Martin Sundermeyer, DLR, TU Munich Tomáš Hodaň, Reality Labs at Meta Yann Labbé, Inria Paris Gu Wang, Tsinghua University Eric Brachmann, Niantic Bertram Drost, MVTec Software Carsten Rother, Heidelberg Uni 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

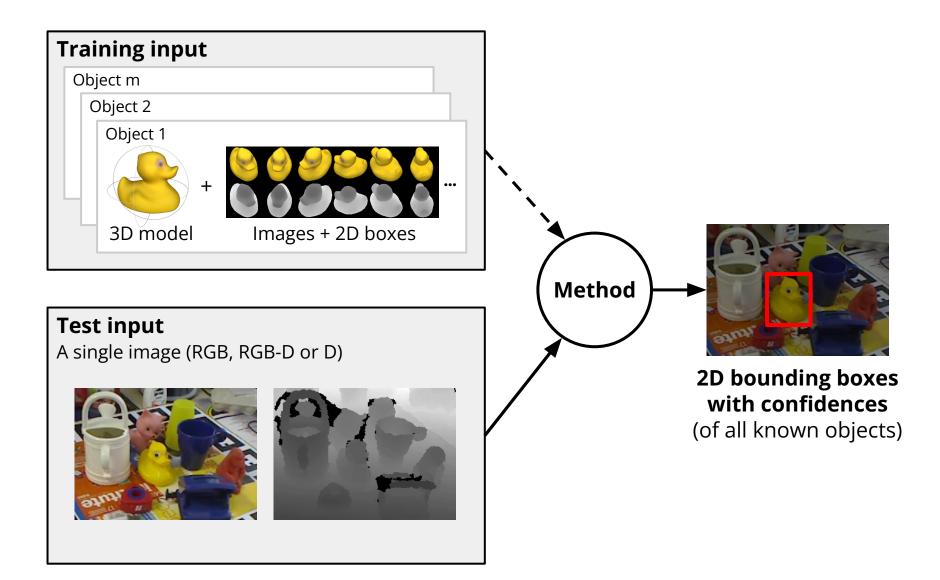
#### BOP Challenge 2022 – Tasks

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

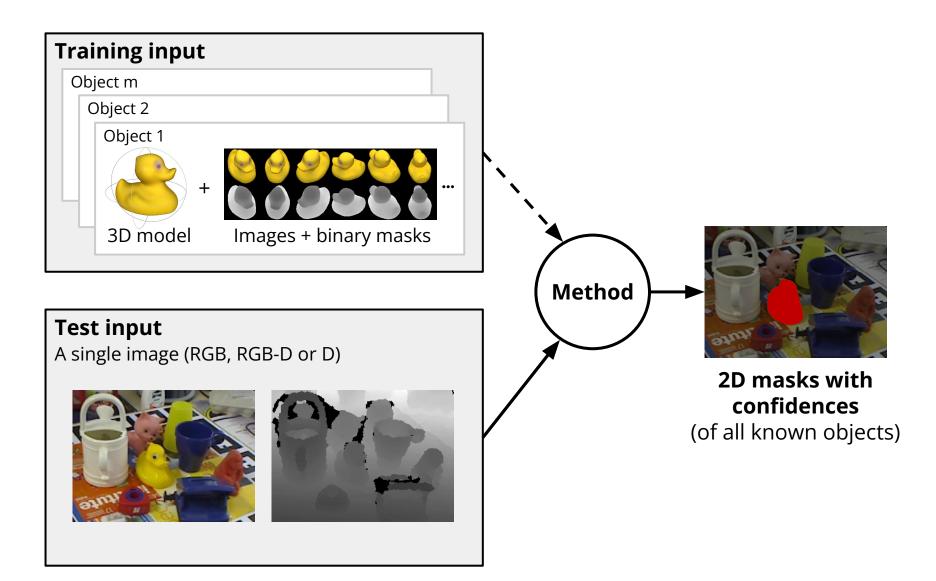
The new tasks were introduced to address the design of many recent methods for object pose estimation, which start by detecting/segmenting objects and then estimate the poses from the predicted regions.

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



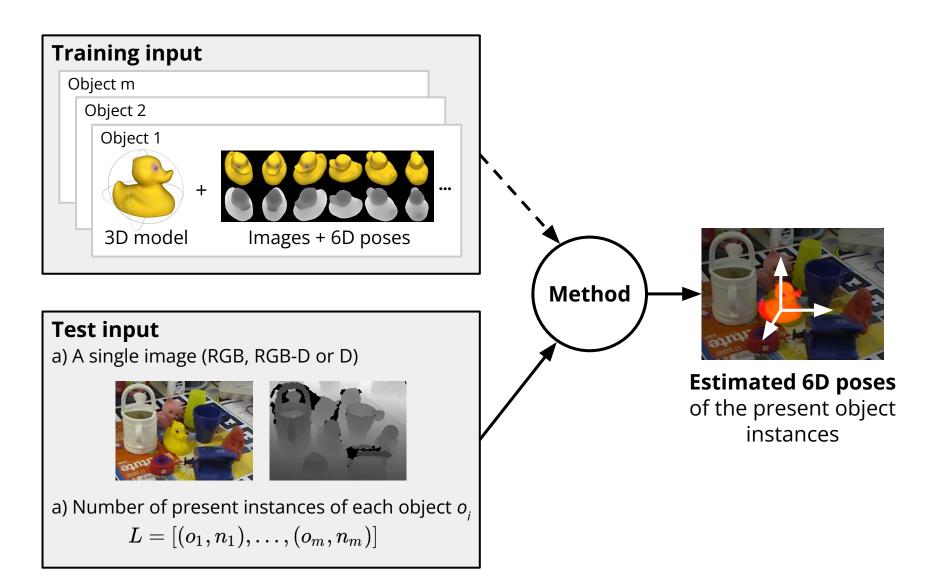
#### **Evaluation of 2D object detection/segmentation**

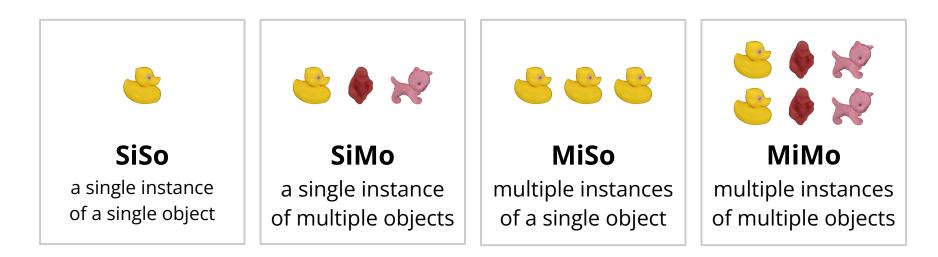
We adopt metrics from the COCO Object Detection Challenge.

