

BOP Challenge 2020

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Carsten Rother, Heidelberg Uni

6th International Workshop on Recovering 6D Object Pose
ECCV 2020, August 23, online

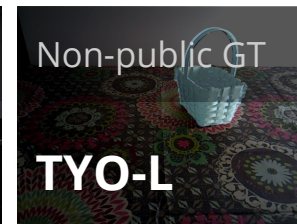
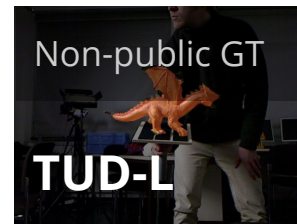
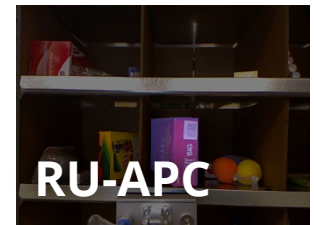
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BOP: Benchmark for 6D object pose estimation

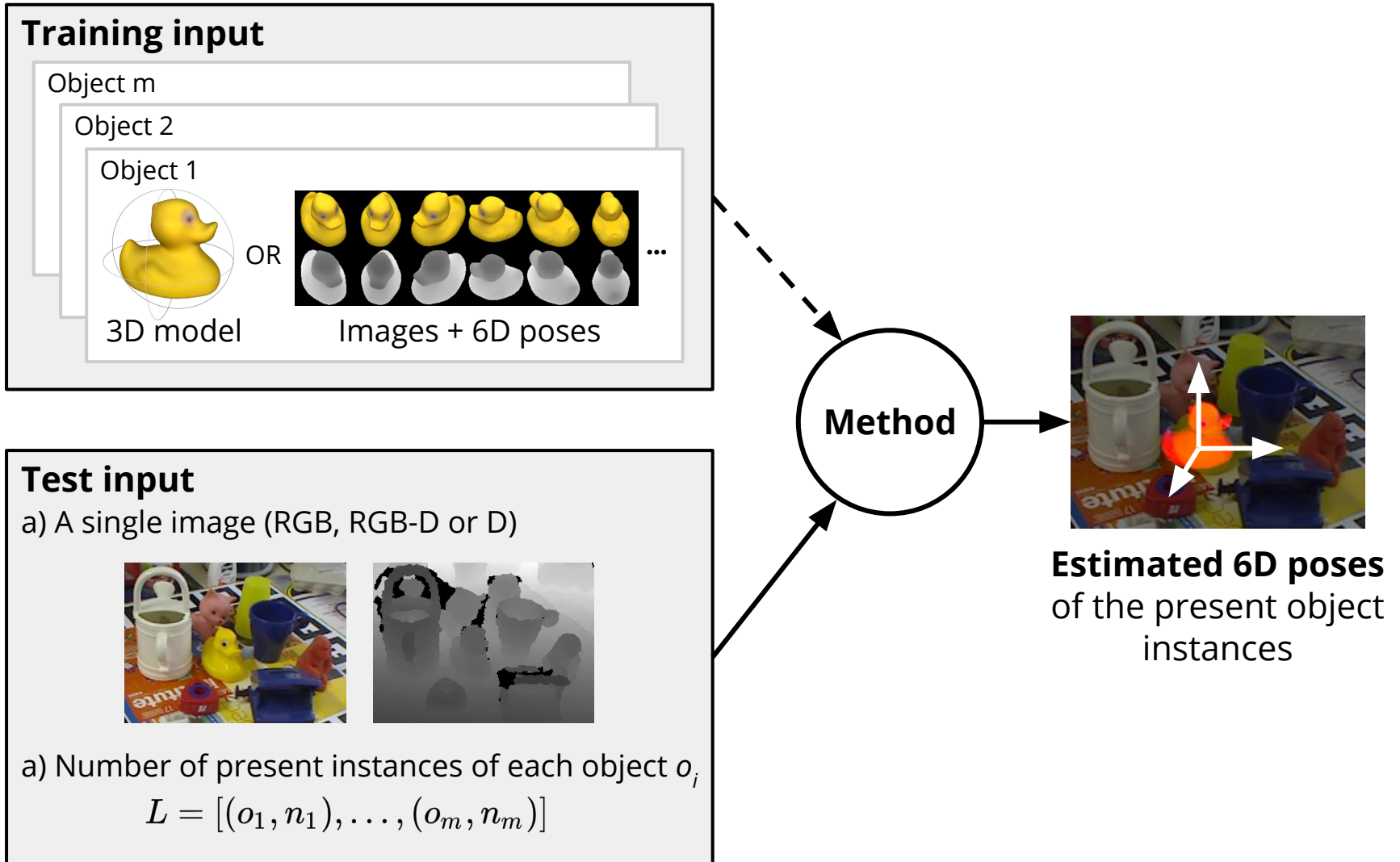
Hodan, Michel et al. (ECCV 2018) – To capture and report SOTA in estimating the 6D pose of rigid objects from RGB/RGB-D images.

BOP currently comprises of:

- **Evaluation methodology**
- **Online evaluation system at bop.felk.cvut.cz**
- **11 datasets in a unified format**
 - Texture-mapped 3D models of 171 objects
 - >700K training RGB-D images (mostly synthetic)
 - >100K test RGB-D images of scenes with graded complexity
 - Images are annotated with ground-truth 6D object poses



6D object localization



6D object localization – Variants



SiSo

a single instance
of a single object



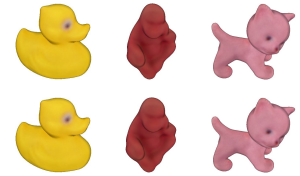
SiMo

a single instance
of multiple objects



MiSo

multiple instances
of a single object



MiMo

multiple instances
of multiple objects

6D object localization – Variants



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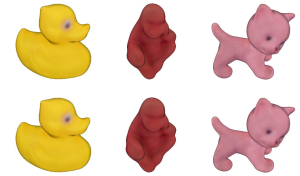
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BOP 2018

6D object localization – Variants



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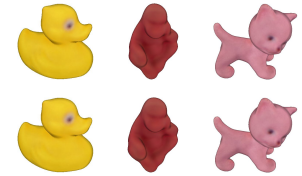
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multiple instances
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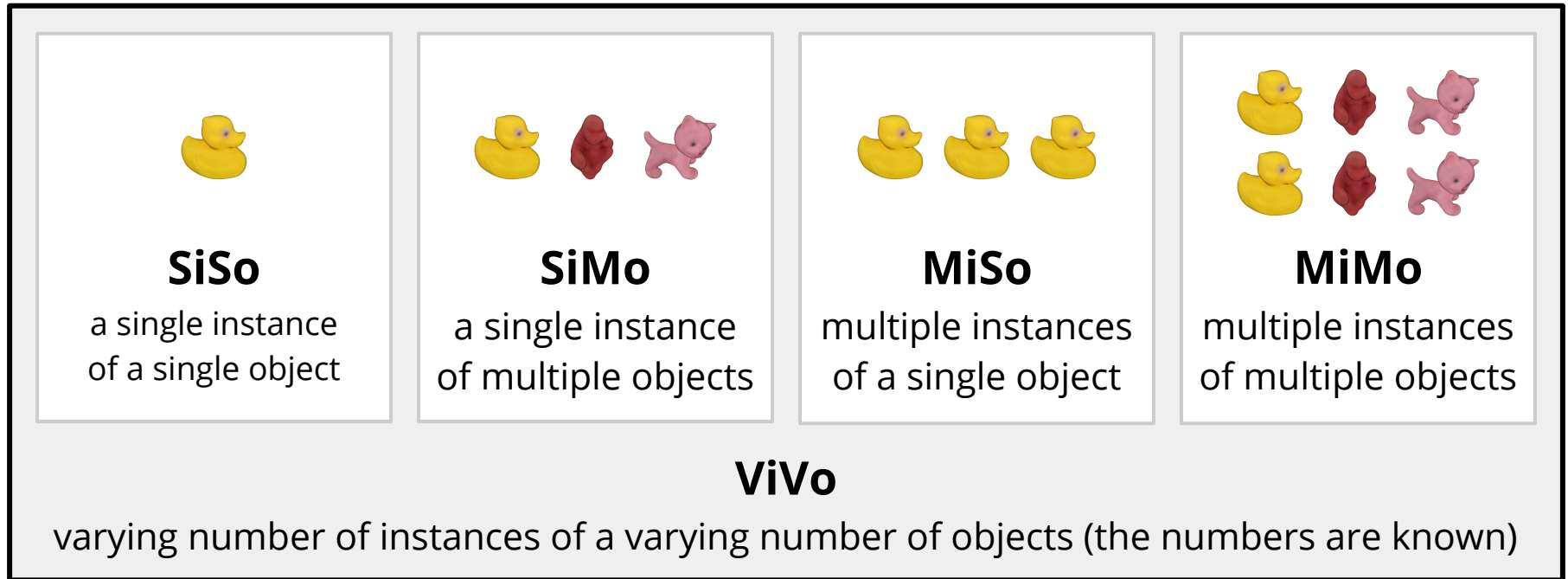
multiple instances
of multiple objects

ViVo

varying number of instances of a varying number of objects (the numbers are known)

BOP 2019 & 2020

6D object localization – Variants

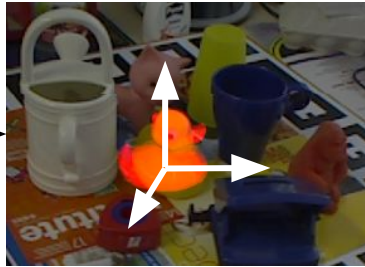
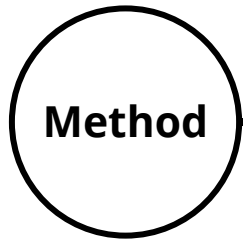


BOP 2019 & 2020

Why not 6D object detection, where the number of instances is unknown?

1. Evaluating 6D object detection is expensive as many more estimates need to be evaluated to calculate the precision/recall curve.
2. The scores on the simpler 6D localization task are far from being saturated.

