BOP Challenge 2023

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8th International Workshop on Recovering 6D Object Pose
ICCV 2023, October 3, Paris

bop.felk.cvut.cz

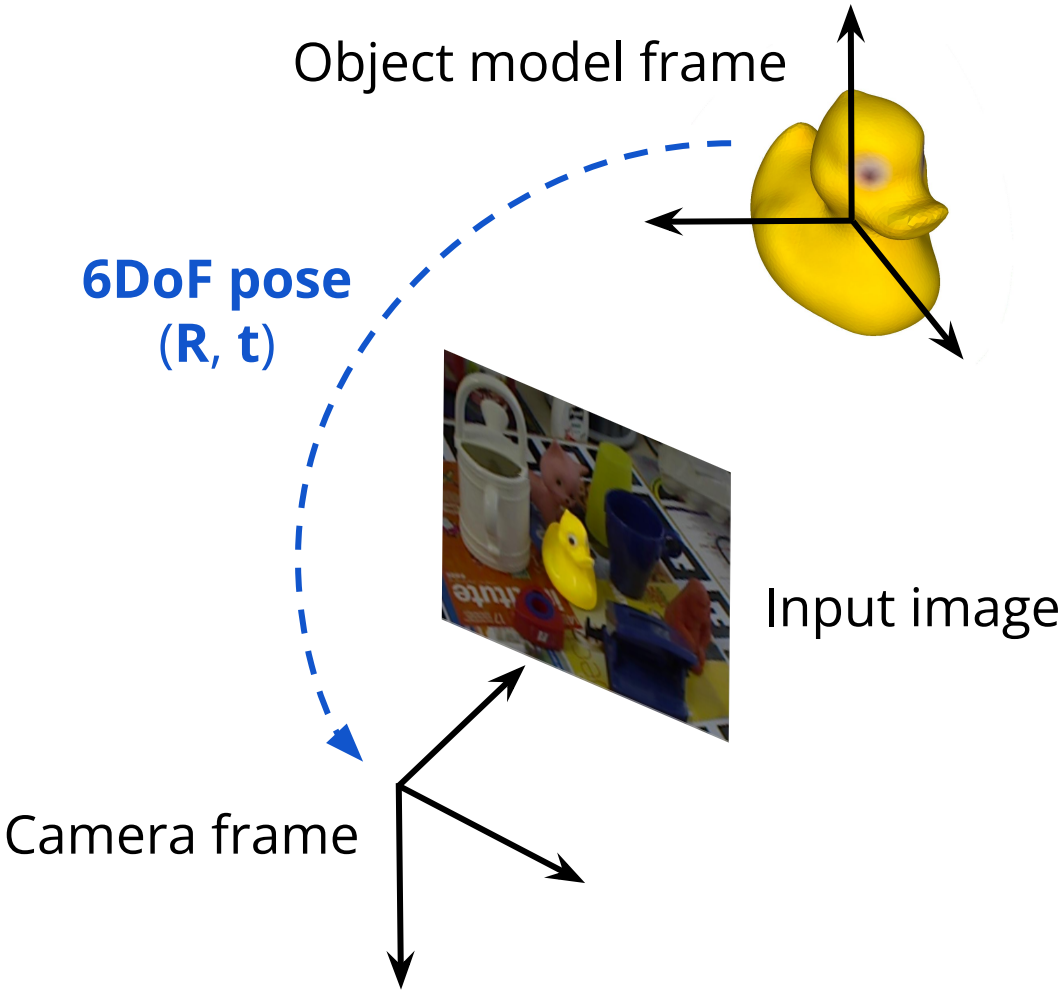
BOP: Benchmark for 6D object pose estimation

Goal: Capture and report the state of the art in estimating the 6D pose of rigid objects from RGB or RGB-D images

BOP currently comprises of:

- **Evaluation methodology**
- **Online evaluation system at bop.felk.cvut.cz**
- **12 datasets in a unified format**
  - Texture-mapped 3D models of 199 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 pose estimation



BOP publications

BOP: Benchmark for 6D Object Pose Estimation, ECCV 2018
T. Hodaň, F. Michel, E. Brachmann, W. Kehl, A. G. Buch, D. Kraft, B. Drost, J. Vidal, S. Ihrke, X. Zabulis, C. Sahin, F. Manhardt, F. Tombari, T.-K. Kim, J. Matas, C. Rother

BOP Challenge 2020 on 6D Object Localization, ECCVW 2020
T. Hodaň, M. Sundermeyer, B. Drost, Y. Labbé, E. Brachmann, F. Michel, C. Rother, J. Matas

BOP Challenge 2022 on Detection, Segmentation and Pose Estimation of Specific Rigid Objects, CVPRW 2023
M. Sundermeyer, T. Hodaň, Y. Labbé, G. Wang, E. Brachmann, B. Drost, C. Rother, J. Matas

BOP Challenge 2023 on Pose Estimation of Seen and Unseen Rigid Objects
– in preparation

Stages of a method

Training (hours/days) → **Onboarding** (sec/min) → **Inference** (online)

A computationally heavy stage that typically requires a large-scale training dataset and multiple GPUs for hours/days

Supervised methods trained for specific objects need to go through this stage

Onboarding of a new object that may take **max 5 min per object on 1 GPU**

Few-shot learning methods rely on this stage

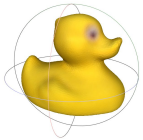
Estimation of 6DoF object poses ideally in real time

2023 tasks on seen objects

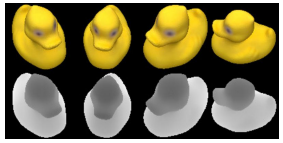
Training (hours/days) → **Onboarding** (sec/min) → **Inference** (online)

Task 1: Model-based 6D localization of seen objects – defined as in 2019, 2020, 2022

Input



3D model



Real / synthetic training images + GT poses

Input

No onboarding (objects already known from training)

Input

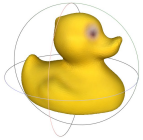
RGB / RGB-D test image

Output

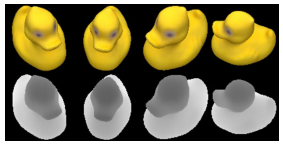
6DoF pose

Task 2: Model-based 2D detection of seen objects – defined as in 2022

Input



3D model



Real / synthetic training images + GT poses

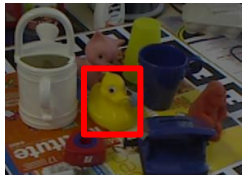
Input

No onboarding (objects already known from training)

Input

RGB / RGB-D test image

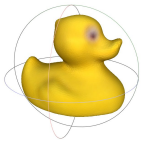
Output



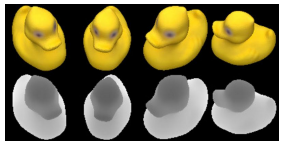
2D bounding box

Task 3: Model-based 2D segmentation of seen objects – defined as in 2022

Input



3D model



Real / synthetic training images + GT poses

Input

No onboarding (objects already known from training)

Input

RGB / RGB-D test image

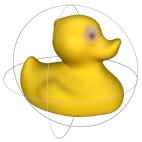
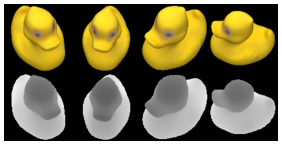
Output

2D segmentation mask

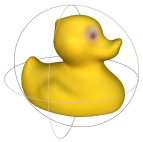
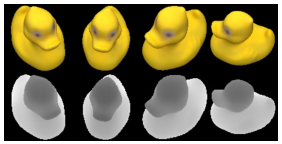
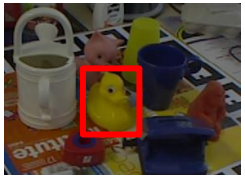
2023 tasks on unseen objects

Training (hours/days) → **Onboarding** (sec/min) → **Inference** (online)

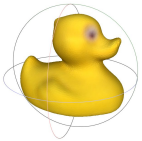
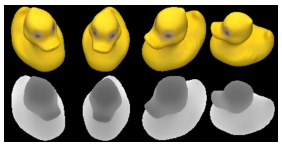
Task 4: Model-based 6D localization of unseen objects – introduced in 2023

Input	Input	Input	Output
No information about target objects	 3D model  Real / synthetic training images + GT poses	 RGB / RGB-D test image	 6DoF pose

Task 5: Model-based 2D detection of unseen objects – introduced in 2023

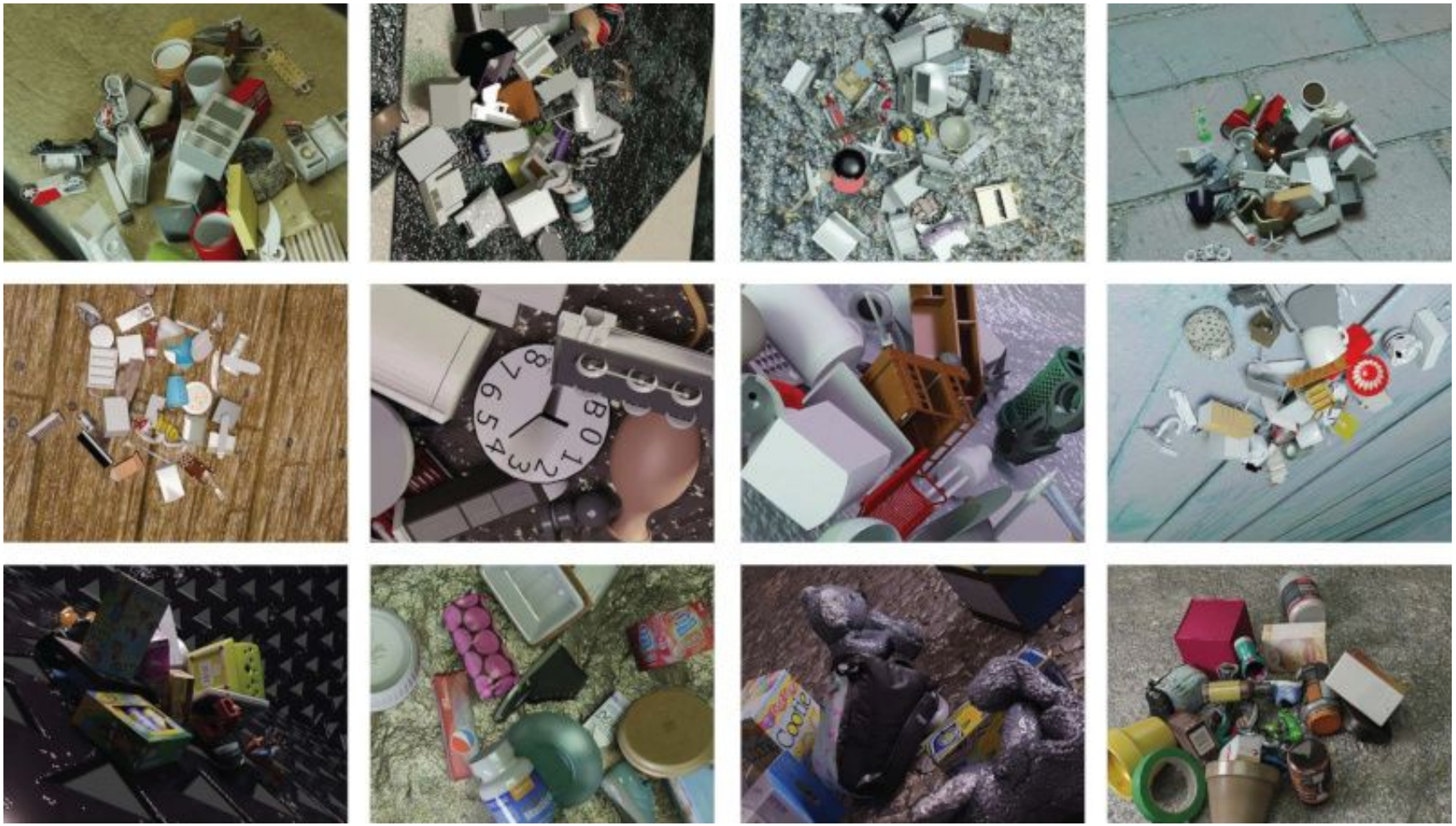
Input	Input	Input	Output
No information about target objects	 3D model  Real / synthetic training images + GT poses	 RGB / RGB-D test image	 2D bounding box

Task 6: Model-based 2D segmentation of unseen objects – introduced in 2023

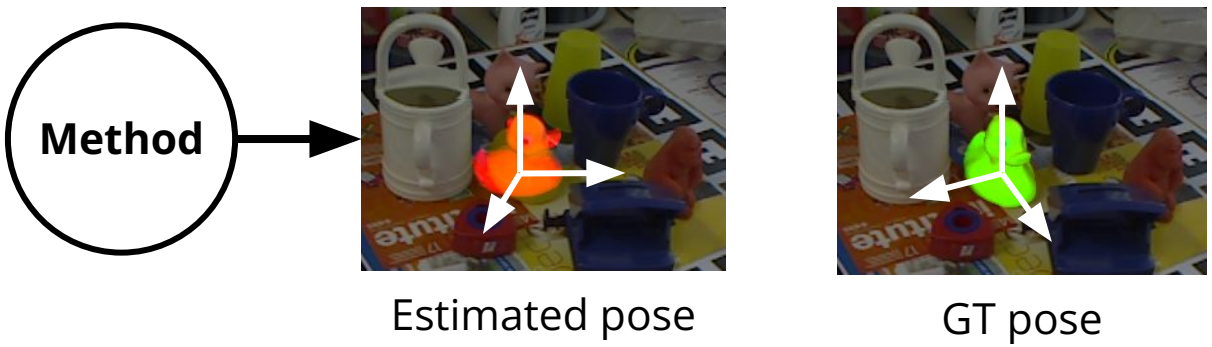
Input	Input	Input	Output
No information about target objects	 3D model  Real / synthetic training images + GT poses	 RGB / RGB-D test image	 2D segmentation mask

Pre-training dataset for Tasks 4–6

- **2M+ PBR images in BOP format showing more than 50K diverse objects**
- Originally synthesized for MegaPose using BlenderProc
- Objects are from the Google Scanned Objects and ShapeNetCore datasets



Evaluation of 6D localization tasks



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 ⇒ indistinguishable poses are equivalent

2. **MSSD: Maximum Symmetry-Aware Surface Distance**
   Measures the surface deviation in 3D ⇒ relevant for robotic applications

3. **MSPD: Maximum Symmetry-Aware Projection Distance**
   Measures the perceivable deviation ⇒ relevant for AR applications

See bop.felk.cvut.cz for details

Evaluation of 6D localization tasks

An estimated pose *E* is considered **correct** w.r.t. ground-truth pose *G* and pose-error function *F,* **if *F(E, G)* < *θ***, 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*:** $AR_D = (AR_{VSD} + AR_{MSSD} + AR_{MSPD}) / 3$
- **Average Recall:** AR = the average of per-dataset AR_D scores

See bop.felk.cvut.cz for details

Evaluation of 2D detection/segmentation tasks

We adopt metrics from the **COCO Object Detection Challenge**

The main metric is the **Average Precision (AP)** calculated at different Intersection over Union (IoU=.50:.05:.95) values

A method is required to detect/segment only objects that are visible from at least 10%. If a method detects/segments also objects that are visible from less than 10%, these are ignored and not counted as false positives

2018

BOP Challenge 2018

Classical pre-DNN (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

BOP Challenge 2018

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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

2019

BOP Challenge 2019

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

Evaluation methodology as in BOP 2020 and 2022

#	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

BOP Challenge 2019

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BOP Challenge 2019

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

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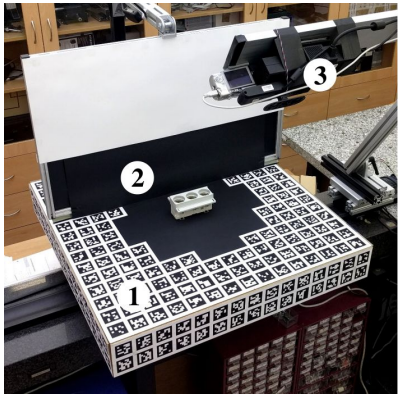
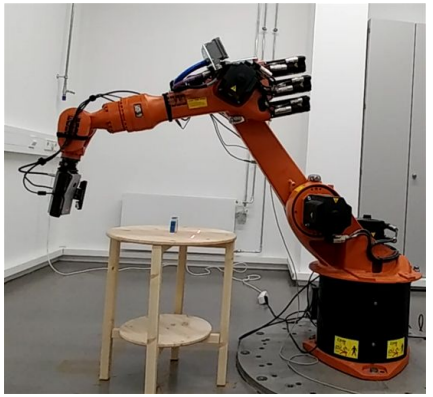
DNN-based methods

BOP Challenge 2019

Classical methods outperformed DNN methods, because of:

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



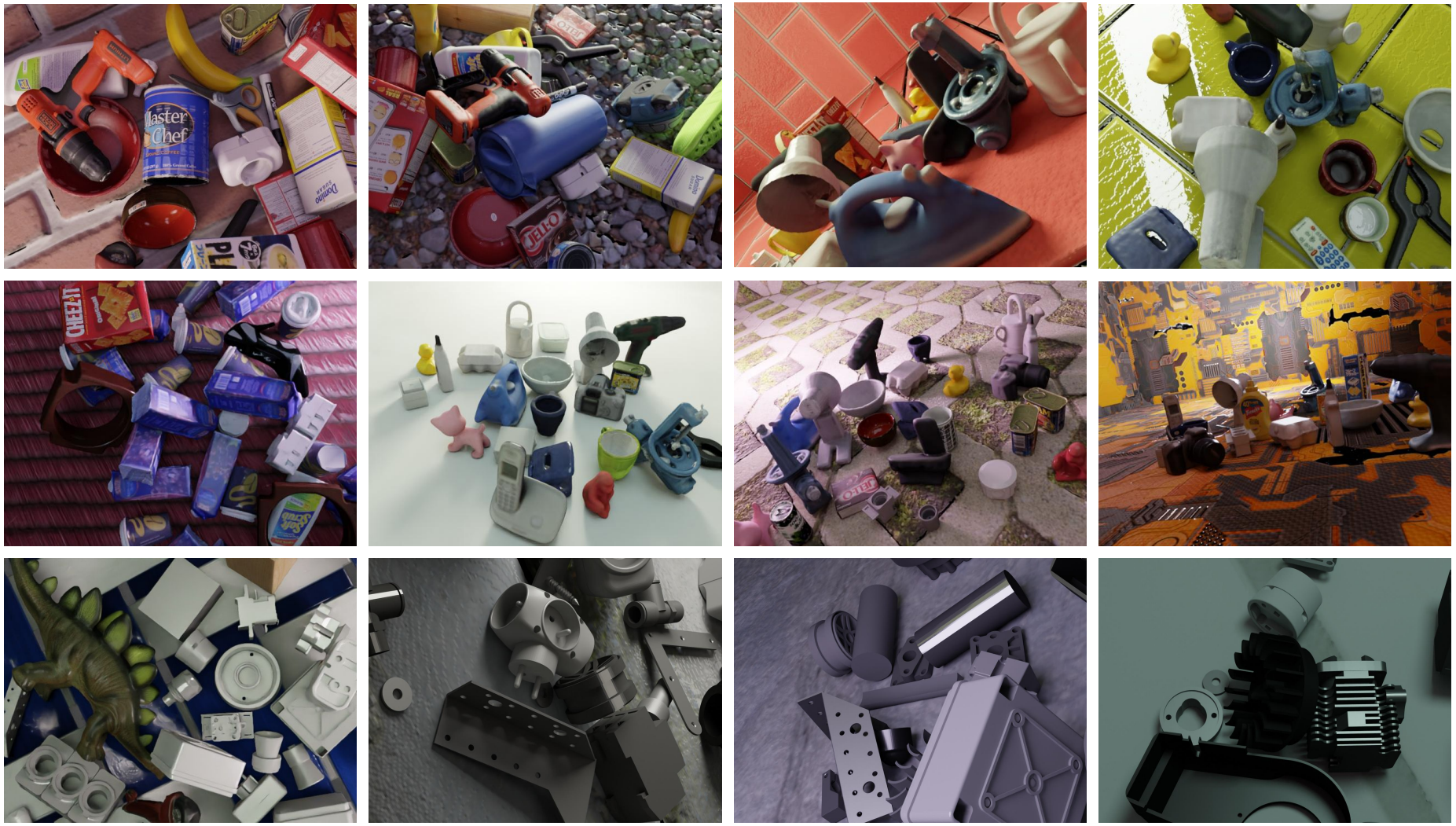
2. **Large domain gap** between real test images and the commonly used synthetic training images (objects rendered on random background)



2020

BOP Challenge 2020

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



BOP Challenge 2020

#	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

#	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
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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
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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
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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

DNN-based methods finally caught up with PPF-based methods!

