	) 2022.
12	SDV-LOAM	***	<u>code</u>	0.60 %	0.0015 [deg/m]	0.06 s	1 core @ 2.5 Ghz (C/C++)	
. Yuan, Q	. Wang, K. Cheng, T. Had MagneticPillars++	o and X. Yang:	SDV-LOA	M: Semi-Direct Visi	ual-LiDAR Odometry and M 0.0018 [deg/m]	lapping. IEEE Tr	GPU @ >3.5 Ghz (Python)	
14	<u>CELLmap</u>	***		0.61 %	0.0017 [deg/m]	0.1 s	8 core @ 2.5 Ghz (C/C++)	
. Duan, X	KISS-ICP	. Chu, J. Ji and	d Y. Zhan	g: <u>CELLmap: Enhar</u>	0.0017 [deg/m]	Elastic and Ligh	titweight Spherical Map Representation. arXiv preprint arXiv:2409.1	9597 2024.
. Vizzo, T.							P Simple, Accurate, and Robust Registration If Done the Right W	<u>/ay</u> . IEEE Robotics and
16	MOLA-LO	***	<u>code</u>	0.62 %	0.0017 [deg/m]	0.05 s	4 cores @ 3.0 Ghz (C/C++)	
17 '. Bhandar	SiMpLE ri, T. Phillips and P. McAi	ree: Minimal c	<u>code</u> onfigurat	0.62 %	0.0015 [deg/m]	0.35 s International Jo	>8 cores @ 2.5 Ghz (C/C++)	
18	MOLA (Kitti config)	*** ***		0.62 %	0.0017 [deg/m]	0.05 s	4 cores @ 2.5 Ghz (C/C++)	
19	<u>p2mesh</u>			0.64 %	0.0019 [deg/m]	0.1 s	1 core @ 2.5 Ghz (C/C++)	
		Posewsky, J. E	code Behley and	0.64 % d C. Stachniss: <u>PIN</u>	0.0015 [deg/m] -SLAM: LiDAR SLAM Using a	0.1 s Point-Based In	GPU @ >3.5 Ghz (Python)  nplicit Neural Representation for Achieving Global Map Consistence	y. IEEE Transactions of
21	filter-reg	*** ***		0.65 %	0.0016 [deg/m]	0.01 s	GPU @ 2.6 Ghz (C/C++)	
. Zheng a	SOFT-SLAM	tive Continuou	s-Time O	dometry Using Rang 0.65 %	ge Image for LiDAR with Sr 0.0014 [deg/m]	nall FoV. IEEE/I	RSJ International Conference on Intelligent Robots and Systems (IR 2 cores @ 2.5 Ghz (C/C++)	OS) 2023.
Cvišić, J		. Petrović: <u>SOI</u>	-		fficient Stereo Visual SLAM	:	us UAVs. Journal of Field Robotics 2017.	
23 . Pan, P.	MULLS Xiao, Y. He, Z. Shao and	Z. Li: MULLS:	<u>code</u> Versatile	0.65 % LiDAR SLAM via Mu	0.0019 [deg/m]  ulti- metric Linear Least Sc	0.08 s <u>juare</u> . IEEE Inte	4 cores @ 2.2 Ghz (C/C++) rnational Conference on Robotics and Automation (ICRA) 2021	
24	MOLA-LO + LC	***	<u>code</u>	0.66 %	0.0016 [deg/m]	0.05 s	8 cores @ 2.5 Ghz (C/C++)	
25 . Zheng a	ELO and J. Zhu: Efficient LiDA	R Odometry fo	or Autonoi	0.68 %	0.0021 [deg/m] Robotics and Automation	0.005 s Letters(RA- L) 2	GPU @ 2.6 Ghz (C/C++)(0.027s Jetson AGX)	
26 RROR: Wr	AZZ rong syntax in BIBTEX file	1	<u>code</u>	0.68 %	0.0017 [deg/m]	0,1 s	1 core @ 2.5 Ghz (C/C++)	
27	IMLS-SLAM	*** ***		0.69 %	0.0018 [deg/m]	1.25 s	1 core @ >3.5 Ghz (C/C++)	
Deschau 28	ıd: IMLS-SLAM: Scan-to-M	odel Matching	Based on	0.69 %	E International Conference  0.0016 [deg/m]	e on Robotics ar	nd Automation (ICRA) 2018.  4 cores @ 2.5 Ghz (C/C++)	
. Neuhaus	s, T. Koss, R. Kohnen and	. —	code	Real-Time Inertial L	idar Odometry using Two-	Scan Motion Co	bmpensation. German Conference on Pattern Recognition 2018.  4 cores @ 3.0 Ghz (C/C++)	
	C. Wang and L. Xie: <u>Inten</u>	. —		ii ng intensity and ge	ometry relations for loop		on. 2020 IEEE International Conference on Robotics and Automatio	n (ICRA) 2020.
30 . Wang, (	FLOAM C. Wang, C. Chen and L.	Xie: <u>F-LOAM</u> :	<u>code</u> Fast LiDA	0.72 % R Odometry and M	0.0022 [deg/m] apping. 2021 IEEE/RSJ Inte	0.1 s ernational Confe	1 core @ 2.5 Ghz (C/C++) erence on Intelligent Robots and Systems (IROS) 2021.	
31	APMC-LOM	***		0.77 %	0.0019 [deg/m]	0.1 s	1 core @ 2.5 Ghz (C/C++)	
32 . Chen, B	PSF-LO B. Wang, X. Wang, H. Der	ng, B. Wang an	nd S. Zhan	0.82 % g: <u>PSF-LO: Parame</u>	0.0032 [deg/m] terized Semantic Features	0.2s Based Lidar Od	4 cores @ 3.2 GHz dometry. 2021 IEEE International Conference on Robotics and Auto	mation (ICRA) 2021.
33	RADVO	Tand Accurate	Dotormir	0.82 %	0.0018 [deg/m]	0.07 s	1 core @ 3.0 Ghz (C/C++)	Carrier (ION CNSS)
34		TATIO ACCURATE	Determin	0.82 %	0.0020 [deg/m]	0.2 s	4 cores @ 2.5 Ghz (C/C++)	/igation (ION GN35+
		I. Petrović: Ex	actly spa				ph SLAM. The International Journal of Robotics Research 2018.	
35 I. Buczko	RotRocc+ and V. Willert: Flow-Dec	oupled Norma	lized Rep	0.83 %	0.0026 [deg/m] Visual Odometry. 19th IEE	0.25 s E Intelligent Tr	2 cores @ 2.0 Ghz (C/C++) cansportation Systems Conference (ITSC) 2016.	
N. Buczko:	: <u>Automotive Visual Odon</u>	<u>netry</u> . 2018.					icles Symposium (IV) 2018.	
36 . Graeter	LIMO2 GP , A. Wilczynski and M. La		<u>code</u> lar-Monoc		0.0022 [deg/m]  try. arXiv preprint arXiv:18	0.2 s 307.07524 2018.	2 cores @ 2.5 Ghz (C/C++)	<u> </u>
		7. Wang, J. Ma	code nanpää, H		0.0025 [deg/m] d R. Chen: <u>CAE-LO: LiDAR</u>	2 s Odometry Leve	8 cores @ 3.5 Ghz (Python) <u>Praging Fully Unsupervised Convolutional Auto-Encoder for Interest</u>	Point Detection and
38	GDVO	ďď		0.86 %	0.0031 [deg/m]	0.09 s	1 core @ >3.5 Ghz (C/C++)	
. Zhu: <u>lma</u>	age Gradient-based Joint  LIMO2			y for Stereo Camer	<u> </u>	ference on Artif	ficial Intelligence, IJCAI 2017.  2 cores @ 2.5 Ghz (C/C++)	
. Graeter	, A. Wilczynski and M. La	uer: <u>LIMO: Lid</u>	<u>code</u> lar-Monoc	.i. ular Visual Odomet	t <u>ry</u> . arXiv preprint arXiv:18	307.07524 2018.	•	<u> </u>
40 Ji and T	CPFG-slam  Thuiyan Chen: CPFG-SLA	AM:a robust Sir	multaneo	0.87 % us Localization and	0.0025 [deg/m]  I Mapping based on LIDAR i	0.03 s in off-road envi	4 cores @ 2.5 Ghz (C/C++)  ronment. IEEE Intelligent Vehicles Symposium (IV) 2018.	
41 . Cvišić an	<u>SOFT</u> nd I. Petrović: Stereo odo	metry based o	on careful	0.88 %	0.0022 [deg/m]  and tracking. European Co	0.1 s	2 cores @ 2.5 Ghz (C/C++)	
42	RotRocc	ďď		0.88 %	0.0025 [deg/m]	0.3 s	2 cores @ 2.0 Ghz (C/C++)	
۸. Buczko 43	and V. Willert: Flow-Dec	oupled Norma	llized Rep	0.88 %	Visual Odometry. 19th IEE 0.0021 [deg/m]	E Intelligent Tr	ansportation Systems Conference (ITSC) 2016.  1 core @ 2.5 Ghz (C/C++)	
N. Yang, L. 2020.	. Stumberg, R. Wang and	D. Cremers:	03VO: Dec				<u>sual Odometry</u> . The IEEE Conference on Computer Vision and Patte	ern Recognition (CVPR