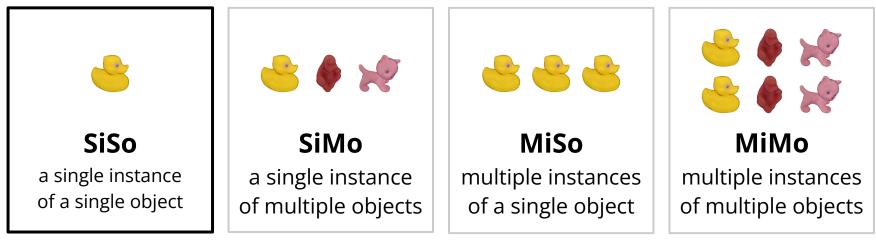
The main metric is the **Average Precision (AP)** calculated at different Intersection over Union (IoU=.50:.05:.95) values.

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.

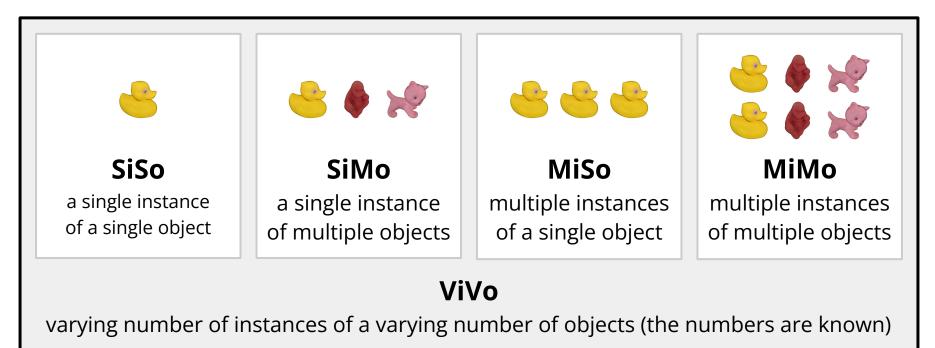
## **6D object localization task**



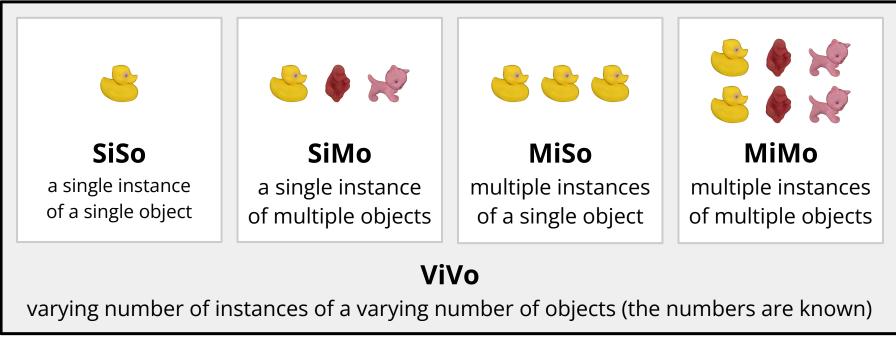




#### **BOP 2018**



#### BOP 2019, 2020 and 2022

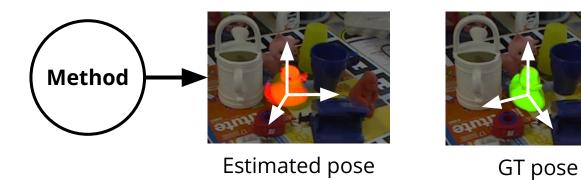


#### BOP 2019, 2020 and 2022

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**



How good is the estimated pose?

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

- 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 <u>bop.felk.cvut.cz</u> 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  $\theta$  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  $\theta$  (and tolerance  $\tau$  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  $AR_p$  scores.  $\Rightarrow$  Each dataset is treated as a separate sub-challenge which avoids the overall score being dominated by larger datasets.

See <u>bop.felk.cvut.cz</u> 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.

G thodan / bop_toolkit Public			A Notifications     A	양 Fork 92 ☆ Star 244 🗸
<> Code ⓒ Issues 5 차 Pull	requests 1 🕑 Actions 🖽 Projects	🕑 Security 🛛 🗠 Insight	ts	
	<b>0</b> tags	Go to file	Code - At	pout
MartinSmeyer Fix(inout): tolist() t	o list()	af380d7 on Jul 7 🕚 162		Python toolkit of the BOP benchmark r 6D object pose estimation.
bop_toolkit_lib	Fix(inout): tolist() to list()	4 m	nonths ago 🔗	bop.felk.cvut.cz
docs	Updated download links.	5 m	ionths ago	Readme
scripts	Updated download links.	5 m	nonths ago	MIT license
🖺 .gitignore	Minor changes.	3	years ago 💿	
🖺 .gitmodules	remove cocoapi submodule, add dep to requi	rement.txt 13 m	nonths ago    ¥	92 forks
	The first public version.	3	years ago	
C README.md	Updated download links.	5 m	nonths ago Re	leases
🗅 requirements.txt	handle depth_scale parameter. update READM	1E 6 m	nonths ago <sup>No</sup>	releases published
ြို setup.py	Update setup.py with pytz requirement	11 m	nonths ago	
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i⊟ README.md			No	packages published

# 

#### 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
	. Buch-17-ecsad	13.27	9.62	40.67	59.00	7.16	6.59	24.00	22.90	5.9
	. Buch-17-shot	5.97	1.45	43.00	38.50	3.83	0.07	16.67	15.64	6.7
	. Tejani-14	12.10	4.50	36.33	10.00	0.13	1.52	0.00	9.23	1.4
	. 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