2022

BOP Challenge 2022: 6D object localization

#	Method	Year	PPF	DNN	...models per	Det./seg.	Refine.	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	GDRNPP-PBRReal-RGBD-MModel	2022	No	Yes	Object	YOLOX	~CIR	RGB-D	PBR+real	RGB-D	0.837	0.775	0.874	0.966	0.722	0.679	0.926	0.921	6.263
2	GDRNPP-PBR-RGBD-MModel	2022	No	Yes	Object	YOLOX	~CIR	RGB-D	PBR only	RGB-D	0.827	0.775	0.852	0.929	0.722	0.679	0.926	0.906	6.264
3	GDRNPP-PBRReal-RGBD-MModel-Fast	2022	No	Yes	Object	YOLOX	Depth adjust.	RGB	PBR+real	RGB-D	0.805	0.792	0.872	0.936	0.702	0.588	0.909	0.834	0.228
4	GDRNPP-PBRReal-RGBD-MModel-OfficialDet	2022	No	Yes	Object	Default MaskRCNN (synt+real)	~CIR	RGB-D	PBR+real	RGB-D	0.798	0.758	0.824	0.966	0.708	0.543	0.890	0.896	6.406
5	RADet+PFA-MixPBR-RGBD	2022	No	Yes	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB-D	0.787	0.797	0.850	0.960	0.676	0.469	0.869	0.888	2.317
6	RADet+PFA-MixPBR-RGBD-Fast	2022	No	Yes	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB-D	0.771	0.792	0.779	0.958	0.671	0.460	0.860	0.880	0.639
7	RCVPose 3D_SingleModel_VIVO_PBR	2022	No	Yes	Dataset	-	ICP	RGB-D	PBR+real	RGB-D	0.768	0.729	0.708	0.966	0.733	0.536	0.863	0.843	1.336
8	ZebraPoseSAT-EffnetB4 + ICP (DefaultD...	2022	No	Yes	Object	Default MaskRCNN (synt+real)	ICP	RGB	PBR+real	RGB-D	0.765	0.752	0.727	0.948	0.652	0.527	0.883	0.866	0.500
9	RADet+PFA-PBR-RGBD	2022	No	Yes	Dataset	Extended FCOS	PFA	RGB	PBR only	RGB-D	0.762	0.797	0.802	0.893	0.676	0.469	0.869	0.826	2.631
10	SurfEmb-PBR-RGBD	2021	No	Yes	Dataset	Default MaskRCNN (synt+real)	Custom	RGB-D	PBR only	RGB-D	0.758	0.760	0.828	0.854	0.659	0.538	0.866	0.799	9.048
11	GDRNPP-PBRReal-RGBD-SModel	2022	No	Yes	Dataset	YOLOX	Depth adjust.	RGB	PBR+real	RGB-D	0.748	0.757	0.856	0.906	0.680	0.356	0.864	0.817	0.556
12	Coupled Iterative Refinement (CIR)	2022	No	Yes	Object	Default MaskRCNN (synt+real)	CIR	RGB-D	PBR+real	RGB-D	0.741	0.734	0.776	0.968	0.676	0.381	0.757	0.893	-
13	GDRNPP-PBRReal-RGB-MModel	2022	No	Yes	Object	YOLOX	-	RGB	PBR+real	RGB	0.728	0.713	0.786	0.831	0.623	0.448	0.869	0.825	0.229
14	ZebraPoseSAT-EffnetB4	2022	No	Yes	Object	FCOS	-	RGB	PBR+real	RGB	0.720	0.721	0.806	0.850	0.545	0.410	0.882	0.830	0.250
15	ZebraPoseSAT-EffnetB4 (DefaultDetection)	2022	No	Yes	Object	Default MaskRCNN (synt+real)	-	RGB	PBR+real	RGB	0.720	0.707	0.768	0.849	0.597	0.417	0.887	0.816	0.250
16	ZebraPose-SAT	2022	No	Yes	Object	FCOS	-	RGB	PBR+real	RGB	0.710	0.721	0.787	0.861	0.549	0.379	0.847	0.828	-
17	RADet+PFA-MixPBR-RGB	2022	No	Yes	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB	0.709	0.745	0.778	0.839	0.600	0.353	0.841	0.806	3.019
18	GDRNPP-PBR-RGB-MModel	2022	No	Yes	Object	YOLOX	-	RGB	PBR only	RGB	0.702	0.713	0.796	0.752	0.623	0.448	0.869	0.713	0.284
19	CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020	No	Yes	Dataset	Default MaskRCNN (synt+real)	~DeepIM+ICP	RGB	PBR+real	RGB-D	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
20	ZebraPoseSAT-EffnetB4 (PBR_Only)	2022	No	Yes	Object	FCOS	-	RGB	PBR only	RGB	0.670	0.721	0.723	0.717	0.545	0.410	0.882	0.691	-
21	PFA-cosypose	2022	No	Yes	Dataset	MaskRCNN	PFA	RGB-D	PBR+real	RGB	0.664	0.714	0.738	0.837	0.596	0.246	0.712	0.807	-
22	RADet+PFA-PBR-RGB	2022	No	Yes	Dataset	Extended FCOS	PFA	RGB	PBR only	RGB	0.663	0.745	0.719	0.732	0.600	0.353	0.841	0.648	3.497
23	SurfEmb-PBR-RGB	2021	No	Yes	Dataset	Default MaskRCNN (synt+real)	Custom	RGB	PBR only	RGB	0.650	0.663	0.735	0.715	0.588	0.413	0.791	0.647	8.891
24	Koenig-Hybrid-DL-PointPairs	2020	Yes	Yes	Dataset	RetinaMask/MaskRCNN	ICP	RGB	Synt+real	RGB-D	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
25	CosyPose-ECCV20-SYNT+REAL-1VIEW	2020	No	Yes	Dataset	Default MaskRCNN (synt+real)	~DeepIM	RGB	PBR+real	RGB	0.637	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
26	CRT-6D	2022	No	Yes	Dataset	Default MaskRCNN (synt+real)	Custom	RGB	PBR+real	RGB	0.599	0.660	0.644	0.789	0.537	0.208	0.603	0.752	0.059
27	Pix2Pose-BOP20_w/ICP-ICCV19	2020	No	Yes	Object	MaskRCNN	ICP	RGB	PBR+real	RGB-D	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844
28	ZTE_PPF	2022	Yes	Yes	Dataset	Default MaskRCNN (synt+real)	ICP	RGB	PBR+real	RGB-D	0.578	0.663	0.374	0.904	0.396	0.470	0.735	0.502	0.901
29	CosyPose-ECCV20-PBR-1VIEW	2020	No	Yes	Dataset	Default MaskRCNN (pbr)	~DeepIM	RGB	PBR only	RGB	0.570	0.633	0.640	0.685	0.583	0.216	0.656	0.574	0.475
30	Vidal-Sensors18	2019	Yes	No	-	-	ICP	-	-	D	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
31	CDPNv2_BOP20 (RGB-only & ICP)	2020	No	Yes	Object	FCOS	ICP	RGB	Synt+real	RGB-D	0.568	0.630	0.464	0.913	0.450	0.186	0.712	0.619	1.462
32	Drost-CVPR10-Edges	2019	Yes	No	-	-	ICP	-	-	RGB-D	0.550	0.515	0.500	0.851	0.368	0.570	0.671	0.375	87.568
33	CDPNv2_BOP20 (PBR-only & ICP)	2020	No	Yes	Object	FCOS	ICP	RGB	PBR only	RGB-D	0.534	0.630	0.435	0.791	0.450	0.186	0.712	0.532	1.491
34	CDPNv2_BOP20 (RGB-only)	2020	No	Yes	Object	FCOS	-	RGB	Synt+real	RGB	0.529	0.624	0.478	0.772	0.473	0.102	0.722	0.532	0.935
35	Drost-CVPR10-3D-Edges	2019	Yes	No	-	-	ICP	-	-	D	0.500	0.469	0.404	0.852	0.373	0.462	0.623	0.316	80.055
36	Drost-CVPR10-3D-Only	2019	Yes	No	-	-	ICP	-	-	D	0.487	0.527	0.444	0.775	0.388	0.316	0.615	0.344	7.704
37	CDPN_BOP19 (RGB-only)	2020	No	Yes	Object	RetinaNet	-	RGB	Synt+real	RGB	0.479	0.569	0.490	0.769	0.327	0.067	0.672	0.457	0.480
38	CDPNv2_BOP20 (PBR-only & RGB-only)	2020	No	Yes	Object	FCOS	-	RGB	PBR only	RGB	0.472	0.624	0.407	0.588	0.473	0.102	0.722	0.390	0.978
39	leaping from 2D to 6D	2020	No	Yes	Object	???	-	RGB	Synt+real	RGB	0.471	0.525	0.403	0.751	0.342	0.077	0.658	0.543	0.425
40	EPOS-BOP20-PBR	2020	No	Yes	Dataset	-	-	RGB	PBR only	RGB	0.457	0.547	0.467	0.558	0.363	0.186	0.580	0.499	1.874
41	Drost-CVPR10-3D-Only-Faster	2019	Yes	No	-	-	ICP	-	-	D	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	1.383
42	Félix&Neves-ICRA2017-IET2019	2019	Yes	Yes	Dataset	MaskRCNN	ICP	RGB-D	Synt+real	RGB-D	0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
43	Sundermeyer-IJCV19+ICP	2019	No	Yes	Object	RetinaNet	ICP	RGB	Synt+real	RGB-D	0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
44	Zhigang-CDPN-ICCV19	2019	No	Yes	Object	RetinaNet	-	RGB	Synt+real	RGB	0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
45	PointVoteNet2	2020	No	Yes	Object	-	ICP	RGB-D	PBR only	RGB-D	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
46	Pix2Pose-BOP20-ICCV19	2020	No	Yes	Object	MaskRCNN	-	RGB	PBR+real	RGB	0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
47	Sundermeyer-IJCV19	2021	No	Yes	Object	RetinaNet	-	RGB	Synt+real	RGB	0.280	0.146	0.304	0.401	0.217	0.101	0.346	0.446	0.196
48	SingleMultiPathEncoder-CVPR20	2020	No	Yes	All datasets	MaskRCNN	-	RGB	Synt+real	RGB	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
49	DPOD (synthetic)	2019	No	Yes	Scene	-	-	RGB	Synt	RGB	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231

BOP Challenge 2022: 6D object localization

#	Method	Year	PPF	DNN	...models per	Det./seg.	Refine.	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	GDRNPP-PBRReal-RGBD-MModel	2022	No	Yes	Object	YOLOX	~CIR	RGB-D	PBR+real	RGB-D	0.837	0.775	0.874	0.966	0.722	0.679	0.926	0.921	6.263
2	GDRNPP-PBR-RGBD-MModel	2022	No	Yes	Object	YOLOX	~CIR	RGB-D	PBR only	RGB-D	0.827	0.775	0.852	0.929	0.722	0.679	0.926	0.906	6.264
3	GDRNPP-PBRReal-RGBD-MModel-Fast	2022	No	Yes	Object	YOLOX	Depth adjust.	RGB	PBR+real	RGB-D	0.805	0.792	0.872	0.936	0.702	0.588	0.909	0.834	0.228
4	GDRNPP-PBRReal-RGBD-MModel-OfficialDet	2022	No	Yes	Object	Default MaskRCNN (synt+real)	~CIR	RGB-D	PBR+real	RGB-D	0.798	0.758	0.824	0.966	0.708	0.543	0.890	0.896	6.406
5	RADet+PFA-MixPBR-RGBD	2022	No	Yes	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB-D	0.787	0.797	0.850	0.960	0.676	0.469	0.869	0.888	2.317
6	RADet+PFA-MixPBR-RGBD-Fast	2022	No	Yes	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB-D	0.771	0.792	0.779	0.958	0.671	0.460	0.860	0.880	0.639
7	RCVPose 3D_SingleModel_VIVO_PBR	2022	No	Yes	Dataset	-	ICP	RGB-D	PBR+real	RGB-D	0.768	0.729	0.708	0.966	0.733	0.536	0.863	0.843	1.336
8	ZebraPoseSAT-EffnetB4 + ICP (DefaultD...	2022	No	Yes	Object	Default MaskRCNN (synt+real)	ICP	RGB	PBR+real	RGB-D	0.765	0.752	0.727	0.948	0.652	0.527	0.883	0.866	0.500
9	RADet+PFA-PBR-RGBD	2022	No	Yes	Dataset	Extended FCOS	PFA	RGB	PBR only	RGB-D	0.762	0.797	0.802	0.893	0.676	0.469	0.869	0.826	2.631
10	SurfEmb-PBR-RGBD	2021	No	Yes	Dataset	Default MaskRCNN (synt+real)	Custom	RGB-D	PBR only	RGB-D	0.758	0.760	0.828	0.854	0.659	0.538	0.866	0.799	9.048
11	GDRNPP-PBRReal-RGBD-SModel	2022	No	Yes	Dataset	YOLOX	Depth adjust.	RGB	PBR+real	RGB-D	0.748	0.757	0.856	0.906	0.680	0.356	0.864	0.817	0.556
12	Coupled Iterative Refinement (CIR)	2022	No	Yes	Object	Default MaskRCNN (synt+real)	CIR	RGB-D	PBR+real	RGB-D	0.741	0.734	0.776	0.968	0.676	0.381	0.757	0.893	-
13	GDRNPP-PBRReal-RGB-MModel	2022	No	Yes	Object	YOLOX	-	RGB	PBR+real	RGB	0.728	0.713	0.786	0.831	0.623	0.448	0.869	0.825	0.229
14	ZebraPoseSAT-EffnetB4	2022	No	Yes	Object	FCOS	-	RGB	PBR+real	RGB	0.720	0.721	0.806	0.850	0.545	0.410	0.882	0.830	0.250
15	ZebraPoseSAT-EffnetB4 (DefaultDetection)	2022	No	Yes	Object	Default MaskRCNN (synt+real)	-	RGB	PBR+real	RGB	0.720	0.707	0.768	0.849	0.597	0.417	0.887	0.816	0.250
16	ZebraPose-SAT	2022	No	Yes	Object	FCOS	-	RGB	PBR+real	RGB	0.710	0.721	0.787	0.861	0.549	0.379	0.847	0.828	-
17	RADet+PFA-MixPBR-RGB	2022	No	Yes	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB	0.709	0.745	0.778	0.839	0.600	0.353	0.841	0.806	3.019
18	GDRNPP-PBR-RGB-MModel	2022	No	Yes	Object	YOLOX	-	RGB	PBR only	RGB	0.702	0.713	0.796	0.752	0.623	0.448	0.869	0.713	0.284
19	CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020	No	Yes	Dataset	Default MaskRCNN (synt+real)	~DeepIM+ICP	RGB	PBR+real	RGB-D	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
20	ZebraPoseSAT-EffnetB4 (PBR_Only)	2022	No	Yes	Object	FCOS	-	RGB	PBR only	RGB	0.670	0.721	0.723	0.717	0.545	0.410	0.882	0.691	-
21	PFA-cosypose	2022	No	Yes	Dataset	MaskRCNN	PFA	RGB-D	PBR+real	RGB	0.664	0.714	0.738	0.837	0.596	0.246	0.712	0.807	-
22	RADet+PFA-PBR-RGB	2022	No	Yes	Dataset	Extended FCOS	PFA	RGB	PBR only	RGB	0.663	0.745	0.719	0.732	0.600	0.353	0.841	0.648	3.497
23	SurfEmb-PBR-RGB	2021	No	Yes	Dataset	Default MaskRCNN (synt+real)	Custom	RGB	PBR only	RGB	0.650	0.663	0.735	0.715	0.588	0.413	0.791	0.647	8.891
24	Koenig-Hyb[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.701	0.633
25	CosyPose-ECCV20-SYNT+REAL-1VIEW	2020	No	Yes	Dataset	Default MaskRCNN (synt+real)	~DeepIM	RGB	PBR+real	RGB	0.637	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
26	CRT-6D	2022	No	Yes	Dataset	Default MaskRCNN (synt+real)	Custom	RGB	PBR+real	RGB	0.599	0.660	0.644	0.789	0.537	0.208	0.603	0.752	0.059
27	Pix2Pose-BOP20_w/ICP-ICCV19	2020	No	Yes	Object	MaskRCNN	ICP	RGB	PBR+real	RGB-D	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844
28	ZTE_PPF	2022	Yes	Yes	Dataset	Default MaskRCNN (synt+real)	ICP	RGB	PBR+real	RGB-D	0.578	0.663	0.374	0.904	0.396	0.470	0.735	0.502	0.901
29	CosyPose-ECCV20-PBR-1VIEW	2020	No	Yes	Dataset	Default MaskRCNN (pbr)	~DeepIM	RGB	PBR only	RGB	0.570	0.633	0.640	0.685	0.583	0.216	0.656	0.574	0.475
30	Vidal-Sensors18	2019	Yes	No	-	-	ICP	-	-	D	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
31	CDPNv2_BOP20 (RGB-only & ICP)	2020	No	Yes	Object	FCOS	ICP	RGB	Synt+real	RGB-D	0.568	0.630	0.464	0.913	0.450	0.186	0.712	0.619	1.462
32	Drost-CVPR10-Edges	2019	Yes	No	-	-	ICP	-	-	RGB-D	0.550	0.515	0.500	0.851	0.368	0.570	0.671	0.375	87.568
33	CDPNv2_BOP20 (PBR-only & ICP)	2020	No	Yes	Object	FCOS	ICP	RGB	PBR only	RGB-D	0.534	0.630	0.435	0.791	0.450	0.186	0.712	0.532	1.491
34	CDPNv2_BOP20 (RGB-only)	2020	No	Yes	Object	FCOS	-	RGB	Synt+real	RGB	0.529	0.624	0.478	0.772	0.473	0.102	0.722	0.532	0.935
35	Drost-CVPR10-3D-Edges	2019	Yes	No	-	-	ICP	-	-	D	0.500	0.469	0.404	0.852	0.373	0.462	0.623	0.316	80.055
36	Drost-CVPR10-3D-Only	2019	Yes	No	-	-	ICP	-	-	D	0.487	0.527	0.444	0.775	0.388	0.316	0.615	0.344	7.704
37	CDPN_BOP19 (RGB-only)	2020	No	Yes	Object	RetinaNet	-	RGB	Synt+real	RGB	0.479	0.569	0.490	0.769	0.327	0.067	0.672	0.457	0.480
38	CDPNv2_BOP20 (PBR-only & RGB-only)	2020	No	Yes	Object	FCOS	-	RGB	PBR only	RGB	0.472	0.624	0.407	0.588	0.473	0.102	0.722	0.390	0.978
39	leaping from 2D to 6D	2020	No	Yes	Object	???	-	RGB	Synt+real	RGB	0.471	0.525	0.403	0.751	0.342	0.077	0.658	0.543	0.425
40	EPOS-BOP20-PBR	2020	No	Yes	Dataset	-	-	RGB	PBR only	RGB	0.457	0.547	0.467	0.558	0.363	0.186	0.580	0.499	1.874
41	Drost-CVPR10-3D-Only-Faster	2019	Yes	No	-	-	ICP	-	-	D	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	1.383
42	Félix&Neves-ICRA2017-IET2019	2019	Yes	Yes	Dataset	MaskRCNN	ICP	RGB-D	Synt+real	RGB-D	0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
43	Sundermeyer-IJCV19+ICP	2019	No	Yes	Object	RetinaNet	ICP	RGB	Synt+real	RGB-D	0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
44	Zhigang-CDPN-ICCV19	2019	No	Yes	Object	RetinaNet	-	RGB	Synt+real	RGB	0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
45	PointVoteNet2	2020	No	Yes	Object	-	ICP	RGB-D	PBR only	RGB-D	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
46	Pix2Pose-BOP20-ICCV19	2020	No	Yes	Object	MaskRCNN	-	RGB	PBR+real	RGB	0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
47	Sundermeyer-IJCV19	2021	No	Yes	Object	RetinaNet	-	RGB	Synt+real	RGB	0.280	0.146	0.304	0.401	0.217	0.101	0.346	0.446	0.196
48	SingleMultiPathEncoder-CVPR20	2020	No	Yes	All datasets	MaskRCNN	-	RGB	Synt+real	RGB	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
49	DPOD (synthetic)	2019	No	Yes	Scene	-	-	RGB	Synt	RGB	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231