	CT-ICP2	***	<u>code</u>	0.58 %	0.0012 [deg/m]	0.06 s	1 core @ 3.5 Ghz (C/C++)	
. Dellenba	nch, J. Deschaud, B. Jacq Traj-LO	uet and F. G	oulette: <u>CT</u> <u>code</u>	7-ICP: Real-time E	lastic LiDAR Odometry wit 0.0014 [deg/m]	h Loop Closure.  0.1 s	2022 International Conference on Robotics and Automation (ICRA) 4 cores @ 3.5 Ghz (C/C++)	2022.
		. —				: :	Robotics and Automation Letters 2024.  GPU @ 2.5 Ghz (C/C++)	
		A. Banno: GI	obally Con		<u> </u>	<u> </u>	ing Cost Factors. IEEE Robotics and Automation Letters 2021.	
9	Universal-SLAM	***		0.59 %	0.0014 [deg/m]	0.04 s	1 cores @ 2.5 Ghz (C/C++)	
Dellenba	CT-ICP ach, J. Deschaud, B. Jacq	uet and F. G	<u>code</u> oulette: <u>C1</u>	0.59 % -ICP: Real-time E	0.0014 [deg/m]  lastic LiDAR Odometry wit	0.06 s h Loop Closure.	1 core @ 3.5 Ghz (C/C++)  2022 International Conference on Robotics and Automation (ICRA)	2022.
1	DG-LIO			0.59 %	0.0014 [deg/m]	0.02 s	4 cores @ >3.5 Ghz (C/C++)	
2 Yuan, Q.	SDV-LOAM Wang, K. Cheng, T. Hao	and X. Yang	<u>code</u> : <u>SDV-LOAN</u>	0.60 % N: Semi-Direct Vis	0.0015 [deg/m]	0.06 s	1 core @ 2.5 Ghz (C/C++) ansactions on Pattern Analysis and Machine Intelligence 2023.	
···· <del>·</del>	MagneticPillars++	***		0.60 %	0.0018 [deg/m]	0.06 s	GPU @ >3.5 Ghz (Python)	
14	CELLmap	***		0.61 %	0.0017 [deg/m]	0.1 s	8 core @ 2.5 Ghz (C/C++)	
Duan, X.	Zhang, Y. Li, G. You, X. KISS-ICP	Chu, J. Ji ar	d Y. Zhang	: <u>CELLmap: Enhar</u> 0.61 %	ncing LiDAR SLAM through I	Elastic and Light  0.05 s	tweight Spherical Map Representation. arXiv preprint arXiv:2409.19  1 core @ 4.5 Ghz (Python/C++)	597 2024.
Vizzo, T. Itomation		. —		and C. Stachniss:	1	int-to- Point ICF	P Simple, Accurate, and Robust Registration If Done the Right Wa	y. IEEE Robotics a
6	MOLA-LO	***	<u>code</u>	0.62 %	0.0017 [deg/m]	0.05 s	4 cores @ 3.0 Ghz (C/C++)	
17	SiMpLE	l l	<u>code</u>	0.62 %	0.0015 [deg/m]	0.35 s	>8 cores @ 2.5 Ghz (C/C++) urnal of Robotics Research 0.	
	MOLA (Kitti config)	***	<u>.omgarati</u>	0.62 %	0.0017 [deg/m]	0.05 s	4 cores @ 2.5 Ghz (C/C++)	
19	p2mesh	1 1 1 1 1 1 1 1		0.64 %	0.0019 [deg/m]	0.1 s	1 core @ 2.5 Ghz (C/C++)	
20	PIN-SLAM	***	<u>code</u>	0.64 %	0.0015 [deg/m]	0.1 s	GPU @ >3.5 Ghz (Python)	
botics (TI	RO) 2024.		Behley and				plicit Neural Representation for Achieving Global Map Consistency.	
.1 Zheng an	<u>filter-reg</u> nd J. Zhu: <u>ECTLO: Effecti</u>	ve Continuou	us-Time Od	0.65 % ometry Using Ran	0.0016 [deg/m] ge Image for LiDAR with Sn	0.01 s	GPU @ 2.6 Ghz (C/C++) RSJ International Conference on Intelligent Robots and Systems (IRC	(S) 2023.
2	SOFT-SLAM	ăă Determi		0.65 %	0.0014 [deg/m]	0.1 s	2 cores @ 2.5 Ghz (C/C++)	
23	MULLS	***	code	0.65 %	0.0019 [deg/m]	0.08 s	us UAVs. Journal of Field Robotics 2017.  4 cores @ 2.2 Ghz (C/C++)	
Pan, P. X	MOLA-LO + LC	Z. Li: MULLS:	Versatile I	LiDAR SLAM via Mu 0.66 %	ulti- metric Linear Least Sq 0.0016 [deg/m]	<u>uare</u> . IEEE Inter	rnational Conference on Robotics and Automation (ICRA) 2021  8 cores @ 2.5 Ghz (C/C++)	
25	ELO	**	<u>code</u>	0.68 %	0.0021 [deg/m]	0.005 s	GPU @ 2.6 Ghz (C/C++)(0.027s Jetson AGX)	
		-	or Autonom		Robotics and Automation I	1		
26 RROR: Wro	AZZ ong syntax in BIBTEX file.		<u>code</u>	0.68 %	0.0017 [deg/m]	0,1 s	1 core @ 2.5 Ghz (C/C++)	
27	IMLS-SLAM	***		0.69 %	0.0018 [deg/m]	1.25 s	1 core @ >3.5 Ghz (C/C++)	
Deschaud			Based on				d Automation (ICRA) 2018.	
	MC2SLAM , T. Koss, R. Kohnen and	D. Paulus: M	C2SLAM: Re	0.69 % eal-Time Inertial I	0.0016 [deg/m] <u>lidar Odometry using Two-</u>	0.1 s Scan Motion Cor	4 cores @ 2.5 Ghz (C/C++)  mpensation. German Conference on Pattern Recognition 2018.	
9 Wang C	ISC-LOAM Wang and I Xie: Intens	sity scan cont	code	0.72 %	0.0022 [deg/m]	0.1 s	4 cores @ 3.0 Ghz (C/C++) n. 2020 IEEE International Conference on Robotics and Automation	(ICRA) 2020
0	FLOAM		code	0.72 %	0.0022 [deg/m]	0.1 s	1 core @ 2.5 Ghz (C/C++)	
Wang, C.	. Wang, C. Chen and L. X	ie: <u>F-LOAM :</u>	Fast LiDAR	Odometry and M	apping. 2021 IEEE/RSJ Inte	rnational Confe	erence on Intelligent Robots and Systems (IROS) 2021.  1 core @ 2.5 Ghz (C/C++)	
2	APMC-LOM PSF-LO	***		0.77 %	0.0019 [deg/m] 0.0032 [deg/m]	0.1 s 0.2s	1 core @ 2.5 Ghz (C/C++)  4 cores @ 3.2 GHz	
Chen, B.	. Wang, X. Wang, H. Deng	g, B. Wang a	nd S. Zhang	: <u>PSF-LO: Parame</u>	terized Semantic Features	Based Lidar Od	ometry. 2021 IEEE International Conference on Robotics and Autom	nation (ICRA) 2021.
		and Accurate	e Determin	0.82 %	0.0018 [deg/m] etry. Proceedings of the 33	0.07 s rd International	1 core @ 3.0 Ghz (C/C++)  I Technical Meeting of the Satellite Division of The Institute of Navi	gation (ION GNSS+
20) 2020.		TY ACCURACE		0.82 %	0.0020 [deg/m]	0.2 s	4 cores @ 2.5 Ghz (C/C++)	, ,,, J,,,,,,,
		. Petrović: E	xactly spars		ilter on Lie groups for long	1	4 cores @ 2.5 Ghz (C/C++)  ch SLAM. The International Journal of Robotics Research 2018.	
35 Buczko a	RotRocc+ and V. Willert: Flow-Deco	bupled Norma	alized Repr	0.83 %	0.0026 [deg/m] Visual Odometry. 19th IEE	0.25 s E Intelligent Tra	2 cores @ 2.0 Ghz (C/C++) ansportation Systems Conference (ITSC) 2016.	
Buczko,		nd J. Adamy:			<u>Visual Odometry</u> . 19th IEE			
Graeter.	LIMO2 GP  A. Wilczynski and M. Lau	Jer: LIMO: Li	code	0.84 %	0.0022 [deg/m]	0.2 s	2 cores @ 2.5 Ghz (C/C++)	