#### 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	
•	2. Drost-Metho 3. Drost-10	82.00	55.36	oint Pa	87.00	ures (	22.25		d best	2.3
•	4. Hodan-15 5. Brachmann-16	$87.10 \\ 75.33$	$\begin{array}{c} 51.42 \\ 52.04 \end{array}$	95.33 73.33	$90.50 \\ 56.50$	63.18 $17.84$	$\begin{array}{r} 37.61 \\ 24.35 \end{array}$	$\frac{45.50}{88.67}$	$\begin{array}{c} 67.23 \\ 55.44 \end{array}$	$13.5\\4.4$
•	6. Hodan-15-nopso 7. Buch-17-ppfh	$\begin{array}{c} 69.83\\ 56.60\end{array}$	$34.39 \\ 36.96$	$84.67 \\ 95.00$	$\begin{array}{c} 76.00 \\ 75.00 \end{array}$	$\begin{array}{c} 62.70\\ 25.10\end{array}$	$\begin{array}{c} 32.39\\ 20.80 \end{array}$	$27.83 \\ 68.67$	$\begin{array}{c} 55.40 \\ 54.02 \end{array}$	$\begin{array}{c} 12.3 \\ 14.2 \end{array}$
•	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 10. Brachmann-14	$\begin{array}{c} 33.33\\ 67.60 \end{array}$	$\begin{array}{c} 20.35\\ 41.52 \end{array}$	$\begin{array}{c} 67.33 \\ 78.67 \end{array}$	59.00 $24.00$	$\begin{array}{c} 13.34 \\ 0.25 \end{array}$	$23.12 \\ 30.22$	$\begin{array}{c} 41.17\\ 0.00\end{array}$	$\begin{array}{c} 36.81\\ 34.61 \end{array}$	$15.9\\1.4$
•	11. Buch-17-ecsad 12. Buch-17-shot	$\frac{13.27}{5.97}$	$9.62 \\ 1.45$	$\begin{array}{c} 40.67\\ 43.00\end{array}$	59.00 38.50	$7.16\\3.83$	$6.59 \\ 0.07$	$\begin{array}{c} 24.00 \\ 16.67 \end{array}$	$\begin{array}{c} 22.90 \\ 15.64 \end{array}$	$5.9\\6.7$
	13. Tejani-14 14. Buch-16-ppfh	$\frac{12.10}{8.13}$	$\begin{array}{c} 4.50 \\ 2.28 \end{array}$	$\frac{36.33}{20.00}$	$\begin{array}{c} 10.00\\ 2.50\end{array}$	$\begin{array}{c} 0.13 \\ 7.81 \end{array}$	$\begin{array}{c} 1.52 \\ 8.99 \end{array}$	$\begin{array}{c} 0.00 \\ 0.67 \end{array}$	$9.23 \\ 7.20$	$\begin{array}{c} 1.4 \\ 47.1 \end{array}$
	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

# 

#### 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

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4	Drost-CVPR10-3D-Only [2]	hoa	o.500 s bas	eu <sub>0.52</sub>	<b>P 9</b> .444	t Pair	Featu	1 <b>res</b> .316	0.615	0.344	7.704
5	Drost-CVPR10-3D-Only-Faster [2]	D	0.454	0.492	0.405	0.696				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
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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
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11	DPOD (synthetic) [8]	RGB	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231

Classical methods outperformed DNN methods, because of:

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

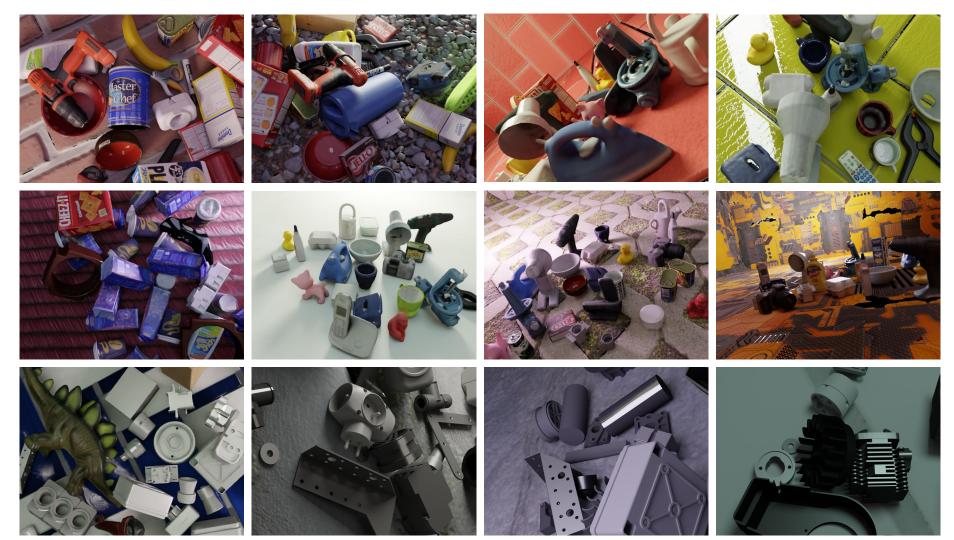


2. **Large domain gap** between real test images and the commonly used synthetic training images (objects rendered on random background).



## 

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



<u> </u>	Marthagen I.	<u>.</u>	DDC	0111				<b>T</b>				TIFCO	TUR		ITODE			
	Method					Train. im.	type			J. J.		T-LESS						Time
1	CosyPose-ECCV20-Synt+Real-1View-ICP	2020	No	Yes	3/dataset	RGB	Synt+real		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
-	<b>_ \</b>		<u> </u>															~

#	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!

#	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...

#	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		2020		Yes	1/dataset		Synt+real		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	28	R	YeO	ther	synt	hetic	RUB (	eal in	nage	<b>9S</b> .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	RGE	BR ir	nage	<b>95</b> .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

## **Competitive results can be achieved with PBR training images only.**

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

#	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+r al	3R I	mage	<b>95</b> .47§	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
				Yes			Synt+real		ICP	0.398	0 237	0 487	0 614	0 281	0 158	0 506	0.505	0.865
	zhigang-CDPN-Images of o			Ss(	Did bje ca		Ŋnbac		ound		0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
_			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	-
		2020		Yes	1/object	RGB	- ,	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		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
	Carl Charles and Beneral Charles and Charles and Charles and Charles	2019		Yes	1/object	RGB	Synt+real		No	0.205	0.077	0.275	0.349	0.215	0.032	0.200	0.290	0.793
26	DPOD (synthetic)	2019	No	Yes	1/scene	RGB	Synt	RGB	No	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231

**PBR training images yield a noticeable improvement over "naively" synthesized images (objects rendered on random backgrounds).** Similarly to CDPN, EPOS jumped from 0.44 to 0.55 on LM-O with PBR images.

## 

#### **BOP Challenge 2022** – Submissions

Submission system: <u>bop.felk.cvut.cz</u>, 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.