18 methods from 2022 outperform CosyPose, the winner from 2020

BOP Challenge 2022: 6D object localization

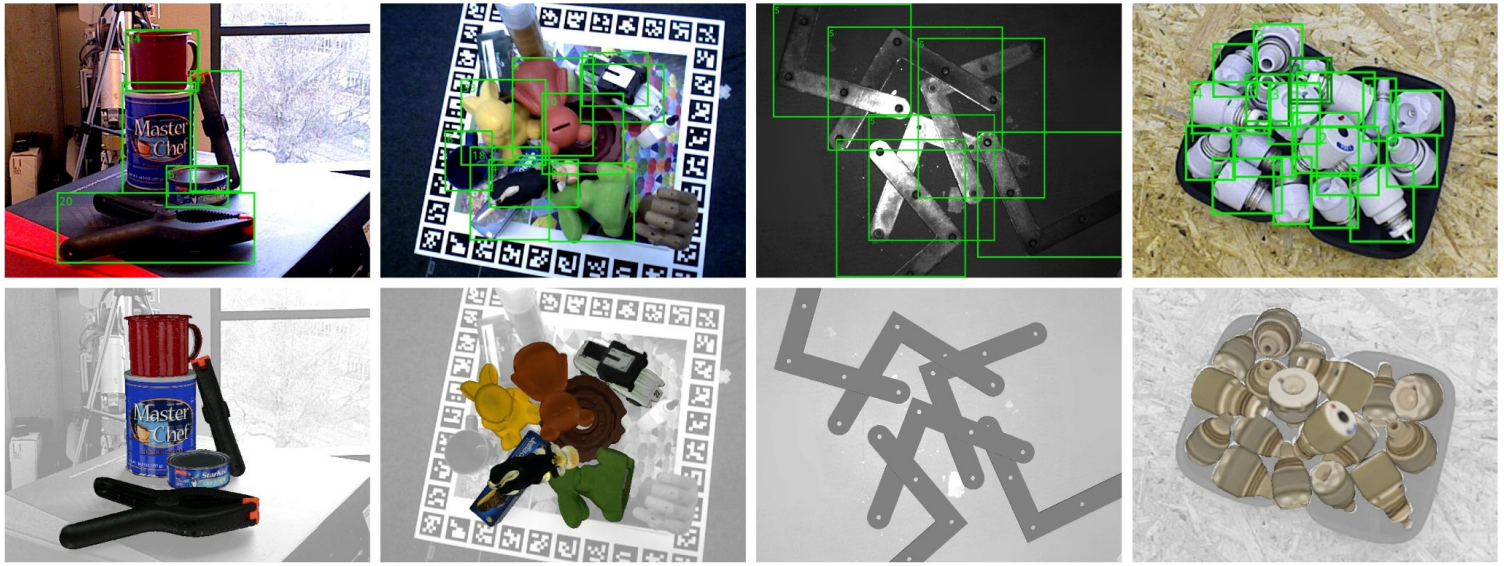
#	Method	Year	PPF	DNN	...models per	Det./seg.	Refine.	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	GDRNPP-PBRReal-RGBD-MModel	2022	No	Yes	Object	YOLOX	~CIR	RGB-D	PBR+real	RGB-D	0.837	0.775	0.874	0.966	0.722	0.679	0.926	0.921	6.263
2	GDRNPP-PBR-RGBD-MModel	2022	No	Yes	Object	YOLOX	~CIR	RGB-D	PBR only	RGB-D	0.827	0.775	0.852	0.929	0.722	0.679	0.926	0.906	6.264
3	GDRNPP-PBRReal-RGBD-MModel-Fast	2022	No	Yes	Object	YOLOX	Depth adjust.	RGB	PBR+real	RGB-D	0.805	0.792	0.872	0.936	0.702	0.588	0.909	0.834	0.228
4	GDRNPP-PBRReal-RGBD-MModel-OfficialDet	2022	No	Yes	Object	Default MaskRCNN (synt+real)	~CIR	RGB-D	PBR+real	RGB-D	0.798	0.758	0.824	0.966	0.708	0.543	0.890	0.896	6.406
5	RADet+PFA-MixPBR-RGBD	2022	No	Yes	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB-D	0.787	0.797	0.850	0.960	0.676	0.469	0.869	0.888	2.317
6	RADet+PFA-MixPBR-RGBD-Fast	2022	No	Yes	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB-D	0.771	0.792	0.779	0.958	0.671	0.460	0.860	0.880	0.639
7	RCVPose 3D_SingleModel_VIVO_PBR	2022	No	Yes	Dataset	-	ICP	RGB-D	PBR+real	RGB-D	0.768	0.729	0.708	0.966	0.733	0.536	0.863	0.843	1.336
8	ZebraPoseSAT-EffnetB4 + ICP (DefaultD...	2022	No	Yes	Object	Default MaskRCNN (synt+real)	ICP	RGB	PBR+real	RGB-D	0.765	0.752	0.727	0.948	0.652	0.527	0.883	0.866	0.500
9	RADet+PFA-PBR-RGBD	2022	No	Yes	Dataset	Extended FCOS	PFA	RGB	PBR only	RGB-D	0.762	0.797	0.802	0.893	0.676	0.469	0.869	0.826	2.631
10	SurfEmb-PBR-RGBD	2021	No	Yes	Dataset	Default MaskRCNN (synt+real)	Custom	RGB-D	PBR only	RGB-D	0.758	0.760	0.828	0.854	0.659	0.538	0.866	0.799	9.048
11	GDRNPP-PBRReal-RGBD-SModel	2022	No	Yes	Dataset	YOLOX	Depth adjust.	RGB	PBR+real	RGB-D	0.748	0.757	0.856	0.906	0.680	0.356	0.864	0.817	0.556
12	Coupled Iterative Refinement (CIR)	2022	No	Yes	Object	Default MaskRCNN (synt+real)	CIR	RGB-D	PBR+real	RGB-D	0.741	0.734	0.776	0.968	0.676	0.381	0.757	0.893	-
13	GDRNPP-PBRReal-RGB-MModel	2022	No	Yes	Object	YOLOX	-	RGB	PBR+real	RGB	0.728	0.713	0.786	0.831	0.623	0.448	0.869	0.825	0.229
14	ZebraPoseSAT-EffnetB4	2022	No	Yes	Object	FCOS	-	RGB	PBR+real	RGB	0.720	0.721	0.806	0.850	0.545	0.410	0.882	0.830	0.250
15	ZebraPoseSAT-EffnetB4 (DefaultDetection)	2022	No	Yes	Object	Default MaskRCNN (synt+real)	-	RGB	PBR+real	RGB	0.720	0.707	0.768	0.849	0.597	0.417	0.887	0.816	0.250
16	ZebraPose-SAT	2022	No	Yes	Object	FCOS	-	RGB	PBR+real	RGB	0.710	0.721	0.787	0.861	0.549	0.379	0.847	0.828	-
17	RADet+PFA-MixPBR-RGB	2022	No	Yes	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB	0.709	0.745	0.778	0.839	0.600	0.353	0.841	0.806	3.019
18	GDRNPP-PBR-RGB-MModel	2022	No	Yes	Object	YOLOX	-	RGB	PBR only	RGB	0.702	0.713	0.796	0.752	0.623	0.448	0.869	0.713	0.284
19	CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020	No	Yes	Dataset	Default MaskRCNN (synt+real)	~DeepIM+ICP	RGB	PBR+real	RGB-D	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
20	ZebraPoseSAT-EffnetB4 (PBR_Only)	2022	No	Yes	Object	FCOS	-	RGB	PBR only	RGB	0.670	0.721	0.723	0.717	0.545	0.410	0.882	0.691	-
21	PFA-cosypose	2022	No	Yes	Dataset	MaskRCNN	PFA	RGB-D	PBR+real	RGB	0.664	0.714	0.738	0.837	0.596	0.246	0.712	0.807	-
22	RADet+PFA-PBR-RGB	2022	No	Yes	Dataset	Extended FCOS	PFA	RGB	PBR only	RGB	0.663	0.745	0.719	0.732	0.600	0.353	0.841	0.648	3.497
23	SurfEmb-PBR-RGB	2021	No	Yes	Dataset	Default MaskRCNN (synt+real)	Custom	RGB	PBR only	RGB	0.650	0.663	0.735	0.715	0.588	0.413	0.791	0.647	8.891
24	Koenig-Hybrid-DL-PointPairs	2020	Yes	Yes	Dataset	RetinaMask/MaskRCNN	ICP	RGB	Synt+real	RGB-D	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
25	CosyPose-ECCV20-SYNT+REAL-1VIEW	2020	No	Yes	Dataset	Default MaskRCNN (synt+real)	~DeepIM+ICP	RGB	PBR+real	RGB-D	0.[illegible]	0.[illegible]	0.[illegible]	0.[illegible]	0.[illegible]	0.[illegible]	0.[illegible]	0.821	0.449
26	CRT-6D	2022	No	Yes	Dataset	Default MaskRCNN (synt+real)	Custom	RGB	PBR+real	RGB	0.599	0.660	0.644	0.789	0.537	0.208	0.603	0.752	0.059
27	Pix2Pose-BOP20_w/ICP-ICCV19	2020	No	Yes	Object	MaskRCNN	ICP	RGB	PBR+real	RGB-D	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844
28	ZTE_PPF	2022	Yes	Yes	Dataset	Default MaskRCNN (synt+real)	ICP	RGB	PBR+real	RGB-D	0.578	0.663	0.374	0.904	0.396	0.470	0.735	0.502	0.901
29	CosyPose-ECCV20-PBR-1VIEW	2020	No	Yes	Dataset	Default MaskRCNN (pbr)	~DeepIM	RGB	PBR only	RGB	0.570	0.633	0.640	0.685	0.583	0.216	0.656	0.574	0.475
30	Vidal-Sensors18	2019	Yes	No	-	-	ICP	-	-	D	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
31	CDPNv2_BOP20 (RGB-only & ICP)	2020	No	Yes	Object	FCOS	ICP	RGB	Synt+real	RGB-D	0.568	0.630	0.464	0.913	0.450	0.186	0.712	0.619	1.462
32	Drost-CVPR10-Edges	2019	Yes	No	-	-	ICP	-	-	RGB-D	0.550	0.515	0.500	0.851	0.368	0.570	0.671	0.375	87.568
33	CDPNv2_BOP20 (PBR-only & ICP)	2020	No	Yes	Object	FCOS	ICP	RGB	PBR only	RGB-D	0.534	0.630	0.435	0.791	0.450	0.186	0.712	0.532	1.491
34	CDPNv2_BOP20 (RGB-only)	2020	No	Yes	Object	FCOS	-	RGB	Synt+real	RGB	0.529	0.624	0.478	0.772	0.473	0.102	0.722	0.532	0.935
35	Drost-CVPR10-3D-Edges	2019	Yes	No	-	-	ICP	-	-	D	0.500	0.469	0.404	0.852	0.373	0.462	0.623	0.316	80.055
36	Drost-CVPR10-3D-Only	2019	Yes	No	-	-	ICP	-	-	D	0.487	0.527	0.444	0.775	0.388	0.316	0.615	0.344	7.704
37	CDPN_BOP19 (RGB-only)	2020	No	Yes	Object	RetinaNet	-	RGB	Synt+real	RGB	0.479	0.569	0.490	0.769	0.327	0.067	0.672	0.457	0.480
38	CDPNv2_BOP20 (PBR-only & RGB-only)	2020	No	Yes	Object	FCOS	-	RGB	PBR only	RGB	0.472	0.624	0.407	0.588	0.473	0.102	0.722	0.390	0.978
39	leaping from 2D to 6D	2020	No	Yes	Object	???	-	RGB	Synt+real	RGB	0.471	0.525	0.403	0.751	0.342	0.077	0.658	0.543	0.425
40	EPOS-BOP20-PBR	2020	No	Yes	Dataset	-	-	RGB	PBR only	RGB	0.457	0.547	0.467	0.558	0.363	0.186	0.580	0.499	1.874
41	Drost-CVPR10-3D-Only-Faster	2019	Yes	No	-	-	ICP	-	-	D	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	1.383
42	Félix&Neves-ICRA2017-IET2019	2019	Yes	Yes	Dataset	MaskRCNN	ICP	RGB-D	Synt+real	RGB-D	0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
43	Sundermeyer-IJCV19+ICP	2019	No	Yes	Object	RetinaNet	ICP	RGB	Synt+real	RGB-D	0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
44	Zhigang-CDPN-ICCV19	2019	No	Yes	Object	RetinaNet	-	RGB	Synt+real	RGB	0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
45	PointVoteNet2	2020	No	Yes	Object	-	ICP	RGB-D	PBR only	RGB-D	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
46	Pix2Pose-BOP20-ICCV19	2020	No	Yes	Object	MaskRCNN	-	RGB	PBR+real	RGB	0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
47	Sundermeyer-IJCV19	2021	No	Yes	Object	RetinaNet	-	RGB	Synt+real	RGB	0.280	0.146	0.304	0.401	0.217	0.101	0.346	0.446	0.196
48	SingleMultiPathEncoder-CVPR20	2020	No	Yes	All datasets	MaskRCNN	-	RGB	Synt+real	RGB	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
49	DPOD (synthetic)	2019	No	Yes	Scene	-	-	RGB	Synt	RGB	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231

Overall SOTA moved from **0.698 AR** (CosyPose) to **0.837 AR** (GDRNPP)

New tasks of 2D instance detection/segment.

2D detection 2D segmentation 6D localization

Introduced to address the design of many recent object pose estimation methods, which first detect the objects and then estimate their poses from the detections:



BOP Challenge 2022: 2D object det./seg.

2D object detection:

#	Method	Year	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	GDRNPPDet_PBRReal	2022	RGB	PBR+real	RGB	0.773	0.695	0.876	0.895	0.689	0.593	0.809	0.852	0.081
2	GDRNPPDet_PBR	2022	RGB	PBR only	RGB	0.738	0.695	0.865	0.728	0.689	0.593	0.809	0.786	0.081
3	RADet-MixPBR	2022	RGB	PBR+real	RGB	0.721	0.675	0.798	0.866	0.638	0.486	0.735	0.850	0.030
4	RADet-PBR	2022	RGB	PBR only	RGB	0.667	0.675	0.734	0.663	0.638	0.486	0.735	0.735	-
5	DLZDet-PBR1	2022	RGB	PBR only	RGB	0.656	0.706	0.808	0.696	0.494	0.344	0.777	0.770	-
6	CosyPose-ECCV20-SYNT+REAL-1VIEW = default	2022	RGB	PBR+real	RGB	0.605	0.566	0.693	0.826	0.401	0.365	0.635	0.745	0.054
7	CosyPose-ECCV20-PBR-1VIEW	2022	RGB	PBR only	RGB	0.557	0.566	0.671	0.664	0.401	0.365	0.635	0.594	0.055
8	FCOS-CDPN-PBR	2022	RGB	PBR only	RGB	0.507	0.570	0.625	0.585	0.272	0.304	0.604	0.590	0.047

2D object segmentation:

#	Method	Year	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	ZebraPoseSAT-EffnetB4 (DefaultDetection)	2022	RGB	PBR+real	RGB	0.587	0.502	0.682	0.713	0.468	0.352	0.662	0.727	0.080
2	ZebraPoseSAT-EffnetB4	2022	RGB	PBR+real	RGB	0.578	0.506	0.709	0.707	0.379	0.361	0.644	0.740	0.080
3	ZebraPoseSAT-EffnetB4 (DefaultDet+PBR_Only)	2022	RGB	PBR only	RGB	0.538	0.502	0.655	0.517	0.468	0.352	0.662	0.609	0.080
4	ZebraPoseSAT-EffnetB4 (PBR_Only)	2022	RGB	PBR only	RGB	0.523	0.506	0.629	0.514	0.379	0.361	0.644	0.626	0.080
5	DLZDet-PBRREAL	2022	RGB	PBR+real	RGB	0.496	0.460	0.584	0.606	0.316	0.239	0.600	0.669	-
6	DLZDet-PBR+Real	2022	RGB	PBR+real	RGB	0.433	0.460	0.596	0.464	0.192	0.239	0.600	0.483	-
7	DLZDet-PBR1	2022	RGB	PBR only	RGB	0.429	0.460	0.584	0.452	0.192	0.239	0.600	0.477	-
8	CosyPose-ECCV20-SYNT+REAL-1VIEW = default	2022	RGB	PBR+real	RGB	0.405	0.375	0.544	0.489	0.316	0.122	0.471	0.520	0.054
9	CosyPose-ECCV20-PBR-1VIEW	2022	RGB	PBR only	RGB	0.362	0.375	0.517	0.306	0.316	0.122	0.471	0.429	0.055

BOP Challenge 2022: 2D object det./seg.

2D object detection:

#	Method	Year	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	GDRNPPDet_PBRReal	2022	RGB	PBR+real	RGB	0.773	0.695	0.876	0.895	0.689	0.593	0.809	0.852	0.081
2	GDRNPPDet_PBR	2022	RGB	PBR only	RGB	0.738	0.695	0.865	0.728	0.689	0.593	0.809	0.786	0.081
3	RADet-MixPBR	2022	RGB	PBR+real	RGB	0.721	0.675	0.798	0.866	0.638	0.486	0.735	0.850	0.030
4	RADet-PBR	2022	RGB	PBR only	RGB	0.667	0.675	0.734	0.663	0.638	0.486	0.735	0.735	-
5	DLZDet-PBR1	2022	RGB	PBR only	RGB	0.656	0.706	0.808	0.696	0.494	0.344	0.777	0.770	-
6	CosyPose-ECCV20-SYNT+REAL-1VIEW = default	2022	RGB	PBR+real	RGB	0.605	0.566	0.693	0.826	0.401	0.365	0.635	0.745	0.054
7	CosyPose-ECCV20-PBR-1VIEW	2022	RGB	PBR only	RGB	0.557	0.566	0.671	0.664	0.401	0.365	0.635	0.594	0.055
8	FCOS-CDPN-PBR	2022	RGB	PBR only	RGB	0.507	0.570	0.625	0.585	0.272	0.304	0.604	0.590	0.047

YOLOX from GDRNPP gains +16.8 AP over MaskRCNN from Cosypose!