Graeter,	A. Wilczynski and M. Lau	ıer: <u>LIMO: Li</u>	dar-Monocu code	llar Visual Odome 0.86 %	try. arXiv preprint arXiv:18	2 s	8 cores @ 3.5 Ghz (Python)	
Yin, Q. Z		: —			<u> </u>		raging Fully Unsupervised Convolutional Auto-Encoder for Interest P	oint Detection and
7hu: Imag	GDVO	Direct Visual	Odo	0.86 %	0.0031 [deg/m]	0.09 s	1 core @ >3.5 Ghz (C/C++)	
Zhu: <u>Ima</u> 19	<u>LIMO2</u>	Direct Visual	Odometry code	0.86 %	a. International Joint Conf	erence on Artifi 0.2 s	icial Intelligence, IJCAI 2017.  2 cores @ 2.5 Ghz (C/C++)	
		uer: <u>LIMO: Li</u>	dar-Monocu		t <u>ry</u> . arXiv preprint arXiv:18			
Ji and T.	<u>CPFG-slam</u> . Huiyan Chen: <u>CPFG-SLA</u>	M:a robust Si	multaneou	0.87 % s Localization and	0.0025 [deg/m]    Mapping based on LIDAR i	0.03 s n off-road envir	4 cores @ 2.5 Ghz (C/C++)  onment. IEEE Intelligent Vehicles Symposium (IV) 2018.	
1	SOFT	řă		0.88 %	0.0022 [deg/m]	0.1 s	2 cores @ 2.5 Ghz (C/C++)	
Cvišić and	d I. Petrović: <u>Stereo odor</u> RotRocc	netry based	on careful	0.88 %	and tracking. European Co 0.0025 [deg/m]	nference on Mol	bile Robots (ECMR) 2015.  2 cores @ 2.0 Ghz (C/C++)	
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14	PNDT LO	***		0.89 %	0.0030 [deg/m]	0.2 s	8 cores @ 3.5 Ghz (C/C++)	
		rmal distribu	utions trans		-		n. IEEE/RSJ International Conference on Intelligent Robots and Syst	tems (IROS) 2017.
45 . Yang, R. )18.	DVSO Wang, J. Stueckler and I	D. Cremers:	Deep Virtua	0.90 %	0.0021 [deg/m]	0.1 s	GPU @ 2.5 Ghz (C/C++)	
110.					y: Leveraging Deep Depth	Frediction for h	Monocular Direct Sparse Odometry. European Conference on Compu	ter Vision (ECCV)
46	LIMO	***	<u>code</u>	0.93 %	0.0026 [deg/m]	0.2 s	Aonocular Direct Sparse Odometry. European Conference on Compu  2 cores @ 2.5 Ghz (C/C++)	ter Vision (ECCV)
Graeter,	A. Wilczynski and M. Lau	uer: <u>LIMO: Li</u>		0.93 % Ilar Visual Odome	0.0026 [deg/m]	0.2 s	2 cores @ 2.5 Ghz (C/C++)	ter Vision (ECCV)
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Graeter, Wang, M.  48	A. Wilczynski and M. Lau  Stereo DSO  I. Schw\"orer and D. Crem  SaacElbrusGPUSLAM  D. Robustov, D. Slepiche  OV2SLAM  A. Eudes, J. Moras, M. S.  ROCC  and V. Willert: How to District of the second	anfourche ar  anfourche ar  anfourche ar  anfourche ar  anfourche ar  anfourche ar  ann, J. Gall,  Gigul`ere, J.  Thomas and d.  A General Operation of the country of the	code Code Code Code Code Code Code Code C	0.93 %  lar Visual Odome  0.93 %  scale direct spars  0.94 %  Volodarskiy: Rea  0.98 %  snerais: OVZSLAM  0.98 %  snerais: OVZSLAM  0.99 %  1.06 %  1.06 %  1.06 %  1.07 %  Unsupervised Lea  1.09 %  ereo Visual Odom  1.09 %  based Framework  1.11 %  1.14 %  Monocular Odom  1.15 %  LAM System for Medical Accordance of the supervised of	0.0026 [deg/m]  try. ArXiv e-prints 2018.  0.0020 [deg/m]  visual odometry with ste  0.0019 [deg/m]  oltime Stereo Visual Odome  0.0023 [deg/m]  : A Fully Online and Versa  0.0023 [deg/m]  : A Fully Online and Versa  0.0028 [deg/m]  dometry for High-speed Au  0.0020 [deg/m]  altime Stereo Visual Odome  0.0033 [deg/m]  doving Object Segmentation  0.0034 [deg/m]  unda++: Efficient LiDAR-bas  0.0024 [deg/m]  vming of Lidar Features for  0.0029 [deg/m]  etry from Monocular Techn  0.0029 [deg/m]  etry from Monocular Techn  0.0028 [deg/m]  etry from Monocular Techn  0.0029 [deg/m]  etry. IEEE/RSJ International  0.0027 [deg/m]  onocular, Stereo and RGB-  10.0025 [deg/m]  ization and Mapping. Conf	0.2 s  0.1 s  reo cameras. In  0.007 s  etry  0.01 s  tile Visual SLAM  0.03 s  tomotive Applic  0.08 s  etry  0.1s  0.1s  0.1s  0.1s  0.1s  1 s  on a Probat  0.145 s  iniques. IEEE Inte  0.1s  0.1s  0.1s  1 s  considerence of the construction of the construct	2 cores @ 2.5 Ghz (C/C++)  1 core @ 3.4 Ghz (C/C++)  ternational Conference on Computer Vision (ICCV), Venice, Italy 20  Jetson AGX  1 core @ 2.5 Ghz (C/C++)  Ifor Real-Time Applications. IEEE Robotics and Automation Letters  8 cores @ 3.0 Ghz (C/C++)  Ifor Real-Time Applications. IEEE Robotics and Automation Letters  2 cores @ 2.0 Ghz (C/C++)  attions. IEEE Intelligent Vehicles Symposium (IV) 2016.  3 cores @ 3.3 Ghz (C/C++)  1 core @ 2.5 Ghz (C/C++)  ata: A Learning-based Approach Exploiting Sequential Data. IEEE Robotics and Systems (IV)  GPU and CPU @ 2.2 Ghz (C/C++)  CPU @ 3.5 Ghz (C/C++)  GPU @ 3.5 Ghz (C/C++)  celligent Vehicles Symposium 2015.  1 core @ 3.0 Ghz (C/C++)  ple Sensors. 2019.  2 cores @ 2.0 Ghz (C/C++)  1 core @ 2.5 Ghz (C/C++)  1 core @ 2.5 Ghz (C/C++)  1 core @ 2.5 Ghz (C/C++)  2 cores @ 2.5 Ghz (C/C++)  1 core @ 2.5 Ghz (C/C++)  2 cores @ 2.5 Ghz (C/C++)  1 core @ 2.5 Ghz (C/C++)  2 cores @ 2.5 Ghz (C/C++)  1 core @ 2.5 Ghz (C/C++)  2 cores @ 3.5 Ghz (C/C++)  1 core @ 2.5 Ghz (C/C++)  2 cores @ 2.5 Ghz (C/C++)  1 core @ 2.5 Ghz (C/C++)  2 cores @ 2.5 Ghz (C/C++)  1 cores @ 2.5 Ghz (C/C++)  2 cores @ 3.5 Ghz (C/C++)  3 cores @ 3.5 Ghz (C/C++)  4 cores @ 3.5 Ghz (C/C++)  5 cores @ 3.5 Ghz (C/C++)  4 cores @ 3.5 Ghz (C/C++)  5 cores @ 3.5 Ghz (C/C++)  6 cores @ 3.5 Ghz (C/C++)  6 cores @ 3.5 Ghz (C/C++)	2021.