Pose error functions



Estimated pose



GT pose

How good is the estimated pose?

The error of an estimated pose w.r.t. the GT pose is measured by:

1. **VSD: Visible Surface Discrepancy**

Error calculated over the visible part \Rightarrow indistinguishable poses are equivalent.

2. **MSSD: Maximum Symmetry-Aware Surface Distance**

Measures the surface deviation in 3D \Rightarrow relevant for robotic applications.

3. **MSPD: Maximum Symmetry-Aware Projection Distance**

Measures the perceivable deviation \Rightarrow relevant for AR applications.

See bop.felk.cvut.cz for details.

Accuracy score

An estimated pose E is considered **correct** w.r.t. ground-truth pose G and pose-error function F , **if $F(E, G) < \theta$** , where F is VSD, MSSD or MSPD, and θ is the threshold of correctness.

Average Recall w.r.t. function F : AR_F = the average of recall rates calculated for multiple settings of threshold θ (and tolerance τ for VSD).
Recall rate = the fraction of objects for which a correct pose is estimated.

Average Recall on dataset D : $AR_D = (AR_{VSD} + AR_{MSSD} + AR_{MSPD}) / 3$

The overall accuracy (AR) = the average of per-dataset AR_D scores.
⇒ Each dataset is treated as a separate sub-challenge which avoids the overall score being dominated by larger datasets.

See bop.felk.cvut.cz for details.

Rules

1. **For training, a method *can*...**
 - a. use the provided 3D object models and training images.
 - b. render extra training images.
 - c. use the range (not a probability distribution) of all GT poses in the test images (e.g. objects are from 20 to 100 cm from the camera).
2. **For training, a method *cannot*...**
 - a. use a single pixel of test images.
 - b. use the individual ground-truth poses from test images.
3. **A fixed set of hyper-parameters** required for all objects/datasets.

BOP Toolkit

Scripts for reading the standard dataset format, evaluation etc.

thodan / bop_toolkit

Unwatch 12 Unstar 99 Fork 35

Code Issues 6 Pull requests 1 Actions Projects Wiki Security Insights Settings

master 2 branches 0 tags

Go to file Add file Code

thodan	Parameters of both versions of the HB dataset are now i...	53150b6	9 days ago	85 commits
bop_toolkit_lib	Parameters of both versions of the HB dataset are now in...		9 days ago	
docs	Minor change.		2 months ago	
scripts	The visualization script now does not depend on matplotl...		last month	
.gitignore	Minor changes.		13 months ago	
LICENSE	The first public version.		13 months ago	
README.md	Update README.md		12 months ago	
requirements.txt	Update requirements.		last month	

About

A Python toolkit of the BOP benchmark for 6D object pose estimation.

bop.felk.cvut.cz

Readme

MIT License

Releases

No releases published

[Create a new release](#)

BOP Challenge 2018

Hodan, Michel et al. (ECCV 2018).

Classical pre-CNN (RGB-D and D) methods on the **SiSo** task.

Pose error measured with only **Visible Surface Discrepancy (VSD)**.

#	Method	LM	LM-O	IC-MI	IC-BIN	T-LESS	RU-APC	TUD-L	Average	Time (s)
●	1. Vidal-18	87.83	59.31	95.33	96.50	66.51	36.52	80.17	74.60	4.7
●	2. Drost-10-edge	79.13	54.95	94.00	92.00	67.50	27.17	87.33	71.73	21.5
●	3. Drost-10	82.00	55.36	94.33	87.00	56.81	22.25	78.67	68.06	2.3
●	4. Hodan-15	87.10	51.42	95.33	90.50	63.18	37.61	45.50	67.23	13.5
●	5. Brachmann-16	75.33	52.04	73.33	56.50	17.84	24.35	88.67	55.44	4.4
●	6. Hodan-15-nopso	69.83	34.39	84.67	76.00	62.70	32.39	27.83	55.40	12.3
●	7. Buch-17-ppfh	56.60	36.96	95.00	75.00	25.10	20.80	68.67	54.02	14.2
●	8. Kehl-16	58.20	33.91	65.00	44.00	24.60	25.58	7.50	36.97	1.8
●	9. Buch-17-si	33.33	20.35	67.33	59.00	13.34	23.12	41.17	36.81	15.9
●	10. Brachmann-14	67.60	41.52	78.67	24.00	0.25	30.22	0.00	34.61	1.4
●	11. Buch-17-ecsad	13.27	9.62	40.67	59.00	7.16	6.59	24.00	22.90	5.9
●	12. Buch-17-shot	5.97	1.45	43.00	38.50	3.83	0.07	16.67	15.64	6.7
●	13. Tejani-14	12.10	4.50	36.33	10.00	0.13	1.52	0.00	9.23	1.4
●	14. Buch-16-ppfh	8.13	2.28	20.00	2.50	7.81	8.99	0.67	7.20	47.1
●	15. Buch-16-ecsad	3.70	0.97	3.67	4.00	1.24	2.90	0.17	2.38	39.1

Methods based on Point Pair Features, Template matching methods,
Learning-based methods, Methods based on 3D local features

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15.	Buch-16-ecsad	3.70	0.97	3.67	4.00	1.24	2.90	0.17	2.38	39.1

Methods based on Point Pair Features (PPF) performed best

Methods based on Point Pair Features, Template matching methods,
Learning-based methods, Methods based on 3D local features

BOP Challenge 2019

Classical and CNN (RGB, RGB-D and D) methods on the **ViVo task**.

#	Method	Image	Average	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time (s)
1	Vidal-Sensors18 [1]	D	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
2	Drost-CVPR10-Edges [2]	RGB-D	0.550	0.515	0.500	0.851	0.368	0.570	0.671	0.375	87.568
3	Drost-CVPR10-3D-Edges [2]	D	0.500	0.469	0.404	0.852	0.373	0.462	0.623	0.316	80.055
4	Drost-CVPR10-3D-Only [2]	D	0.487	0.527	0.444	0.775	0.388	0.316	0.615	0.344	7.704
5	Drost-CVPR10-3D-Only-Faster [2]	D	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	1.383
6	Félix&Neves-ICRA17-IET19 [3,4]	RGB-D	0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
7	Sundermeyer-IJCV19+ICP [5]	RGB-D	0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
8	Zhigang-CDPN-ICCV19 [6]	RGB	0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
9	Sundermeyer-IJCV19 [5]	RGB	0.270	0.146	0.304	0.401	0.217	0.101	0.346	0.377	0.186
10	Pix2Pose-BOP-ICCV19 [7]	RGB	0.205	0.077	0.275	0.349	0.215	0.032	0.200	0.290	0.793
11	DPOD (synthetic) [8]	RGB	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231

[1] **Joel Vidal et al.**, *A Method for 6D Pose Estimation of Free-Form Rigid Objects Using Point Pair Features on Range Data*, Sensors 2018.

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[6] **Zhigang Li et al.**, *CDPN: Coordinates-Based Disentangled Pose Network for Real-Time RGB-Based 6-DoF Object Pose Estimation*, ICCV 2019.

[7] **Kiru Park et al.**, *Pix2Pose: Pixel-Wise Coordinate Regression of Objects for 6D Pose Estimation*, ICCV 2019.

[8] **Sergey Zakharov et al.**, *DPOD: Dense 6D Pose Object Detector in RGB images*, ICCV 2019.

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4	Drost-CVPR10-3D-Only [2]	D	Methods using depth				0.388	0.316	0.615	0.344	7.704
5	Drost-CVPR10-3D-Only-Faster [2]	D	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	1.383
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CNN-based methods

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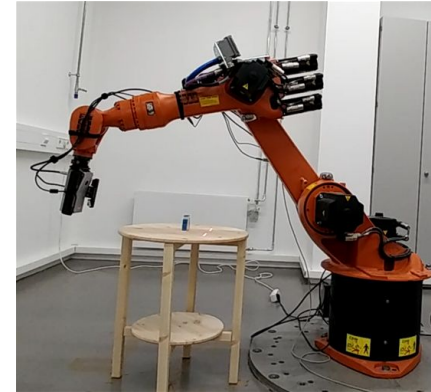
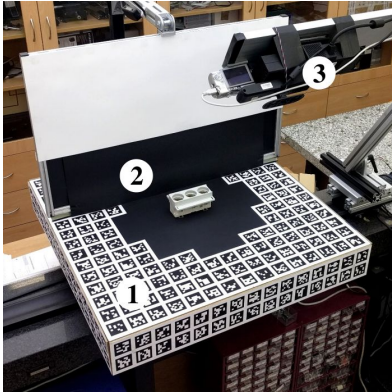
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BOP Challenge 2019

Classical methods outperformed CNN methods, because of:

1. **Insufficient number of real training images** annotated with 6D object poses – annotation is expensive!



2. **Large domain gap** between real test images and the commonly used synthetic training images (objects rendered on random background).



BOP Challenge 2020 – What is new?

- **BlenderProc4BOP** – an open-source photorealistic (PBR) renderer.
- **350K pre-rendered training images** provided to the participants.



BOP Challenge 2020 – Submissions

Submission system: bop.felk.cvut.cz, deadline: August 19, 2020.

862 submissions, 665 since BOP 2019.

One submission = results of one method on one dataset.

26 methods, 15 since BOP 2019, evaluated on all 7 core datasets:
LM-O, T-LESS, TUD-L, IC-BIN, ITODD, HB, YCB-V.

BOP: Benchmark for 6D Object Pose Estimation

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BOP Challenge 2019/2020: [Core datasets](#) [LM](#) [LM-O](#) [T-LESS](#) [ITODD](#) [HB](#) [YCB-V](#) [RU-APC](#) [IC-BIN](#) [IC-MI](#) [TUD-L](#) [TYO-L](#)

BOP Challenge 2019/2020 – core datasets

This leaderbord shows the overall ranking on the [core datasets](#) (LM-O, T-LESS, TUD-L, IC-BIN, ITODD, HB, YCB-V). For each method, the date of the latest considered submission is reported. If more submissions of a method are available for a dataset, the submission with the highest AR score is considered. The performance scores are defined in the [challenge description](#). The reported time is the average image processing time averaged over the core datasets.