2D object segmentation:

#	Method	Year	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	ZebraPoseSAT-EffnetB4 (DefaultDetection)	2022	RGB	PBR+real	RGB	0.587	0.502	0.682	0.713	0.468	0.352	0.662	0.727	0.080
2	ZebraPoseSAT-EffnetB4	2022	RGB	PBR+real	RGB	0.578	0.506	0.709	0.707	0.379	0.361	0.644	0.740	0.080
3	ZebraPoseSAT-EffnetB4 (DefaultDet+PBR_Only)	2022	RGB	PBR only	RGB	0.538	0.502	0.655	0.517	0.468	0.352	0.662	0.609	0.080
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5	DLZDet-PBRREAL	2022	RGB	PBR+real	RGB	0.496	0.460	0.584	0.606	0.316	0.239	0.600	0.669	-
6	DLZDet-PBR+Real	2022	RGB	PBR+real	RGB	0.433	0.460	0.596	0.464	0.192	0.239	0.600	0.483	-
7	DLZDet-PBR1	2022	RGB	PBR only	RGB	0.429	0.460	0.584	0.452	0.192	0.239	0.600	0.477	-
8	CosyPose-ECCV20-SYNT+REAL-1VIEW = default	2022	RGB	PBR+real	RGB	0.405	0.375	0.544	0.489	0.316	0.122	0.471	0.520	0.054
9	CosyPose-ECCV20-PBR-1VIEW	2022	RGB	PBR only	RGB	0.362	0.375	0.517	0.306	0.316	0.122	0.471	0.429	0.055

ZebraPose refines masks from CosyPose detections: +18.2 AP!

2023

BOP Challenge 2023 – Submissions

Submission system: bop.felk.cvut.cz, deadline: September 28, 2023

2400+ submissions since 2022 (submission = results of a method on a dataset)

The submission form stays open! All raw predictions are publicly available

BOP: Benchmark for 6D Object Pose Estimation

Signed in as **thodan**: My methods My submissions Edit account Sign out

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Tasks on seen objects: 6D localization of seen objects 2D detection of seen objects 2D segmentation of seen objects
Tasks on unseen objects: 6D localization of unseen objects 2D detection of unseen objects 2D segmentation of unseen objects

Datasets: Core datasets LM LM-O T-LESS ITODD HB HOPE YCB-V RU-APC IC-BIN IC-MI TUD-L TYO-L

6D localization of seen objects – Core datasets

This leaderbord shows the overall ranking for Task 1 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_{Core} score is considered. The reported time is the average image processing time averaged over the core datasets.

Show 50 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	2023-09-27	GPose2023	RGB-D	0.856	0.794	0.914	0.964	0.737	0.704	0.950	0.928	2.670
2	2023-09-24	GPose2023-OfficialDet	RGB-D	0.851	0.805	0.895	0.966	0.734	0.687	0.944	0.929	4.575
3	2023-09-27	GPose2023-PBR	RGB-D	0.844	0.794	0.890	0.931	0.737	0.704	0.950	0.901	2.686
4	2022-10-15	GDRNPP-PBRReal-RGBD-MModel	RGB-D	0.837	0.775	0.874	0.966	0.722	0.679	0.926	0.921	6.263

BOP 2023: Model-based 2D detection of seen objects

#	Method	Year	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	GDet2023	2023	RGB	PBR+real	RGB	0.798	0.707	0.894	0.891	0.731	0.640	0.847	0.877	0.204
2	GDRNPPDet_PBRReal	2022	RGB	PBR+real	RGB	0.773	0.695	0.876	0.895	0.689	0.593	0.809	0.852	0.081
3	GDet2023-PBR	2023	RGB	PBR only	RGB	0.769	0.707	0.882	0.755	0.731	0.640	0.847	0.823	0.207
4	GDRNPPDet_PBR	2022	RGB	PBR only	RGB	0.738	0.695	0.865	0.728	0.689	0.593	0.809	0.786	0.081
5	Extended FCOS-MixPBR	2022	RGB	PBR+real	RGB	0.721	0.675	0.798	0.866	0.638	0.486	0.735	0.850	0.030
6	Extended FCOS-PBR	2022	RGB	PBR only	RGB	0.667	0.675	0.734	0.663	0.638	0.486	0.735	0.735	-
7	DLZDet-PBR1	2022	RGB	PBR only	RGB	0.656	0.706	0.808	0.696	0.494	0.344	0.777	0.770	-
8	CosyPose-ECCV20-SYNT+REAL-1VIEW	2022	RGB	PBR+real	RGB	0.605	0.566	0.693	0.826	0.401	0.365	0.635	0.745	0.054
9	CosyPose-ECCV20-PBR-1VIEW	2022	RGB	PBR only	RGB	0.557	0.566	0.671	0.664	0.401	0.365	0.635	0.594	0.055

BOP 2023: Model-based 2D detection of seen objects

#	Method	Year	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	GDet2023	2023	RGB	PBR+real	RGB	0.798	0.707	0.894	0.891	0.731	0.640	0.847	0.877	0.204
2	GDRNPPDet_PBRReal	2022	RGB	PBR+real	RGB	0.773	0.695	0.876	0.895	0.689	0.593	0.809	0.852	0.081
3	GDet2023-PBR	2023	RGB	PBR only	RGB	0.769	0.707	0.882	0.755	0.731	0.640	0.847	0.823	0.207
4	GDRNPPDet_PBR	2022	RGB	PBR only	RGB	0.738	0.695	0.865	0.728	0.689	0.593	0.809	0.786	0.081
5	Extended FCOS-MixPBR	2022	RGB	PBR+real	RGB	0.721	0.675	0.798	0.866	0.638	0.486	0.735	0.850	0.030
6	Extended FCOS-PBR	2022	RGB	PBR only	RGB	0.667	0.675	0.734	0.663	0.638	0.486	0.735	0.735	-
7	DLZDet-PBR1	2022	RGB	PBR only	RGB	0.656	0.706	0.808	0.696	0.494	0.344	0.777	0.770	-
8	CosyPose-ECCV20-SYNT+REAL-1VIEW	2022	RGB	PBR+real	RGB	0.605	0.566	0.693	0.826	0.401	0.365	0.635	0.745	0.054
9	CosyPose-ECCV20-PBR-1VIEW	2022	RGB	PBR only	RGB	0.557	0.566	0.671	0.664	0.401	0.365	0.635	0.594	0.055

+0.025 AP from GDRNPP_Det (YOLOX) to GDet2023 (YOLOv8)

BOP 2023: Model-based 2D segmentation of seen objects

#	Method	Year	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	ZebraPoseSAT-EffnetB4(DefaultDete...	2023	RGB	PBR+real	RGB	0.619	0.516	0.721	0.718	0.493	0.462	0.689	0.731	0.080
2	ZebraPoseSAT-EffnetB4 (DefaultDet...	2022	RGB	PBR+real	RGB	0.587	0.502	0.682	0.713	0.468	0.352	0.662	0.727	0.080
3	ZebraPoseSAT-EffnetB4(PBR only De...	2023	RGB	PBR only	RGB	0.579	0.516	0.701	0.536	0.493	0.462	0.689	0.658	0.080
4	ZebraPoseSAT-EffnetB4	2022	RGB	PBR+real	RGB	0.578	0.506	0.709	0.707	0.379	0.361	0.644	0.740	0.080
5	ZebraPoseSAT-EffnetB4 (DefaultDet...	2022	RGB	PBR only	RGB	0.538	0.502	0.655	0.517	0.468	0.352	0.662	0.609	0.080
6	ZebraPoseSAT-EffnetB4 (PBR_Only)	2022	RGB	PBR only	RGB	0.523	0.506	0.629	0.514	0.379	0.361	0.644	0.626	0.080
7	DLZDet-PBRREAL	2022	RGB	PBR+real	RGB	0.496	0.460	0.584	0.606	0.316	0.239	0.600	0.669	-
8	DLZDet-PBR+Real	2022	RGB	PBR+real	RGB	0.433	0.460	0.596	0.464	0.192	0.239	0.600	0.483	-
9	DLZDet-PBR1	2022	RGB	PBR only	RGB	0.429	0.460	0.584	0.452	0.192	0.239	0.600	0.477	-
10	CosyPose-ECCV20-SYNT+REAL-1VIEW	2022	RGB	PBR+real	RGB	0.405	0.375	0.544	0.489	0.316	0.122	0.471	0.520	0.054
11	CosyPose-ECCV20-PBR-1VIEW	2022	RGB	PBR only	RGB	0.362	0.375	0.517	0.306	0.316	0.122	0.471	0.429	0.055

BOP 2023: Model-based 2D segmentation of seen objects

#	Method	Year	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	ZebraPoseSAT-EffnetB4(DefaultDete...	2023	RGB	PBR+real	RGB	0.619	0.516	0.721	0.718	0.493	0.462	0.689	0.731	0.080
2	ZebraPoseSAT-EffnetB4 (DefaultDet...	2022	RGB	PBR+real	RGB	0.587	0.502	0.682	0.713	0.468	0.352	0.662	0.727	0.080
3	ZebraPoseSAT-EffnetB4(PBR only De...	2023	RGB	PBR only	RGB	0.579	0.516	0.701	0.536	0.493	0.462	0.689	0.658	0.080
4	ZebraPoseSAT-EffnetB4	2022	RGB	PBR+real	RGB	0.578	0.506	0.709	0.707	0.379	0.361	0.644	0.740	0.080
5	ZebraPoseSAT-EffnetB4 (DefaultDet...	2022	RGB	PBR only	RGB	0.538	0.502	0.655	0.517	0.468	0.352	0.662	0.609	0.080
6	ZebraPoseSAT-EffnetB4 (PBR_Only)	2022	RGB	PBR only	RGB	0.523	0.506	0.629	0.514	0.379	0.361	0.644	0.626	0.080
7	DLZDet-PBRREAL	2022	RGB	PBR+real	RGB	0.496	0.460	0.584	0.606	0.316	0.239	0.600	0.669	-
8	DLZDet-PBR+Real	2022	RGB	PBR+real	RGB	0.433	0.460	0.596	0.464	0.192	0.239	0.600	0.483	-
9	DLZDet-PBR1	2022	RGB	PBR only	RGB	0.429	0.460	0.584	0.452	0.192	0.239	0.600	0.477	-
10	CosyPose-ECCV20-SYNT+REAL-1VIEW	2022	RGB	PBR+real	RGB	0.405	0.375	0.544	0.489	0.316	0.122	0.471	0.520	0.054
11	CosyPose-ECCV20-PBR-1VIEW	2022	RGB	PBR only	RGB	0.362	0.375	0.517	0.306	0.316	0.122	0.471	0.429	0.055

ZebraPoseSAT: +0.032 AP over their 2022 submission
masks predicted from provided default detections

All methods still use RGB only

BOP 2023 : Model-based 6D localization of seen objects

#	Method	Year	Type	...models per	Det./seg.	Refine.	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	GPose2023	2023	DNN	Object	Custom	Coordinate-guide	RGB-D	PBR+real	RGB-D	0.856	0.794	0.914	0.964	0.737	0.704	0.950	0.928	2.670
2	GPose2023-OfficialDet	2023	DNN	Object	Default GDRNPPDet	Coordinate-guide	RGB-D	PBR+real	RGB-D	0.851	0.805	0.895	0.966	0.734	0.687	0.944	0.929	4.575
3	GPose2023-PBR	2023	DNN	Object	Custom	Coordinate-guide	RGB-D	PBR only	RGB-D	0.844	0.794	0.890	0.931	0.737	0.704	0.950	0.901	2.686
4	GDRNPP-PBRReal-RGBD-MModel	2022	DNN	Object	YOLOX	~CIR	RGB-D	PBR+real	RGB-D	0.837	0.775	0.874	0.966	0.722	0.679	0.926	0.921	6.263
5	GDRNPP-PBR-RGBD-MModel	2022	DNN	Object	YOLOX	~CIR	RGB-D	PBR only	RGB-D	0.827	0.775	0.852	0.929	0.722	0.679	0.926	0.906	6.264
6	ZebraPoseSAT-EffnetB4_refined(Def...	2023	DNN	Object	Default GDRNPPDet	~CIR	RGB-D	PBR+real	RGB-D	0.813	0.780	0.862	0.956	0.654	0.618	0.921	0.899	2.577
7	GDRNPP-PBRReal-RGBD-MModel-Fast	2022	DNN	Object	YOLOX	Depth adjust.	RGB	PBR+real	RGB-D	0.805	0.792	0.872	0.936	0.702	0.588	0.909	0.834	0.228
8	OfficialDet-PFA-Mixpbr-RGB-D	2023	DNN	Dataset	Default GDRNPPDet	PFA	RGB	PBR+real	RGB-D	0.800	0.792	0.849	0.963	0.706	0.526	0.867	0.899	1.193
9	GDRNPP-PBRReal-RGBD-MModel-Offici...	2022	DNN	Object	Default MaskRCNN (synt+real)	~CIR	RGB-D	PBR+real	RGB-D	0.798	0.758	0.824	0.966	0.708	0.543	0.890	0.896	6.406
10	GDRNPPDet_PBRReal+GenFlow-MultiHypo	2023	DNN	Dataset for det	Default GDRNPPDet	Recurrent Flow	RGB-D	PBR+real	RGB-D	0.792	0.744	0.780	0.924	0.651	0.647	0.916	0.884	36.012
11	Extended FCOS+PFA-MixPBR-RGBD	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB-D	0.787	0.797	0.850	0.960	0.676	0.469	0.869	0.888	2.317
12	Extended FCOS+PFA-MixPBR-RGBD-Fast	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB-D	0.771	0.792	0.779	0.958	0.671	0.460	0.860	0.880	0.639
13	RCVPose 3D_SingleModel_VIVO_PBR	2022	DNN	Dataset	-	ICP	RGB-D	PBR+real	RGB-D	0.768	0.729	0.708	0.966	0.733	0.536	0.863	0.843	1.336
14	ZebraPoseSAT-EffnetB4 + ICP (Defa...	2022	DNN	Object	Default MaskRCNN (synt+real)	ICP	RGB	PBR+real	RGB-D	0.765	0.752	0.727	0.948	0.652	0.527	0.883	0.866	0.500
15	Extended FCOS+PFA-PBR-RGBD	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR only	RGB-D	0.762	0.797	0.802	0.893	0.676	0.469	0.869	0.826	2.631
16	SurfEmb-PBR-RGBD	2021	DNN	Dataset	Default MaskRCNN (PBR)	Custom	RGB-D	PBR only	RGB-D	0.758	0.760	0.828	0.854	0.659	0.538	0.866	0.799	9.048
17	ZebraPoseSAT-EffnetB4(DefaultDete...	2023	DNN	Object	Default GDRNPPDet	-	RGB	PBR+real	RGB	0.749	0.729	0.821	0.850	0.592	0.504	0.922	0.828	0.250
18	GDRNPP-PBRReal-RGBD-SModel	2022	DNN	Dataset	YOLOX	Depth adjust.	RGB	PBR+real	RGB-D	0.748	0.757	0.856	0.906	0.680	0.356	0.864	0.817	0.556
19	Megapose-GDRNPPDet_PBRReal+MultiH...	2023	DNN	Dataset	Default GDRNPPDet	Teaser++	RGB	RGB	RGB-D	0.744	0.704	0.718	0.916	0.592	0.553	0.872	0.855	93.267
20	Coupled Iterative Refinement	2022	DNN	Dataset	Default MaskRCNN (synt+real)	CIR	RGB-D	PBR+real	RGB-D	0.741	0.734	0.776	0.968	0.676	0.381	0.757	0.893	-
21	GPose2023-RGB	2023	DNN	Object	GDet2023	-	RGB	PBR+real	RGB	0.729	0.699	0.799	0.831	0.626	0.460	0.876	0.809	0.243
22	GDRNPP-PBRReal-RGB-MModel	2022	DNN	Object	YOLOX	-	RGB	PBR+real	RGB	0.728	0.713	0.786	0.831	0.623	0.448	0.869	0.825	0.229
23	ZebraPoseSAT-EffnetB4	2022	DNN	Object	FCOS	-	RGB	PBR+real	RGB	0.720	0.721	0.806	0.850	0.545	0.410	0.882	0.830	0.250
24	ZebraPoseSAT-EffnetB4 (DefaultDet...	2022	DNN	Object	Default MaskRCNN (synt+real)	-	RGB	PBR+real	RGB	0.720	0.707	0.768	0.849	0.597	0.417	0.887	0.816	0.250
25	ZebraPoseSAT-EffnetB4(PBR only De...	2023	DNN	Object	Default GDRNPPDet	-	RGB	PBR only	RGB	0.720	0.729	0.811	0.756	0.592	0.504	0.921	0.729	0.250
26	ZebraPose-SAT	2022	DNN	Object	FCOS	-	RGB	PBR+real	RGB	0.710	0.721	0.787	0.861	0.549	0.379	0.847	0.828	-
27	Extended FCOS+PFA-MixPBR-RGB	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB	0.709	0.745	0.778	0.839	0.600	0.353	0.841	0.806	3.019
28	GDRNPP-PBR-RGB-MModel	2022	DNN	Object	YOLOX	-	RGB	PBR only	RGB	0.702	0.713	0.796	0.752	0.623	0.448	0.869	0.713	0.284
29	GDRNPPDet_PBRReal+GenFlow-MultiHy...	2023	DNN	Dataset	Default GDRNPPDet	-	RGB	PBR+real	RGB	0.701	0.668	0.823	0.760	0.581	0.486	0.893	0.698	35.360
30	CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020	DNN	Dataset	Default MaskRCNN (synt+real)	~DeepIM+ICP	RGB	PBR+real	RGB-D	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
31	MRPE-PBRReal-RGB-SModel	2023	DNN	Dataset	Default GDRNPPDet	Render & compa	RGB	PBR+real	RGB	0.694	0.744	0.758	0.824	0.550	0.368	0.770	0.843	0.100
32	GDRNPP-PBRReal-RGB-SModel	2022	DNN	Dataset	YOLOX	~CIR	RGB	PBR+real	RGB	0.678	0.686	0.776	0.827	0.617	0.260	0.809	0.768	0.466
33	Megapose-GDRNPPDet_PBRReal+MultiHyp	2023	DNN	Dataset for det	Default GDRNPPDet	~DeepIM	RGB	-	RGB	0.675	0.648	0.781	0.741	0.569	0.422	0.863	0.702	36.285
34	ZebraPoseSAT-EffnetB4 (PBR_Only)	2022	DNN	Object	FCOS	-	RGB	PBR only	RGB	0.670	0.721	0.723	0.717	0.545	0.410	0.882	0.691	-
35	Extended FCOS+PFA-PBR-RGB	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR only	RGB	0.663	0.745	0.719	0.732	0.600	0.353	0.841	0.648	3.497
36	PFA-cosypose	2022	DNN	Dataset	MaskRCNN	PFA	RGB-D	PBR+real	RGB	0.659	0.674	0.738	0.837	0.596	0.246	0.712	0.807	
37	Megapose-GDRNPPDet_PBRReal	2023	DNN	Dataset for det	Default GDRNPPDet	~DeepIM	RGB	-	RGB	0.657	0.612	0.766	0.723	0.555	0.402	0.851	0.692	32.349
38	SurfEmb-PBR-RGB	2021	DNN	Dataset	Default MaskRCNN (PBR)	Custom	RGB	PBR only	RGB	0.650	0.663	0.735	0.715	0.588	0.413	0.791	0.647	8.891
39	Koenig-Hybrid-DL-PointPairs	2020	DNN+PPF	Dataset	RetinaMask/MaskRCNN	ICP	RGB	Synt+real	RGB-D	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
40	CosyPose-ECCV20-SYNT+REAL-1VIEW	2020	DNN	Dataset	Default MaskRCNN (synt+real)	~DeepIM	RGB	PBR+real	RGB	0.637	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
41	CRT-6D	2022	DNN	Dataset	Default MaskRCNN (synt+real)	Custom	RGB	PBR+real	RGB	0.599	0.660	0.644	0.789	0.537	0.208	0.603	0.752	0.059
42	Pix2Pose-BOP20_w/ICP-ICCV19	2020	DNN	Object	MaskRCNN	ICP	RGB	PBR+real	RGB-D	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844
43	ZTE_PPF	2022	DNN+PPF	Dataset	Default MaskRCNN (synt+real)	ICP	RGB	PBR+real	RGB-D	0.578	0.663	0.374	0.904	0.396	0.470	0.735	0.502	0.901
44	CosyPose-ECCV20-PBR-1VIEW	2020	DNN	Dataset	Default MaskRCNN (PBR)	~DeepIM	RGB	PBR only	RGB	0.570	0.633	0.640	0.685	0.583	0.216	0.656	0.574	0.475
45	Vidal-Sensors18	2019	PPF	-	-	ICP	-	-	D	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
46	CDPNv2_BOP20 (RGB-only & ICP)	2020	DNN	Object	FCOS	ICP	RGB	Synt+real	RGB-D	0.568	0.630	0.464	0.913	0.450	0.186	0.712	0.619	1.462
47	Drost-CVPR10-Edges	2019	PPF	-	-	ICP	-	-	RGB-D	0.550	0.515	0.500	0.851	0.368	0.570	0.671	0.375	87.568
48	MRPE-PBR-RGB-SModel	2023	DNN	Dataset	Default GDRNPPDet	-	RGB	PBR only	RGB	0.540	0.715	0.729	0.206	0.462	0.353	0.765	0.552	0.099
49	CDPNv2_BOP20 (PBR-only & ICP)	2020	DNN	Object	FCOS	ICP	RGB	PBR only	RGB-D	0.534	0.630	0.435	0.791	0.450	0.186	0.712	0.532	1.491
50	CDPNv2_BOP20 (RGB-only)	2020	DNN	Object	FCOS	-	RGB	Synt+real	RGB	0.529	0.624	0.478	0.772	0.473	0.102	0.722	0.532	0.935
51	Drost-CVPR10-3D-Edges	2019	PPF	-	-	ICP	-	-	D	0.500	0.469	0.404	0.852	0.373	0.462	0.623	0.316	80.055
52	Drost-CVPR10-3D-Only	2019	PPF	-	-	ICP	-	-	D	0.487	0.527	0.444	0.775	0.388	0.316	0.615	0.344	7.704
53	CDPN_BOP19 (RGB-only)	2020	DNN	Object	RetinaNet	-	RGB	Synt+real	RGB	0.479	0.569	0.490	0.769	0.327	0.067	0.672	0.457	0.480
54	CDPNv2_BOP20 (PBR-only & RGB-only)	2020	DNN	Object	FCOS	-	RGB	PBR only	RGB	0.472	0.624	0.407	0.588	0.473	0.102	0.722	0.390	0.978
55	leaping from 2D to 6D	2020	DNN	Object	???	-	RGB	Synt+real	RGB	0.471	0.525	0.403	0.751	0.342	0.077	0.658	0.543	0.425
56	EPOS-BOP20-PBR	2020	DNN	Dataset	-	-	RGB	PBR only	RGB	0.457	0.547	0.467	0.558	0.363	0.186	0.580	0.499	1.874
57	Drost-CVPR10-3D-Only-Faster	2019	PPF	-	-	ICP	-	-	D	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	1.383
58	Félix&Neves-ICRA2017-IET2019	2019	DNN+PPF	Dataset	MaskRCNN	ICP	RGB-D	Synt+real	RGB-D	0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
59	Sundermeyer-IJCV19+ICP	2019	DNN	Object	RetinaNet	ICP	RGB	Synt+real	RGB-D	0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
60	Zhigang-CDPN-ICCV19	2019	DNN	Object	RetinaNet	-	RGB	Synt+real	RGB	0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
61	PointVoteNet2	2020	DNN	Object	-	ICP	RGB-D	PBR only	RGB-D	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
62	Pix2Pose-BOP20-ICCV19	2020	DNN	Object	MaskRCNN	-	RGB	PBR+real	RGB	0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
63	Sundermeyer-IJCV19	2021	DNN	Object	RetinaNet	-	RGB	Synt+real	RGB	0.280	0.146	0.304	0.401	0.217	0.101	0.346	0.446	0.196
64	SingleMultiPathEncoder-CVPR20	2020	DNN	All datasets	MaskRCNN	-	RGB	Synt+real	RGB	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
65	DPOD (synthetic)	2019	DNN	Scene	-	-	RGB	Synt	RGB	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231

