BOP Challenge 2022

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Tomáš Hodaň, Reality Labs at Meta
Yann Labbé, Inria Paris
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Bertram Drost, MVTec Software
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Jiří Matas, CTU in Prague

7th International Workshop on Recovering 6D Object Pose
ECCV 2022, October 23, Tel Aviv

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/RGB-D images.

BOP currently comprises of:

- **Evaluation methodology**
- **Online evaluation system at <u>bop.felk.cvut.cz</u>**
- **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

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 Object – In preparation

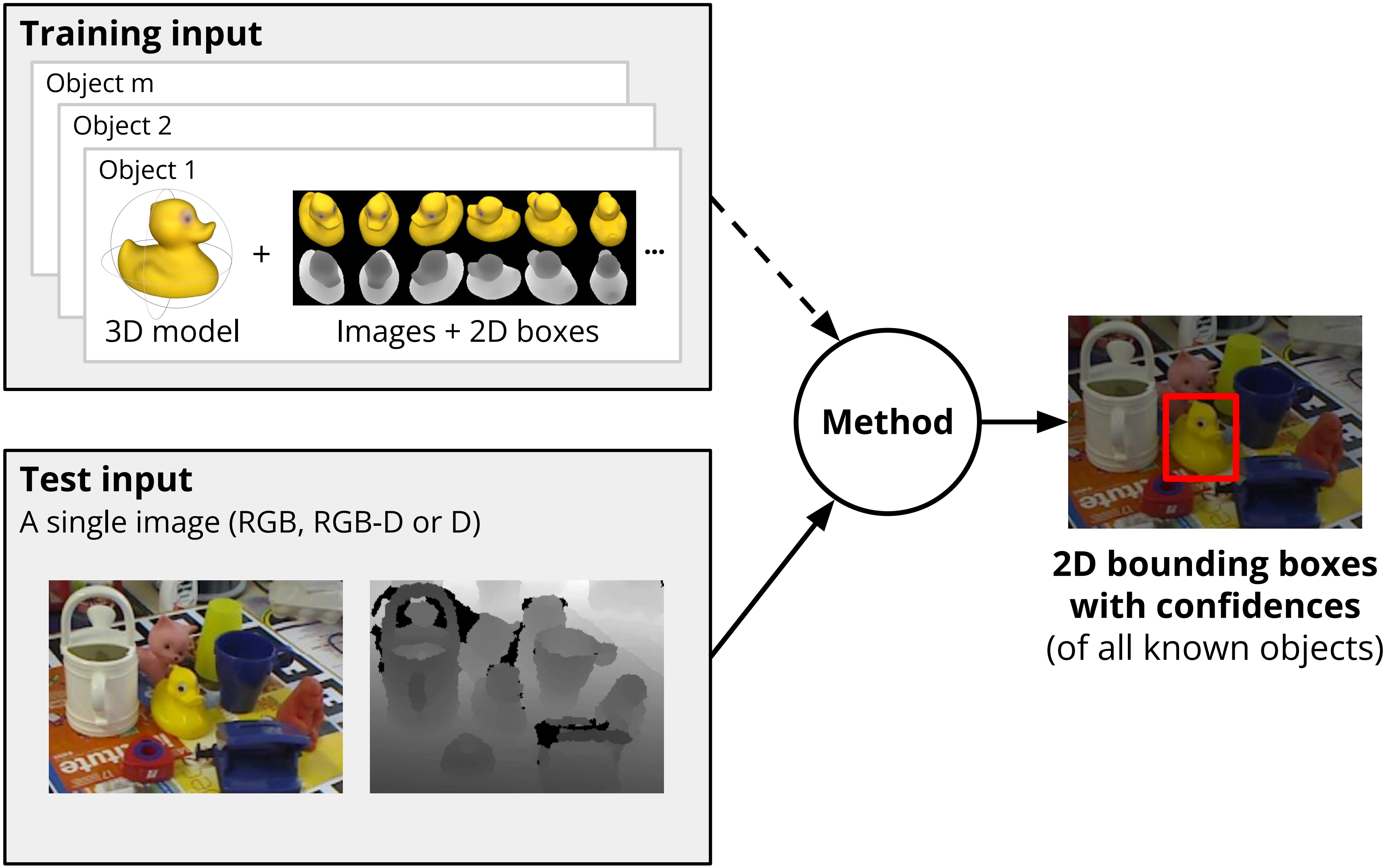
BOP Challenge 2022 – Tasks

- **2D object detection** – new in BOP 2022
- **2D object segmentation** – new in BOP 2022
- **6D object localization** – as in BOP 2019 and 2020