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

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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 <u>core datasets</u> (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<sub>Core</sub> score is considered. The performance scores are defined in the <u>BOP</u> <u>Challenge 2019 description</u>. The reported time is the average image processing time averaged over the core datasets.

Show	50 🗸 entries	i de la construcción de la constru									Search:		
	Date (UTC) 🔷	Method	÷	Test image 🍦	AR <sub>Core</sub>	AR <sub>LM-0</sub>	AR <sub>T-LESS</sub>	AR <sub>TUD-L</sub> \$	AR <sub>IC-BIN</sub>	AR <sub>ITODD</sub>	AR <sub>HB</sub> 🔶	AR <sub>YCB-V</sub>	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

	#	Method	Year	PPF	DNN	models per	Det./seg.	Refine.	Train. im.	type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	НВ	YCB-V	Time
on	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
tic	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
σ	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
N	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
ali	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
U	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
0	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
Ļ	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
ec	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
· Ē	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
q	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
0	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
9	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
5	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
5	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	-
20	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
e U	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
60	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
en	20	ZebraPoseSAT-EffnetB4 (PBR_Only)	2022	No	Yes	Object	FCOS	-21	RGB	PBR only	RGB	0.670	0.721	0.723	0.717	0.545	0.410	0.882	0.691	-
le	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	-
al	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
μ	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
Ch	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
Ъ.	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
Ο	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
В	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	-1	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
		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
σ	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
<u>N</u> [	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
a	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
U	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
<u>e</u> [	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
ี 5	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
e	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
ŏŀ	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
5	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	-
ן מ	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
NI	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
5	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	-
Ñ	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
Ψ⊢	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+ICF	RGB	PBR+real	RGB-D	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
e	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	Ч.,
≚∣	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	3
•• E	22	RADet+PFA-PBR-RGB	2022		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
- T	23	SurfEmb-PBR-RGB	2021	No	Yes	Dataset	Default MaskRCNN (synt+real)	Custom	RGB		RGB	0.650	0.663	0.735	0.715		0.413	0.791	0.647	8.891
	24	Koenig-Hyb18Pmethods CosyPose-ECCV20-SYNT+REAL-1VIEW		0	m-	2022	outperfo	rm C	osv	POS PBR+real	<b>Е</b> В-D 1	the	_Wİ	nne	≥r₂t	ror	nr₄82	020	0.701	0.633
												0.637	0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
5 H		CRT-6D	2022		Yes	Dataset	Default MaskRCNN (synt+real)	Custom	RGB			0.599	0.660	0.644	0.789	0.537	0.208	0.603	0.752	0.059
- 8		Pix2Pose-BOP20_w/ICP-ICCV19	2020		Yes	Object	MaskRCNN	ICP	RGB		RGB-D	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844
- 8		ZTE_PPF	2022		Yes	Dataset	Default MaskRCNN (synt+real)	ICP	RGB			0.578	0.663	0.374	0.904	0.396	0.470	0.735	0.502	0.901
- 8	29	CosyPose-ECCV20-PBR-1VIEW	2020		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
- 8	30	Vidal-Sensors18	2019		No	-	-	ICP	-	-	D	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
- 8	31	CDPNv2_BOP20 (RGB-only & ICP)	2020		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
- 6	32	Drost-CVPR10-Edges	2019		No	-	-	ICP	-	-	RGB-D	0.550	0.515	0.500	0.851	0.368	0.570	0.671	0.375	87.568
- 8	33	CDPNv2_BOP20 (PBR-only & ICP)	2020		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
- 8	34	CDPNv2_BOP20 (RGB-only)	2020		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
- 8	35	Drost-CVPR10-3D-Edges	2019		No	-		ICP	-	-	D	0.500	0.469		0.852	0.373	0.462	0.623	0.316	80.055
- 8	36 37	Drost-CVPR10-3D-Only	2019 2020		No Yes	Object	- RetinaNet	ICP	- RGB	Sunttract	D RGB	0.487	0.527	0.444	0.775	0.388	0.316	0.615	0.344	7.704 0.480
- 8	37 38	CDPN_BOP19 (RGB-only)	2020			Object	FCOS	-	RGB		RGB	0.479	0.569	0.490	0.789	0.327	0.007	0.672	0.457	0.480
- 8	39	CDPNv2_BOP20 (PBR-only & RGB-only) leaping from 2D to 6D	2020		Yes	Object Object	222	-	RGB	PBR only Synt+real	RGB	0.472	0.525	0.407	0.368	0.342	0.102	0.658	0.543	0.425
- 8		EPOS-BOP20-PBR	2020		Yes	Dataset		-	RGB		RGB	0.471	0.525	0.467	0.558	0.363	0.186	0.580	0.499	1.874
- 1		Drost-CVPR10-3D-Only-Faster		1008	No		-	ICP	KGB		D	0.454	0.492	0.407	0.696		0.100	0.603		100000000
		Félix&Neves-ICRA2017-IET2019				Dataset	MaskRCNN	ICP	- RGB-D	- Synt+real		0.412	0.394	0.212	0.851	0.323	0.069	0.529		55.780
		Sundermeyer-IJCV19+ICP				Object	RetinaNet	ICP	RGB	Synt+real		0.398	0.237	0.487	0.614		0.158	0.506	0.505	0.865
		Zhigang-CDPN-ICCV19		No		Object	RetinaNet	-	RGB	Synt+real		0.353	0.237	0.487	0.814		0.158	0.308	0.422	0.513
		PointVoteNet2		No		Object	-	- ICP	RGB-D	PBR only		0.351	0.653	0.004	0.673	0.264	0.070	0.556	0.308	-
- 1		Pix2Pose-BOP20-ICCV19		No		Object	- MaskRCNN	-	RGB-D	PBR+real		0.342	0.363	0.344	0.420		0.134	0.330	0.308	1.215
- 8		Sundermeyer-IJCV19		No		Object	RetinaNet	-	RGB	Synt+real		0.280	0.303	0.304	0.420		0.101	0.346		0.196
		SingleMultiPathEncoder-CVPR20		No		All datasets	MaskRCNN	-	RGB	Synt+real		0.280	0.217	0.304	0.334		0.067	0.293	0.289	0.186
		DPOD (synthetic)				Scene	-	-	RGB	Synt	RGB	0.241	0.217	0.081	0.334			0.293		0.180
				1.10	1.00	200110				3,		0.101	0.100	0.001	0.272	0.100	0.000	0.200		0.201