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#	Method	Year	Type	...models per	Det./seg.	Refine.	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	GPose2023	2023	DNN	Object	Custom	Coordinate-guide	RGB-D	PBR+real	RGB-D	0.856	0.794	0.914	0.964	0.737	0.704	0.950	0.928	2.670
2	GPose2023-OfficialDet	2023	DNN	Object	Default GDRNPPDet	Coordinate-guide	RGB-D	PBR+real	RGB-D	0.851	0.805	0.895	0.966	0.734	0.687	0.944	0.929	4.575
3	GPose2023-PBR	2023	DNN	Object	Custom	Coordinate-guide	RGB-D	PBR only	RGB-D	0.844	0.794	0.890	0.931	0.737	0.704	0.950	0.901	2.686
4	GDRNPP-PBRReal-RGBD-MModel	2022	DNN	Object	YOLOX	~CIR	RGB-D	PBR+real	RGB-D	0.837	0.775	0.874	0.966	0.722	0.679	0.926	0.921	6.263
5	GDRNPP-PBR-RGBD-MModel	2022	DNN	Object	YOLOX	~CIR	RGB-D	PBR only	RGB-D	0.827	0.775	0.852	0.929	0.722	0.679	0.926	0.906	6.264
6	ZebraPoseSAT-EffnetB4_refined(Def...	2023	DNN	Object	Default GDRNPPDet	~CIR	RGB-D	PBR+real	RGB-D	0.813	0.780	0.862	0.956	0.654	0.618	0.921	0.899	2.577
7	GDRNPP-PBRReal-RGBD-MModel-Fast	2022	DNN	Object	YOLOX	Depth adjust.	RGB	PBR+real	RGB-D	0.805	0.792	0.872	0.936	0.702	0.588	0.909	0.834	0.228
8	OfficialDet-PFA-Mixpbr-RGB-D	2023	DNN	Dataset	Default GDRNPPDet	PFA	RGB	PBR+real	RGB-D	0.800	0.792	0.849	0.963	0.706	0.526	0.867	0.899	1.193
9	GDRNPP-PBRReal-RGBD-MModel-Offici...	2022	DNN	Object	Default MaskRCNN (synt+real)	~CIR	RGB-D	PBR+real	RGB-D	0.798	0.758	0.824	0.966	0.708	0.543	0.890	0.896	6.406
10	GDRNPPDet_PBRReal+GenFlow-MultiHypo	2023	DNN	Dataset for det	Default GDRNPPDet	Recurrent Flow	RGB-D	PBR+real	RGB-D	0.792	0.744	0.780	0.924	0.651	0.647	0.916	0.884	36.012
11	Extended FCOS+PFA-MixPBR-RGBD	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB-D	0.787	0.797	0.850	0.960	0.676	0.469	0.869	0.888	2.317
12	Extended FCOS+PFA-MixPBR-RGBD-Fast	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB-D	0.771	0.792	0.779	0.958	0.671	0.460	0.860	0.880	0.639
13	RCVPose 3D_SingleModel_VIVO_PBR	2022	DNN	Dataset	-	ICP	RGB-D	PBR+real	RGB-D	0.768	0.729	0.708	0.966	0.733	0.536	0.863	0.843	1.336
14	ZebraPoseSAT-EffnetB4 + ICP (Defa...	2022	DNN	Object	Default MaskRCNN (synt+real)	ICP	RGB	PBR+real	RGB-D	0.765	0.752	0.727	0.948	0.652	0.527	0.883	0.866	0.500
15	Extended FCOS+PFA-PBR-RGBD	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR only	RGB-D	0.762	0.797	0.802	0.893	0.676	0.469	0.869	0.826	2.631
16	SurfEmb-PBR-RGBD	2021	DNN	Dataset	[illegible]	[illegible]	[illegible]	[illegible]	RGB-D	0.758	0.760	0.828	0.854	0.659	0.538	0.866	0.799	9.048
17	ZebraPoseSAT-EffnetB4(DefaultDete...	2023	DNN	Object	Default GDRNPPDet	-	RGB	PBR+real	RGB	0.749	0.729	0.821	0.850	0.592	0.504	0.922	0.828	0.250
18	GDRNPP-PBRReal-RGBD-SModel	2022	DNN	Dataset	YOLOX	Default	RGB	PBR+real	RGB-D	0.748	0.757	0.856	0.906	0.680	0.356	0.864	0.817	0.556
19	Megapose-GDRNPPDet_PBRReal+MultiH...	2023	DNN	Dataset	Default GDRNPPDet	Teaser++	RGB	RGB	RGB-D	0.744	0.704	0.718	0.916	0.592	0.553	0.872	0.855	93.267
20	Coupled Iterative Refinement	2022	DNN	Dataset	Default MaskRCNN (synt+real)	CIR	RGB-D	PBR+real	RGB-D	0.741	0.734	0.776	0.968	0.676	0.381	0.757	0.893	-
21	GPose2023-RGB	2023	DNN	Object	GDet2023	-	RGB	PBR+real	RGB	0.729	0.699	0.799	0.831	0.626	0.460	0.876	0.809	0.243
22	GDRNPP-PBRReal-RGB-MModel	2022	DNN	Object	YOLOX	-	RGB	PBR+real	RGB	0.728	0.713	0.786	0.831	0.623	0.448	0.869	0.825	0.229
23	ZebraPoseSAT-EffnetB4	2022	DNN	Object	FCOS	-	RGB	PBR+real	RGB	0.720	0.721	0.806	0.850	0.545	0.410	0.882	0.830	0.250
24	ZebraPoseSAT-EffnetB4 (DefaultDet...	2022	DNN	Object	Default MaskRCNN (synt+real)	-	RGB	PBR+real	RGB	0.720	0.707	0.768	0.849	0.597	0.417	0.887	0.816	0.250
25	ZebraPoseSAT-EffnetB4(PBR only De...	2023	DNN	Object	Default GDRNPPDet	-	RGB	PBR only	RGB	0.720	0.729	0.811	0.756	0.592	0.504	0.921	0.729	0.250
26	ZebraPose-SAT	2022	DNN	Object	FCOS	-	RGB	PBR+real	RGB	0.710	0.721	0.787	0.861	0.549	0.379	0.847	0.828	-
27	Extended FCOS+PFA-MixPBR-RGB	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB	0.709	0.745	0.778	0.839	0.600	0.353	0.841	0.806	3.019
28	GDRNPP-PBR-RGB-MModel	2022	DNN	Object	YOLOX	-	RGB	PBR only	RGB	0.702	0.713	0.796	0.752	0.623	0.448	0.869	0.713	0.284
29	GDRNPPDet_PBRReal+GenFlow-MultiHy...	2023	DNN	Dataset	Default GDRNPPDet	-	RGB	PBR+real	RGB	0.701	0.668	0.823	0.760	0.581	0.486	0.893	0.698	35.360
30	CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020	DNN	Dataset	Default MaskRCNN (synt+real)	~DeepIM+ICP	RGB	PBR+real	RGB-D	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
31	MRPE-PBRReal-RGB-SModel	2023	DNN	Dataset	Default GDRNPPDet	Render & compa	RGB	PBR+real	RGB	0.694	0.744	0.758	0.824	0.550	0.368	0.770	0.843	0.100
32	GDRNPP-PBRReal-RGB-SModel	2022	DNN	Dataset	YOLOX	~CIR	RGB	PBR+real	RGB	0.678	0.686	0.776	0.827	0.617	0.260	0.809	0.768	0.466
33	Megapose-GDRNPPDet_PBRReal+MultiHyp	2023	DNN	Dataset for det	Default GDRNPPDet	~DeepIM	RGB	-	RGB	0.675	0.648	0.781	0.741	0.569	0.422	0.863	0.702	36.285
34	ZebraPoseSAT-EffnetB4 (PBR_Only)	2022	DNN	Object	FCOS	-	RGB	PBR only	RGB	0.670	0.721	0.723	0.717	0.545	0.410	0.882	0.691	-
35	Extended FCOS+PFA-PBR-RGB	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR only	RGB	0.663	0.745	0.719	0.732	0.600	0.353	0.841	0.648	3.497
36	PFA-cosypose	2022	DNN	Dataset	MaskRCNN	PFA	RGB-D	PBR+real	RGB	0.659	0.674	0.738	0.837	0.596	0.246	0.712	0.807	
37	Megapose-GDRNPPDet_PBRReal	2023	DNN	Dataset for det	Default GDRNPPDet	~DeepIM	RGB	-	RGB	0.657	0.612	0.766	0.723	0.555	0.402	0.851	0.692	32.349
38	SurfEmb-PBR-RGB	2021	DNN	Dataset	Default MaskRCNN (PBR)	Custom	RGB	PBR only	RGB	0.650	0.663	0.735	0.715	0.588	0.413	0.791	0.647	8.891
39	Koenig-Hybrid-DL-PointPairs	2020	DNN+PPF	Dataset	RetinaMask/MaskRCNN	ICP	RGB	Synt+real	RGB-D	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
40	CosyPose-ECCV20-SYNT+REAL-1VIEW	2020	DNN	Dataset	Default MaskRCNN (synt+real)	~DeepIM	RGB	PBR+real	RGB	0.637	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
41	CRT-6D	2022	DNN	Dataset	Default MaskRCNN (synt+real)	Custom	RGB	PBR+real	RGB	0.599	0.660	0.644	0.789	0.537	0.208	0.603	0.752	0.059
42	Pix2Pose-BOP20_w/ICP-ICCV19	2020	DNN	Object	MaskRCNN	ICP	RGB	PBR+real	RGB-D	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844

6 new entries in Top 10
(including new Top 3)

BOP 2023: Model-based 6D localization of seen objects

0.856 AR (GPose2023) over 0.837 AR (GDRNPP)
at 42.6% inference time

Accuracy is slowly saturating,
but runtime is still far from practical in most cases

#	Method	Year	Type	...models per	Det./seg.	Refine.	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	GPose2023	2023	DNN	Object	Custom	Coordinate-guide	RGB-D	PBR+real	RGB-D	0.856	0.794	0.914	0.964	0.737	0.704	0.950	0.928	2.670
2	GPose2023-OfficialDet	2023	DNN	Object	Default GDRNPPDet	Coordinate-guide	RGB-D	PBR+real	RGB-D	0.851	0.805	0.895	0.966	0.734	0.687	0.944	0.929	4.575
3	GPose2023-PBR	2023	DNN	Object	Custom	Coordinate-guide	RGB-D	PBR only	RGB-D	0.844	0.794	0.890	0.931	0.737	0.704	0.950	0.901	2.686
4	GDRNPP-PBRReal-RGBD-MModel	2022	DNN	Object	YOLOX	~CIR	RGB-D	PBR+real	RGB-D	0.837	0.775	0.874	0.966	0.722	0.679	0.926	0.921	6.263
5	GDRNPP-PBR-RGBD-MModel	2022	DNN	Object	YOLOX	~CIR	RGB-D	PBR only	RGB-D	0.827	0.775	0.852	0.929	0.722	0.679	0.926	0.906	6.264
6	ZebraPoseSAT-EffnetB4_refined(Def...	2023	DNN	Object	Default GDRNPPDet	~CIR	RGB-D	PBR+real	RGB-D	0.813	0.780	0.862	0.956	0.654	0.618	0.921	0.899	2.577
7	GDRNPP-PBRReal-RGBD-MModel-Fast	2022	DNN	Object	YOLOX	Depth adjust.	RGB	PBR+real	RGB-D	0.805	0.792	0.872	0.936	0.702	0.588	0.909	0.834	0.228
8	OfficialDet-PFA-Mixpbr-RGB-D	2023	DNN	Dataset	Default GDRNPPDet	PFA	RGB	PBR+real	RGB-D	0.800	0.792	0.849	0.963	0.706	0.526	0.867	0.899	1.193
9	GDRNPP-PBRReal-RGBD-MModel-Offici...	2022	DNN	Object	Default MaskRCNN (synt+real)	~CIR	RGB-D	PBR+real	RGB-D	0.798	0.758	0.824	0.966	0.708	0.543	0.890	0.896	6.406
10	GDRNPPDet_PBRReal+GenFlow-MultiHypo	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.924	0.651	0.647	0.916	0.884	36.012
11	Extended FCOS+PFA-MixPBR-RGBD	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB-D	0.787	0.797	0.850	0.960	0.676	0.469	0.869	0.888	2.317
12	Extended FCOS+PFA-MixPBR-RGBD-Fast	2022	DNN	Dataset	Extended FCOS	PFA	[illegible]	[illegible]	RGB-D	0.771	0.792	0.779	0.958	0.671	0.460	0.860	0.880	0.639
13	RCVPose 3D_SingleModel_VIVO_PBR	2022	DNN	Dataset	-	ICP	RGB-D	PBR+real	RGB-D	0.768	0.729	0.708	0.966	0.733	0.536	0.863	0.843	1.336
14	ZebraPoseSAT-EffnetB4 + ICP (Defa...	2022	DNN	Object	Default MaskRCNN (synt+real)	ICP	RGB	PBR+real	RGB-D	0.765	0.752	0.727	0.948	0.652	0.527	0.883	0.866	0.500
15	Extended FCOS+PFA-PBR-RGBD	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR only	RGB-D	0.762	0.797	0.802	0.893	0.676	0.469	0.869	0.826	2.631
16	SurfEmb-PBR-RGBD	2021	DNN	Dataset	Default MaskRCNN (PBR)	Custom	RGB-D	PBR only	RGB-D	0.758	0.760	0.828	0.854	0.659	0.538	0.866	0.799	9.048
17	ZebraPoseSAT-EffnetB4(DefaultDete...	2023	DNN	Object	Default GDRNPPDet	-	RGB	PBR+real	RGB	0.749	0.729	0.821	0.850	0.592	0.504	0.922	0.828	0.250
18	GDRNPP-PBRReal-RGBD-SModel	2022	DNN	Dataset	YOLOX	Depth adjust.	RGB	PBR+real	RGB-D	0.748	0.757	0.856	0.906	0.680	0.356	0.864	0.817	0.556
19	Megapose-GDRNPPDet_PBRReal+MultiH...	[illegible]	DNN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	RGB-D	[illegible]	[illegible]	[illegible]	[illegible]	0.592	0.553	0.872	0.855	93.267
20	Coupled Iterative Refinement	2022	DNN	Dataset	Default MaskRCNN (synt+real)	CIR	RGB-D	PBR+real	RGB-D	0.741	0.734	0.776	0.968	0.676	0.381	0.757	0.893	-
21	GPose2023-RGB	2023	DNN	Object	GDet2023	-	RGB	PBR+real	RGB	0.729	0.699	0.799	0.831	0.626	0.460	0.876	0.809	0.243
22	GDRNPP-PBRReal-RGB-MModel	2022	DNN	Object	YOLOX	-	RGB	PBR+real	RGB	0.728	0.713	0.786	0.831	0.623	0.448	0.869	0.825	0.229
23	ZebraPoseSAT-EffnetB4	2022	DNN	Object	FCOS	-	RGB	PBR+real	RGB	0.720	0.721	0.806	0.850	0.545	0.410	0.882	0.830	0.250
24	ZebraPoseSAT-EffnetB4 (DefaultDet...	2022	DNN	Object	Default MaskRCNN (synt+real)	-	RGB	PBR+real	RGB	0.720	0.707	0.768	0.849	0.597	0.417	0.887	0.816	0.250
25	ZebraPoseSAT-EffnetB4(PBR only De...	2023	DNN	Object	Default GDRNPPDet	-	RGB	PBR only	RGB	0.720	0.729	0.811	0.756	0.592	0.504	0.921	0.729	0.250
26	ZebraPose-SAT	2022	DNN	Object	FCOS	-	RGB	PBR+real	RGB	0.710	0.721	0.787	0.861	0.549	0.379	0.847	0.828	-
27	Extended FCOS+PFA-MixPBR-RGB	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB	0.709	0.745	0.778	0.839	0.600	0.353	0.841	0.806	3.019
28	GDRNPP-PBR-RGB-MModel	2022	DNN	Object	YOLOX	-	RGB	PBR only	RGB	0.702	0.713	0.796	0.752	0.623	0.448	0.869	0.713	0.284
29	GDRNPPDet_PBRReal+GenFlow-MultiHy...	2023	DNN	Dataset	Default GDRNPPDet	-	RGB	PBR+real	RGB	0.701	0.668	0.823	0.760	0.581	0.486	0.893	0.698	35.360
30	CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020	DNN	Dataset	Default MaskRCNN (synt+real)	~DeepIM+ICP	RGB	PBR+real	RGB-D	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
31	MRPE-PBRReal-RGB-SModel	2023	DNN	Dataset	Default GDRNPPDet	Render & compa	RGB	PBR+real	RGB	0.694	0.744	0.758	0.824	0.550	0.368	0.770	0.843	0.100
32	GDRNPP-PBRReal-RGB-SModel	2022	DNN	Dataset	YOLOX	~CIR	RGB	PBR+real	RGB	0.678	0.686	0.776	0.827	0.617	0.260	0.809	0.768	0.466
33	Megapose-GDRNPPDet_PBRReal+MultiHyp	2023	DNN	Dataset for det	Default GDRNPPDet	~DeepIM	RGB	-	RGB	0.675	0.648	0.781	0.741	0.569	0.422	0.863	0.702	36.285
34	ZebraPoseSAT-EffnetB4 (PBR_Only)	2022	DNN	Object	FCOS	-	RGB	PBR only	RGB	0.670	0.721	0.723	0.717	0.545	0.410	0.882	0.691	-
35	Extended FCOS+PFA-PBR-RGB	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR only	RGB	0.663	0.745	0.719	0.732	0.600	0.353	0.841	0.648	3.497
36	PFA-cosypose	2022	DNN	Dataset	MaskRCNN	PFA	RGB-D	PBR+real	RGB	0.659	0.674	0.738	0.837	0.596	0.246	0.712	0.807	
37	Megapose-GDRNPPDet_PBRReal	2023	DNN	Dataset for det	Default GDRNPPDet	~DeepIM	RGB	-	RGB	0.657	0.612	0.766	0.723	0.555	0.402	0.851	0.692	32.349
38	SurfEmb-PBR-RGB	2021	DNN	Dataset	Default MaskRCNN (PBR)	Custom	RGB	PBR only	RGB	0.650	0.663	0.735	0.715	0.588	0.413	0.791	0.647	8.891
39	Koenig-Hybrid-DL-PointPairs	2020	DNN+PPF	Dataset	RetinaMask/MaskRCNN	ICP	RGB	Synt+real	RGB-D	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
40	CosyPose-ECCV20-SYNT+REAL-1VIEW	2020	DNN	Dataset	Default MaskRCNN (synt+real)	~DeepIM	RGB	PBR+real	RGB	0.637	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
41	CRT-6D	2022	DNN	Dataset	Default MaskRCNN (synt+real)	Custom	RGB	PBR+real	RGB	0.599	0.660	0.644	0.789	0.537	0.208	0.603	0.752	0.059
42	Pix2Pose-BOP20_w/ICP-ICCV19	2020	DNN	Object	MaskRCNN	ICP	RGB	PBR+real	RGB-D	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844