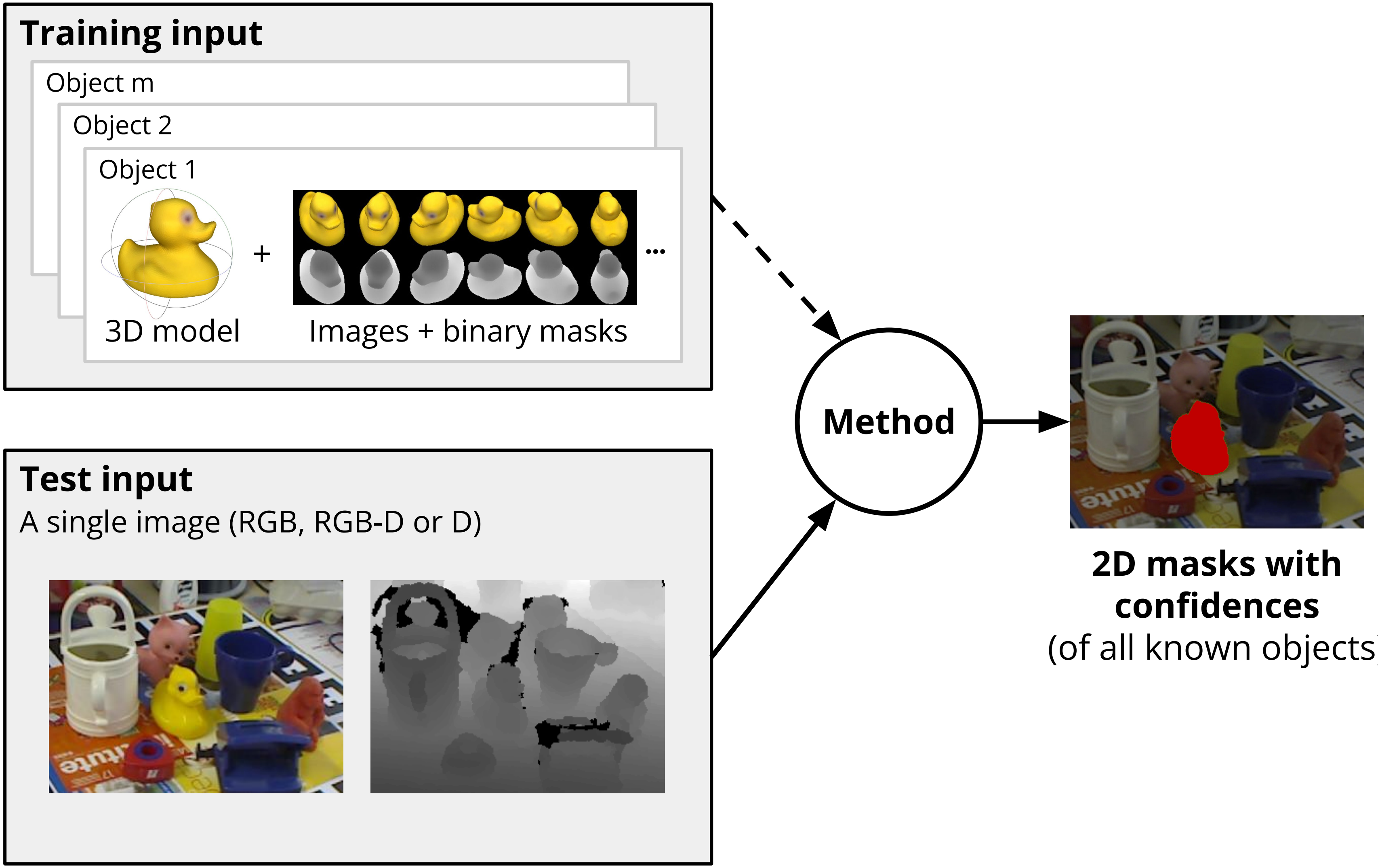
The new tasks were introduced to address the design of many recent methods for object pose estimation, which start by detecting/segmenting objects and then estimate the poses from the predicted regions.

Evaluating the detection/segmentation stage and the pose estimation stage separately allows to better understand advances in the two stages (participants could use provided default detections/segmentations).

2D object detection task



2D object segmentation task



Evaluation of 2D object detection/segmentation

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.

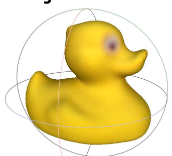
6D object localization task

Training input

Object m

Object 2

Object 1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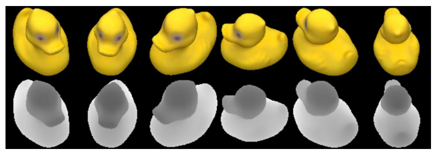

...

3D model

Images + 6D poses

Test input

a) A single image (RGB, RGB-D or D)


a) Number of present instances of each object o_i

$$L = [(o_1, n_1), \ldots, (o_m, n_m)]$$

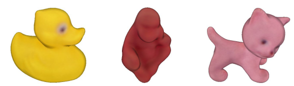
Method

Estimated 6D poses of the present object instances

6D object localization task – Variants

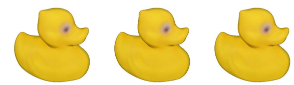
SiSo

a single instance
of a single object



SiMo

a single instance
of multiple objects



MiSo

multiple instances
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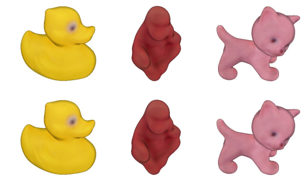

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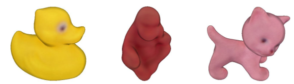

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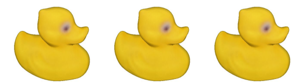

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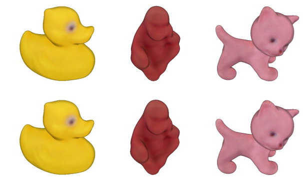

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BOP 2018

6D object localization task – Variants

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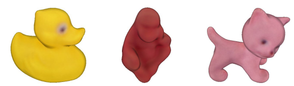

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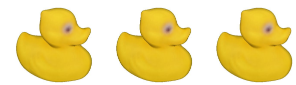

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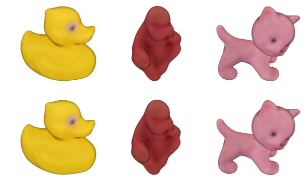


MiMo

multiple instances
of multiple objects

ViVo

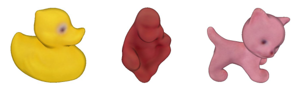
varying number of instances of a varying number of objects (the numbers are known)

BOP 2019, 2020 and 2022

6D object localization task – Variants

SiSo

a single instance
of a single object



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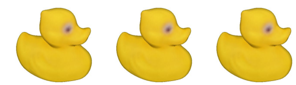

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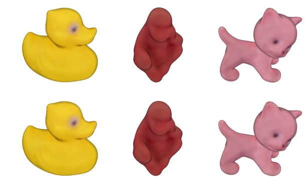


MiMo

multiple instances
of multiple objects

ViVo

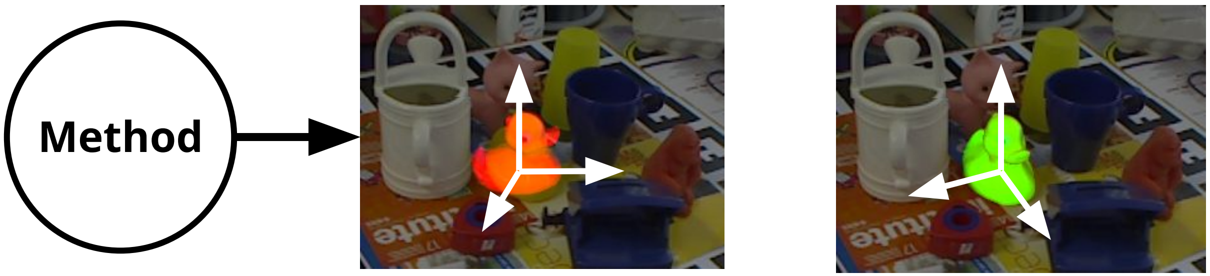
varying number of instances of a varying number of objects (the numbers are known)

BOP 2019, 2020 and 2022

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

1. Evaluating 6D object detection is expensive as many more estimates need to be evaluated to calculate the precision/recall curve.
2. The scores on the simpler 6D localization task are not saturated.