**BOP Challenge 2022: 6D object localization** 

_	# Method	Year	PPF	DNN	models per	Det./seg.	Refine.	Train. im.	type	Test im	Ava	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
5	1 GDRNPP-PBRReal-RGBD-MModel	2022	No	Yes	Object	YOLOX	~CIR	RGB-D	PBR+real	RGB-	0.837	0.775	0.874	0.966	0.722	0.679	0.926	0.921	6.263
5 I	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
5	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
2	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
6	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
ונ	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
2	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
ا ي	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
וה	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
5	10 Surfemb-PB Verall SOTA	2021	'nc	$\mathbf{M}$	eo∞tro	om <b>0.698 A</b>	(Rtor)	DSV	<sup>D</sup> OSE	Эс)в-† (	$\mathcal{O}(0)$	.83	7.8A	<b>R</b> *5(	GD	RN	PP	0.799	9.048
5	11 GDRNPP-PBRReal-RGBD-SModel		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	-
3	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
1	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	-
Í I	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
וע	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
20	19 CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020	No	Yes	Dataset	Default MaskRCNN (synt+real)	~DeepIM+ICF	RGB	PBR+real	RGB-	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	21	RGB	PBR only	RGB	0.670	0.721	0.723	0.717	0.545	0.410	0.882	0.691	-
Ľ	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	÷
5	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
ן נ	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
2	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
ן ב	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	-	34	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		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		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)		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		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		No		Dataset	-	-	RGB		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		Yes		-	-	ICP	-		D	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	
	42 Félix&Neves-ICRA2017-IET2019				Dataset	MaskRCNN	ICP	RGB-D	Synt+real		0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
	43 Sundermeyer-IJCV19+ICP				Object	RetinaNet	ICP	RGB	Synt+real		0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
	44 Zhigang-CDPN-ICCV19				Object	RetinaNet	-	RGB	Synt+real		0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
	45 PointVoteNet2				Object	-	ICP	RGB-D	PBR only		0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
	46 Pix2Pose-BOP20-ICCV19		10		Object	MaskRCNN	-	RGB	PBR+real		0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
	47 Sundermeyer-IJCV19				Object	RetinaNet	-	RGB	Synt+real		0.280	0.146	0.304	0.401	0.217	0.101	0.346	0.446	0.196
	48 SingleMultiPathEncoder-CVPR20				All datasets	MaskRCNN	-	RGB	Synt+real		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

I	#	Method	Year PPF	DNN	models per	Det./seg.	Refine.	Train. im.	type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN		НВ	YCB-V	Time
D	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
ס	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
7	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
σ	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
S S	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
2	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
<b>ا</b>	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
IJ	9	RADet+PFA-PBR-RGBD Large I	mp	r0\	veme	nt on the h	nard	Indi	ustr	laÞ	dat	ase	2 <b>T</b> .802	(89)	DD	0.469	0.869	0.826	2.631
2		SUITEMD-PBR-RGBD	2021 No		Dataset		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
5	11	GDRNPP-PBRReal-RGBD-SModel	2(2) 15	15	PAR (	CosyPose)			PBAR		DR	N۲	PJ.)56	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	-
0		GDRNPP-PBRReal-RGB-MModel	2022 No	Yes	Object	YOLOX	-	RGB	PBR+real		0.728	0.713	0.786	0.831	0.623	0.448	0.869	0.825	0.229
		ZebraPoseSAT-EffnetB4	2022 No	Yes	Object	FCOS	<del></del>	RGB	PBR+real		0.720	0.721	0.806	0.850	0.545	0.410	0.882	0.830	0.250
Z		ZebraPoseSAT-EffnetB4 (DefaultDetection)	2022 No	Yes	Object	Default MaskRCNN (synt+real)	-	RGB	PBR+real		0.720	0.707	0.768	0.849	0.597	0.417	0.887	0.816	0.250
5		ZebraPose-SAT	2022 No	Yes	Object	FCOS		RGB	PBR+real		0.710	0.721	0.787	0.861	0.549	0.379	0.847	0.828	-
V		RADet+PFA-MixPBR-RGB	2022 No	Yes	Dataset	Extended FCOS	PFA	RGB	PBR+real		0.709	0.745	0.778	0.839	0.600	0.353	0.841	0.806	3.019
D		GDRNPP-PBR-RGB-MModel	2022 No	Yes	Object	YOLOX	-	RGB	PBR only	RGB	0.702	0.713	0.796	0.752	0.623		0.869	0.713	0.284
S S		CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020 No	Yes	Dataset	Default MaskRCNN (synt+real)	~DeepIM+ICP	Company of the local division of the local d	and the second		0.698	0.714	0.701	0.939	0.64	0.313	0.712	0.861	13.743
ע		ZebraPoseSAT-EffnetB4 (PBR_Only)	2022 No	Yes	Object	FCOS	-	RGB	PBR only	RGB	0.670	0.721	0.723	0.717	0.545		0.882	0.691	-
			2022 No	Yes	Dataset	MaskRCNN	PFA	RGB-D	PBR+real		0.664	0.714	0.738	0.837	0.596	0.246	0.712	0.807	-
σ		RADet+PFA-PBR-RGB SurfEmb-PBR-RGB	2022 No 2021 No	Yes	Dataset	Extended FCOS	PFA	RGB RGB		RGB	0.663	0.745	0.719 0.735	0.732	0.588	0.353	0.791	0.648	3.497 8.891
5		Koenig-Hybrid-DL-PointPairs	2021 No 2020 Yes	Yes	Dataset Dataset	Default MaskRCNN (synt+real) RetinaMask/MaskRCNN	Custom ICP	RGB	PBR only Synt+real	RGB RGB-D	0.650	0.631	0.655	0.920	0.388	0.413	0.651	0.701	0.633
			2020 165	Yes	Dataset		~Deep	ROD	DDD		0.005	0.001	0.000	0.920	0.430	0.403	0.050	0.821	0.449
5		CRT-6D			144.	1	Custon	6	-			1000	C. C. C.					0.752	0.059
Ó		Pix2Pose-E			3	1	ICP	V	201	~								0.780	4.844
		ZTE_PPF		100			ICP		0		R	3 6						0.502	0.901
	29	CosyPose-				÷.	~Deep			Aller.	-	-6						0.574	0.475
	30	Vidal-Sensi					ICP				-	12						0.450	3.220
	31	CDPNv2_E	2000	-	/ /	A line	ICP											0.619	1.462
	32	Drost-CVPI			-		ICP				11		520					0.375	87.568
	33	CDPNv2_E					ICP				- Mill		- Hall	(0)				0.532	1.491
	34	CDPNv2_E			VOT		-		6	-	2	12	121					0.532	0.935
	35	Drost-CVPI		-	10		ICP			= >		10 3		Mr.				0.316	80.055
	36	Drost-CVPI					ICP				3	1		2)				0.344	7.704
	37	CDPN_BO		11-1			-				2.0	nor a		()				0.457	0.480
	38	CDPNv2_E		Y	to .		-			1	6.1	0.6		F.				0.390	0.978
	39	leaping from				//	-			-	-	• 📓						0.543	0.425
	40	EPOS-BOF		.)			-				175		( ? )					0.499	1.874
		Drost-CVPI			1 · · ·		ICP					3	<u> </u>					0.330	
		Félix&Neve	0	•			ICP		•	6	21		10					0.510	
		Sundermey	1.4	1253			ICP			( and								0.505	0.865
		Zhigang-Cl			0		-											0.422	0.513
		PointVoteNet2	2020 No		Object	-	ICP	RGB-D	PBR only		0.351	0.653	0.004	0.673	0.264		0.556	0.308	-
		Pix2Pose-BOP20-ICCV19	2020 No	Yes	Object	MaskRCNN	-	RGB	PBR+real		0.342	0.363	0.344	0.420		0.134	0.446	0.457	1.215
		Sundermeyer-IJCV19	2021 No		Object	RetinaNet	-	RGB	Synt+real		0.280	0.146	0.304	0.401	0.217	0.101	0.346	0.446	0.196
		SingleMultiPathEncoder-CVPR20 DPOD (synthetic)	2020 No 2019 No		All datasets Scene	MaskRCNN	-	RGB RGB	Synt+real	RGB RGB	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
	49	Dr OD (Synthetic)	2019 100	Tes	ocene			KOD	Synt	NOB	0.101	0.169	0.001	0.242	0.130	0.000	0.200	0.222	0.231