Graeter, 47 Wang, M. 48 Is Korovko, 49 Ferrera, 50 Korovko, 51 Korovko, 53 Chen, S. Graeter, 54 Chen, S. Graeter, 56 Chen, S. Graeter, 57 Chen, S. Graeter, 58 Qin, J. Particological Stang, M. 59 Chang, M. 51 Chang, M. 52 Mur-Artal 53 Rabiee ar 54	A. Wilczynski and M. Lau  Stereo DSO  J. Schw\"orer and D. Crem  SaacElbrusGPUSLAM  D. Robustov, D. Slepiche  OV2SLAM  A. Eudes, J. Moras, M. S.  ROCC  and V. Willert: How to District of the second	anfourche ar  an	code Code Code Code Code Code Code Code C	0.93 %  Ilar Visual Odome  0.93 %  scale direct spars  0.94 %  Volodarskiy: Rea  0.98 %  snerais: OVZSLAM  0.98 %  Juliers in Visual Odome  1.06 %  1.06 %  1.06 %  1.06 %  1.07 %  Unsupervised Lea  1.09 %  based Framework  1.11 %  1.11 %  1.11 %  Monocular Odom  1.15 %  LAM System for Me  imultaneous Local  1.17 %  inultaneous Local  1.17 %	0.0026 [deg/m]  Lry. ArXiv e-prints 2018.  0.0020 [deg/m]  e visual odometry with ste  0.0019 [deg/m]  attime Stereo Visual Odome  0.0023 [deg/m]  : A Fully Online and Versa  0.0028 [deg/m]  dometry for High-speed Au  0.0020 [deg/m]  attime Stereo Visual Odome  0.0020 [deg/m]  dometry for High-speed Au  0.0020 [deg/m]  attime Stereo Visual Odome  0.0033 [deg/m]  Moving Object Segmentation  0.0034 [deg/m]  uning of Lidar Features for  0.0029 [deg/m]  etry from Monocular Techn  0.0028 [deg/m]  etry from Monocular Techn  0.0028 [deg/m]  etry from Monocular Techn  0.0028 [deg/m]  etry. IEEE Intelligent Vehicles Sy  0.0023 [deg/m]  0.0023 [deg/m]  etry. IEEE/RSJ Internationa  0.0027 [deg/m]  onocular, Stereo and RGB-  0.0025 [deg/m]	0.2 s  0.1 s  reo cameras. In  0.007 s  etry  0.01 s  tile Visual SLAM  0.01 s  tomotive Applic  0.008 s  etry  0.1s  n in 3D LiDAR D  0.1s  o.1s  o.1s  o.3 s  tomotive Applic  0.1s  o.1s  considerence of o.1s  o.1s  o.1s  o.1s  o.1s  o.1s  o.1s  o.1s  considerence of o.1s  o.1s  o.1s  o.1s  considerence of o.1s  o.1s  o.1s  o.1s  o.1s  o.1s  considerence of o.1s	2 cores @ 2.5 Ghz (C/C++)  1 core @ 3.4 Ghz (C/C++)  ternational Conference on Computer Vision (ICCV), Venice, Italy 20  Jetson AGX  1 core @ 2.5 Ghz (C/C++)  Ifor Real-Time Applications. IEEE Robotics and Automation Letters  8 cores @ 3.0 Ghz (C/C++)  Ifor Real-Time Applications. IEEE Robotics and Automation Letters  2 cores @ 2.0 Ghz (C/C++)  Intelligent Vehicles Symposium (IV) 2016.  3 cores @ 3.3 Ghz (C/C++)  1 core @ 2.5 Ghz (C/C++)  1 core @ 3.5 Ghz (C/C++)  AM. IEEE/RSJ International Conference on Intelligent Robots and Sy  1 core @ 2.5 Ghz (C/C++)  GPU and CPU @ 2.2 Ghz (Python + C/C++)  bilistic Trajectory Estimator. IEEE Robotics and Automation Letters  GPU @ 3.5 Ghz (C/C++)  elligent Vehicles Symposium 2015.  1 core @ 3.0 Ghz (C/C++)  2 cores @ 2.0 Ghz (C/C++)  In Intelligent Robots and Systems (IROS) 2014.  2 cores @ 2.5 Ghz (C/C++)  In Intelligent Robots and Systems (IROS) 2014.  2 cores @ 3.5 Ghz (C/C++)  Transactions on Robotics 2017.  GPU @ 2.5 Ghz (C/C++)  I core @ 3.0 Ghz (C/C++)  Transactions on Robotics 2017.  GPU @ 2.5 Ghz (C/C++)  I core @ 3.0 Ghz (C/C++)	2021.
Graeter, Wang, M.  18	A. Wilczynski and M. Lau  Stereo DSO  J. Schw\"orer and D. Crem  SaacElbrusGPUSLAM  D. Robustov, D. Slepiche  OV2SLAM  A. Eudes, J. Moras, M. S.  OV2SLAM  A. Eudes, J. Moras, M. S.  ROCC  and V. Willert: How to District of the second of the	anfourche ar  an	code	0.93 %  clar Visual Odome  0.93 %  scale direct spars  0.94 %  . Volodarskiy: Rea  0.94 %  snerais: OVZSLAM  0.98 %  snerais: OVZSLAM  0.98 %  utliers in Visual On  0.99 %  . Volodarskiy: Rea  0.99 %  nd C. Stachniss: A  1.06 %  1.06 %  1.06 %  1.07 %  Unsupervised Lea  1.09 %  ereo Visual Odom  1.09 %  based Framework  1.11 %  //isual Odometry.  1.11 %  //isual Odometry.  1.11 %  //isual Odometry.  1.11 %	0.0026 [deg/m]  try. ArXiv e-prints 2018.  0.0020 [deg/m] e visual odometry with ste  0.0019 [deg/m] eltime Stereo Visual Odome  0.0023 [deg/m] : A Fully Online and Versa  0.0023 [deg/m] : A Fully Online and Versa  0.0028 [deg/m] dometry for High-speed Au  0.0020 [deg/m] eltime Stereo Visual Odome  0.0033 [deg/m]  Noving Object Segmentation  0.0034 [deg/m]  uning of Lidar Features for  0.0029 [deg/m] etry from Monocular Techn  0.0028 [deg/m]  etry from Monocular Techn  0.0029 [deg/m]  etry from Monocular Techn  0.0028 [deg/m]  etry. IEEE Intelligent Vehicles Sy  0.0028 [deg/m]  EEE Intelligent Vehicles Sy  0.0028 [deg/m]  etry. IEEE/RSJ International 0.0027 [deg/m]  onocular, Stereo and RGB-  0.0025 [deg/m]  ization and Mapping. Conf  0.0035 [deg/m]  ering. German Conference  0.0025 [deg/m]	0.2 s  0.1 s  reo cameras. In  0.007 s  etry  0.01 s  tile Visual SLAM  0.01 s  tile Visual SLAM  0.08 s  tomotive Applic  0.1 s  ed Semantic SLAM  0.1 s  ed Semantic SLAM  0.1 s  o.1 s  o.1 s  ed Semantic SLAM  0.1 s  o.1 s  o.1 s  o.1 s  consideration with Multical series on Robor  0.1 s  o.1 s  o.1 s  o.1 s  o.1 s  consideration with Multical series on Robor  0.1 s  o.1 s  o.1 s  o.1 s  o.1 s  o.1 s  consideration with Multical series on Robor  o.1 s	2 cores @ 2.5 Ghz (C/C++)  1 core @ 3.4 Ghz (C/C++)  ternational Conference on Computer Vision (ICCV), Venice, Italy 20  Jetson AGX  1 core @ 2.5 Ghz (C/C++)  Ifor Real-Time Applications. IEEE Robotics and Automation Letters  8 cores @ 3.0 Ghz (C/C++)  Ifor Real-Time Applications. IEEE Robotics and Automation Letters  2 cores @ 2.0 Ghz (C/C++)  Internations. IEEE Intelligent Vehicles Symposium (IV) 2016.  3 cores @ 3.3 Ghz (C/C++)  1 core @ 2.5 Ghz (C/C++)  AM. IEEE/RSJ International Conference on Intelligent Robots and Sy  1 core @ 2.5 Ghz (C/C++)  GPU and CPU @ 2.2 Ghz (Python + C/C++)  Dilistic Trajectory Estimator. IEEE Robotics and Automation Letters  GPU @ 3.5 Ghz (C/C++)  2 cores @ 3.0 Ghz (C/C++)  1 core @ 3.0 Ghz (C/C++)  2 cores @ 2.0 Ghz (C/C++)  1 core @ 2.5 Ghz (C/C++)  2 cores @ 2.5 Ghz (C/C++)  1 core @ 2.5 Ghz (C/C++)  2 cores @ 2.5 Ghz (C/C++)  1 core @ 2.5 Ghz (C/C++)  1 core @ 3.0 Ghz (C/C++)  2 cores @ 3.0 Ghz (C/C++)  3 cores @ 3.0 Ghz (C/C++)  4 cores @ 3.0 Ghz (C/C++)	2021.