Pose error functions



Estimated pose GT pose

How good is the estimated pose?

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

1. **VSD: Visible Surface Discrepancy**
   Error calculated over the visible part ⇒ 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.

Accuracy score

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

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

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

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

See bop.felk.cvut.cz for details.

Rules

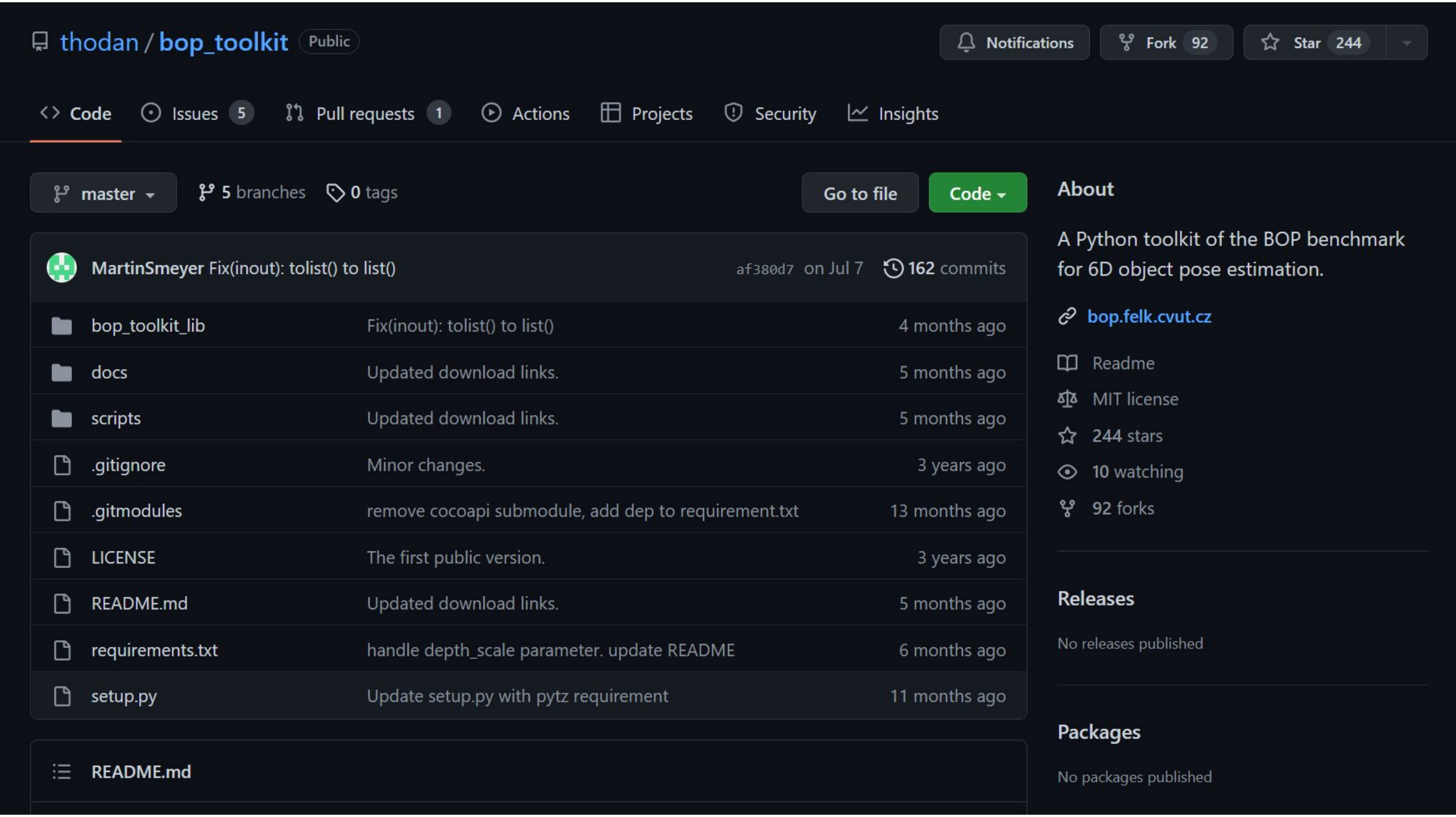
1. **For training, a method *can*...**
    a. use the provided 3D object models and training images.
    b. render extra training images.
    c. use the range (not a probability distribution) of all GT poses in the test images (e.g. objects are from 20 to 100 cm from the camera).

2. **For training, a method *cannot*...**
    a. use a single pixel of test images.
    b. use the individual ground-truth poses from test images.

3. **A fixed set of hyper-parameters** required for all objects/datasets.

BOP Toolkit

Scripts for reading the standard dataset format, evaluation etc.