#	ŧ I	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
5 🛛	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
5	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	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
3	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
5	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
2	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
۰ I	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
י	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
5	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
2	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
1	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	-
5	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
2	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
i I	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
í I	16	ZebraPose-SAT	2022	No	Yes		FCOS		RGB	PBR+real	RGB	0.710	0.721	0.787	0.861	0.549	0.379	0.847	0.828	-
3		RADet+PFA-MixPBR-RGB	2022	No			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
, I		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
		CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020	No			Default MaskRCNN (synt+real)	~DeepIM+ICF		PBR+real	RGB-D	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
- T		ZebraPoseSAT-EffnetB4 (PBR Only)	2022	No	Yes			-		PBR-only	Sth	<u></u>	0.731	A 723	A747	0.545	10-41 h	0.882	0.691	-
2		PFA-cosypose	2022	No		Dataset	2020: PPF	ar ia-i		PBR+real	eru	QQ.	s₀ä₁r	-ec	.QJJ	IDd	rat		0.807	2
3		RADet+PFA-PBR-RGB	2022	No			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
_		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
ז ו	24	Koenig-Hybrid-DL-PointPairs	202	Yes	es						GR-P	0,439	1.611	0.655	0.920	0.430	0.483	0.651	0.701	0.633
_ 1		CosyPose-ECCV20-SYNT+REAL-1VIEW	2020	NO		Dataset	2022: DNN		ЦПО	- BR - real	191	J.J.37	GU	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
ב ב	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
2	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
2	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
1.1	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
11	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
12	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
1	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
1	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	eaping 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
4	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
4	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
4	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
4	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
4	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
4	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	-
2	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
4	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
4	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
4	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