Show entries

Search:

	Date (UTC) ↕	Method	Test image ↕	AR _{Core} ↕	AR _{LM-O} ↕	AR _{T-LESS} ↕	AR _{TUD-L} ↕	AR _{IC-BIN} ↕	AR _{ITODD} ↕	AR _{HB} ↕	AR _{YCB-V} ↕	Time (s) ↕
1	2020-08-19	CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	RGB-D	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
2	2020-08-19	Koenig-Hybrid-DL-PointPairs	RGB-D	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
3	2020-08-18	CosyPose-ECCV20-SYNT+REAL-1VIEW	RGB	0.637	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
4	2020-08-17	Pix2Pose-BOP20_w/ICP-ICCV19	RGB-D	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844
5	2020-08-18	CosyPose-ECCV20-PBR-1VIEW	RGB	0.570	0.633	0.640	0.685	0.583	0.216	0.656	0.574	0.475
6	2019-10-22	Vidal-Sensors18	D	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220

BOP Challenge 2020 – Results

#	Method	Year	PPF	CNN	...models	Train. im.	...type	Test im.	Refine.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	CosyPose-ECCV20-Synt+Real-1View-ICP	2020	No	Yes	3/dataset	RGB	Synt+real	RGB-D	RGB+ICP	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
2	Koenig-Hybrid-DL-PointPairs	2020	Yes	Yes	1/dataset	RGB	Synt+real	RGB-D	ICP	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
3	CosyPose-ECCV20-Synt+Real-1View	2020	No	Yes	3/dataset	RGB	Synt+real	RGB	RGB	0.637	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
4	Pix2Pose-BOP20_w/ICP-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844
5	CosyPose-ECCV20-PBR-1View	2020	No	Yes	3/dataset	RGB	PBR only	RGB	RGB	0.570	0.633	0.640	0.685	0.583	0.216	0.656	0.574	0.475
6	Vidal-Sensors18	2019	Yes	No	-	-	-	D	ICP	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
7	CDPNv2_BOP20 (RGB-only & ICP)	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.568	0.630	0.464	0.913	0.450	0.186	0.712	0.619	1.462
8	Drost-CVPR10-Edges	2019	Yes	No	-	-	-	RGB-D	ICP	0.550	0.515	0.500	0.851	0.368	0.570	0.671	0.375	87.568
9	CDPNv2_BOP20 (PBR-only & ICP)	2020	No	Yes	1/object	RGB	PBR only	RGB-D	ICP	0.534	0.630	0.435	0.791	0.450	0.186	0.712	0.532	1.491
10	CDPNv2_BOP20 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.529	0.624	0.478	0.772	0.473	0.102	0.722	0.532	0.935
11	Drost-CVPR10-3D-Edges	2019	Yes	No	-	-	-	D	ICP	0.500	0.469	0.404	0.852	0.373	0.462	0.623	0.316	80.055
12	Drost-CVPR10-3D-Only	2019	Yes	No	-	-	-	D	ICP	0.487	0.527	0.444	0.775	0.388	0.316	0.615	0.344	7.704
13	CDPN_BOP19 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.479	0.569	0.490	0.769	0.327	0.067	0.672	0.457	0.480
14	CDPNv2_BOP20 (PBR-only&RGB-only)	2020	No	Yes	1/object	RGB	PBR only	RGB	No	0.472	0.624	0.407	0.588	0.473	0.102	0.722	0.390	0.978
15	leaping from 2D to 6D	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.471	0.525	0.403	0.751	0.342	0.077	0.658	0.543	0.425
16	EPOS-BOP20-PBR	2020	No	Yes	1/dataset	RGB	PBR only	RGB	No	0.457	0.547	0.467	0.558	0.363	0.186	0.580	0.499	1.874
17	Drost-CVPR10-3D-Only-Faster	2019	Yes	No	-	-	-	D	ICP	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	1.383
18	Félix&Neves-ICRA2017-IET2019	2019	Yes	Yes	1/dataset	RGB-D	Synt+real	RGB-D	ICP	0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
19	Sundermeyer-IJCV19+ICP	2019	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
20	Zhigang-CDPN-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
21	PointVoteNet2	2020	No	Yes	1/object	RGB-D	PBR only	RGB-D	ICP	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
22	Pix2Pose-BOP20-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
23	Sundermeyer-IJCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.270	0.146	0.304	0.401	0.217	0.101	0.346	0.377	0.186
24	SingleMultiPathEncoder-CVPR20	2020	No	Yes	1/all	RGB	Synt+real	RGB	No	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
25	Pix2Pose-BOP19-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.205	0.077	0.275	0.349	0.215	0.032	0.200	0.290	0.793
26	DPOD (synthetic)	2019	No	Yes	1/scene	RGB	Synt	RGB	No	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231

BOP Challenge 2020 – Results

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26	DPOD (synthetic)	2019	No	Yes	1/scene	RGB	Synt	RGB	No	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231

Five new methods outperform Vidal-Sensors18, the winner of BOP 2018 & 2019.

BOP Challenge 2020 – Results

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4	Pix2Pose-BOP20_w/ICP-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844
5	CosyPose-ECCV20-PBR-1View	2020	No	Yes	3/dataset	RGB	PBR only	RGB	RGB	0.570	0.633	0.640	0.685	0.583	0.216	0.656	0.574	0.475
6	Vidal-Sensors18	2019	Yes	No	-	-	-	D	ICP	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
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CNN-based methods finally caught up with PPF-based methods!

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13	CDPN_BOP19 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.479	0.569	0.490	0.769	0.327	0.067	0.672	0.457	0.480
14	CDPNv2_BOP20 (PBR-only&RGB-only)	2020	No	Yes	1/object	RGB	PBR only	RGB	No	0.472	0.624	0.407	0.588	0.473	0.102	0.722	0.390	0.978
15	leaping from 2D to 6D	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.471	0.525	0.403	0.751	0.342	0.077	0.658	0.543	0.425
16	EPOS-BOP20-PBR	2020	No	Yes	1/dataset	RGB	PBR only	RGB	No	0.457	0.547	0.467	0.558	0.363	0.186	0.580	0.499	1.874
17	Drost-CVPR10-3D-Only-Faster	2019	Yes	No	-	-	-	D	ICP	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	1.383
18	Félix&Neves-ICRA2017-IET2019	2019	Yes	Yes	1/dataset	RGB-D	Synt+real	RGB-D	ICP	0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
19	Sundermeyer-IJCV19+ICP	2019	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
20	Zhigang-CDPN-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
21	PointVoteNet2	2020	No	Yes	1/object	RGB-D	PBR only	RGB-D	ICP	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
22	Pix2Pose-BOP20-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
23	Sundermeyer-IJCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.270	0.146	0.304	0.401	0.217	0.101	0.346	0.377	0.186
24	SingleMultiPathEncoder-CVPR20	2020	No	Yes	1/all	RGB	Synt+real	RGB	No	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
25	Pix2Pose-BOP19-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.205	0.077	0.275	0.349	0.215	0.032	0.200	0.290	0.793
26	DPOD (synthetic)	2019	No	Yes	1/scene	RGB	Synt	RGB	No	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231

CNN models can be effectively shared among multiple objects.
 Training special CNN model(s) per object used to be a common practise.

BOP Challenge 2020 – Results

#	Method	Year	PPF	CNN	...models	Train. im.	...type	Test im.	Refine.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	CosyPose-ECCV20-Synt+Real-1View-ICP	2020	No	Yes	3/dataset	RGB	Synt+real	RGB-D	RGB+ICP	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
2	Koenig-Hybrid-DL-PointPairs	2020	Yes	Yes	1/dataset	RGB	Synt+real	RGB-D	ICP	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
3	CosyPose-ECCV20-Synt+Real-1View	2020	No	Yes	3/dataset	RGB	Synt+real	RGB	RGB	0.637	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
4	Pix2Pose-BOP20_w/ICP-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844
5	CosyPose-ECCV20-PBR-1View	2020	No	Yes	3/dataset	RGB	PBR only	RGB	RGB	0.570	0.633	0.640	0.685	0.583	0.216	0.656	0.574	0.475
6	Vidal-Sensors18	2019	Yes	No	-	-	-	D	ICP	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
7	CDPNv2_BOP20 (RGB-only & ICP)	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.568	0.630	0.464	0.913	0.450	0.186	0.712	0.619	1.462
8	Drost-CVPR10-Edges	2019	Yes	No	-	-	-	RGB-D	ICP	0.550	0.515	0.500	0.851	0.368	0.570	0.671	0.375	87.568
9	CDPNv2_BOP20 (PBR-only & ICP)	2020	No	Yes	1/object	RGB	PBR only	RGB-D	ICP	0.534	0.630	0.435	0.791	0.450	0.186	0.712	0.532	1.491
10	CDPNv2_BOP20 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.529	0.624	0.478	0.772	0.473	0.102	0.722	0.532	0.935
11	Drost-CVPR10-3D-Edges	2019	Yes	No	-	-	-	D	ICP	0.500	0.469	0.404	0.852	0.373	0.462	0.623	0.316	80.055
12	Drost-CVPR10-3D-Only	2019	Yes	No	-	-	-	D	ICP	0.487	0.527	0.444	0.775	0.388	0.316	0.615	0.344	7.704
13	CDPN_BOP19 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.479	0.569	0.490	0.769	0.327	0.067	0.672	0.457	0.480
14	CDPNv2_BOP20 (PBR-only&RGB-only)	2020	No	Yes	1/object	RGB	PBR only	RGB	No	0.472	0.624	0.407	0.588	0.473	0.102	0.722	0.390	0.978
15	leaping from 2D to 6D	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.471	0.525	0.403	0.751	0.342	0.077	0.658	0.543	0.425
16	EPOS-BOP20-PBR	2020	No	Yes	1/dataset	RGB	PBR only	RGB	No	0.457	0.547	0.467	0.558	0.363	0.186	0.580	0.499	1.874
17	Drost-CVPR10-3D-Only-Faster	2019	Yes	No	-	-	-	D	ICP	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	1.383
18	Félix&Neves-ICRA2017-IET2019	2019	Yes	Yes	1/dataset	RGB-D	Synt+real	RGB-D	ICP	0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
19	Sundermeyer-IJCV19+ICP	2019	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
20	Zhigang-CDPN-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
21	PointVoteNet2	2020	No	Yes	1/object	RGB-D	PBR only	RGB-D	ICP	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
22	Pix2Pose-BOP20-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
23	Sundermeyer-IJCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.270	0.146	0.304	0.401	0.217	0.101	0.346	0.377	0.186
24	SingleMultiPathEncoder-CVPR20	2020	No	Yes	1/all	RGB	Synt+real	RGB	No	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
25	Pix2Pose-BOP19-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.205	0.077	0.275	0.349	0.215	0.032	0.200	0.290	0.793
26	DPOD (synthetic)	2019	No	Yes	1/scene	RGB	Synt	RGB	No	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231

Almost all participating deep learning methods train on RGB images only.
 Deep RGB-D approaches (e.g. DenseFusion) are welcome to join the challenge!