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

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

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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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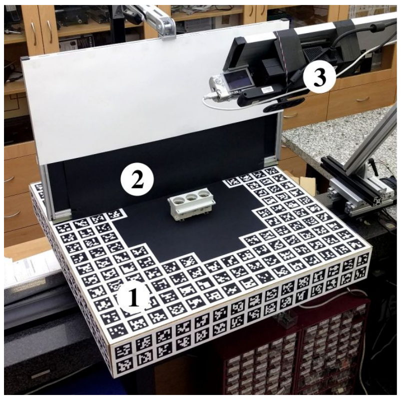
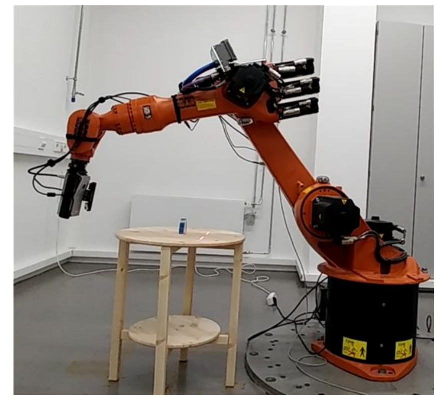
DNN-based methods

BOP Challenge 2019

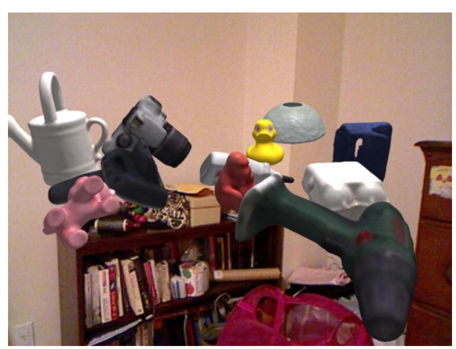
Classical methods outperformed DNN methods, because of:

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



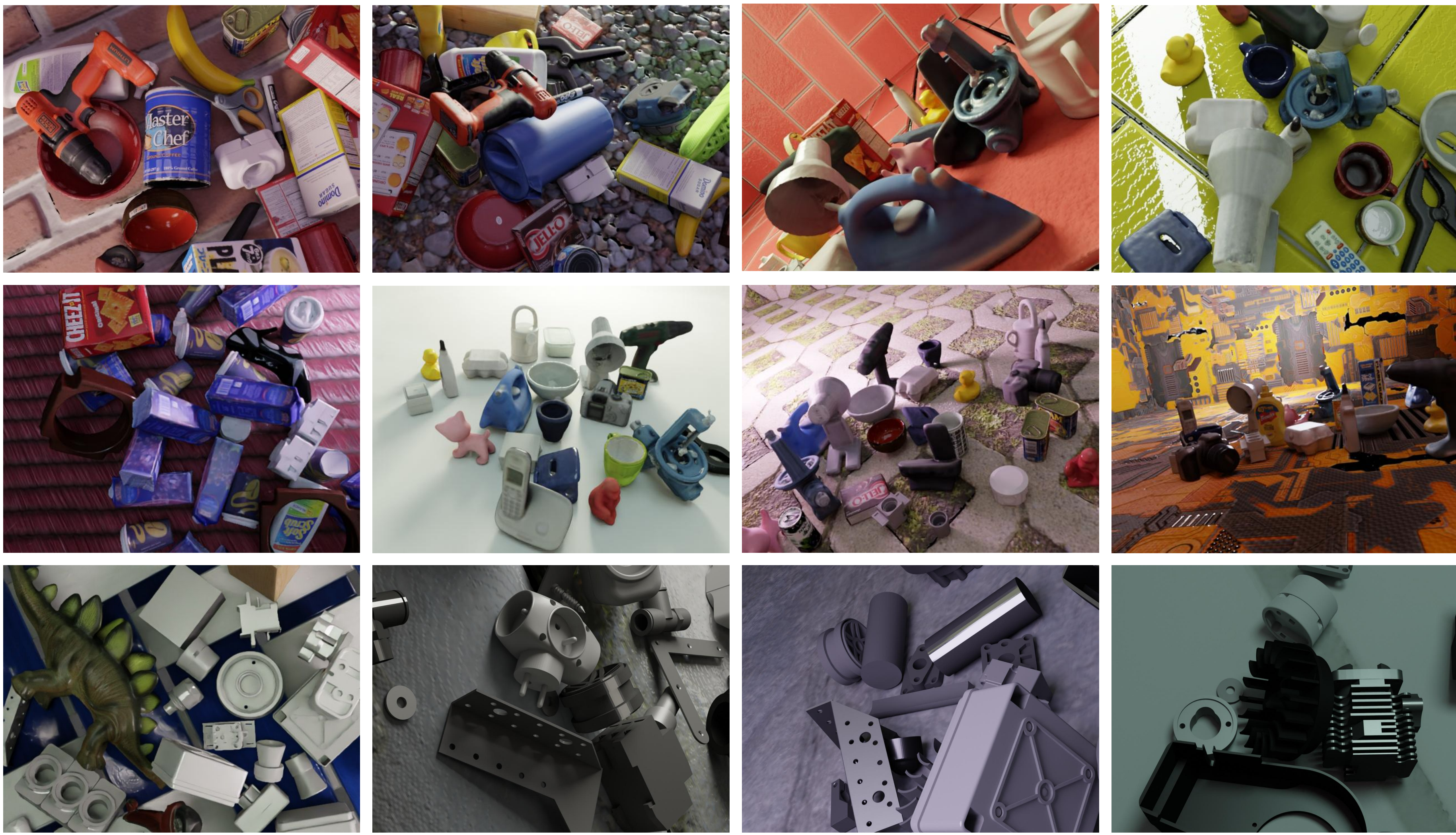
2. **Large domain gap** between real test images and the commonly used synthetic training images (objects rendered on random background).


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
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

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

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

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

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
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3	CosyPose-ECCV20-Synt+Real-1View	[illegible]	No	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	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
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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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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
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18	Félix&Neves-ICRA2017-IET2019	2019	Yes	Yes	1/dataset	RGB-D	Synt+real	RGB-D	ICP	0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
19	Sundermeyer-IJCV19+ICP	2019	No	Yes	1/object	RGB	Synt+real	RGB-D	ICP	0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
20	Zhigang-CDPN-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
21	PointVoteNet2	2020	No	Yes	1/object	RGB-D	PBR only	RGB-D	ICP	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
22	Pix2Pose-BOP20-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
23	Sundermeyer-IJCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.270	0.146	0.304	0.401	0.217	0.101	0.346	0.377	0.186
24	SingleMultiPathEncoder-CVPR20	2020	No	Yes	1/all	RGB	Synt+real	RGB	No	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
25	Pix2Pose-BOP19-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.205	0.077	0.275	0.349	0.215	0.032	0.200	0.290	0.793
26	DPOD (synthetic)	2019	No	Yes	1/scene	RGB	Synt	RGB	No	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231

PBR + other synthetic + real images

PBR images

Competitive results can be achieved with PBR training images only.