Call for BOP'24 Datasets

Candidates for addition to the core set:

HOPE

HouseCat6D

Want datasets with:

- Challenging materials (e.g. transparent, metallic)
- New environments (e.g. hand-object interactions)
- New tasks (e.g. templates for few-shot, multi-view)

BOP 2023: Model-based 6D localization of seen objects

#	Method	Year	Type	...models per	Det./seg.	Refine.	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	GPose2023	2023	DNN	Object	Custom	Coordinate-guide	RGB-D	PBR+real	RGB-D	0.856	0.794	0.914	0.964	0.737	0.704	0.950	0.928	2.670
2	GPose2023-OfficialDet	2023	DNN	Object	Default GDRNPPDet	Coordinate-guide	RGB-D	PBR+real	RGB-D	0.851	0.805	0.895	0.966	0.734	0.687	0.944	0.929	4.575
3	GPose2023-PBR	2023	DNN	Object	Custom	Coordinate-guide	RGB-D	PBR only	RGB-D	0.844	0.794	0.890	0.931	0.737	0.704	0.950	0.901	2.686
4	GDRNPP-PBRReal-RGBD-MModel	2022	DNN	Object	YOLOX	~CIR	RGB-D	PBR+real	RGB-D	0.837	0.775	0.874	0.966	0.722	0.679	0.926	0.921	6.263
5	GDRNPP-PBR-RGBD-MModel	2022	DNN	Object	YOLOX	~CIR	RGB-D	PBR only	RGB-D	0.827	0.775	0.852	0.929	0.722	0.679	0.926	0.906	6.264
6	ZebraPoseSAT-EffnetB4_refined(Def...	2023	DNN	Object	Default GDRNPPDet	~CIR	RGB-D	PBR+real	RGB-D	0.813	0.780	0.862	0.956	0.654	0.618	0.921	0.899	2.577
7	GDRNPP-PBRReal-RGBD-MModel-Fast	2022	DNN	Object	YOLOX	Depth adjust.	RGB	PBR+real	RGB-D	0.805	0.792	0.872	0.936	0.702	0.588	0.909	0.834	0.228
8	OfficialDet-PFA-Mixpbr-RGB-D	2023	DNN	Dataset	Default GDRNPPDet	PFA	RGB	PBR+real	RGB-D	0.800	0.792	0.849	0.963	0.706	0.526	0.867	0.899	1.193
9	GDRNPP-PBRReal-RGBD-MModel-Offici...	2022	DNN	Object	Default MaskRCNN (synt+real)	~CIR	RGB-D	PBR+real	RGB-D	0.798	0.758	0.824	0.966	0.708	0.543	0.890	0.896	6.406
10	GDRNPPDet_PBRReal+GenFlow-MultiHypo	2022	DNN	Dataset	Default GDRNPPDet	~DeepIM	RGB	-	RGB	0.797	0.760	0.924	0.651	0.647	0.916	0.884	36.012
11	Extended FCOS+PFA-MixPBR-RGBD	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB-D	0.787	0.797	0.850	0.960	0.676	0.469	0.869	0.888	2.317
12	Extended FCOS+PFA-MixPBR-RGBD-Fast	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB-D	0.771	0.792	0.779	0.958	0.671	0.460	0.860	0.880	0.639
13	RCVPose 3D_SingleModel_VIVO_PBR	2022	DNN	Dataset	-	ICP	RGB-D	PBR+real	RGB-D	0.768	0.729	0.708	0.966	0.733	0.536	0.863	0.843	1.336
14	ZebraPoseSAT-EffnetB4 + ICP (Defa...	2022	DNN	Object	Default MaskRCNN (synt+real)	ICP	RGB	PBR+real	RGB-D	0.765	0.752	0.727	0.948	0.652	0.527	0.883	0.866	0.500
15	Extended FCOS+PFA-PBR-RGBD	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR only	RGB-D	0.762	0.797	0.802	0.893	0.676	0.469	0.869	0.826	2.631
16	SurfEmb-PBR-RGBD	2021	DNN	Dataset	Default MaskRCNN (PBR)	Custom	RGB-D	PBR only	RGB-D	0.758	0.760	0.828	0.854	0.659	0.538	0.866	0.799	9.048
17	ZebraPoseSAT-EffnetB4(DefaultDete...	2023	DNN	Object	Default GDRNPPDet	-	RGB	PBR+real	RGB	0.749	0.729	0.821	0.850	0.592	0.504	0.922	0.828	0.250
18	GDRNPP-PBRReal-RGBD-SModel	2022	DNN	Dataset	YOLOX	Depth adjust.	RGB	PBR+real	RGB-D	0.748	0.757	0.856	0.906	0.680	0.356	0.864	0.817	0.556
19	Megapose-GDRNPPDet_PBRReal+MultiH...	2023	DNN	Dataset	Default GDRNPPDet	Teaser++	RGB	RGB	RGB-D	0.744	0.704	0.718	0.916	0.592	0.553	0.872	0.855	93.267
20	Coupled Iterative Refinement	2022	DNN	Dataset	Default MaskRCNN (synt+real)	CIR	RGB-D	PBR+real	RGB-D	0.741	0.734	0.776	0.968	0.676	0.381	0.757	0.893	-
21	GPose2023-RGB	2023	DNN	Object	GDet2023	-	RGB	PBR+real	RGB	0.729	0.699	0.799	0.831	0.626	0.460	0.876	0.809	0.243
22	GDRNPP-PBRReal-RGB-MModel	2022	DNN	Object	YOLOX	-	RGB	PBR+real	RGB	0.728	0.713	0.786	0.831	0.623	0.448	0.869	0.825	0.229
23	ZebraPoseSAT-EffnetB4	2022	DNN	Object	FCOS	-	RGB	PBR+real	RGB	0.720	0.721	0.806	0.850	0.545	0.410	0.882	0.830	0.250
24	ZebraPoseSAT-EffnetB4 (DefaultDet...	2022	DNN	Object	Default MaskRCNN (synt+real)	-	RGB	PBR+real	RGB	0.720	0.707	0.768	0.849	0.597	0.417	0.887	0.816	0.250
25	ZebraPoseSAT-EffnetB4(PBR only De...	2023	DNN	Object	Default GDRNPPDet	-	RGB	PBR only	RGB	0.720	0.729	0.811	0.756	0.592	0.504	0.921	0.729	0.250
26	ZebraPose-SAT	2022	DNN	Object	FCOS	-	RGB	PBR+real	RGB	0.710	0.721	0.787	0.861	0.549	0.379	0.847	0.828	-
27	Extended FCOS+PFA-MixPBR-RGB	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB	0.709	0.745	0.778	0.839	0.600	0.353	0.841	0.806	3.019
28	GDRNPP-PBR-RGB-MModel	2022	DNN	Object	YOLOX	-	RGB	PBR only	RGB	0.702	0.713	0.796	0.752	0.623	0.448	0.869	0.713	0.284
29	GDRNPPDet_PBRReal+GenFlow-MultiHy...	2023	DNN	Dataset	Default GDRNPPDet	-	RGB	PBR+real	RGB	0.701	0.668	0.823	0.760	0.581	0.486	0.893	0.698	35.360
30	CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020	DNN	Dataset	Default MaskRCNN (synt+real)	~DeepIM+ICP	RGB	PBR+real	RGB-D	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
31	MRPE-PBRReal-RGB-SModel	2023	DNN	Dataset	Default GDRNPPDet	Render & compa	RGB	PBR+real	RGB	0.694	0.744	0.758	0.824	0.550	0.368	0.770	0.843	0.100
32	GDRNPP-PBRReal-RGB-SModel	2022	DNN	Dataset	YOLOX	~CIR	RGB	PBR+real	RGB	0.678	0.686	0.776	0.827	0.617	0.260	0.809	0.768	0.466
33	Megapose-GDRNPPDet_PBRReal+MultiHyp	2023	DNN	Dataset for det	Default GDRNPPDet	~DeepIM	RGB	-	RGB	0.675	0.648	0.781	0.741	0.569	0.422	0.863	0.702	36.285
34	ZebraPoseSAT-EffnetB4 (PBR_Only)	2022	DNN	Object	FCOS	-	RGB	PBR only	RGB	0.670	0.721	0.723	0.717	0.545	0.410	0.882	0.691	-
35	Extended FCOS+PFA-PBR-RGB	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR only	RGB	0.663	0.745	0.719	0.732	0.600	0.353	0.841	0.648	3.497
36	PFA-cosypose	2022	DNN	Dataset	MaskRCNN	PFA	RGB-D	PBR+real	RGB	0.659	0.674	0.738	0.837	0.596	0.246	0.712	0.807	
37	Megapose-GDRNPPDet_PBRReal	2023	DNN	Dataset for det	Default GDRNPPDet	~DeepIM	RGB	-	RGB	0.657	0.612	0.766	0.723	0.555	0.402	0.851	0.692	32.349
38	SurfEmb-PBR-RGB	2021	DNN	Dataset	Default MaskRCNN (PBR)	Custom	RGB	PBR only	RGB	0.650	0.663	0.735	0.715	0.588	0.413	0.791	0.647	8.891
39	Koenig-Hybrid-DL-PointPairs	2020	DNN+PPF	Dataset	RetinaMask/MaskRCNN	ICP	RGB	Synt+real	RGB-D	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
40	CosyPose-ECCV20-SYNT+REAL-1VIEW	2020	DNN	Dataset	Default MaskRCNN (synt+real)	~DeepIM	RGB	PBR+real	RGB	0.637	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
41	CRT-6D	2022	DNN	Dataset	Default MaskRCNN (synt+real)	Custom	RGB	PBR+real	RGB	0.599	0.660	0.644	0.789	0.537	0.208	0.603	0.752	0.059
42	Pix2Pose-BOP20_w/ICP-ICCV19	2020	DNN	Object	MaskRCNN	ICP	RGB	PBR+real	RGB-D	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844

GPose trained purely synthetically outperforms GDRNPP trained with real data

BOP 2023: Model-based 6D localization of seen objects

#	Method	Year	Type	...models per	Det./seg.	Refine.	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	GPose2023	2023	DNN	Object	Custom	Coordinate-guide	RGB-D	PBR+real	RGB-D	0.856	0.794	0.914	0.964	0.737	0.704	0.950	0.928	2.670
2	GPose2023-OfficialDet	2023	DNN	Object	Default GDRNPPDet	Coordinate-guide	RGB-D	PBR+real	RGB-D	0.851	0.805	0.895	0.966	0.734	0.687	0.944	0.929	4.575
3	GPose2023-PBR	2023	DNN	Object	Custom	Coordinate-guide	RGB-D	PBR only	RGB-D	0.844	0.794	0.890	0.931	0.737	0.704	0.950	0.901	2.686
4	GDRNPP-PBRReal-RGBD-MModel	2022	DNN	Object	YOLOX	~CIR	RGB-D	PBR+real	RGB-D	0.837	0.775	0.874	0.966	0.722	0.679	0.926	0.921	6.263
5	GDRNPP-PBR-RGBD-MModel	2022	DNN	Object	YOLOX	~CIR	RGB-D	PBR only	RGB-D	0.827	0.775	0.852	0.929	0.722	0.679	0.926	0.906	6.264
6	ZebraPoseSAT-EffnetB4_refined(Def...	2023	DNN	Object	Default GDRNPPDet	~CIR	RGB-D	PBR+real	RGB-D	0.813	0.780	0.862	0.956	0.654	0.618	0.921	0.899	2.577
7	GDRNPP-PBRReal-RGBD-MModel-Fast	2022	DNN	Object	YOLOX	Depth adjust.	RGB	PBR+real	RGB-D	0.805	0.792	0.872	0.936	0.702	0.588	0.909	0.834	0.228
8	OfficialDet-PFA-Mixpbr-RGB-D	2023	DNN	Dataset	Default GDRNPPDet	PFA	RGB	PBR+real	RGB-D	0.800	0.792	0.849	0.963	0.706	0.526	0.867	0.899	1.193
9	GDRNPP-PBRReal-RGBD-MModel-Offici...	2022	DNN	Object	Default MaskRCNN (synt+real)	~CIR	RGB-D	PBR+real	RGB-D	0.798	0.758	0.824	0.966	0.708	0.543	0.890	0.896	6.406
10	GDRNPPDet_PBRReal+GenFlow-MultiHypo	2023	DNN	Dataset for de	Default GDRNPPDet	Recurrent Flow	RGB-D	PBR+real	RGB-D	0.792	0.744	0.780	0.924	0.651	0.647	0.916	0.884	36.012
11	Extended FCOS+PFA-MixPBR-RGBD	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB-D	0.787	0.797	0.850	0.960	0.676	0.469	0.869	0.888	2.317
12	Extended FCOS+PFA-MixPBR-RGBD-Fast	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB-D	0.771	0.792	0.779	0.958	0.671	0.460	0.860	0.880	0.639
13	RCVPose 3D_SingleModel_VIVO_PBR	2022	DNN	Dataset	-	ICP	RGB-D	PBR+real	RGB-D	0.768	0.729	0.708	0.966	0.733	0.536	0.863	0.843	1.336
14	ZebraPoseSAT-EffnetB4 + ICP (Defa...	2022	DNN	Object	Default MaskRCNN (synt+real)	ICP	RGB	PBR+real	RGB-D	0.765	0.752	0.727	0.948	0.652	0.527	0.883	0.866	0.500
15	Extended FCOS+PFA-PBR-RGBD	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR only	RGB-D	0.762	0.797	0.802	0.893	0.676	0.469	0.869	0.826	2.631
16	SurfEmb-PBR-RGB[illegible]	2021	[illegible]	Dataset	Default MaskRCNN [illegible]	[illegible]	RGB-D	PBR only	RGB-D	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.866	0.799	9.048
17	ZebraPoseSAT-EffnetB4(DefaultDete...	2023	DNN	Object	Default GDRNPPDet	-	RGB	PBR+real	RGB	0.749	0.729	0.821	0.850	0.592	0.504	0.922	0.828	0.250
18	GDRNPP-PBRReal-RGBD-SModel	2022	DNN	Dataset	YOLOX	Depth adjust.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.680	0.356	0.864	0.817	0.556
19	Megapose-GDRNPPDet_PBRReal+MultiH...	2023	DNN	Dataset	Default GDRNPPDet	Teaser++	RGB	RGB	RGB-D	0.744	0.704	0.718	0.916	0.592	0.553	0.872	0.855	93.267
20	Coupled Iterative Refinement	[illegible]	DNN	Dataset	Default MaskRCNN (synt+real)	[illegible]	[illegible]	[illegible]	[illegible]	0.741	[illegible]	[illegible]	0.968	0.676	0.381	0.757	0.893	-
21	GPose2023-RGB	2023	DNN	Object	GDet2023	-	RGB	PBR+real	RGB	0.729	0.699	0.799	0.831	0.626	0.460	0.876	0.809	0.243
22	GDRNPP-PBRReal-RGB-MModel	2022	DNN	Object	YOLOX	-	RGB	PBR+real	RGB	0.728	0.713	0.786	0.831	0.623	0.448	0.869	0.825	0.229
23	ZebraPoseSAT-EffnetB4	2022	DNN	Object	FCOS	-	RGB	PBR+real	RGB	0.720	0.721	0.806	0.850	0.545	0.410	0.882	0.830	0.250
24	ZebraPoseSAT-EffnetB4 (DefaultDet...	2022	DNN	Object	Default MaskRCNN (synt+real)	-	RGB	PBR+real	RGB	0.720	0.707	0.768	0.849	0.597	0.417	0.887	0.816	0.250
25	ZebraPoseSAT-EffnetB4(PBR only De...	2023	DNN	Object	Default GDRNPPDet	-	RGB	PBR only	RGB	0.720	0.729	0.811	0.756	0.592	0.504	0.921	0.729	0.250
26	ZebraPose-SAT	2022	DNN	Object	FCOS	-	RGB	PBR+real	RGB	0.710	0.721	0.787	0.861	0.549	0.379	0.847	0.828	-
27	Extended FCOS+PFA-MixPBR-RGB	2022	DNN	Dataset	[illegible]	[illegible]	[illegible]	[illegible]	RGB	0.709	0.745	0.778	0.839	0.600	0.353	0.841	0.806	3.019
28	GDRNPP-PBR-RGB-MModel	2022	DNN	Object	YOLOX	-	RGB	PBR only	RGB	0.702	0.713	0.796	0.752	0.623	0.448	0.869	0.713	0.284
29	GDRNPPDet_PBRReal+GenFlow-[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.486	0.893	0.698	35.360
30	CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020	DNN	Dataset	Default MaskRCNN (synt+real)	~DeepIM+ICP	RGB	PBR+real	RGB-D	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
31	MRPE-PBRReal-RGB-SModel	2023	DNN	Dataset	Default GDRNPPDet	Render & compa	RGB	PBR+real	RGB	0.694	0.744	0.758	0.824	0.550	0.368	0.770	0.843	0.100
32	GDRNPP-PBRReal-RGB-SModel	2022	DNN	Dataset	YOLOX	~CIR	RGB	PBR+real	RGB	0.678	0.686	0.776	0.827	0.617	0.260	0.809	0.768	0.466
33	Megapose-GDRNPPDet_PBRReal+MultiHyp	2023	DNN	Dataset for det	Default GDRNPPDet	~DeepIM	RGB	-	RGB	0.675	0.648	0.781	0.741	0.569	0.422	0.863	0.702	36.285
34	ZebraPoseSAT-EffnetB4 (PBR_Only)	2022	DNN	Object	FCOS	-	RGB	PBR only	RGB	0.670	0.721	0.723	0.717	0.545	0.410	0.882	0.691	-
35	Extended FCOS+PFA-PBR-RGB	2022	DNN	Dataset	Extended FCOS	PFA	RGB	PBR only	RGB	0.663	0.745	0.719	0.732	0.600	0.353	0.841	0.648	3.497
36	PFA-cosypose	2022	DNN	Dataset	MaskRCNN	PFA	RGB-D	PBR+real	RGB	0.659	0.674	0.738	0.837	0.596	0.246	0.712	0.807	
37	Megapose-GDRNPPDet_PBRReal	2023	DNN	Dataset for det	Default GDRNPPDet	~DeepIM	RGB	-	RGB	0.657	0.612	0.766	0.723	0.555	0.402	0.851	0.692	32.349
38	SurfEmb-PBR-RGB	2021	DNN	Dataset	Default MaskRCNN (PBR)	Custom	RGB	PBR only	RGB	0.650	0.663	0.735	0.715	0.588	0.413	0.791	0.647	8.891
39	Koenig-Hybrid-DL-PointPairs	2020	DNN+PPF	Dataset	RetinaMask/MaskRCNN	ICP	RGB	Synt+real	RGB-D	0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
40	CosyPose-ECCV20-SYNT+REAL-1VIEW	2020	DNN	Dataset	Default MaskRCNN (synt+real)	~DeepIM	RGB	PBR+real	RGB	0.637	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
41	CRT-6D	2022	DNN	Dataset	Default MaskRCNN (synt+real)	Custom	RGB	PBR+real	RGB	0.599	0.660	0.644	0.789	0.537	0.208	0.603	0.752	0.059
42	Pix2Pose-BOP20_w/ICP-ICCV19	2020	DNN	Object	MaskRCNN	ICP	RGB	PBR+real	RGB-D	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844