BOP Challenge 2020 – Results

#	Method	Year	PPF	CNN	...models	Train. im.	...type	Test im.	Refine.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	CosyPose-ECCV20-Synt+Real-1View-ICP	2020	No	Yes	3/dataset	RGB	Synt+real	RGB-D	RGB+ICP	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
2	Koenig-Hybrid-DL-PointPairs	2020	Yes	Yes	1/dataset	RGB	Synt+real	RGB-D	ICP	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
3	CosyPose-ECCV20-Synt+Real-1View	2020	No	Yes	3/dataset	RGB	Synt+real	RGB	RGB	0.637	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
4	Pix2Pose-BOP20_w/ICP-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844
5	CosyPose-ECCV20-PBR-1View	2020	No	Yes	3/dataset	RGB	PBR only	RGB	RGB	0.570	0.633	0.640	0.685	0.583	0.216	0.656	0.574	0.475
6	Vidal-Sensors18	2019	Yes	No	-	-	-	D	ICP	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
7	CDPNv2_BOP20 (RGB-only & ICP)	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.568	0.630	0.464	0.913	0.450	0.186	0.712	0.619	1.462
8	Drost-CVPR10-Edges	2019	Yes	No	-	-	-	RGB-D	ICP	0.550	0.515	0.500	0.851	0.368	0.570	0.671	0.375	87.568
9	CDPNv2_BOP20 (PBR-only & ICP)	2020	No	Yes	1/object	RGB	PBR only	RGB-D	ICP	0.534	0.630	0.435	0.791	0.450	0.186	0.712	0.532	1.491
10	CDPNv2_BOP20 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.529	0.624	0.478	0.772	0.473	0.102	0.722	0.532	0.935
11	Drost-CVPR10-3D-Edges	2019	Yes	No	-	-	-	D	ICP	0.500	0.469	0.404	0.852	0.373	0.462	0.623	0.316	80.055
12	Drost-CVPR10-3D-Only	2019	Yes	No	-	-	-	D	ICP	0.487	0.527	0.444	0.775	0.388	0.316	0.615	0.344	7.704
13	CDPN_BOP19 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.479	0.569	0.490	0.769	0.327	0.067	0.672	0.457	0.480
14	CDPNv2_BOP20 (PBR-only&RGB-only)	2020	No	Yes	1/object	RGB	PBR only	RGB	No	0.472	0.624	0.407	0.588	0.473	0.102	0.722	0.390	0.978
15	leaping from 2D to 6D	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.471	0.525	0.403	0.751	0.342	0.077	0.658	0.543	0.425
16	EPOS-BOP20-PBR	2020	No	Yes	1/dataset	RGB	PBR only	RGB	No	0.457	0.547	0.467	0.558	0.363	0.186	0.580	0.499	1.874
17	Drost-CVPR10-3D-Only-Faster	2019	Yes	No	-	-	-	D	ICP	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	1.383
18	Félix&Neves-ICRA2017-IET2019	2019	Yes	Yes	1/dataset	RGB-D	Synt+real	RGB-D	ICP	0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
19	Sundermeyer-IJCV19+ICP	2019	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
20	Zhigang-CDPN-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
21	PointVoteNet2	2020	No	Yes	1/object	RGB-D	PBR only	RGB-D	ICP	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
22	Pix2Pose-BOP20-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
23	Sundermeyer-IJCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.270	0.146	0.304	0.401	0.217	0.101	0.346	0.377	0.186
24	SingleMultiPathEncoder-CVPR20	2020	No	Yes	1/all	RGB	Synt+real	RGB	No	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
25	Pix2Pose-BOP19-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.205	0.077	0.275	0.349	0.215	0.032	0.200	0.290	0.793
26	DPOD (synthetic)	2019	No	Yes	1/scene	RGB	Synt	RGB	No	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231

Most methods used both synthetic and real training images, but...

BOP Challenge 2020 – Results

#	Method	Year	PPF	CNN	...models	Train. im.	...type	Test im.	Refine.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	CosyPose-ECCV20-Synt+Real-1View-ICP	2020	No	Yes	3/dataset	RGB	Synt+real	RGB-D	RGB+ICP	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
2	Koenig-Hybrid-DL-PointPairs	2020	Yes	Yes	1/dataset	RGB	Synt+real	RGB-D	ICP	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
3	CosyPose-ECCV20-Synt+Real-1View	2020	No	Yes	3/dataset	RGB	Synt+real	RGB-D	ICP	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
4	Pix2Pose-BOP20_w/ICP-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844
5	CosyPose-ECCV20-PBR-1View	2020	No	Yes	3/dataset	RGB	PBR only	RGB-D	ICP	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
6	Vidal-Sensors18	2019	Yes	No	-	-	-	D	ICP	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
7	CDPNv2_BOP20 (RGB-only & ICP)	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.568	0.630	0.464	0.913	0.450	0.186	0.712	0.619	1.462
8	Drost-CVPR10-Edges	2019	Yes	No	-	-	-	RGB-D	ICP	0.550	0.515	0.500	0.851	0.368	0.570	0.671	0.375	87.568
9	CDPNv2_BOP20 (PBR-only & ICP)	2020	No	Yes	1/object	RGB	PBR only	RGB-D	ICP	0.534	0.630	0.435	0.791	0.450	0.186	0.712	0.532	1.491
10	CDPNv2_BOP20 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.529	0.624	0.478	0.772	0.473	0.102	0.722	0.532	0.935
11	Drost-CVPR10-3D-Edges	2019	Yes	No	-	-	-	D	ICP	0.500	0.469	0.404	0.852	0.373	0.462	0.623	0.316	80.055
12	Drost-CVPR10-3D-Only	2019	Yes	No	-	-	-	D	ICP	0.487	0.527	0.444	0.775	0.388	0.316	0.615	0.344	7.704
13	CDPN_BOP19 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.479	0.569	0.490	0.769	0.327	0.067	0.672	0.457	0.480
14	CDPNv2_BOP20 (PBR-only&RGB-only)	2020	No	Yes	1/object	RGB	PBR only	RGB	No	0.472	0.624	0.407	0.588	0.473	0.102	0.722	0.390	0.978
15	leaping from 2D to 6D	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.471	0.525	0.403	0.751	0.342	0.077	0.658	0.543	0.425
16	EPOS-BOP20-PBR	2020	No	Yes	1/dataset	RGB	PBR only	RGB	No	0.457	0.547	0.467	0.558	0.363	0.186	0.580	0.499	1.874
17	Drost-CVPR10-3D-Only-Faster	2019	Yes	No	-	-	-	D	ICP	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	1.383
18	Félix&Neves-ICRA2017-IET2019	2019	Yes	Yes	1/dataset	RGB-D	Synt+real	RGB-D	ICP	0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
19	Sundermeyer-IJCV19+ICP	2019	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
20	Zhigang-CDPN-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
21	PointVoteNet2	2020	No	Yes	1/object	RGB-D	PBR only	RGB-D	ICP	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
22	Pix2Pose-BOP20-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
23	Sundermeyer-IJCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.270	0.146	0.304	0.401	0.217	0.101	0.346	0.377	0.186
24	SingleMultiPathEncoder-CVPR20	2020	No	Yes	1/all	RGB	Synt+real	RGB	No	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
25	Pix2Pose-BOP19-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.205	0.077	0.275	0.349	0.215	0.032	0.200	0.290	0.793
26	DPOD (synthetic)	2019	No	Yes	1/scene	RGB	Synt	RGB	No	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231

PBR + other synthetic + real images

PBR images

Competitive results can be achieved with PBR training images only.
 (For LM-O, IC-BIN, ITODD and HB, only synthetic training images are provided.)