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

BOP Challenge 2020

#	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	[illegible]	[illegible]	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-[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
21	PointVoteNet2	2020	No	Yes	1/object	RGB-D	PBR only	RGB-D	ICP	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
22	Pix2Pose-BOP20-ICCV19	2020	No	Yes	1/object	RGB	Synt+real	RGB	No	0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
23	Sundermeyer-IJCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.270	0.146	0.304	0.401	0.217	0.101	0.346	0.377	0.186
24	SingleMultiPathEncoder-CVPR20	2020	No	Yes	1/all	RGB	Synt+real	RGB	No	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
25	Pix2Pose-BOP19-ICCV19	2019	No	Yes	1/object	RGB	Synt+real	RGB	No	0.205	0.077	0.275	0.349	0.215	0.032	0.200	0.290	0.793
26	DPOD (synthetic)	2019	No	Yes	1/scene	RGB	Synt	RGB	No	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231

PBR images

Images of objects on random backgrounds

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

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

2022

BOP Challenge 2022 – Submissions

Submission system: bop.felk.cvut.cz, deadline: October 16, 2022.

49 pose estimation methods (23 since BOP 2020) evaluated on all 7 core datasets: LM-O, T-LESS, TUD-L, IC-BIN, ITODD, HB, YCB-V.

The submission form stays open!

Coming soon: All raw predictions available on the BOP website.

BOP: Benchmark for 6D Object Pose Estimation

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

HOME CHALLENGES DATASETS LEADERBOARDS SUBMIT RESULTS

Task: Pose estimation (BOP 2019-2022) Detection (BOP 2022) Segmentation (BOP 2022)

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

Pose estimation (BOP 2019-2022) – Core datasets

This leaderbord shows the overall ranking on the core datasets (LM-O, T-LESS, TUD-L, IC-BIN, ITODD, HB, YCB-V). For each method, the date of the latest considered submission is reported. If more submissions of a method are available for a dataset, the submission with the highest AR_{Core} score is considered. The performance scores are defined in the BOP Challenge 2019 description. 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	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
2	2022-10-15	GDRNPP-PBR-RGBD-MModel	RGB-D	0.827	0.775	0.852	0.929	0.722	0.679	0.926	0.906	6.264
3	2022-10-14	GDRNPP-PBRReal-RGBD-MModel-Fast	RGB-D	0.805	0.792	0.872	0.936	0.702	0.588	0.909	0.834	0.228

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

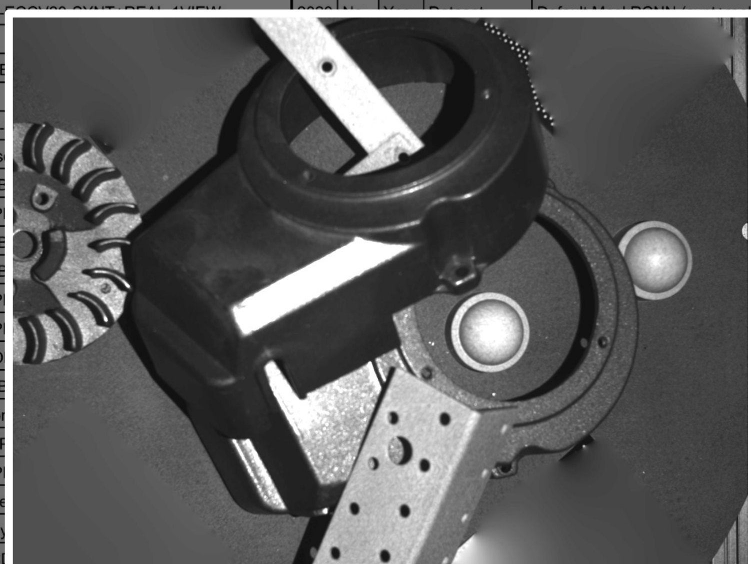
Overall SOTA moved from **0.698 AR** (CosyPose) to **0.837 AR** (GDRNPP)

#	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-PB[illegible]	2021	No	Yes	Dataset	[illegible]	[illegible]	[illegible]	[illegible]	RGB-D	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	0.72	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	0.64	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-						~DeepIM											0.821	0.449
26	CRT-6D						Custom											0.752	0.059
27	Pix2Pose-E						ICP											0.780	4.844
28	ZTE_PPF						ICP											0.502	0.901
29	CosyPose-						~Deep											0.574	0.475
30	Vidal-Sens						ICP											0.450	3.220
31	CDPNv2_E						ICP											0.619	1.462
32	Drost-CVPI						ICP											0.375	87.568
33	CDPNv2_E						ICP											0.532	1.491
34	CDPNv2_E						-											0.532	0.935
35	Drost-CVPI						ICP											0.316	80.055
36	Drost-CVPI						ICP											0.344	7.704
37	CDPN_BO						-											0.457	0.480
38	CDPNv2_E						-											0.390	0.978
39	leaping fror						-											0.543	0.425
40	EPOS-BOF						-											0.499	1.874
41	Drost-CVPI						ICP											0.330	1.383
42	Félix&Neve						ICP											0.510	55.780
43	Sundermey						ICP											0.505	0.865
44	Zhigang-CI						-											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

Large improvement on the hard industrial dataset ITODD:
0.313 AR (CosyPose) to **0.679 AR** (GDRNPP)



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	[illegible]	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	[illegible]	ICP	[illegible]	Synt+real	RGB-D	0.639	[illegible]	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

2020: PPF and DNN methods are comparable

2022: DNN methods dominate

BOP Challenge 2022: 6D object localization

RGB-D sim2real gap is almost gone:

2022 gap: **0.0247 AR** (GDRNPP)

(Only T-LESS, TUD-L and YCB-V include real & synthetic images)

#	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	0.77	0.874	0.966	0.722	0.679	0.92	0.921	6.263
2	GDRNPP-PBR-RGBD-MModel	2022	No	Yes	Object	YOLOX	~CIR	RGB-D	PBR only	RGB-D	0.827	0.77	0.852	0.929	0.722	0.679	0.92	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	No	Yes	Object	YOLOX	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	RGB-D	0.741	0.734	[illegible]	[illegible]	0.676	0.381	0.757	[illegible]	
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	[illegible]	RGB	0.709	0.745	[illegible]	[illegible]	0.600	0.353	0.841	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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