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44 H. Ho	PNDT LO ng and B. Lee: <u>Probabilistic norm</u>	nal distribut	ions tran	U.89 % sform representation	on for accurate 3d point cl	U.Z S oud registration	8 CORES @ 3.3 GNZ (C/C++) on. IEEE/RSJ International Conference on Intelligent Robots and Sys	tems (IROS	 5) 201
45	DVSO			0.90 %	0.0021 [deg/m]	0.1 s	GPU @ 2.5 Ghz (C/C++)		
N. Yar 2018.	ng, R. Wang, J. Stueckler and D.	Cremers: De	eep Virtu	al Stereo Odometry	: Leveraging Deep Depth	Prediction for I	Monocular Direct Sparse Odometry. European Conference on Comp	uter Vision	(ECC
46 J. Gra	LIMO eter, A. Wilczynski and M. Lauer	r: LIMO: Lida	<u>code</u> ar-Monoci	0.93 %	0.0026 [deg/m]	0.2 s	2 cores @ 2.5 Ghz (C/C++)	[	
47	Stereo DSO	ăă		0.93 %	0.0020 [deg/m]	0.1 s	1 core @ 3.4 Ghz (C/C++)	(	
			so: Large	scale direct sparse		eo cameras. Ir	iternational Conference on Computer Vision (ICCV), Venice, Italy 2	1 ,	$\overline{\overline{}}$
48 A. Kor	IsaacElbrusGPUSLAM ovko, D. Robustov, D. Slepichev	E. Vendrov	sky and S		0.0019 [deg/m] time Stereo Visual Odome		Jetson AGX	<u> </u>	
49	<u>OV2SLAM</u>	m	<u>code</u>	0.94 %	0.0023 [deg/m]	0.01 s	1 core @ 2.5 Ghz (C/C++)		
м. Fei 50	OV2SLAM	Tourche and	code	0.98 %	0.0023 [deg/m]	0.01 s	A for Real-Time Applications. IEEE Robotics and Automation Letters  8 cores @ 3.0 Ghz (C/C++)	:	$\Box$
M. Fei		fourche and	_	i esnerais: <u>OV2SLAM :</u>			In the Applications of the Real-Time	-	<u> </u>
51 M. Bu	ROCC czko and V. Willert: How to Disti	inguish Inlier	rs from 0	0.98 % Outliers in Visual Odd	0.0028 [deg/m] ometry for High-speed Aut	0.3 s	2 cores @ 2.0 Ghz (C/C++)  cations. IEEE Intelligent Vehicles Symposium (IV) 2016.		<u> </u>
52	<u>IsaacElbrusSLAM</u>	ďď		0.99 %	0.0020 [deg/m]	0.008 s	3 cores @ 3.3 Ghz (C/C++)	(	
A. Kor 53	rovko, D. Robustov, D. Slepichev	, E. Vendrov	<u> </u>	. Volodarskiy: <u>Real</u>	time Stereo Visual Odome 0.0033 [deg/m]	<u>try</u> 0.1s	1 core @ 2.5 Ghz (C/C++)		$\overline{-}$
X. Che	SuMa-MOS en, S. Li, B. Mersch, L. Wiesmann nation Letters (RA-L) 2021.	: —	code Behley a				Data: A Learning-based Approach Exploiting Sequential Data. IEEE R	lobotics and	 d
54	SuMa++	<b> </b>	<u>code</u>	1.06 %	0.0034 [deg/m]	0.1 s	1 core @ 3.5 Ghz (C/C++)		
			Behley a				AM. IEEE/RSJ International Conference on Intelligent Robots and S	ystems (IRC	)S) 2(
55	V2-SLAM	<b>::</b>		1.06 %	0.0024 [deg/m]	0.07 s	1 core @ 2.5 Ghz (C/C++)	[	<u> </u>
56 D. You	ULF-ESGVI on, H. Zhang, M. Gridseth, H. Th	omas and T.	. Barfoot:	1.07 %  Unsupervised Lear	0.0036 [deg/m] ning of Lidar Features for	0.3 s Use in a Proba	GPU and CPU @ 2.2 Ghz (Python + C/C++) bilistic Trajectory Estimator. IEEE Robotics and Automation Letters	s (RAL) 202	1.
57	<u>cv4xv1-sc</u>	ďď		1.09 %	0.0029 [deg/m]	0.145 s	GPU @ 3.5 Ghz (C/C++)		
M. Pe	rsson, T. Piccini, R. Mester and A  VINS-Fusion	A. Felsberg:	<u>code</u>		o.0033 [deg/m]	niques. IEEE Int	relligent Vehicles Symposium 2015.  1 core @ 3.0 Ghz (C/C++)		
	, J. Pan, S. Cao and S. Shen: A C	: —	<u> </u>			ation with Mult			<u> </u>
<b>59</b> M. Bu	MonoROCC czko and V. Willert: Monocular O	Outlier Detec	tion for	1.11 % Visual Odometry, IE	0.0028 [deg/m] EE Intelligent Vehicles Svi	1 s	2 cores @ 2.0 Ghz (C/C++)		
60	<u>vins</u>	ďď		1.11 %	0.0023 [deg/m]	0.1 s	1 core @ 2.5 Ghz (C/C++)	[	
61	<u>DEMO</u>	:::		1.14 %	0.0049 [deg/m]	0.1 s	2 cores @ 2.5 Ghz (C/C++)	[	<u> </u>
	<u> </u>		<del></del>	1			in Intelligent Robots and Systems (IROS) 2014.	· ·	_
62 R. Mu	ORB-SLAM2 r-Artal and J. Tard\'os: ORB-SLAM	M2: an Open	<u>code</u> -Source S	1.15 % LAM System for Mor	0.0027 [deg/m] nocular, Stereo and RGB-D	0.06 s Cameras. IEE	2 cores @ >3.5 Ghz (C/C++) E Transactions on Robotics 2017.		
63	<u>IV-SLAM</u>	ďď	<u>code</u>	1.17 %	0.0025 [deg/m]	0.1 s	GPU @ 2.5 Ghz (C/C++)	(	
S. Rab 64	oiee and J. Biswas: <u>IV-SLAM: Intro</u>	ospective Vi	sion for S	Simultaneous Localiz	zation and Mapping. Confe 0.0035 [deg/m]	erence on Robo	1 core @ 3.0 Ghz (C/C++)	<u> </u>	
	gmoeller and J. Eggert: Stereo V		etry with						
65 T Pir	S-PTAM  B. T. Fischer, G. Castro, P. De Cr	rist\'oforis	<u>code</u>	1.19 %	0.0025 [deg/m]	0.03 s	4 cores @ 3.0 Ghz (C/C++)  Mapping. Robotics and Autonomous Systems (RAS) 2017.	[	<u> </u>
T. Pir	e, T. Fischer, J. Civera, P. Crist\	'{o}foris and	J. Jacob	o-Berlles: <u>Stereo pa</u>	arallel tracking and mappi	ng for robot lo	calization. IROS 2015.	<u> </u>	
66 J. Eng	S-LSD-SLAM el, J. St\"uckler and D. Cremers:	Large-Scale	<u>code</u> e Direct S	1.20 % SLAM with Stereo Ca	0.0033 [deg/m] ameras. Int.~Conf.~on Inte	0.07 s elligent Robot S	1 core @ 3.5 Ghz (C/C++) Systems (IROS) 2015.	<u> </u>	
67	<u>VoBa</u>	ăă .		1.22 %	0.0029 [deg/m]	0.1 s	1 core @ 2.0 Ghz (C/C++)	(	