BOP Challenge 2020 – Results

#	Method	Year	PPF	CNN	...models	Train. im.	...type	Test im.	Refine.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	CosyPose-ECCV20-Synt+Real-1View-ICP	2020	No	Yes	3/dataset	RGB	Synt+real	RGB-D	RGB+ICP	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
2	Koenig-Hybrid-DL-PointPairs	2020	Yes	Yes	1/dataset	RGB	Synt+real	RGB-D	ICP	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
3	CosyPose-ECCV20-Synt+Real-1View	2020	No	Yes	3/dataset	RGB	Synt+real	RGB	RGB	0.637	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
4	Pix2Pose-BOP20_w/ICP-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844
5	CosyPose-ECCV20-PBR-1View	2020	No	Yes	3/dataset	RGB	PBR only	RGB	RGB	0.570	0.633	0.640	0.685	0.583	0.216	0.656	0.574	0.475
6	Vidal-Sensors18	2019	Yes	No	-	-	-	D	ICP	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
7	CDPNv2_BOP20 (RGB-only & ICP)	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.568	0.630	0.464	0.913	0.450	0.186	0.712	0.619	1.462
8	Drost-CVPR10-Edges	2019	Yes	No	-	-	-	RGB-D	ICP	0.550	0.515	0.500	0.851	0.368	0.570	0.671	0.375	87.568
9	CDPNv2_BOP20 (PBR-only & ICP)	2020	No	Yes	1/object	RGB	PBR only	RGB-D	ICP	0.534	0.630	0.435	0.791	0.450	0.186	0.712	0.532	1.491
10	CDPNv2_BOP20 (RGB-only)	2020	No	Yes	1/object	RGB	PBR + real images	RGB	ICP	0.624	0.624	0.478	0.772	0.473	0.102	0.722	0.532	0.935
11	Drost-CVPR10-3D-Edges	2019	Yes	No	-	-	-	D	ICP	0.500	0.469	0.404	0.852	0.373	0.462	0.623	0.316	80.055
12	Drost-CVPR10-3D-Only	2019	Yes	No	-	-	-	D	ICP	0.487	0.527	0.444	0.775	0.388	0.316	0.615	0.344	7.704
13	CDPN_BOP19 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.479	0.569	0.490	0.769	0.327	0.067	0.672	0.457	0.480
14	CDPNv2_BOP20 (PBR-only&RGB-only)	2020	No	Yes	1/object	RGB	PBR images	RGB	ICP	0.624	0.624	0.407	0.588	0.473	0.102	0.722	0.390	0.978
15	leaping from 2D to 6D	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.471	0.525	0.403	0.751	0.342	0.077	0.658	0.543	0.425
16	EPOS-BOP20-PBR	2020	No	Yes	1/dataset	RGB	PBR only	RGB	No	0.457	0.547	0.467	0.558	0.363	0.186	0.580	0.499	1.874
17	Drost-CVPR10-3D-Only-Faster	2019	Yes	No	-	-	-	D	ICP	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	1.383
18	Félix&Neves-ICRA2017-IET2019	2019	Yes	Yes	1/dataset	RGB-D	Synt+real	RGB-D	ICP	0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
19	Sundermeyer-IJCV19+ICP	2019	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
20	Zhigang-CDPN-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
21	PointVoteNet2	2020	No	Yes	1/object	RGB-D	PBR only	RGB-D	ICP	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
22	Pix2Pose-BOP20-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
23	Sundermeyer-IJCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.270	0.146	0.304	0.401	0.217	0.101	0.346	0.377	0.186
24	SingleMultiPathEncoder-CVPR20	2020	No	Yes	1/all	RGB	Synt+real	RGB	No	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
25	Pix2Pose-BOP19-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.205	0.077	0.275	0.349	0.215	0.032	0.200	0.290	0.793
26	DPOD (synthetic)	2019	No	Yes	1/scene	RGB	Synt	RGB	No	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231

Competitive results can be achieved with PBR training images only.

(For LM-O, IC-BIN, ITODD and HB, only synthetic training images are provided.)

BOP Challenge 2020 – Results

#	Method	Year	PPF	CNN	...models	Train. im.	...type	Test im.	Refine.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	CosyPose-ECCV20-Synt+Real-1View-ICP	2020	No	Yes	3/dataset	RGB	Synt+real	RGB-D	RGB+ICP	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
2	Koenig-Hybrid-DL-PointPairs	2020	Yes	Yes	1/dataset	RGB	Synt+real	RGB-D	ICP	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
3	CosyPose-ECCV20-Synt+Real-1View	2020	No	Yes	3/dataset	RGB	Synt+real	RGB	RGB	0.637	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
4	Pix2Pose-BOP20_w/ICP-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844
5	CosyPose-ECCV20-PBR-1View	2020	No	Yes	3/dataset	RGB	PBR only	RGB	RGB	0.570	0.633	0.640	0.685	0.583	0.216	0.656	0.574	0.475
6	Vidal-Sensors18	2019	Yes	No	-	-	-	D	ICP	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
7	CDPNv2_BOP20 (RGB-only & ICP)	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.568	0.630	0.464	0.913	0.450	0.186	0.712	0.619	1.462
8	Drost-CVPR10-Edges	2019	Yes	No	-	-	-	RGB-D	ICP	0.550	0.515	0.500	0.851	0.368	0.570	0.671	0.375	87.568
9	CDPNv2_BOP20 (PBR-only & ICP)	2020	No	Yes	1/object	RGB	PBR only	RGB-D	ICP	0.534	0.630	0.435	0.791	0.450	0.186	0.712	0.532	1.491
10	CDPNv2_BOP20 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.529	0.624	0.478	0.772	0.473	0.102	0.722	0.532	0.935
11	Drost-CVPR10-3D-Edges	2019	Yes	No	-	-	-	D	ICP	0.500	0.469	0.404	0.852	0.373	0.462	0.623	0.316	80.055
12	Drost-CVPR10-3D-Only	2019	Yes	No	-	-	-	D	ICP	0.487	0.527	0.444	0.775	0.388	0.316	0.615	0.344	7.704
13	CDPN_BOP19 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.479	0.569	0.490	0.769	0.327	0.067	0.672	0.457	0.480
14	CDPNv2_BOP20 (PBR-only&RGB-only)	2020	No	Yes	1/object	RGB	PBR only	RGB	No	0.472	0.624	0.407	0.588	0.473	0.102	0.722	0.390	0.978
15	leaping from 2D to 6D	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.471	0.525	0.403	0.751	0.342	0.077	0.658	0.543	0.425
16	EPOS-BOP20-PBR	2020	No	Yes	1/dataset	RGB	PBR only	RGB	No	0.457	0.547	0.467	0.558	0.363	0.186	0.580	0.499	1.874
17	Drost-CVPR10-3D-Only-Faster	2019	Yes	No	-	-	-	D	ICP	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	1.383
18	Félix&Neves-ICRA2017-IET2019	2019	Yes	Yes	1/dataset	RGB-D	Synt+real	RGB-D	ICP	0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
19	Sundermeyer-IJCV19+ICP	2019	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
20	Zhigang-CDPN-Images of objects on random backgrounds	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
21	PointVoteNet2	2020	No	Yes	1/object	RGB-D	PBR only	RGB-D	ICP	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
22	Pix2Pose-BOP20-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
23	Sundermeyer-IJCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.270	0.146	0.304	0.401	0.217	0.101	0.346	0.377	0.186
24	SingleMultiPathEncoder-CVPR20	2020	No	Yes	1/all	RGB	Synt+real	RGB	No	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
25	Pix2Pose-BOP19-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.205	0.077	0.275	0.349	0.215	0.032	0.200	0.290	0.793
26	DPOD (synthetic)	2019	No	Yes	1/scene	RGB	Synt	RGB	No	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231

PBR training images yield a noticeable improvement over “naively” synthesized images (objects rendered on random backgrounds).

Similarly to CDPN, EPOS jumped from 0.44 to 0.55 on LM-O with the PBR images.

BOP Challenge 2020 – Results

#	Method	Year	PPF	CNN	...models	Train. im.	...type	Test im.	Refine.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	CosyPose-ECCV20-Synt+Real-1View-ICP	2020	No	Yes	3/dataset	RGB	Synt+real	RGB-D	RGB+ICP	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
2	Koenig-Hybrid-DL-PointPairs	2020	Yes	Yes	1/dataset	RGB	Synt+real	RGB-D	ICP	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
3	CosyPose-ECCV20-Synt+Real-1View	2020	No	Yes	3/dataset	RGB	Synt+real	RGB	RGB	0.637	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
4	Pix2Pose-BOP20_w/ICP-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844
5	CosyPose-ECCV20-PBR-1View	2020	No	Yes	3/dataset	RGB	PBR only	RGB	RGB	0.570	0.633	0.640	0.685	0.583	0.216	0.656	0.574	0.475
6	Vidal-Sensors18	2019	Yes	No	-	-	-	D	ICP	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
7	CDPNv2_BOP20 (RGB-only & ICP)	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.568	0.630	0.464	0.913	0.450	0.186	0.712	0.619	1.462
8	Drost-CVPR10-Edges	2019	Yes	No	-	-	-	RGB-D	ICP	0.550	0.515	0.500	0.851	0.368	0.570	0.671	0.375	87.568
9	CDPNv2_BOP20 (PBR-only & ICP)	2020	No	Yes	1/object	RGB	PBR only	RGB-D	ICP	0.534	0.630	0.435	0.791	0.450	0.186	0.712	0.532	1.491
10	CDPNv2_BOP20 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.529	0.624	0.478	0.772	0.473	0.102	0.722	0.532	0.935
11	Drost-CVPR10-3D-Edges	2019	Yes	No	-	-	-	D	ICP	0.500	0.469	0.404	0.852	0.373	0.462	0.623	0.316	80.055
12	Drost-CVPR10-3D-Only	2019	Yes	No	-	-	-	D	ICP	0.487	0.527	0.444	0.775	0.388	0.316	0.615	0.344	7.704
13	CDPN_BOP19 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.479	0.569	0.490	0.769	0.327	0.067	0.672	0.457	0.480
14	CDPNv2_BOP20 (PBR-only&RGB-only)	2020	No	Yes	1/object	RGB	PBR only	RGB	No	0.472	0.624	0.407	0.588	0.473	0.102	0.722	0.390	0.978
15	leaping from 2D to 6D	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.471	0.525	0.403	0.751	0.342	0.077	0.658	0.543	0.425
16	EPOS-BOP20-PBR	2020	No	Yes	1/dataset	RGB	PBR only	RGB	No	0.457	0.547	0.467	0.558	0.363	0.186	0.580	0.499	1.874
17	Drost-CVPR10-3D-Only-Faster	2019	Yes	No	-	-	-	D	ICP	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	1.383
18	Félix&Neves-ICRA2017-IET2019	2019	Yes	Yes	1/dataset	RGB-D	Synt+real	RGB-D	ICP	0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
19	Sundermeyer-IJCV19+ICP	2019	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
20	Zhigang-CDPN-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
21	PointVoteNet2	2020	No	Yes	1/object	RGB-D	PBR only	RGB-D	ICP	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
22	Pix2Pose-BOP20-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
23	Sundermeyer-IJCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.270	0.146	0.304	0.401	0.217	0.101	0.346	0.377	0.186
24	SingleMultiPathEncoder-CVPR20	2020	No	Yes	1/all	RGB	Synt+real	RGB	No	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
25	Pix2Pose-BOP19-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.205	0.077	0.275	0.349	0.215	0.032	0.200	0.290	0.793
26	DPOD (synthetic)	2019	No	Yes	1/scene	RGB	Synt	RGB	No	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231

The RGB methods are back! The clear dominance of D-based methods is over.