RGB sim2real gap reduced significantly:

2020 gap: **0.158 AR** (CosyPose)
2022 gap: **0.062 AR** (GDRNPP)

(Only T-LESS, TUD-L and YCB-V include real & synthetic images)

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	[illegible]	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	[illegible]
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	[illegible]	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	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.473	0.102	0.722	0.532	0.935
35	Drost-CVPR10-3D-Edges	2019	Yes	No	-	-	[illegible]	-	-	D	0.500	0.469	0.404	0.852	0.373	0.462	0.623	0.316	80.055
36	Drost-CVPR10-3D-Only	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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

Best fast method (<1s per image):

2020: **0.639 AR @ 0.633s per image** (Koenig-hybrid)

2022: **0.805 AR @ 0.228s per image** (GDRNPP)

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	0.92	6.263
2	GDRNPP-PBR-RGBD-MModel	2022	No	Yes	Object	YOLOX	[illegible]	RGB-D	PBR only	RGB-D	0.827	0.775	0.852	0.929	0.722	0.679	0.926	0.906	[illegible]
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	0.83	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	[illegible]
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	0.70	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	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)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.473	0.102	0.722	0.532	0.935
35	Drost-CVPR10-3D-Edges	2019	Yes	No	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.500	[illegible]	[illegible]	0.852	0.373	0.462	0.623	0.316	80.055
36	Drost-CVPR10-3D-Only	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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

Best fast method (<1s per image):

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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

RGB-only improves further:

2020: **0.637 AR** (CosyPose)
2022: **0.728 AR** (GDRNPP)

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	[illegible]	[illegible]	[illegible]	[illegible]	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
26	CRT-6D	2022	No	Yes	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.660	0.644	0.789	0.537	0.208	0.603	0.752	0.059
27	Pix2Pose-BOP20_w/ICP-ICCV19	[illegible]	[illegible]	[illegible]	Object	MaskRCNN	ICP	RGB	PBR+real	RGB-D	0.591	[illegible]	[illegible]	0.820	0.390	0.351	0.695	0.780	4.844
28	ZTE_PPF	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	ICP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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

Methods can learn from RGB-D

(in 2020, methods were learning only from RGB)

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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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

GDRNPP dominates BOP 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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	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

Reasons for using other methods?

GDRNPP top entries train **a network per object**

→ more inference memory and training time

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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	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

Reasons for using other methods?

GDRNPP top entries train **a network per object**

→ more inference memory and training time

RADet+PFA > GDRNPP when training per dataset

BOP Challenge 2022: 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

Most top BOP methods use 3 stages:

1. Detection / segmentation
2. Pose estimation
3. Pose refinement

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#	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
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- Measures COCO metrics (AP) of detection / segmentation

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#	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

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- Provides the best detections from BOP 2020 (CosyPose)

BOP Challenge 2022: 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

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- Provides the best detections from BOP 2020 (CosyPose)

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

BOP Challenge 2022

#	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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

GDRNPP builds on strong YOLOX detections,
but performs well also with Default Detections from CosyPose

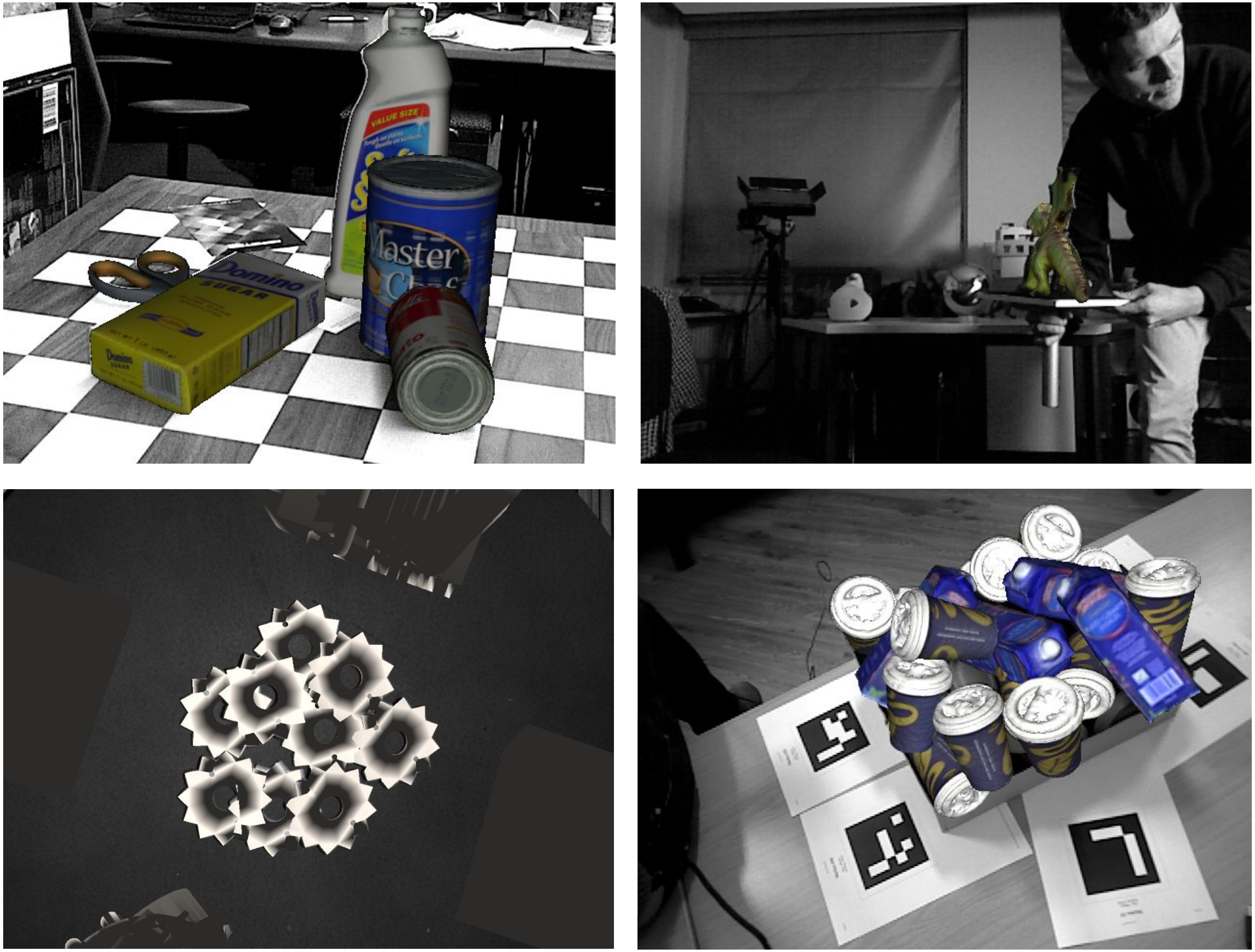
BOP Challenge 2022: 2D object segmentation