Seen object detection + unseen object pose estimation = 0.792 AR

–0.059 AR against GPose2023 (best **per object** model)

–0.008 AR against PFA (best **per dataset** model)

If runtime is secondary:

no need to train a pose network on multiple known objects

BOP 2023: Model-based 2D detection of unseen objects

#	Method	Year	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	CNOS (FastSAM)	2023	RGB	PBR only	RGB	0.428	0.433	0.395	0.534	0.226	0.325	0.517	0.568	0.221
2	CNOS (SAM)	2023	RGB	PBR only	RGB	0.361	0.395	0.33	0.368	0.207	0.313	0.423	0.49	1.847
3	ZeroPose	2023	RGB	PBR only	RGB	0.341	0.367	0.3	0.431	0.228	0.25	0.398	0.416	3.821

BOP 2023: Model-based 2D segmentation of unseen objects

#	Method	Year	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	CNOS (FastSAM)	2023	RGB	PBR only	RGB	0.412	0.397	0.374	0.48	0.27	0.254	0.511	0.599	0.221
2	CNOS (SAM)	2023	RGB	PBR only	RGB	0.403	0.396	0.397	0.391	0.284	0.282	0.48	0.595	1.847
3	ZeroPose	2023	RGB	PBR only	RGB	0.372	0.356	0.337	0.421	0.293	0.21	0.453	0.534	3.821
4	lcc-fastsam	2023	RGB	PBR only	RGB	0.149	0.167	0.097	0.153	0.11	0.041	0.253	0.22	1.182

CNOS: A Strong Baseline for CAD-based Novel Object Segmentation

Very strong baseline.

BOP 2023: Model-based 2D detection of unseen objects

#	Method	Year	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
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BOP 2023: Model-based 2D segmentation of unseen objects

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3	ZeroPose	2023	RGB	PBR only	RGB	0.372	0.356	0.337	0.421	0.293	0.21	0.453	0.534	3.821
4	lcc-fastsam	2023	RGB	PBR only	RGB	0.149	0.167	0.097	0.153	0.11	0.041	0.253	0.22	1.182

All entries are RGB-only and based on “foundation vision models”
(SAM, FastSAM, DinoV2)

BOP 2023: Model-based 2D detection of unseen objects

#	Method	Year	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	CNOS (FastSAM)	2023	RGB	PBR only	RGB	0.428	0.433	0.395	0.534	0.226	0.325	0.517	0.568	0.221
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BOP 2023: Model-based 2D segmentation of unseen objects

#	Method	Year	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
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2	CNOS (SAM)	2023	RGB	PBR only	RGB	0.403	0.396	0.397	0.391	0.284	0.282	0.48	0.595	1.847
3	ZeroPose	2023	RGB	PBR only	RGB	0.372	0.356	0.337	0.421	0.293	0.21	0.453	0.534	3.821
4	lcc-fastsam	2023	RGB	PBR only	RGB	0.149	0.167	0.097	0.153	0.11	0.041	0.253	0.22	1.182

CNOS reaches 0.412 AP for unseen object segmentation in 0.22s
(with just 200 synthetic reference images per object)

Mask R-CNN (default 2022) reached 0.405 AP for seen object segmentation
(trained on 1M+ synthetic+real images)

BOP 2023: Model-based 6D localization of unseen objects

#	Method	Year	Type	...models per	Det./seg.	Refine.	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	GenFlow-MultiHypo16	2023	DNN	All datasets	Default CNOS-fastSAM	Recurrent Flow	RGB-D	PBR only	RGB-D	0.674	0.635	0.521	0.862	0.534	0.554	0.779	0.833	34.578
2	GenFlow-MultiHypo	2023	DNN	All datasets	Default CNOS-fastSAM	Recurrent Flow	RGB-D	PBR only	RGB-D	0.662	0.622	0.509	0.849	0.524	0.544	0.77	0.818	21.457
3	Megapose-CNOS_fastSAM+Multih_Teaserpp-10	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine+Teaser++	RGB	PBR only	RGB-D	0.628	0.626	0.487	0.851	0.467	0.468	0.73	0.764	141.965
4	Megapose-CNOS_fastSAM+Multih_Teaserpp-10	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine+Teaser++	RGB	PBR only	RGB-D	0.623	0.62	0.485	0.846	0.462	0.46	0.725	0.764	116.564
5	SAM6D-CNOSmask	2023	DNN	All datasets	Default CNOS-fastSAM	Cross-attention	RGB-D	PBR only	RGB-D	0.616	0.648	0.483	0.794	0.504	0.351	0.727	0.804	3.872
6	PoZe (CNOS)	2023	DNN	All datasets	Default CNOS-fastSAM	ICP	RGB-D	PBR only	RGB-D	0.616	0.644	0.494	0.924	0.409	0.516	0.712	0.611	159.425
7	ZeroPose-Multi-Hypo-Refinement-De...	2023	DNN	All datasets	Default CNOS-fastSAM	Megapose-Fine	RGB-D	PBR+real	RGB-D	0.57	0.538	0.4	0.835	0.392	0.521	0.653	0.653	16.168
8	GenFlow-MultiHypo-RGB	2023	DNN	All datasets	Default CNOS-fastSAM	Recurrent Flow	RGB-D	PBR only	RGB	0.57	0.563	0.523	0.684	0.453	0.395	0.739	0.633	20.890
9	Megapose-CNOS_fastSAM+Multih-10	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine	RGB	PBR only	RGB	0.549	0.56	0.508	0.687	0.419	0.346	0.706	0.62	53.878
10	Megapose-CNOS_fastSAM+Multih	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine	RGB	PBR only	RGB	0.547	0.56	0.507	0.684	0.414	0.338	0.704	0.621	47.386
11	ZeroPose-Multi-Hypo-Refinement	2023	DNN	All datasets	SAM + ImageBind	MegaPose-Fine	RGB-D	PBR+real	RGB-D	0.534	0.493	0.342	0.79	0.396	0.465	0.629	0.623	18.971
12	MegaPose-CNOS_fastSAM	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine	RGB	PBR only	RGB	0.509	0.499	0.477	0.653	0.367	0.315	0.654	0.601	31.724
13	ZeroPose-One-Hypo	2023	DNN	All datasets	SAM + ImageBind	MegaPose-Fine	RGB-D	PBR+real	RGB-D	0.348	0.272	0.156	0.536	0.307	0.362	0.462	0.341	9.756
14	GenFlow-coarse	2023	DNN	All datasets	Default CNOS-fastSAM	-	RGB	PBR only	RGB	0.235	0.25	0.215	0.3	0.168	0.154	0.283	0.277	3.839

BOP 2023: Model-based 6D localization of unseen objects

#	Method	Year	Type	...models per	Det./seg.	Refine.	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	GenFlow-MultiHypo16	2023	DNN	All datasets	Default CNOS-fastSAM	Recurrent Flow	RGB-D	PBR only	RGB-D	0.674	0.635	0.521	0.862	0.534	0.554	0.779	0.833	34.578
2	GenFlow-MultiHypo	2023	DNN	All datasets	Default CNOS-fastSAM	Recurrent Flow	RGB-D	PBR only	RGB-D	0.662	0.622	0.509	0.849	0.524	0.544	0.77	0.818	21.457
3	Megapose-CNOS_fastSAM+Multih_Teaserpp-10	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine+Teaser++	RGB	PBR only	RGB-D	0.628	0.626	0.487	0.851	0.467	0.468	0.73	0.764	141.965
4	Megapose-CNOS_fastSAM+Multih_Teaserpp-10	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine+Teaser++	RGB	PBR only	RGB-D	0.623	0.62	0.485	0.846	0.462	0.46	0.725	0.764	116.564
5	SAM6D-CNOSmask	2023	DNN	All datasets	Default CNOS-fastSAM	Cross-attention	RGB-D	PBR only	RGB-D	0.616	0.648	0.483	0.794	0.504	0.351	0.727	0.804	3.872
6	PoZe (CNOS)	2023	DNN	All datasets	Default CNOS-fastSAM	ICP	RGB-D	PBR only	RGB-D	0.616	0.644	0.494	0.924	0.409	0.516	0.712	0.611	159.425
7	ZeroPose-Multi-Hypo-Refinement-De...	2023	DNN	All datasets	Default CNOS-fastSAM	Megapose-Fine	RGB-D	PBR+real	RGB-D	0.57	0.538	0.4	0.835	0.392	0.521	0.653	0.653	16.168
8	GenFlow-MultiHypo-RGB	2023	DNN	All datasets	Default CNOS-fastSAM	Recurrent Flow	RGB-D	PBR only	RGB	0.57	0.563	0.523	0.684	0.453	0.395	0.739	0.633	20.890
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10	Megapose-CNOS_fastSAM+Multih	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine	RGB	PBR only	RGB	0.547	0.56	0.507	0.684	0.414	0.338	0.704	0.621	47.386
11	ZeroPose-Multi-Hypo-Refinement	2023	DNN	All datasets	SAM + ImageBind	MegaPose-Fine	RGB-D	PBR+real	RGB-D	0.534	0.493	0.342	0.79	0.396	0.465	0.629	0.623	18.971
12	MegaPose-CNOS_fastSAM	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine	RGB	PBR only	RGB	0.509	0.499	0.477	0.653	0.367	0.315	0.654	0.601	31.724
13	ZeroPose-One-Hypo	2023	DNN	All datasets	SAM + ImageBind	MegaPose-Fine	RGB-D	PBR+real	RGB-D	0.348	0.272	0.156	0.536	0.307	0.362	0.462	0.341	9.756
14	GenFlow-coarse	2023	DNN	All datasets	Default CNOS-fastSAM	-	RGB	PBR only	RGB	0.235	0.25	0.215	0.3	0.168	0.154	0.283	0.277	3.839

GenFlow achieves +0.046 AR and is 4x faster
than a variant of the first published method MegaPose from Dec'22

(MegaPose on BOP'23 uses CNOS detections and extra Teaserpp refinement)

BOP 2023: Model-based 6D localization of unseen objects

#	Method	Year	Type	...models per	Det./seg.	Refine.	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	GenFlow-MultiHypo16	2023	DNN	All datasets	Default CNOS-fastSAM	Recurrent Flow	RGB-D	PBR only	RGB-D	0.674	0.635	0.521	0.862	0.534	0.554	0.779	0.833	34.578
2	GenFlow-MultiHypo	2023	DNN	All datasets	Default CNOS-fastSAM	Recurrent Flow	RGB-D	PBR only	RGB-D	0.662	0.622	0.509	0.849	0.524	0.544	0.77	0.818	21.457
3	Megapose-CNOS_fastSAM+Multih_Teaserpp-10	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine+Teaser++	RGB	PBR only	RGB-D	0.628	0.626	0.487	0.851	0.467	0.468	0.73	0.764	141.965
4	Megapose-CNOS_fastSAM+Multih_Teaserpp-10	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine+Teaser++	RGB	PBR only	RGB-D	0.623	0.62	0.485	0.846	0.462	0.46	0.725	0.764	116.564
5	SAM6D-CNOSmask	2023	DNN	All datasets	Default CNOS-fastSAM	Cross-attention	RGB-D	PBR only	RGB-D	0.616	0.648	0.483	0.794	0.504	0.351	0.727	0.804	3.872
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7	ZeroPose-Multi-Hypo-Refinement-De...	2023	DNN	All datasets	Default CNOS-fastSAM	Megapose-Fine	RGB-D	PBR+real	RGB-D	0.57	0.538	0.4	0.835	0.392	0.521	0.653	0.653	16.168
8	GenFlow-MultiHypo-RGB	2023	DNN	All datasets	Default CNOS-fastSAM	Recurrent Flow	RGB-D	PBR only	RGB	0.57	0.563	0.523	0.684	0.453	0.395	0.739	0.633	20.890
9	Megapose-CNOS_fastSAM+Multih-10	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine	RGB	PBR only	RGB	0.549	0.56	0.508	0.687	0.419	0.346	0.706	0.62	53.878
10	Megapose-CNOS_fastSAM+Multih	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine	RGB	PBR only	RGB	0.547	0.56	0.507	0.684	0.414	0.338	0.704	0.621	47.386
11	ZeroPose-Multi-Hypo-Refinement	2023	DNN	All datasets	SAM + ImageBind	MegaPose-Fine	RGB-D	PBR+real	RGB-D	0.534	0.493	0.342	0.79	0.396	0.465	0.629	0.623	18.971
12	MegaPose-CNOS_fastSAM	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine	RGB	PBR only	RGB	0.509	0.499	0.477	0.653	0.367	0.315	0.654	0.601	31.724
13	ZeroPose-One-Hypo	2023	DNN	All datasets	SAM + ImageBind	MegaPose-Fine	RGB-D	PBR+real	RGB-D	0.348	0.272	0.156	0.536	0.307	0.362	0.462	0.341	9.756
14	GenFlow-coarse	2023	DNN	All datasets	Default CNOS-fastSAM	-	RGB	PBR only	RGB	0.235	0.25	0.215	0.3	0.168	0.154	0.283	0.277	3.839

The fastest method SAM6D is 10–30x faster
than MegaPose and the winner GenFlow

BOP 2023: Model-based 6D localization of unseen objects

#	Method	Year	Type	...models per	Det./seg.	Refine.	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	GenFlow-MultiHypo16	2023	DNN	All datasets	Default CNOS-fastSAM	Recurrent Flow	RGB-D	PBR only	RGB-D	0.674	0.635	0.521	0.862	0.534	0.554	0.779	0.833	34.578
2	GenFlow-MultiHypo	2023	DNN	All datasets	Default CNOS-fastSAM	Recurrent Flow	RGB-D	PBR only	RGB-D	0.662	0.622	0.509	0.849	0.524	0.544	0.77	0.818	21.457
3	Megapose-CNOS_fastSAM+Multih_Teaserpp-10	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine+Teaser++	RGB	PBR only	RGB-D	0.628	0.626	0.487	0.851	0.467	0.468	0.73	0.764	141.965
4	Megapose-CNOS_fastSAM+Multih_Teaserpp-10	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine+Teaser++	RGB	PBR only	RGB-D	0.623	0.62	0.485	0.846	0.462	0.46	0.725	0.764	116.564
5	SAM6D-CNOSmask	2023	DNN	All datasets	Default CNOS-fastSAM	Cross-attention	RGB-D	PBR only	RGB-D	0.616	0.648	0.483	0.794	0.504	0.351	0.727	0.804	3.872
6	PoZe (CNOS)	2023	DNN	All datasets	Default CNOS-fastSAM	ICP	RGB-D	PBR only	RGB-D	0.616	0.644	0.494	0.924	0.409	0.516	0.712	0.611	159.425
7	ZeroPose-Multi-Hypo-Refinement-De...	2023	DNN	All datasets	Default CNOS-fastSAM	Megapose-Fine	RGB-D	PBR+real	RGB-D	0.57	0.538	0.4	0.835	0.392	0.521	0.653	0.653	16.168
8	GenFlow-MultiHypo-RGB	2023	DNN	All datasets	Default CNOS-fastSAM	Recurrent Flow	RGB-D	PBR only	RGB	0.57	0.563	0.523	0.684	0.453	0.395	0.739	0.633	20.890
9	Megapose-CNOS_fastSAM+Multih-10	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine	RGB	PBR only	RGB	0.549	0.56	0.508	0.687	0.419	0.346	0.706	0.62	53.878
10	Megapose-CNOS_fastSAM+Multih	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine	RGB	PBR only	RGB	0.547	0.56	0.507	0.684	0.414	0.338	0.704	0.621	47.386
11	ZeroPose-Multi-Hypo-Refinement	2023	DNN	All datasets	SAM + ImageBind	MegaPose-Fine	RGB-D	PBR+real	RGB-D	0.534	0.493	0.342	0.79	0.396	0.465	0.629	0.623	18.971
12	MegaPose-CNOS_fastSAM	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine	RGB	PBR only	RGB	0.509	0.499	0.477	0.653	0.367	0.315	0.654	0.601	31.724
13	ZeroPose-One-Hypo	2023	DNN	All datasets	SAM + ImageBind	MegaPose-Fine	RGB-D	PBR+real	RGB-D	0.348	0.272	0.156	0.536	0.307	0.362	0.462	0.341	9.756
14	GenFlow-coarse	2023	DNN	All datasets	Default CNOS-fastSAM	-	RGB	PBR only	RGB	0.235	0.25	0.215	0.3	0.168	0.154	0.283	0.277	3.839