BOP Challenge 2020 – Results

#	Method	Year	PPF	CNN	...models	Train. im.	...type	Test im.	Refine.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	CosyPose-ECCV20-Synt+Real-1View-ICP	2020	No	Yes	3/dataset	RGB	Synt+real	RGB-D	RGB+ICP	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
2	Koenig-Hybrid-DL-PointPairs	2020	Yes	Yes	1/dataset	RGB	Synt+real	RGB-D	ICP	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
3	CosyPose-ECCV20-Synt+Real-1View	2020	No	Yes	3/dataset	RGB	Synt+real	RGB	RGB	0.637	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
4	Pix2Pose-BOP20_w/ICP-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844
5	CosyPose-ECCV20-PBR-1View	2020	No	Yes	3/dataset	RGB	PBR only	RGB	RGB	0.570	0.633	0.640	0.685	0.583	0.216	0.656	0.574	0.475
6	Vidal-Sensors18	2019	Yes	No	-	-	-	D	ICP	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
7	CDPNv2_BOP20 (RGB-only & ICP)	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.568	0.630	0.464	0.913	0.450	0.186	0.712	0.619	1.462
8	Drost-CVPR10-Edges	2019	Yes	No	-	-	-	RGB-D	ICP	0.550	0.515	0.500	0.851	0.368	0.570	0.671	0.375	87.568
9	CDPNv2_BOP20 (PBR-only & ICP)	2020	No	Yes	1/object	RGB	PBR only	RGB-D	ICP	0.534	0.630	0.435	0.791	0.450	0.186	0.712	0.532	1.491
10	CDPNv2_BOP20 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.529	0.624	0.478	0.772	0.473	0.102	0.722	0.532	0.935
11	Drost-CVPR10-3D-Edges	2019	Yes	No	-	-	-	D	ICP	0.500	0.469	0.404	0.852	0.373	0.462	0.623	0.316	80.055
12	Drost-CVPR10-3D-Only	2019	Yes	No	-	-	-	D	ICP	0.487	0.527	0.444	0.775	0.388	0.316	0.615	0.344	7.704
13	CDPN_BOP19 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.479	0.569	0.490	0.769	0.327	0.067	0.672	0.457	0.480
14	CDPNv2_BOP20 (PBR-only&RGB-only)	2020	No	Yes	1/object	RGB	PBR only	RGB	No	0.472	0.624	0.407	0.588	0.473	0.102	0.722	0.390	0.978
15	leaping from 2D to 6D	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.471	0.525	0.403	0.751	0.342	0.077	0.658	0.543	0.425
16	EPOS-BOP20-PBR	2020	No	Yes	1/dataset	RGB	PBR only	RGB	No	0.457	0.547	0.467	0.558	0.363	0.186	0.580	0.499	1.874
17	Drost-CVPR10-3D-Only-Faster	2019	Yes	No	-	-	-	D	ICP	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	1.383
18	Félix&Neves-ICRA2017-IET2019	2019	Yes	Yes	1/dataset	RGB-D	Synt+real	RGB-D	ICP	0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
19	Sundermeyer-IJCV19+ICP	2019	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
20	Zhigang-CDPN-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
21	PointVoteNet2	2020	No	Yes	1/object	RGB-D	PBR only	RGB-D	ICP	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
22	Pix2Pose-BOP20-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
23	Sundermeyer-IJCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.270	0.146	0.304	0.401	0.217	0.101	0.346	0.377	0.186
24	SingleMultiPathEncoder-CVPR20	2020	No	Yes	1/all	RGB	Synt+real	RGB	No	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
25	Pix2Pose-BOP19-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.205	0.077	0.275	0.349	0.215	0.032	0.200	0.290	0.793
26	DPOD (synthetic)	2019	No	Yes	1/scene	RGB	Synt	RGB	No	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231

Post-refinement of pose estimates boosts accuracy, but reduces speed (sometimes significantly).

BOP Challenge 2020 – Awards

#	Method	Year	PPF	CNN	...models	Train. im.	...type	Test im.	Refine.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	CosyPose-ECCV20-Synt+Real-1View-ICP	2020	No	Yes	3/dataset	RGB	Synt+real	RGB-D	RGB+ICP	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
2	Koenig-Hybrid-DL-PointPairs	2020	Yes	Yes	1/dataset	RGB	Synt+real	RGB-D	ICP	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
3	CosyPose-ECCV20-Synt+Real-1View	2020	No	Yes	3/dataset	RGB	Synt+real	RGB	RGB	0.637	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
4	Pix2Pose-BOP20_w/ICP-ICP	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844
5	CosyPose-ECCV20-PBR-1View	2020	No	Yes	3/dataset	RGB	PBR only	RGB	RGB	0.570	0.633	0.640	0.685	0.583	0.216	0.656	0.574	0.475
6	Vidal-Sensors	2019	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.568	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
7	CDPNv2-BOP20 (RGB-only & ICP)	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.568	0.630	0.464	0.913	0.450	0.186	0.712	0.619	1.462
8	Drost-CVPR10-3D-Edges	2019	Yes	No	-	-	-	D	ICP	0.529	0.624	0.478	0.772	0.473	0.102	0.722	0.532	87.568
9	CDPNv2-BOP20 (PBR-only & ICP)	2020	No	Yes	1/object	RGB	PBR only	RGB-D	ICP	0.534	0.630	0.435	0.791	0.450	0.186	0.712	0.532	1.491
10	CDPNv2_BOP20 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.529	0.624	0.478	0.772	0.473	0.102	0.722	0.532	0.935
11	Drost-CVPR10-3D-Edges	2019	Yes	No	-	-	-	D	ICP	0.506	0.469	0.404	0.755	0.377	0.462	0.623	0.316	80.055
12	Drost-CVPR10-3D-Only	2019	Yes	No	-	-	-	D	ICP	0.477	0.518	0.403	0.718	0.327	0.067	0.615	0.344	7.704
13	CDPN_BOP19 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.479	0.569	0.490	0.769	0.327	0.067	0.672	0.457	0.480
14	CDPNv2_BOP20 (PBR-only&RGB-only)	2020	No	Yes	1/object	RGB	PBR only	RGB	No	0.472	0.624	0.407	0.588	0.473	0.102	0.722	0.390	0.978
15	leaping from 2D to 6D	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.471	0.525	0.403	0.751	0.342	0.077	0.658	0.543	0.425
16	EPOS-BOP20-PBR	2020	No	Yes	1/dataset	RGB	PBR only	RGB	No	0.457	0.547	0.467	0.558	0.363	0.186	0.580	0.499	1.874
17	Drost-CVPR10-3D-Only-Faster	2019	Yes	No	-	-	-	D	ICP	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	1.383
18	Félix&Neves-ICRA2017-IET2019	2019	Yes	Yes	1/dataset	RGB-D	Synt+real	RGB-D	ICP	0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
19	Sundermeyer-IJCV19+ICP	2019	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
20	Zhigang-CDPN-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
21	PointVoteNet2	2020	No	Yes	1/object	RGB-D	PBR only	RGB-D	ICP	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
22	Pix2Pose-BOP20-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
23	Sundermeyer-IJCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.270	0.146	0.304	0.401	0.217	0.101	0.346	0.377	0.186
24	SingleMultiPathEncoder-CVPR20	2020	No	Yes	1/all	RGB	Synt+real	RGB	No	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
25	Pix2Pose-BOP19-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.205	0.077	0.275	0.349	0.215	0.032	0.200	0.290	0.793
26	DPOD (synthetic)	2019	No	Yes	1/scene	RGB	Synt	RGB	No	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231



The Overall Best Method
CosyPose-ECCV20-Synt+Real-1View-ICP

Yann Labbé, Justin Carpentier, Mathieu Aubry, Josef Sivic,
CosyPose: Consistent multi-view multi-object 6D pose estimation, ECCV20.

The top-performing method on the seven core datasets.