	dir, m. George, m. Laverne, A. K i, Taiwan 2010.		Stentz: A	· · ·	ision-aided inertial naviga		E/RSJ International Conference on Intelligent Robots and Systems,	Uctober 18	-22,
68 T. Tar	STEAM-L WNOJ ng, D. Yoon and T. Barfoot: A Wh	nite-Noise-O	n-Jerk Mo	1.22 % otion Prior for Conti	0.0058 [deg/m]	0.2 s timation on SE	1 core @ 2.5 Ghz (C/C++)  (3). arXiv preprint arXiv:1809.06518 2018.		<u> </u>
69	<u>LiViOdo</u>	**		1.22 %	0.0042 [deg/m]	0.5 s	1 core @ 2.5 Ghz (C/C++)	[	
J. Gra 70	eter, A. Wilczynski and M. Lauer  SLUP	r: <u>LIMO: Lida</u>	ar-Monoci	ular Visual Odometr	y. ArXiv e-prints 2018. 0.0041 [deg/m]	0.17 s	4 cores @ 3.3 Ghz (C/C++)		$\overline{\neg}$
	<del></del>	:	based loc				metry and Remote Sensing 2017.		
71	STEAM-L	Parfort Le	i arning a	1.26 %	0.0061 [deg/m]	0.2 s	1 core @ 2.5 Ghz (C/C++) ference on Computer and Robot Vision (CRV) 2018.	(	
72		. вагтоот. <u>се</u>	earning a	1.26 %	0.0038 [deg/m]	0.03 s		[	
	•	<u>:                                    </u>	mework		<u>Visual Odometry</u> . IEEE Tr		intelligent Transportation Systems 2017.		<u> </u>
<b>7</b> 3 R. Sar	JFBVO-FM dana, V. Karar and S. Poddar: <u>Im</u>	nproving visu	ual odom	1.28 % etry pipeline with f	0.0010 [deg/m] eedback from forward and	0.1 s d backward mo	1 core @ 3.4 Ghz (C/C++) tion estimates. Machine Vision and Applications 2023.	[	
74	<u>MFI</u>	88		1.30 %	0.0030 [deg/m]	0.1 s	1 core @ 2.2 Ghz (C/C++)		
H. Bad 75	dino, A. Yamamoto and T. Kanad  TLBBA	le: <u>Visual Od</u>	<u>lometry l</u>	oy Multi-frame Feat	ure Integration. First Integration of the original of the orig	rnational Work  0.1 s	shop on Computer Vision for Autonomous Driving at ICCV 2013.  1 Core @2.8GHz (C/C++)		$\overline{}$
			al odome				Vehicles Symposium (IV), 2013 IEEE 2013.		<u> </u>
76 I. Kre	2FO-CC so and S. Segvić: Improving the E	gomotion Es	<u>code</u>	1.37 %	0.0035 [deg/m]	0.1 s	1 core @ 3.0 Ghz (C/C++)	[	
77	SALO	<b>::</b>		1.37 %	0.0051 [deg/m]	0.6 s	1 core @ 2.5 Ghz (C/C++)	(	
	valenko, M. Korobkin and A. Mini		ware Lida					·	
78 J. Beh	SuMa Ney and C. Stachniss: Efficient St	urfel-Based	SLAM usii	1.39 % ng 3D Laser Range D	0.0034 [deg/m] Data in Urban Environment	0.1 s s. Robotics: So	1 core @ 3.5 Ghz (C/C++) cience and Systems (RSS) 2018.	<u> </u>	
79	<u>ProSLAM</u>	<b>88</b>	code	1.39 %	0.0035 [deg/m]	0.02 s	1 core @ 3.0 Ghz (C/C++)	(	
D. Sch 80	nlegel, M. Colosi and G. Grisetti:	FIUSLAM: G	rapn SLA	M from a Programm  1.42 %	o.0048 [deg/m]	1 s	1 core @ 2.5 Ghz (C/C++)	[	
	uyen, T. Nguyen, C. Tran, K. Phu gement and Communication (IMC		iguyen: A	novel translation e	stimation for essential ma	atrix based ste	: reo visual odometry. 2021 15th International Conference on Ubiqui	tous Inform	natio
81	JFBVO	<b>88</b>		1.43 %	0.0038 [deg/m]	0.05 s	1 core @ 3.4 Ghz (C/C++)	(	
R. Sar 82	dana, R. Kottath, V. Karar and S StereoSFM	. Poddar: <u>Jo</u>	code	ard-Backward Visua	O.0042 [deg/m]	neras. Proceed	dings of the Advances in Robotics 2019 2019.  2 cores @ 2.5 Ghz (C/C++)		$\overline{}$
		<u>: — </u>	<u>:                                      </u>				e and Motion. IAPR Conference on Machine Vision Application 2011.		<u> </u>
83 F. Bel	SSLAM lavia, M. Fanfani, F. Pazzaglia ar	nd C. Colom	code	1.57 %	0.0044 [deg/m]	0.5 s	8 cores @ 3.5 Ghz (C/C++)		
F. Bel	lavia, M. Fanfani and C. Colombo	o: Selective	visual od	lometry for accurate	e AUV localization. Autono	omous Robots 2			
84 P. Frf	<u>Stereo-RIVO</u> an Salehi: <u>Stereo-RIVO: Stereo-R</u>	obust Indire	oct Visual	1.61 %	0.0025 [deg/m]	0.07 s	4 cores @ 2.5 Ghz (Matlab)	(	
85	<u>VOLDOR</u>		code	1.65 %	0.0050 [deg/m]	0.1 s	GPU	[	
		Visual Odor	metry Fro				ference on Computer Vision and Pattern Recognition (CVPR) 2020.		
86 87	<u>ddvo</u>			1.70 %	0.0064 [deg/m]	0.16 s 0.05 s	1 core @ 2.5 Ghz (C/C++)	<u> </u>	
87 M. Sar	<u>eVO</u> nfourche, V. Vittori and G. Besne	:	A realtime		0.0036 [deg/m] odometry for MAV applica		2 cores @ 2.0 Ghz (C/C++)  J International Conference on Intelligent Robots and Systems (IROS	5) 2013.	<u> </u>
88	Stereo DWO	inska: Stored	<u>code</u>	1.76 %	0.0026 [deg/m]	0.1 s	4 cores @ 2.5 Ghz (C/C++)	no Instit	
Naviga	ation (ION GNSS+ 2015) 2015.	inska: <u>Stered</u>	o-mertial	:			27th International Technical Meeting of The Satellite Division of th	ie institute	υī
89 F. Per	BVO eira, J. Luft, G. Ilha, A. Sofiatti	and A. Susir	n: <u>Backwa</u>	1.76 % ard Motion for Estim	0.0036 [deg/m] nation Enhancement in Spa	0.1 s arse Visual Odo	1 core @ 2.5GHz (Python)  metry. 2017 Workshop of Computer Vision (WVC) 2017.	<u> </u>	
90	3DOF-SLAM	ort sall	code	1.89 %	0.0083 [deg/m]	0.02 s	1 core @ 2.5 Ghz (C/C++)	Duta: 1/2	
and C	omputer Graphics Theory and Ap		Volume :	3: VISAPP, (VISIGRA	PP 2016) 2016.		omous Vehicles. Proceedings of the 11th Joint Conference on Comp	Jucer Vision	ı, Im
91 G. Wa	EfficientLO-Net Ing, X. Wu, S. Jiang, Z. Liu and H	. Wang: <u>Eff</u>	code icient 3D	1.92 % Deep LiDAR Odome	0.0052 [deg/m] try. arXiv preprint arXiv:2	0.03 s 2111.02135 202	1 core @ 2.5 Ghz (C/C++)	<u> </u> (	
92	D6DVO	MX Ouada	rif -	2.04 %	0.0051 [deg/m]	0.03 s	1 core @ 2.5 Ghz (C/C++)	[	
M. Me	mport, E. Malis and P. Rives: Acc illand, A. Comport and P. Rives:			g of large scale env	rironments for real-time lo	ocalisation. ICR		<u> </u>	
93	PMO / PbT-M2			2.05 %	0.0051 [deg/m]	1 s	1 core @ 2.5 Ghz (Python + C/C++)		