+0.104 AR by using the depth channel of test images

BOP 2023: Model-based 6D localization of unseen objects

#	Method	Year	Type	...models per	Det./seg.	Refine.	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	GenFlow-MultiHypo16	2023	DNN	All datasets	Default CNOS-fastSAM	Recurrent Flow	RGB-D	PBR only	RGB-D	0.674	0.635	0.521	0.862	0.534	0.554	0.779	0.833	34.578
2	GenFlow-MultiHypo	2023	DNN	All datasets	Default CNOS-fastSAM	Recurrent Flow	RGB-D	PBR only	RGB-D	0.662	0.622	0.509	0.849	0.524	0.544	0.77	0.818	21.457
3	Megapose-CNOS_fastSAM+Multih_Teaserpp-10	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine+Teaser++	RGB	PBR only	RGB-D	0.628	0.626	0.487	0.851	0.467	0.468	0.73	0.764	141.965
4	Megapose-CNOS_fastSAM+Multih_Teaserpp-10	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine+Teaser++	RGB	PBR only	RGB-D	0.623	0.62	0.485	0.846	0.462	0.46	0.725	0.764	116.564
5	SAM6D-CNOSmask	2023	DNN	All datasets	Default CNOS-fastSAM	Cross-attention	RGB-D	PBR only	RGB-D	0.616	0.648	0.483	0.794	0.504	0.351	0.727	0.804	3.872
6	PoZe (CNOS)	2023	DNN	All datasets	Default CNOS-fastSAM	ICP	RGB-D	PBR only	RGB-D	0.616	0.644	0.494	0.924	0.409	0.516	0.712	0.611	159.425
7	ZeroPose-Multi-Hypo-Refinement-De...	2023	DNN	All datasets	Default CNOS-fastSAM	Megapose-Fine	RGB-D	PBR+real	RGB-D	0.57	0.538	0.4	0.835	0.392	0.521	0.653	0.653	16.168
8	GenFlow-MultiHypo-RGB	2023	DNN	All datasets	Default CNOS-fastSAM	Recurrent Flow	RGB-D	PBR only	RGB	0.57	0.563	0.523	0.684	0.453	0.395	0.739	0.633	20.890
9	Megapose-CNOS_fastSAM+Multih-10	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine	RGB	PBR only	RGB	0.549	0.56	0.508	0.687	0.419	0.346	0.706	0.62	53.878
10	Megapose-CNOS_fastSAM+Multih	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine	RGB	PBR only	RGB	0.547	0.56	0.507	0.684	0.414	0.338	0.704	0.621	47.386
11	ZeroPose-Multi-Hypo-Refinement	2023	DNN	All datasets	SAM + ImageBind	MegaPose-Fine	RGB-D	PBR+real	RGB-D	0.534	0.493	0.342	0.79	0.396	0.465	0.629	0.623	18.971
12	MegaPose-CNOS_fastSAM	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine	RGB	PBR only	RGB	0.509	0.499	0.477	0.653	0.367	0.315	0.654	0.601	31.724
13	ZeroPose-One-Hypo	2023	DNN	All datasets	SAM + ImageBind	MegaPose-Fine	RGB-D	PBR+real	RGB-D	0.348	0.272	0.156	0.536	0.307	0.362	0.462	0.341	9.756
14	GenFlow-coarse	2023	DNN	All datasets	Default CNOS-fastSAM	-	RGB	PBR only	RGB	0.235	0.25	0.215	0.3	0.168	0.154	0.283	0.277	3.839

12/14 methods focus on pose estimation,
relying on default detections from CNOS

Model-based 6D localization of seen vs unseen objects

Task 1: Model-based 6D localization of seen objects:

#	Method	Year	Type	...models per	Det./seg.	Refine.	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	GPose2023	2023	DNN	Object	Custom	Coordinate-guided depth refi	RGB-D	PBR+real	RGB-D	0.856	0.794	0.914	0.964	0.737	0.704	0.950	0.928	2.670
4	GDRNPP-PBRReal-RGBD-MModel	2022	DNN	Object	YOLOX	~CIR	RGB-D	PBR+real	RGB-D	0.837	0.775	0.874	0.966	0.722	0.679	0.926	0.921	6.263
30	CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020	DNN	Dataset	Default MaskRCNN (synt	~DeepIM+ICP	RGB	PBR+real	RGB-D	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
45	Vidal-Sensors18	2019	PPF	-	-	ICP	-	-	D	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220

Task 4: Model-based 6D localization of unseen objects:

#	Method	Year	Type	...models per	Det./seg.	Refine.	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	GenFlow-MultiHypo16	2023	DNN	All datasets	Default CNOS-fastSAM	Recurrent Flow	RGB-D	PBR only	RGB-D	0.674	0.635	0.521	0.862	0.534	0.554	0.779	0.833	34.578
2	GenFlow-MultiHypo	2023	DNN	All datasets	Default CNOS-fastSAM	Recurrent Flow	RGB-D	PBR only	RGB-D	0.662	0.622	0.509	0.849	0.524	0.544	0.77	0.818	21.457
3	Megapose-CNOS_fastSAM+Multih_Teaserpp-10	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine+Teaser++	RGB	PBR only	RGB-D	0.628	0.626	0.487	0.851	0.467	0.468	0.73	0.764	141.965
4	Megapose-CNOS_fastSAM+Multih_Teaserpp-10	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine+Teaser++	RGB	PBR only	RGB-D	0.623	0.62	0.485	0.846	0.462	0.46	0.725	0.764	116.564
5	SAM6D-CNOSmask	2023	DNN	All datasets	Default CNOS-fastSAM	Cross-attention	RGB-D	PBR only	RGB-D	0.616	0.648	0.483	0.794	0.504	0.351	0.727	0.804	3.872
6	PoZe (CNOS)	2023	DNN	All datasets	Default CNOS-fastSAM	ICP	RGB-D	PBR only	RGB-D	0.616	0.644	0.494	0.924	0.409	0.516	0.712	0.611	159.425
7	ZeroPose-Multi-Hypo-Refinement-De...	2023	DNN	All datasets	Default CNOS-fastSAM	Megapose-Fine	RGB-D	PBR+real	RGB-D	0.57	0.538	0.4	0.835	0.392	0.521	0.653	0.653	16.168
8	GenFlow-MultiHypo-RGB	2023	DNN	All datasets	Default CNOS-fastSAM	Recurrent Flow	RGB-D	PBR only	RGB	0.57	0.563	0.523	0.684	0.453	0.395	0.739	0.633	20.890
9	Megapose-CNOS_fastSAM+Multih-10	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine	RGB	PBR only	RGB	0.549	0.56	0.508	0.687	0.419	0.346	0.706	0.62	53.878
10	Megapose-CNOS_fastSAM+Multih	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine	RGB	PBR only	RGB	0.547	0.56	0.507	0.684	0.414	0.338	0.704	0.621	47.386
11	ZeroPose-Multi-Hypo-Refinement	2023	DNN	All datasets	SAM + ImageBind	MegaPose-Fine	RGB-D	PBR+real	RGB-D	0.534	0.493	0.342	0.79	0.396	0.465	0.629	0.623	18.971
12	MegaPose-CNOS_fastSAM	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine	RGB	PBR only	RGB	0.509	0.499	0.477	0.653	0.367	0.315	0.654	0.601	31.724
13	ZeroPose-One-Hypo	2023	DNN	All datasets	SAM + ImageBind	MegaPose-Fine	RGB-D	PBR+real	RGB-D	0.348	0.272	0.156	0.536	0.307	0.362	0.462	0.341	9.756
14	GenFlow-coarse	2023	DNN	All datasets	Default CNOS-fastSAM	-	RGB	PBR only	RGB	0.235	0.25	0.215	0.3	0.168	0.154	0.283	0.277	3.839

Model-based 6D localization of seen vs unseen objects

Task 1: Model-based 6D localization of seen objects:

#	Method	Year	Type	...models per	Det./seg.	Refine.	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	GPose2023	2023	DNN	Object	Custom	Coordinate-guided depth refi	RGB-D	PBR+real	RGB-D	0.856	0.794	0.914	0.964	0.737	0.704	0.950	0.928	2.670
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30	CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020	DNN	Dataset	Default MaskRCNN (synt	~DeepIM+ICP	RGB	PBR+real	RGB-D	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
45	Vidal-Sensors18	2019	PPF	-	-	ICP	-	-	D	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220

Task 4: Model-based 6D localization of unseen objects:

#	Method	Year	Type	...models per	Det./seg.	Refine.	Train. im.	...type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1	GenFlow-MultiHypo16	2023	DNN	All datasets	Default CNOS-fastSAM	Recurrent Flow	RGB-D	PBR only	RGB-D	0.674	0.635	0.521	0.862	0.534	0.554	0.779	0.833	34.578
2	GenFlow-MultiHypo	2023	DNN	All datasets	Default CNOS-fastSAM	Recurrent Flow	RGB-D	PBR only	RGB-D	0.662	0.622	0.509	0.849	0.524	0.544	0.77	0.818	21.457
3	Megapose-CNOS_fastSAM+Multih_Teaserpp-10	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine+Teaser++	RGB	PBR only	RGB-D	0.628	0.626	0.487	0.851	0.467	0.468	0.73	0.764	141.965
4	Megapose-CNOS_fastSAM+Multih_Teaserpp-10	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine+Teaser++	RGB	PBR only	RGB-D	0.623	0.62	0.485	0.846	0.462	0.46	0.725	0.764	116.564
5	SAM6D-CNOSmask	2023	DNN	All datasets	Default CNOS-fastSAM	Cross-attention	RGB-D	PBR only	RGB-D	0.616	0.648	0.483	0.794	0.504	0.351	0.727	0.804	3.872
6	PoZe (CNOS)	2023	DNN	All datasets	Default CNOS-fastSAM	ICP	RGB-D	PBR only	RGB-D	0.616	0.644	0.494	0.924	0.409	0.516	0.712	0.611	159.425
7	ZeroPose-Multi-Hypo-Refinement-De...	2023	DNN	All datasets	Default CNOS-fastSAM	Megapose-Fine	RGB-D	PBR+real	RGB-D	0.57	0.538	0.4	0.835	0.392	0.521	0.653	0.653	16.168
8	GenFlow-MultiHypo-RGB	2023	DNN	All datasets	Default CNOS-fastSAM	Recurrent Flow	RGB-D	PBR only	RGB	0.57	0.563	0.523	0.684	0.453	0.395	0.739	0.633	20.890
9	Megapose-CNOS_fastSAM+Multih-10	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine	RGB	PBR only	RGB	0.549	0.56	0.508	0.687	0.419	0.346	0.706	0.62	53.878
10	Megapose-CNOS_fastSAM+Multih	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine	RGB	PBR only	RGB	0.547	0.56	0.507	0.684	0.414	0.338	0.704	0.621	47.386
11	ZeroPose-Multi-Hypo-Refinement	2023	DNN	All datasets	SAM + ImageBind	MegaPose-Fine	RGB-D	PBR+real	RGB-D	0.534	0.493	0.342	0.79	0.396	0.465	0.629	0.623	18.971
12	MegaPose-CNOS_fastSAM	2023	DNN	All datasets	Default CNOS-fastSAM	MegaPose-Fine	RGB	PBR only	RGB	0.509	0.499	0.477	0.653	0.367	0.315	0.654	0.601	31.724
13	ZeroPose-One-Hypo	2023	DNN	All datasets	SAM + ImageBind	MegaPose-Fine	RGB-D	PBR+real	RGB-D	0.348	0.272	0.156	0.536	0.307	0.362	0.462	0.341	9.756
14	GenFlow-coarse	2023	DNN	All datasets	Default CNOS-fastSAM	-	RGB	PBR only	RGB	0.235	0.25	0.215	0.3	0.168	0.154	0.283	0.277	3.839

Best method on Task 4 (GenFlow) achieves accuracy on par with the best methods of 2020 on Task 1,
but require 3x runtime

BOP Challenge 2023 Awards

BOP Challenge 2023 Award

The Overall Best Method, The Best Method Using Default Detections, The Best BlenderProc-Trained Method, The Best Method on Datasets LM-O, T-LESS, ITODD, HB, IC-BIN, YCB-V

Task 1: Model-based 6D localization of seen objects

GPose2023

Ruida Zhang, Ziqin Huang, Gu Wang, Xingyu Liu,
Chenyangguang Zhang, Xiangyang Ji (Tsinghua University)

8th International Workshop on Recovering 6D Object Pose, ICCV 2023

BOP Challenge 2023 Award

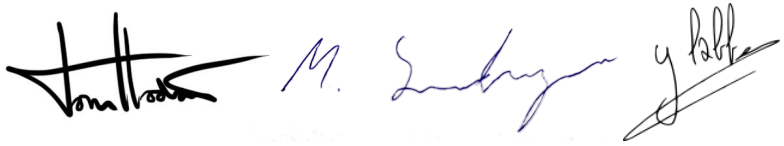
The Best Open-Source Method, The Best Fast Method

Task 1: Model-based 6D localization of seen objects

GDRNPP-PBRReal-RGBD-MModel

Xingyu Liu, Ruida Zhang, Chenyangguang Zhang, Bowen Fu, Jiwen Tang, Xiquan Liang, Jingyi Tang, Xiaotian Cheng, Yukang Zhang, Gu Wang, Xiangyang Ji (Tsinghua University)

8th International Workshop on Recovering 6D Object Pose, ICCV 2023



BOP Challenge 2023 Award

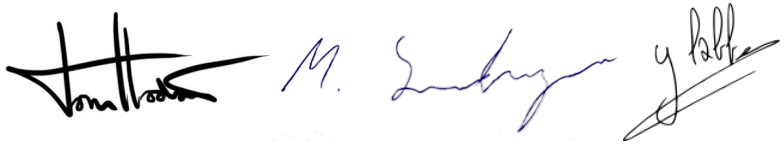
The Best Single-Model Method

Task 1: Model-based 6D localization of seen objects

OfficialDet-PFA-Mixpbr-RGB-D

Xinyao Fan, Fengda Hao, Yang Hai, Jiaojiao Li, Rui Song,
Haixin Shi, Mathieu Salzmann, David Ferstl, Yinlin Hu

8th International Workshop on Recovering 6D Object Pose, ICCV 2023



BOP Challenge 2023 Award

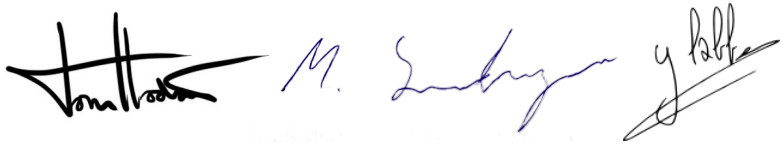
The Best RGB-Only Method

Task 1: Model-based 6D localization of seen objects

ZebraPoseSAT-EffnetB4

Praveen Annamalai Nathan, Sandeep Prudhvi Krishna Inuganti,
Yongliang Lin, Yongzhi Su,Yu Zhang, Didier Stricker, Jason Rambach

8th International Workshop on Recovering 6D Object Pose, ICCV 2023



BOP Challenge 2023 Award

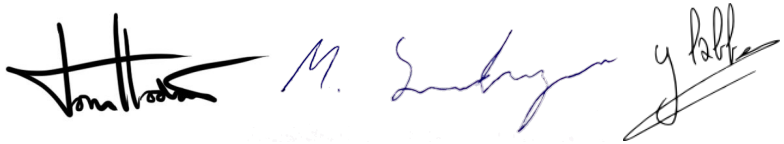
The Best Method on TUD-L

Task 1: Model-based 6D localization of seen objects

Coupled Iterative Refinement

Lahav Lipson, Zachary Teed, Ankit Goyal, Jia Deng

8th International Workshop on Recovering 6D Object Pose, ICCV 2023



BOP Challenge 2023 Award

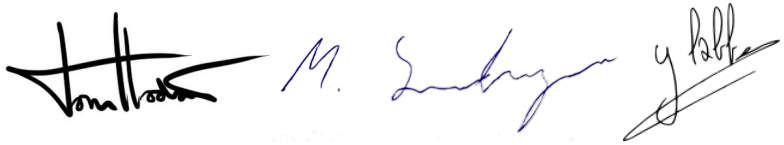
The Overall Best Detection Method,
The Best BlenderProc-Trained Detection Method

Task 2: Model-based 2D detection of seen objects

GDet2023

Ruida Zhang, Ziqin Huang, Gu Wang, Xingyu Liu,
Chenyangguang Zhang, Xiangyang Ji (Tsinghua University)

8th International Workshop on Recovering 6D Object Pose, ICCV 2023



BOP Challenge 2023 Award

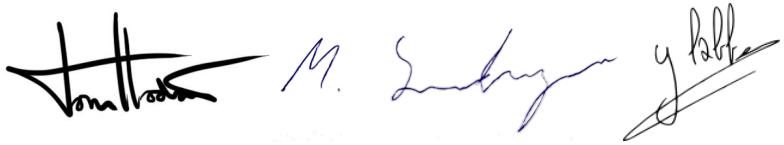
The Overall Best Segmentation Method,
The Best BlenderProc-Trained Segmentation Method

Task 3: Model-based 2D segmentation of seen objects

ZebraPoseSAT-EffnetB4

Praveen Annamalai Nathan, Sandeep Prudhvi Krishna Inuganti,
Yongliang Lin, Yongzhi Su,Yu Zhang, Didier Stricker, Jason Rambach

8th International Workshop on Recovering 6D Object Pose, ICCV 2023



BOP Challenge 2023 Award

The Overall Best Method, The Best BlenderProc-Trained Method, The Best Single-Model Method, The Best Method Using Default Detections/Segmentations, The Best RGB-Only Method, The Best Method on Datasets ITODD, IC-BIN, HB, YCB-V, T-LESS

Task 4: Model-based 6D localization of unseen objects

GenFlow

Sungphill Moon and Hyeontae Son

8th International Workshop on Recovering 6D Object Pose, ICCV 2023

BOP Challenge 2023 Award

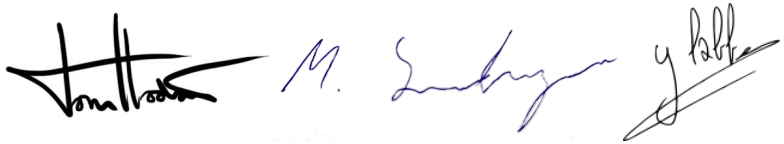
The Fastest Method, The Best Method on Dataset LM-O

Task 4: Model-based 6D localization of unseen objects

SAM6D

Jiehong Lin, Lihua Liu, Dekun Lu and Kui Jia

8th International Workshop on Recovering 6D Object Pose, ICCV 2023



BOP Challenge 2023 Award

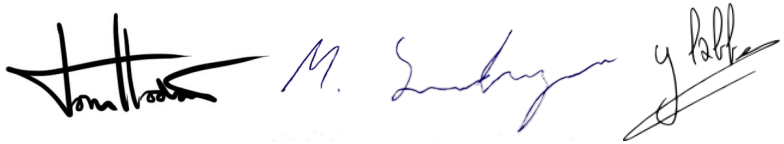
The Best Open-Source Method

Task 4: Model-based 6D localization of unseen objects

MegaPose

Elliot Maître, Mederic Fourmy, Lucas Manuelli, Yann Labbé

8th International Workshop on Recovering 6D Object Pose, ICCV 2023



BOP Challenge 2023 Award

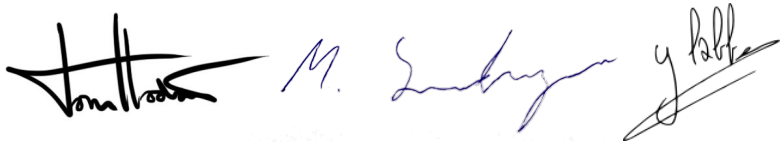
The Best Method on Dataset TUD-L

Task 4: Model-based 6D localization of unseen objects

PoZe (CNOS)

Andrea Caraffa, Davide Boscaini, Fabio Poiesi

8th International Workshop on Recovering 6D Object Pose, ICCV 2023



BOP Challenge 2023 Award

The Overall Best Detection Method, The Best BlenderProc-Trained Detection Method, The Overall Best Segmentation Method, The Best BlenderProc-Trained Segment. Method

Task 4 and 5: Model-based 2D detection/segmentation of unseen objects

CNOS

Van Nguyen Nguyen, Thibault Groueix, Georgy Ponimatkin, Vincent Lepetit, Tomas Hodan

8th International Workshop on Recovering 6D Object Pose, ICCV 2023