BOP Challenge 2020 – Awards

#	Method	Year	PPF	CNN	...models	Train. im.	...type	Test im.	Refine.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	CosyPose-ECCV20-Synt+Real-1View-ICP	2020	No	Yes	3/dataset	RGB	Synt+real	RGB-D	RGB+ICP	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
2	Koenig-Hybrid-DL-PointPairs	2020	Yes	Yes	1/dataset	RGB	Synt+real	RGB-D	ICP	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
3	CosyPose-ECCV20-Synt+Real-1View	2020	No	Yes	3/dataset	RGB	Synt+real	RGB	RGB	0.637	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
4	Pix2Pose-BOP20_w/ICP-ICP	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844
5	CosyPose-ECCV20-PBR-1View	2020	No	Yes	3/dataset	RGB	PBR only	RGB	RGB	0.570	0.633	0.640	0.85	0.583	0.216	0.656	0.574	0.475
6	Vidal-Sensors	2019	No	No	1/object	RGB	Synt+real	D	ICP	0.568	0.602	0.464	0.776	0.393	0.435	0.706	0.450	3.220
7	CDPNv2-BOP20 (RGB-only & ICP)	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.568	0.630	0.464	0.913	0.450	0.186	0.712	0.619	1.462
8	Drost-CVPR10-3D-Edges	2019	Yes	No	-	-	-	D	ICP	0.561	0.624	0.478	0.772	0.473	0.102	0.722	0.532	87.568
9	CDPNv2-BOP20 (PBR-only & ICP)	2020	No	Yes	1/object	RGB	PBR only	RGB-D	ICP	0.534	0.630	0.435	0.791	0.450	0.186	0.712	0.532	1.491
10	CDPNv2_BOP20 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.529	0.624	0.478	0.772	0.473	0.102	0.722	0.532	0.935
11	Drost-CVPR10-3D-Edges	2019	Yes	No	-	-	-	D	ICP	0.500	0.469	0.404	0.75	0.37	0.462	0.623	0.316	80.055
12	Drost-CVPR10-3D-Only	2019	Yes	No	-	-	-	D	ICP	0.477	0.518	0.403	0.718	0.327	0.067	0.615	0.344	7.704
13	CDPN_BOP19 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.479	0.569	0.490	0.769	0.327	0.067	0.672	0.457	0.480
14	CDPNv2_BOP20 (PBR-only&RGB-only)	2020	No	Yes	1/object	RGB	PBR only	RGB	No	0.472	0.624	0.407	0.588	0.473	0.102	0.722	0.390	0.978
15	leaping from 2D to 6D	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.471	0.525	0.403	0.751	0.342	0.077	0.658	0.543	0.425
16	EPOS-BOP20-PBR	2020	No	Yes	1/dataset	RGB	PBR only	RGB	No	0.457	0.547	0.467	0.558	0.363	0.186	0.580	0.499	1.874
17	Drost-CVPR10-3D-Only-Faster	2019	Yes	No	-	-	-	D	ICP	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	1.383
18	Félix&Neves-ICRA2017-IET2019	2019	Yes	Yes	1/dataset	RGB-D	Synt+real	RGB-D	ICP	0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
19	Sundermeyer-IJCV19+ICP	2019	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
20	Zhigang-CDPN-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
21	PointVoteNet2	2020	No	Yes	1/object	RGB-D	PBR only	RGB-D	ICP	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
22	Pix2Pose-BOP20-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
23	Sundermeyer-IJCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.270	0.146	0.304	0.401	0.217	0.101	0.346	0.377	0.186
24	SingleMultiPathEncoder-CVPR20	2020	No	Yes	1/all	RGB	Synt+real	RGB	No	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
25	Pix2Pose-BOP19-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.205	0.077	0.275	0.349	0.215	0.032	0.200	0.290	0.793
26	DPOD (synthetic)	2019	No	Yes	1/scene	RGB	Synt	RGB	No	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231



The Best Open-Source Method

CosyPose-ECCV20-Synt+Real-1View-ICP

Yann Labbé, Justin Carpentier, Mathieu Aubry, Josef Sivic,
 CosyPose: Consistent multi-view multi-object 6D pose estimation, ECCV20.

The top-performing method on the seven core datasets with publicly available source code.

BOP Challenge 2020 – Awards

#	Method	Year	PPF	CNN	...models	Train. im.	...type	Test im.	Refine.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	CosyPose-ECCV20-Synt+Real-1View-ICP	2020	No	Yes	3/dataset	RGB	Synt+real	RGB-D	RGB+ICP	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
2	Koenig-Hybrid-DL-PointPairs	2020	Yes	Yes	1/dataset	RGB	Synt+real	RGB-D	ICP	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
3	CosyPose-ECCV20-Synt+Real-1View	2020	No	Yes	3/dataset	RGB	Synt+real	RGB	RGB	0.637	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
4	Pix2Pose-BOP20_w/ICP-ICP	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844
5	CosyPose-ECCV20-PBR-1View	2020	No	Yes	3/dataset	RGB	PBR only	RGB	RGB	0.570	0.633	0.640	0.855	0.583	0.216	0.656	0.574	0.475
6	Vidal-Fusion	2019	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.568	0.632	0.636	0.876	0.393	0.435	0.706	0.450	3.220
7	CDPNv2-BOP20 (RGB-only & ICP)	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.568	0.630	0.464	0.913	0.450	0.186	0.712	0.619	1.462
8	Drost-CVPR10-3D-Edges	2019	Yes	No	-	-	-	D	ICP	0.561	0.624	0.478	0.772	0.473	0.102	0.722	0.532	87.568
9	CDPNv2-BOP20 (PBR-only & ICP)	2020	No	Yes	1/object	RGB	PBR only	RGB-D	ICP	0.534	0.630	0.435	0.791	0.450	0.186	0.712	0.532	1.491
10	CDPNv2_BOP20 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.529	0.624	0.478	0.772	0.473	0.102	0.722	0.532	0.935
11	Drost-CVPR10-3D-Edges	2019	Yes	No	-	-	-	D	ICP	0.500	0.469	0.404	0.755	0.377	0.462	0.623	0.316	80.055
12	Drost-CVPR10-3D-Only	2019	Yes	No	-	-	-	D	ICP	0.477	0.525	0.403	0.751	0.342	0.077	0.658	0.543	7.704
13	CDPN_BOP19 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.479	0.569	0.490	0.769	0.327	0.067	0.672	0.457	0.480
14	CDPNv2_BOP20 (PBR-only&RGB-only)	2020	No	Yes	1/object	RGB	PBR only	RGB	No	0.472	0.624	0.407	0.588	0.473	0.102	0.722	0.390	0.978
15	leaping from 2D to 6D	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.471	0.525	0.403	0.751	0.342	0.077	0.658	0.543	0.425
16	EPOS-BOP20-PBR	2020	No	Yes	1/dataset	RGB	PBR only	RGB	No	0.457	0.547	0.467	0.558	0.363	0.186	0.580	0.499	1.874
17	Drost-CVPR10-3D-Only-Faster	2019	Yes	No	-	-	-	D	ICP	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	1.383
18	Félix&Neves-ICRA2017-IET2019	2019	Yes	Yes	1/dataset	RGB-D	Synt+real	RGB-D	ICP	0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
19	Sundermeyer-IJCV19+ICP	2019	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
20	Zhigang-CDPN-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
21	PointVoteNet2	2020	No	Yes	1/object	RGB-D	PBR only	RGB-D	ICP	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
22	Pix2Pose-BOP20-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
23	Sundermeyer-IJCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.270	0.146	0.304	0.401	0.217	0.101	0.346	0.377	0.186
24	SingleMultiPathEncoder-CVPR20	2020	No	Yes	1/all	RGB	Synt+real	RGB	No	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
25	Pix2Pose-BOP19-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.205	0.077	0.275	0.349	0.215	0.032	0.200	0.290	0.793
26	DPOD (synthetic)	2019	No	Yes	1/scene	RGB	Synt	RGB	No	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231



The Best Single-Model Method

CosyPose-ECCV20-Synt+Real-1View-ICP

Yann Labbé, Justin Carpentier, Mathieu Aubry, Josef Sivic,

CosyPose: Consistent multi-view multi-object 6D pose estimation, ECCV20.

The top-performing method on the seven core datasets which uses a single machine learning model (e.g. a neural network) per dataset, i.e. not one per object.

BOP Challenge 2020 – Awards

#	Method	Year	PPF	CNN	...models	Train. im.	...type	Test im.	Refine.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	CosyPose-ECCV20-Synt+Real-1View-ICP	2020	No	Yes	3/dataset	RGB	Synt+real	RGB-D	RGB+ICP	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
2	Koenig-Hybrid-DL-PointPairs	2020	Yes	Yes	1/dataset	RGB	Synt+real	RGB-D	ICP	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
3	CosyPose-ECCV20-Synt+Real-1View	2020	No	Yes	3/dataset	RGB	Synt+real	RGB	RGB	0.637	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
4	Pix2Pose-BOP20-w/ICP-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844
5	CosyPose-ECCV20-PBR-1View	2020	No	Yes	3/dataset	RGB	PBR only	RGB	RGB	0.570	0.633	0.640	0.685	0.583	0.216	0.656	0.574	0.475
6	Vidal-CVPR19	2019	Yes	No	-	-	-	D	ICP	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
7	CDPNv2_BOP20 (RGB-only & PBR-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.568	0.630	0.464	0.913	0.450	0.186	0.712	0.619	1.462
8	Drost-CVPR10-3D-Only-Faster	2019	Yes	No	-	-	-	RGB-D	ICP	0.550	0.515	0.500	0.851	0.368	0.570	0.671	0.375	87.568
9	CDPNv2_BOP20 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.534	0.630	0.435	0.791	0.450	0.186	0.712	0.532	1.491
10	CDPNv2_BOP20 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.529	0.624	0.478	0.772	0.473	0.102	0.722	0.532	0.935
11	Drost-CVPR10-3D-Only	2019	Yes	No	-	-	-	D	ICP	0.500	0.469	0.404	0.852	0.373	0.462	0.623	0.316	80.055
12	Drost-CVPR10-3D-Only	2019	Yes	No	-	-	-	D	ICP	0.487	0.527	0.444	0.775	0.388	0.316	0.615	0.344	7.704
13	CDPN_BOP19 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.477	0.624	0.407	0.588	0.473	0.102	0.722	0.390	0.480
14	CDPNv2_BOP20 (PBR-only&RGB-only)	2020	No	Yes	1/object	RGB	PBR only	RGB	No	0.472	0.624	0.407	0.588	0.473	0.102	0.722	0.390	0.978
15	leaping from 2D to 6D	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.471	0.525	0.403	0.751	0.342	0.077	0.658	0.543	0.425
16	EPOS-BOP20-PBR	2020	No	Yes	1/dataset	RGB	PBR only	RGB	No	0.457	0.547	0.467	0.558	0.363	0.186	0.580	0.499	1.874
17	Drost-CVPR10-3D-Only-Faster	2019	Yes	No	-	-	-	D	ICP	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	1.383
18	Félix&Neves-ICRA2017-IET2019	2019	Yes	Yes	1/dataset	RGB-D	Synt+real	RGB-D	ICP	0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
19	Sundermeyer-IJCV19+ICP	2019	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
20	Zhigang-CDPN-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
21	PointVoteNet2	2020	No	Yes	1/object	RGB-D	PBR only	RGB-D	ICP	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
22	Pix2Pose-BOP20-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
23	Sundermeyer-IJCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.270	0.146	0.304	0.401	0.217	0.101	0.346	0.377	0.186
24	SingleMultiPathEncoder-CVPR20	2020	No	Yes	1/all	RGB	Synt+real	RGB	No	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
25	Pix2Pose-BOP19-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.205	0.077	0.275	0.349	0.215	0.032	0.200	0.290	0.793
26	DPOD (synthetic)	2019	No	Yes	1/scene	RGB	Synt	RGB	No	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231



The Best Fast Method

Koenig-Hybrid-DL-PointPairs

Rebecca Koenig, Bertram Drost,
A Hybrid Approach for 6DoF Pose Estimation, ECCVW'20.