#	1	Method	Year	PPF	DNN	models per	Det./seg.	Refine.	Train. im,	tupe	Test im.	Avg.	LM-O	TJESS	TUD-I	IC-BIN	ITODD	нв	YCB-V	Time
5 [	1 (	GDRNPP-PBRReal-RGBD-MModel	2022	No	Yes	Object	YOLOX	~CIR	RGB-D	PBR+real	GB-D	0.837	0.77	0.874	0.966	0.722	0.679	0.92	0.921	6.263
5	2 (	GDRNPP-PBR-RGBD-MModel	2022	2 No	Yes	Object	YOLOX	~CIR	RGB-D	PBR only	GB-D	0.827	0.77	0.852	0.929	0.722	0.679	0.92	0.906	6.264
5	3 (	GDRNPP-PBRReal-RGBD-MModel-Fast	2022	2 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
1	4 (	GDRNPP-PBRReal-RGBD-MModel-OfficialDet	2022	2 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	5 1	RADet+PFA-MixPBR-RGBD	2022	2 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
٦	6 1	RADet+PFA-MixPBR-RGBD-Fast	2022	2 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
2	7 1	RCVPose 3D_SingleModel_VIVO_PBR	2022	2 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
5	8 2	ZebraPoseSAT-EffnetB4 + ICP (DefaultD	2022	2 No	RC	B-D	sim2real <sup>a</sup> g	an i	RGE	mos	₹ B-C	on	<b>e</b> <sup>•52</sup>	0.727	0.948	0.652	0.527	0.883	0.866	0.500
ו	9 1	RADet+PFA-PBR-RGBD	2022	2 No	Yes	Dataset	Extended FCOS	FA	RGB	PBR only	RGB-L	0.762	0.797	0.802	0.893	0.676	0.469	0.869	0.826	2.631
	0 3	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
2 1	1 (	GDRNPP-PBRReal-RGBD-SModel	2022	2 No	Yes	Dataset	YOLOX	Depth adjust.	RGB		RGB-D	0.748	0.757	0.856	0.906	0.680	0.356	0.864	0.817	0.556
1	2 (	Coupled Iterative Refinement (CIR)	2022	2 No	Yes	Objp:07	2 gap: 0.02	A7 A	<b>Р</b> зв//	PRR	NΡ	DJ.741	0.734	0.776	0.968	0.676	0.381	0.757	0.893	-
2 1	3 (	GDRNPP-PBRReal-RGB-MModel	2022	2 No	Yes	Object			RGB	PBR+real	RGB	0.728	0.713	0.786	0.831	0.623	0.448	0.869	0.825	0.229
2	4 2	ZebraPoseSAT-EffnetB4	2022	2 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
j I	5 2	ZebraPoseSAT-EffnetB4 (DefaultDetection)	2022	2 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
1	6	ZebraPose-SAT	2022	2 No	Yes	Object	FCOS	-	RGB	PBR+real	RGB	0.710	0.721	0.787	0.861	0.549	0.379	0.847	0.828	-
j	7 1	RADet+PFA-MixPBR-RGB	2022	2 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
1	8 (	GDRNPP-PBR-RGB-MModel	hlv	/ Np -	Yes	SS;,tTUI	D <u>¤</u> ⊵×and YCB-\	/ inclu	de re	al &	synt	thet	ic in	nage	S) 52	0.623	0.448	0.869	0.713	0.284
10	9 (	CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020	) No	Yes	Dataset	Default MaskRCNN (synt+real)	~DeepIM+ICF		PBR+real	RGB-D	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
2	0 2	ZebraPoseSAT-EffnetB4 (PBR_Only)	2022	2 No	Yes	Object	FCOS	-	RGB	PBR only	RGB	0.670	0.721	0.723	0.717	0.545	0.410	0.882	0.691	-
2	1	PFA-cosypose	2022	2 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	3
3 2	2	RADet+PFA-PBR-RGB	2022	2 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
_	3 3	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
ر 2	4 1	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
2	5 (	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
2	6	CRT-6D	2022	2 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
2	7 1	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
2	8 2	ZTE_PPF	2022	2 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
2	9 (	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
3	0	/idal-Sensors18	2019	Yes	No	-	-	ICP	-	а.	D	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
3	1 (	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
3	2 [	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
3	3 (	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
3	4 (	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
3	5 I	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
3	6 [	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
3	7 (	CDPN_BOP19 (RGB-only)	2020	No 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
3	8	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
3	9	eaping 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
4	0	EPOS-BOP20-PBR	2020	No 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
4	1	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
4	2	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
4	3 3	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
4	4	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
4	5	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	-
4	6	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
4	7 3	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
4	8	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
4	9 1	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
5 [	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
5	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
5	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
<u>'  </u>	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	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
2 L	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
2	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
۱,	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
51	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
5	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
5	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		DBB+rool	RGB-D	0.741	0.734	0.776	0.069	0.676	0.381	0.757	0.902	
5	13 GDRNPP-PBRReal-RGB-MModel	2022	No	Yes	Object	YOLOX	-	RGB	PBR+real	GB	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	<b>.</b>	RGB	PBR+real	RGB	0.720	0.721	0.806	0.850	0.545	0.410	0.882	0.830	0.250
j I	15 ZebraPoseSAT-EffnetB4 (DefaultDetection)	2022			Object	Default MaskRCNN (synt+real)	-	RGB			0.720	0.707	0.768	0.849	0.597	0.417	0.887	0.816	0.250
	16 ZebraPose-SAT	2022		and the second s	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			Dataset	Extended FCOS	PFA	RGB		RGB	0.709	0.745	0.779	0.020	0.600	0.353	0.841	0.000	3.019
<u>' i</u>	18 GDRNPP-PBR-RGB-MModel	2022		Yes	Object	YOLOX	-		PBR only	RGB	0.702	0.713	0.796	0.752		0.448	0.869	0.713	0.284
	19 CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020			Dataset	Default MaskRCNN (synt+real)	~DeepIM+ICF		PBR+real		0.698	0.714	0.701	and the second	0.647	0.313	0.712		13.743
ונ	20 ZebraPoseSAT-EffnetB4 (PBR_Only)	2022			Object	FCOS		RGB	PBR only	RGB	0.670	0.721	0.723	0.717	0.545	0.410	0.882	0.691	-
- 1	21 PFA-cosypose	2022			Dataset	MaskRCNN	PFA	RGB-D	PBR+real	RGB	0.664	0.714	0.738	0.837	0.596	0.246	0.712	0.807	-
: H	22 RADet+PFA-PBR-RGB	2022			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
5 H	23 SurfEmb-PBR-RGB	2021	No		Dataset		Custom	RGB	PBR only	RGB	0.650	0.663	0.735	0.715	0.588	0.413	0.791	0.647	8.891
- 6	24 Koenig-Hybrid-DL-PointPairs	202	ζG	В	SIMZ	real agap r	eau	rea			Ca	ntly	0.655	0.920	0.430	0.483	0.651	0.701	0.633
5 8	25 CosyPose-ECCV20-SYNT+REAL-1VIEW	2020		and the second second			and the second second						0.728	0.823	0.583	0.216	0.656	0.821	0.449
5 H	26 CRT-6D 27 Pix2Pose-BOP20 w/ICP-ICCV19	2022 2020			Dataset Object	Default MaskRCNN (synt+real) MaskRCNN	Custom	RGB RGB	PBR+real PBR+real	RGB	0.599	0.660	0.512	0.789	0.537	0.208	0.603	0.752	0.059
- 6	27         Pix2Pose-BOP20_w/ICP-ICCV19           28         ZTE         PPF	2020	Yes	Yes								0.663	0.374	0.820	0.396	0.351	0.095	0.780	0.901
- 1	29 CosyPose-ECCV20-PBR-1VIEW	2022	No	Yes		0 fa ga p:N 0 nt 1 = 5			JSYF		$e_{570}^{578}$	0.633	0.640	0.685	0.583	0.216	0.656	0.574	0.475
- 6	30 Vidal-Sensors18	2019		No	- <u>)</u>				וחח		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		Yes	Object	2 gap: <b>0.0</b>	DZZ AT	RGD	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		No	-		ICP	-	-	RGB-D	0.550	0.515	0.500	0.851	0.368	0.570	0.671	0.375	87.568
- 1	33 CDPNv2_BOP20 (PBR-only & ICP)		No		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
- 1	34 CDPNv2_BOP20 (RGB-only)	2020	No		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	nlv	Yes	NCE	SS. TUI	D-L and YCB-V	/@nclu	de re	al &	svn	thet	icin	nage	es)75	0.388	0.316	0.615	0.344	7.704
	37 CDPN_BOP19 (RGB-only)	2020	No		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
- 1	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
- 1	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
- 1	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			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	2			Object	MaskRCNN	-	RGB	PBR+real		0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	
	47 Sundermeyer-IJCV19				Object	RetinaNet	-	RGB	Synt+real	RGB	0.280		0.304	0.401		0.101	0.346		0.196
- 8	48 SingleMultiPathEncoder-CVPR20				All datasets	MaskRCNN	-	RGB	Synt+real		0.241	0.217	0.310	0.334		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
5 [	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	~CIR	RGB-D	PBR only	RGB-D	0.827	0.775	0.852	0.929	0.722	0.679	0.926	0.90	
ז ן	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
2	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	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
וו	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
2	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
ן י	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
5	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
5	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
5	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	-
5	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
1	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
5	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	-
1	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
ע	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
0	19 CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020		Yes	Dataset	Default MaskRCNN (synt+real)	~DeepIM+ICP		PBR+real	RGB-D	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
5	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	-
É	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	-
5	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
Ξļ	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	9.901
1	24 Koenig-Hybrid-DL-PointPairs	2020		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
5	25 CosyPose-ECCV20-SYNT+REAL-1VIEW	2020		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
21	26 CRT-6D	2022		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		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
- 1	28 ZTE_PPF	2022		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
- 1	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	ъВ	est ta	ast metho	a (<1	s p	erı	ma	ge	9.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
- 1	31 CDPNv2_BOP20 (RGB-only & ICP)	2020		Yes	Object	FCOS	ICP	RGB	Synt+real	RGB-D		0.630	0.464	0.913	0.450	0.186	0.712	0.619	1.462
	32 Drost-CVPR10-Edges	2019		No	-	-		-	-	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				RGB	PBR only	RGB-D	0.534	0.630	0.435	0.791	0.450	0.186	0.712	0.532	1.491
- 1	34 CDPNv2_BOP20 (RGB-only) 202	2020	<u>ال</u>	.6.	39 AF	<b>≀@ 0.633s</b>	per	ma	ge-	(ΚΟ	eni	g-r	IYD	rid)	0.473	0.102	0.722	0.532	0.935
	35 Drost-CVPR10-3D-Edges 36 Drost-CVPR10-3D-Only	2019		NO	OOF						0.500	D-N-	-20.404	0.852	0.373	0.462	0.623	0.316	80.055 7.704
- 1	36 Drost-CVPR10-3D-Only 37 CDPN BOP19 (RGB-only)			Ves	J.805	AR @ 0.22	85 P			ge (	GU	ΚĮ		0.775	0.388	0.316	0.615	0.344	0.480
	and a second to be an	2020		Yes		FCOS		RGB			0.479	0.624	0.490	0.588	0.327	0.007	0.872	0.457	0.480
- 1		2020	No	Yes	Object Object	222		RGB	PBR only Synt+real	RGB RGB	0.472	0.624	0.407	0.566	0.473	0.102	0.658	0.543	0.978
	39         leaping from 2D to 6D           40         EPOS-BOP20-PBR	2020	No		Dataset	-		RGB	PBR only	RGB	0.471	0.525	0.403	0.558	0.363	0.186	0.580	0.543	1.874
	40 EF03-50F20-FBR 41 Drost-CVPR10-3D-Only-Faster	100000000	Yes		-	-	- ICP	-	- Dictority	D	0.457	0.347			0.303	0.180	0.603	0.330	200000000
	42 Félix&Neves-ICRA2017-IET2019				Dataset	MaskRCNN	ICP	- RGB-D	- Synt+real		0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	
- 1	43 Sundermeyer-IJCV19+ICP		No		Object	RetinaNet	ICP	RGB	Synt+real		0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
- 1	44 Zhigang-CDPN-ICCV19				Object	RetinaNet	-	RGB	Synt+real		0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
	45 PointVoteNet2		No		Object	-	ICP	RGB-D	PBR only		0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
- 1	46 Pix2Pose-BOP20-ICCV19	2020			Object	MaskRCNN	-	RGB	PBR+real		0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
- 1	47 Sundermeyer-IJCV19		No		Object	RetinaNet	-	RGB	Synt+real		0.280	0.146	0.304	0.401	0.217	0.101	0.346	0.446	0.196
- 1	48 SingleMultiPathEncoder-CVPR20	2020			All datasets	MaskRCNN	-		Synt+real		0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
	49 DPOD (synthetic)		No		Scene	-	-		Synt	RGB	0.161	0.169	0.081	0.242	0.130	0.000	0.286	0.222	0.231
	, and a second sec																		