#	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

ZebraPose refines masks from CosyPose detections: **+18.2 AP!**

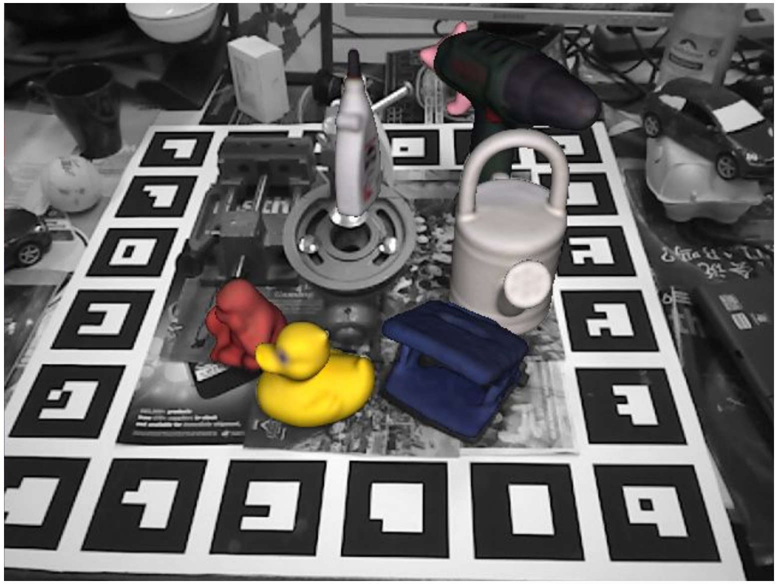
As for detection, segmentation methods still use RGB only.

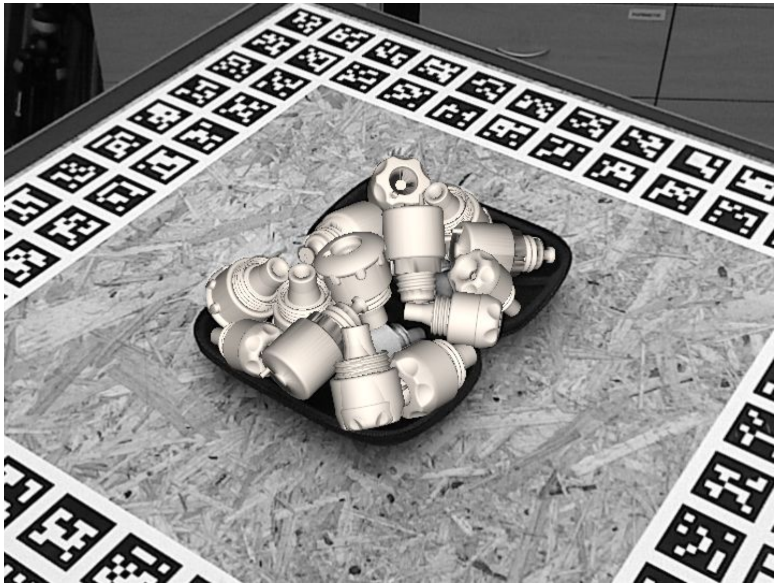
Object poses estimated by GDRNPP [1]



[1] Image courtesy Xingyu Liu

Object poses estimated by GDRNPP [1]





[1] Image courtesy Xingyu Liu

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BOP 2022

The Overall Best Method

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

Award money: $500

#	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-PBR[illegible]-RGBD-M[illegible]-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+P[illegible]PBR-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[illegible]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	RCV[illegible]3D_Si[illegible]_PBR	2022	No	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.729	0.708	0.966	0.733	0.536	0.863	0.843	1.336
8	Zeb[illegible]eSAT-EffnetB4 + ICP (DefaultD[illegible]	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	RAD[illegible]FA-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	Surf[illegible]BR-R[illegible]	2021	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.760	0.828	0.854	0.659	0.538	0.866	0.799	9.048
11	GDR[illegible]RReal-RGBD-SModel	2022	[illegible]	[illegible]	[illegible]	YOLOX	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.757	0.856	0.906	0.680	0.356	0.864	0.817	0.556
12	Couple[illegible]Refinement (CI[illegible]	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-P[illegible]	2022	No	Yes	Object	YOLOX	[illegible]	[illegible]	PBR+real	RGB	0.728	0.713	[illegible]	0.831	0.623	0.448	0.869	0.825	0.229
14	ZebraPoseSAT-EffnetB4	2022	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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 2022

The Best RGB-Only Method

GDRNPP-PBRReal-RGB-MModel

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

Award money: $400

#	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-SA[illegible]	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+P[illegible]BR-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	GDRN[illegible]R-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	Cosy[illegible]ECCV[illegible]1VIE[illegible]P	2020	No	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.701	0.939	0.647	0.313	0.712	0.861	13.743
20	Zeb[illegible]eSAT-E[illegible]Only)	2022	No	[illegible]	[illegible]	[illegible]	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.723	0.717	0.545	0.410	0.882	0.691	-
21	PFA-[illegible]pose	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	RAD[illegible]A-PBR[illegible]B	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	Surf[illegible]R-RGB	2021	N[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.650	0.663	0.735	0.715	0.588	0.413	0.791	0.647	8.891
24	Koenig-Hyb[illegible]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-EC[illegible]NT[illegible]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	N[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	Y[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	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