The top-performing method on the seven core datasets with the average running time per image below 1s.

BOP Challenge 2020 – Awards

#	Method	Year	PPF	CNN	...models	Train. im.	...type	Test im.	Refine.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	CosyPose-ECCV20-Synt+Real-1View-ICP	2020	No	Yes	3/dataset	RGB	Synt+real	RGB-D	RGB+ICP	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
2	Koenig-Hybrid-DL-PointPairs	2020	Yes	Yes	1/dataset	RGB	Synt+real	RGB-D	ICP	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
3	CosyPose-ECCV20-Synt+Real-1View	2020	No	Yes	3/dataset	RGB	Synt+real	RGB	RGB	0.637	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
4	Pix2Pose-BOP20_w/ICP-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844
5	CosyPose-ECCV20-PBR-1View	2020	No	Yes	3/dataset	RGB	PBR only	RGB	RGB	0.570	0.633	0.640	0.685	0.583	0.216	0.656	0.574	0.475
6	Vidal-SemECCV18	2019	Yes	No	-	-	-	D	ICP	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
7	CDPN_v2_BOP20 (RGB-only & ICP)	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.569	0.630	0.464	0.913	0.450	0.186	0.712	0.619	1.462
8	Drost-CVPR10-3D-Edges	2019	Yes	Yes	-	-	-	D	ICP	0.553	0.553	0.500	0.851	0.368	0.570	0.671	0.375	87.568
9	CDPN_v2_BOP20 (PBR-only & ICP)	2020	No	Yes	1/object	RGB	PBR only	RGB-D	ICP	0.534	0.630	0.435	0.791	0.450	0.186	0.712	0.532	1.491
10	CDPN_v2_BOP20 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.534	0.630	0.435	0.791	0.450	0.186	0.712	0.532	0.935
11	Drost-CVPR10-3D-Edges	2019	Yes	No	-	-	-	D	ICP	0.500	0.469	0.404	0.852	0.373	0.462	0.623	0.316	80.055
12	Drost-CVPR10-3D-Edges	2019	Yes	No	-	-	-	D	ICP	0.487	0.527	0.444	0.775	0.388	0.316	0.615	0.344	7.704
13	CDPN_BOP19 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.475	0.369	0.436	0.761	0.327	0.067	0.672	0.457	0.480
14	CDPNv2_BOP20 (PBR-only&RGB-only)	2020	No	Yes	1/object	RGB	PBR only	RGB-D	ICP	0.472	0.630	0.435	0.791	0.450	0.186	0.712	0.390	0.978
15	leaping from 2D to 6D	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.471	0.525	0.403	0.751	0.342	0.077	0.658	0.543	0.425
16	EPOS-BOP20-PBR	2020	No	Yes	1/dataset	RGB	PBR only	RGB	No	0.457	0.547	0.467	0.558	0.363	0.186	0.580	0.499	1.874
17	Drost-CVPR10-3D-Only-Faster	2019	Yes	No	-	-	-	D	ICP	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	1.383
18	Félix&Neves-ICRA2017-IET2019	2019	Yes	Yes	1/dataset	RGB-D	Synt+real	RGB-D	ICP	0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
19	Sundermeyer-IJCV19+ICP	2019	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
20	Zhigang-CDPN-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
21	PointVoteNet2	2020	No	Yes	1/object	RGB-D	PBR only	RGB-D	ICP	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
22	Pix2Pose-BOP20-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
23	Sundermeyer-IJCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.270	0.146	0.304	0.401	0.217	0.101	0.346	0.377	0.186
24	SingleMultiPathEncoder-CVPR20	2020	No	Yes	1/all	RGB	Synt+real	RGB	No	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
25	Pix2Pose-BOP19-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.205	0.077	0.275	0.349	0.215	0.032	0.200	0.290	0.793
26	DPOD (synthetic)	2019	No	Yes	1/scene	RGB	Synt	RGB	No	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231



The Best RGB-Only Method

CosyPose-ECCV20-Synt+Real-1View

Yann Labbé, Justin Carpentier, Mathieu Aubry, Josef Sivic,

CosyPose: Consistent multi-view multi-object 6D pose estimation, ECCV20.

The top-performing RGB-only method on the seven core datasets.

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#	Method	Year	PPF	CNN	...models	Train. im.	...type	Test im.	Refine.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	CosyPose-ECCV20-Synt+Real-1View-ICP	2020	No	Yes	3/dataset	RGB	Synt+real	RGB-D	RGB+ICP	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
2	Koenig-Hybrid-DL-PointPairs	2020	Yes	Yes	1/dataset	RGB	Synt+real	RGB-D	ICP	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
3	CosyPose-ECCV20-Synt+Real-1View	2020	No	Yes	3/dataset	RGB	Synt+real	RGB	RGB	0.637	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
4	Pix2Pose-BOP20_w/ICP-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844
5	CosyPose-ECCV20-PBR-1View	2020	No	Yes	3/dataset	RGB	PBR only	RGB	RGB	0.570	0.633	0.640	0.685	0.583	0.216	0.656	0.574	0.475
6	Vidal-Sensors18	2019	Yes	No	-	-	-	D	ICP	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
7	CDPNv2_BOP20 (RGB-only & ICP)	2020	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.568	0.630	0.464	0.913	0.450	0.186	0.712	0.619	1.462
8	Drost-CVPR10-Edges	2019	Yes	No	-	-	-	RGB-D	ICP	0.550	0.515	0.500	0.851	0.368	0.570	0.671	0.375	87.568
9	CDPNv2_BOP20 (PBR-only & ICP)	2020	No	Yes	1/object	RGB	PBR only	RGB-D	ICP	0.521	0.630	0.435	0.701	0.450	0.186	0.712	0.532	1.491
10	CDPNv2_BOP20 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.520	0.624	0.445	0.772	0.390	0.102	0.722	0.532	0.935
11	Drost-CVPR10-3D-Only-Faster	2019	Yes	No	-	-	-	D	ICP	0.500	0.469	0.404	0.852	0.373	0.462	0.623	0.316	80.055
12	Drost-CVPR10-3D-Only	2019	Yes	No	-	-	-	D	ICP	0.487	0.527	0.444	0.775	0.388	0.316	0.615	0.344	7.704
13	CDPNv2_BOP20 (RGB-only)	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.479	0.569	0.490	0.769	0.327	0.067	0.672	0.457	0.480
14	CDPNv2_BOP20 (PBR-only)	2020	No	Yes	1/object	RGB	PBR only	RGB	No	0.472	0.624	0.407	0.588	0.473	0.102	0.722	0.390	0.978
15	leaping from 2D to 6D	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.471	0.325	0.403	0.716	0.340	0.077	0.658	0.543	0.425
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22	Pix2Pose-BOP20-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
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24	SingleMultiPathEncoder-CVPR20	2020	No	Yes	1/all	RGB	Synt+real	RGB	No	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
25	Pix2Pose-BOP19-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.205	0.077	0.275	0.349	0.215	0.032	0.200	0.290	0.793
26	DPOD (synthetic)	2019	No	Yes	1/scene	RGB	Synt	RGB	No	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231



The Best BlenderProc-Trained Method

CosyPose-ECCV20-PBR-1View

Yann Labbé, Justin Carpentier, Mathieu Aubry, Josef Sivic,

CosyPose: Consistent multi-view multi-object 6D pose estimation, ECCV'20.

The top-performing method on the seven core datasets which was trained only with the provided BlenderProc4BOP images.

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The Best Methods on Individual Datasets (1/2)

LM-O, TUD-L, IC-BIN, YCB-V: CosyPose-ECCV20-Synt+Real-1View-ICP

Yann Labbé, Justin Carpentier, Mathieu Aubry, Josef Sivic,

CosyPose: Consistent multi-view multi-object 6D pose estimation, ECCV'20.

ITODD, TYO-L: Drost-CVPR10-Edges

Bertram Drost, Markus Ulrich, Nassir Navab, Slobodan Ilic,

Model globally, match locally: Efficient and robust 3D object recognition, CVPR'10.

LM: DPODv2 (synthetic train data, RGB + D Kabsch)

Sergey Zakharov, Ivan Shugurov, Slobodan Ilic,

DPOD: Dense 6D Pose Object Detector in RGB images, ICCV'19.

T-LESS: CosyPose-ECCV20-Synt+Real-1View

Yann Labbé, Justin Carpentier, Mathieu Aubry, Josef Sivic,

CosyPose: Consistent multi-view multi-object 6D pose estimation, ECCV'20.

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The Best Methods on Individual Datasets (2/2)

HB: CDPNv2_BOP20 (RGB-only)

Zhigang Li, Gu Wang, Xiangyang Ji,

CDPN: Coordinates-Based Disentangled Pose Network for Real-Time RGB-Based 6-DoF Object Pose Estimation, ICCV'19.

RU-APC: Pix2Pose-BOP19_w/ICP-ICCV19

Kiru Park, Timothy Patten, Markus Vincze,

Pix2Pose: Pixel-Wise Coordinate Regression of Objects for 6D Pose Estimation, ICCV'19.

IC-MI: Drost-CVPR10-3D-Only

Bertram Drost, Markus Ulrich, Nassir Navab, Slobodan Ilic,

Model globally, match locally: Efficient and robust 3D object recognition, CVPR'10.

Summary

- BlenderProc4BOP – an open-source photorealistic (PBR) renderer.
- 350K pre-rendered PBR training images.
- 26 methods evaluated on all core datasets.
- CNN-based methods caught up with PPF-based methods.
- RGB methods yield strong results with the PBR training images.
- **The submission form for the BOP Challenge 2020 stays open!**