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<sup>110</sup> 3.80 % 0.0150 [deg/m] GPU @ 2.5 Ghz (Python) 111 **DeepCLR** \*\*\* <u>code</u> 3.83 % 0.0104 [deg/m] 0.05 sGPU @ 1.0 Ghz (Python) M. Horn, N. Engel, V. Belagiannis, M. Buchholz and K. Dietmayer: <u>DeepCLR: Correspondence-Less Architecture for Deep End-to-End Point Cloud Registration</u>. 2020 IEEE 23rd International Conference on Intelligent Transportation Systems (ITSC) 2020. 1 core @ 2.0 Ghz (C/C++) 3.94 % 0.0099 [deg/m] 0.51 s **VOFS** M. Kaess, K. Ni and F. Dellaert: <u>Flow separation for fast and robust stereo odometry</u>. ICRA 2009. P. Alcantarilla, L. Bergasa and F. Dellaert: <u>Visual Odometry priors for robust EKF-SLAM</u>. ICRA 2010. 0.52 s1 core @ 2.0 Ghz (C/C++) 0.0112 [deg/m] M. Kaess, K. Ni and F. Dellaert: <u>Flow separation for fast and robust stereo odometry</u>. ICRA 2009. P. Alcantarilla, L. Bergasa and F. Dellaert: <u>Visual Odometry priors for robust EKF-SLAM</u>. ICRA 2010. .001 s GPU @ 2.5 Ghz (Matlab) 4.36 % 0.0052 [deg/m] CUDA-EgoMotion A. Aguilar-González, M. Arias- Estrada, F. Berry and J. Osuna-Coutiño: The Fastest Visual Ego-motion Algorithm in the West. Microprocessors and Microsystems 2019. 115 4.57 % 1 core @ 2.5 Ghz (Python) DVLO 0.0069 [deg/m] 0.1s 116 4.59 % 0.0175 [deg/m] 1 s 1 core @ 2.5 Ghz (C/C++) M. Velas, M. Spanel, M. Hradis and A. Herout: CNN for IMU Assisted Odometry Estimation using Velodyne LiDAR. ArXiv e-prints 2017. 0.0154 [deg/m] GPU @ 2.5 Ghz (Python) P. Adis, N. Horst and M. Wien: <u>D3DLO: Deep 3D LiDAR Odometry</u>. 2021. 0.0274 [deg/m] 1 core @ 2.5 Ghz (Matlab) Z. Boukhers, K. Shirahama and M. Grzegorzek: <a href="Example-based 3D Trajectory Extraction of Objects from 2D Videos">Extraction of Objects from 2D Videos</a>. Circuits and Systems for Videos Technology (TCSVT), IEEE Transaction on 2017. Z. Boukhers, K. Shirahama and M. Grzegorzek: <a href="Less restrictive camera odometry estimation from monocular camera">Less restrictive camera odometry estimation from monocular camera</a>. Multimedia Tools and Applications 2017. 7.40 % 0.0142 [deg/m] 1 core @ 2.5 Ghz (C/C++) Y. Zou, P. Ji, Q. Tran, J. Huang and M. Chandraker: Learning Monocular Visual Odometry via Self-Supervised Long-Term Modeling. ECCV 2020. 1 core @ 2.5 Ghz (C/C++) 7.46 % 0.0245 [deg/m] 0.15 s <u>VISO2-M + GP</u> A. Geiger, J. Ziegler and C. Stiller: <u>StereoScan: Dense 3d Reconstruction in Real-time</u>. IV 2011.
S. Song and M. Chandraker: <u>Robust Scale Estimation in Real-Time Monocular SFM for Autonomous Driving</u>. CVPR 2014. 9.21 % 0.0163 [deg/m] 1 core @ 2.5 Ghz (C/C++) M. Velas, M. Spanel, M. Hradis and A. Herout: CNN for IMU Assisted Odometry Estimation using Velodyne LiDAR. ArXiv e-prints 2017. 122 3DG-DVO 11.38 % 0.0305 [deg/m] 0.04 sGPU @ 1.5 Ghz (Python)