The Best Fast Method

GDRNPP-PBRReal-RGBD-MModel-Fast

Xingyu Liu, Ruida Zhang, Chenyangguang Zhang, Bowen Fu, Jiwen Tang, Xiqiang Liang, Jingyi Tang, Xiaotian Cheng, Yukang Zhang, Gu Wang, Xiangyang Ji

Award money: $400

#	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-M[illegible]-RGBD-[illegible]	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[illegible]gleModel_Viv[illegible]	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	ZebraP[illegible]AT-EffnetB4 + ICP (Defa[illegible]	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	RAD[illegible]A-PB[illegible]	2022	No	[illegible]	[illegible]	[illegible]	PFA	[illegible]	[illegible]	RGB-D	0.762	0.797	0.802	0.893	0.676	0.469	0.869	0.826	2.631
10	Su[illegible]PBR-R[illegible]	2021	No	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	RGB-D	0.758	0.760	0.828	0.854	0.659	0.538	0.866	0.799	9.048
11	GD[illegible]-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	Cou[illegible]rative[illegible] (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	GDR[illegible]RReal-RGB-MModel	2022	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.786	0.831	0.623	0.448	0.869	0.825	0.229
14	ZebraPose[illegible]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	ZebraPoseSA[illegible]4 (D[illegible]etection)	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.828	-
17	RADet+PFA-MixPBR-RGB	2022	[illegible]	Yes	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB	0.709	0.745	0.778	[illegible]	0.600	0.353	0.841	0.806	3.019
18	GDRNPP-PBR-RGB-MModel	2022	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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

#	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	[illegible]	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	[illegible]	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	[illegible]	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	[illegible]	2022	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.866	0.500
9	[illegible]	2022	No	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.826	2.631
10	[illegible]	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	[illegible]	2022	No	[illegible]	[illegible]	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	[illegible]	2022	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.741	0.734	0.776	0.968	0.676	0.381	0.757	0.893	-
13	[illegible]	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	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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 2022

The Best BlenderProc-Trained Method

GDRNPP-PBRReal-RGB-MModel

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

Award money: $400

BOP 2022

The Best Open-Source Method

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

Award money: $400

#	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-PB[illegible]-RGBD-M[illegible]-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+P[illegible]PBR-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[illegible]-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	RCV[illegible]3D_Si[illegible]_PBR	2022	No	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.966	0.733	0.536	0.863	0.843	1.336
8	Zeb[illegible]eSAT-EffnetB4 + ICP (DefaultD[illegible]	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	RAD[illegible]FA-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	Surf[illegible]BR-R[illegible]	2021	No	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	RGB-D	0.758	0.760	0.828	0.854	0.659	0.538	0.866	0.799	9.048
11	GDR[illegible]RReal-RGBD-SModel	2022	[illegible]	[illegible]	[illegible]	YOLOX	[illegible]	[illegible]	[illegible]	[illegible]	0.748	0.757	0.856	0.906	0.680	0.356	0.864	0.817	0.556
12	Couple[illegible] Refinement (C[illegible]	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-P[illegible]	2022	No	Yes	Object	YOLOX	-	RGB	PBR+real	RGB	0.728	0.713	[illegible]	0.831	[illegible]	0.448	0.869	0.825	0.229
14	ZebraPoseSAT-EffnetB4	2022	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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

The Best Method Using Provided Detections/Segmentations

GDRNPP-PBRReal-RGBD-MModel-OfficialDet

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

Award money: $200

#	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	[illegible]	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	[illegible]	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	[illegible]	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	[illegible]	2021	No	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.659	0.538	0.866	0.799	9.048
11	[illegible]	2022	No	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.680	0.356	0.864	0.817	0.556
12	[illegible]	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	[illegible]	2022	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.786	0.831	0.623	0.448	0.869	0.825	0.229
14	[illegible]	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	[illegible]	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	[illegible]	2022	[illegible]	[illegible]	[illegible]	[illegible]	-	[illegible]	[illegible]	RGB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.379	0.847	0.828	-
17	[illegible]	2022	[illegible]	[illegible]	[illegible]	[illegible]	PFA	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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

#	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

BOP
2022

The Overall Best Detection Method

GDRNPPDet_PBRReal

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

Award money: $200

#	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

BOP
2022

The Best BlenderProc-Trained Detection Method

GDRNPPDet_PBR

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

Award money: $100

BOP 2022

The Best Single-Model Method

RADet+PFA-MixPBR-RGBD

Yang Hai, Rui Song, Zhiqiang Liu, Jiaojiao Li, Mathieu Salzmann, Pascal Fua, Yinlin Hu

Award money: $400

#	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	[illegible]	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	[illegible]	[illegible]	[illegible]	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	ZebraPoseSAT	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	[illegible]	0.796	[illegible]	[illegible]	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	RetinaNet/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

#	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
2022

The Overall Best Segmentation Method

ZebraPoseSAT-EffnetB4 (DefaultDetection)

Yongzhi Su, Praveen Nathan, Torben Fetzer, Jason Rambach, Didier Stricker, Mahdi Saleh, Yan Di, Nassir Navab, Benjamin Busam, Federico Tombari, Yongliang Lin, Yu Zhang

Award money: $200

#	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
2022

The Best BlenderProc-Trained Segmentation Method

ZebraPoseSAT-EffnetB4 (DefaultDet+PBR_Only)

Yongzhi Su, Praveen Nathan, Torben Fetzer, Jason Rambach, Didier Stricker, Mahdi Saleh, Yan Di, Nassir Navab, Benjamin Busam, Federico Tombari, Yongliang Lin, Yu Zhang

Award money: $100

The Best Methods on Individual Datasets

T-LESS, ITODD, YCB-V, HB: 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

IC-BIN: RCVPose 3D_SingleModel_VIVO_PBR

Yangzheng Wu, Alireza Javaheri, Mohsen Zand, Michael Greenspan

LM-O: RADet+PFA-MixPBR-RGBD

Yang Hai, Rui Song, Zhiqiang Liu, Jiaojiao Li, Mathieu Salzmann, Pascal Fua, Yinlin Hu

TUD-L: Coupled Iterative Refinement

Lahav Lipson, Zachary Teed, Ankit Goyal, Jia Deng

Award money: $100 per dataset