11.94 %

12.59 %

13.25 %

13.69 %

14.15 %

16.06 %

I. Slinko, A. Vorontsova, F. Konokhov, O. Barinova and A. Konushin: Scene Motion Decomposition for Learnable Visual Odometry. 2019.

C. Godard, O. Mac Aodha, M. Firman and G. Brostow: Digging into self-supervised monocular depth estimation. ICCV 2019.

<u>code</u>

<u>code</u>

A. Geiger, J. Ziegler and C. Stiller: <u>StereoScan: Dense 3d Reconstruction in Real-time</u>. IV 2011.

0.0234 [deg/m]

0.0312 [deg/m]

0.0097 [deg/m]

0.0355 [deg/m]

0.0228 [deg/m]

0.0320 [deg/m]

0.0135 [deg/m]

D. Frost, O. Kähler and D. Murray: Object-Aware Bundle Adjustment for Correcting Monocular Scale Drift. Proceedings of the International Conference on Robotics and Automation (ICRA) 2012.

J. Bian, Z. Li, N. Wang, H. Zhan, C. Shen, M. Cheng and I. Reid: <u>Unsupervised scale-consistent depth and ego-motion learning from monocular video</u>. NeurIPS 2019.

0.1 s

0.03 s

0.01 s

0.01 s

0.1 s

A. Ranjan, V. Jampani, L. Balles, K. Kim, D. Sun, J. Wulff and M. Black: Competitive collaboration: Joint unsupervised learning of depth, camera motion, optical flow and motion segmentation. CVPR 2019.

Table as LaTeX | Only published Methods

1 core @ 2.5 Ghz (C/C++)

1 core @ 2.5 Ghz (C/C++)

GPU @ 2.5 Ghz (Python)

1 core @ 2.5 Ghz (C/C++)

GPU @ 1.5 Ghz (Python)

1 core @ 2.5 Ghz (C/C++)

1 core @ 3.5 Ghz (C/C++)

1 core @ 2.5 Ghz (C/C++)

>8 cores @ >3.5 Ghz (C/C++)

1 core @ 2.5 Ghz (C/C++)

- **Related Datasets** 
  - CMU Visual Localization Data Set: Dataset collected using the Navlab 11 equipped with IMU, GPS, Lidars and cameras. NYU RGB-D Dataset: Indoor dataset captured with a Microsoft Kinect that provides semantic labels. • TUM RGB-D Dataset: Indoor dataset captured with Microsoft Kinect and high-accuracy motion capturing.

• New College Dataset: 30 GB of data for 6 D.O.F. navigation and mapping (metric or topological) using vision and/or laser.

- The Rawseeds Project: Indoor and outdoor datasets with GPS, odometry, stereo, omnicam and laser measurements for visual, laser-based, omnidirectional, sonar and multi-sensor SLAM evaluation. • <u>Victoria Park Sequence</u>: Widely used sequence for evaluating laser-based SLAM. Trees serve as landmarks, detection code is included. • Malaga Dataset 2009 and Malaga Dataset 2013: Dataset with GPS, Cameras and 3D laser information, recorded in the city of Malaga, Spain. Ford Campus Vision and Lidar Dataset: Dataset collected by a Ford F-250 pickup, equipped with IMU, Velodyne and Ladybug.
- Citation

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VISO2-M

MonoDepth2

SMD-LVO

SC-SfMLearner (cs+k)

<u>GraphAVO</u>

booktitle = {Conference on Computer Vision and Pattern Recognition (CVPR)},

<sup>&</sup>lt;u>code</u> 21.47 % 0.0425 [deg/m] 0.01 sJ. Bian, Z. Li, N. Wang, H. Zhan, C. Shen, M. Cheng and I. Reid: <u>Unsupervised scale-consistent depth and ego-motion learning from monocular video</u>. NeurIPS 2019. 0.1042 [deg/m] 44.07 % 90.05 % 0.2645 [deg/m] 0.1 s Y. Zhou, H. Fan, S. Gao, Y. Yang, X. Zhang, J. Li and Y. Guo: Retrieval and Localization with Observation Constraints. CoRR 2021.