# Methe	nod	Year	PPF	DNN	models per	Det./seg.	Pofino	Train. im.	type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
1 GDR	RNPP-PBRReal-RGBD-MModel	2022	No	Yes	Object	YOLOX	~CIR	GB-D	PBR+real	RGB-D	0.837	0.775	0.874	0.966	0.722	0.679	0.926	0.92	6.26
2 GDR	RNPP-PBR-RGBD-MModel	2022	No	Yes	Object	YOLOX		RGB-D	PBR only	RGB-D	0.827	0.775	0.852	0.929	0.722	0.679	0.926	0.906	
3 GDRI	RNPP-PBRReal-RGBD-MModel-Fast	2022	No	Yes	Object	YOLOX	Depth adjust.	GB	PBR+real	RGB-D	0.805	0.792	0.872	0.936	0.702	0.588	0.909	0.83	0.22
4 GDR	RNPP-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	6.40
5 RAD	et+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	2.31
6 RAD	et+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	0.63
7 RCV	Pose 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	1.33
8 Zebra	aPoseSAT-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	0.50
9 RAD	et+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	2.63
10 SurfE	Emb-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	9.04
11 GDR	RNPP-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	0.55
12 Coup	pled 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 GDR	RNPP-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	0.22
14 Zebra	aPoseSAT-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	0.25
15 Zebra	aPoseSAT-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	0.25
16 Zebra	aPose-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 RADe	et+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	3.01
18 GDRI	RNPP-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	0.28
19 Cosy	Pose-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	13.74
20 Zebra	aPoseSAT-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-0	-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	-
	et+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	3.49
23 SurfE	Emb-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	0.90
24 Koen	nig-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	0.63
25 Cosy	Pose-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	0.44
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	0.05
27 Pix2F	Pose-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	4.84
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	0.90
29 Cosyl	Pose-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	0.47
30 Vidal-	I-Sensors18	2019	Yes	NR	est f	ast metho	d (<1	s n	er i	ma	σρ	9.582	0.538	0.876	0.393	0.435	0.706	0.450	3.22
31 CDP	Nv2_BOP20 (RGB-only & ICP)	2020	No	Yes	Object	FCOS	ICP	RGB	Synt+real	RGB-D	<b>lge</b>	0.630	0.464	0.913	0.450	0.186	0.712	0.619	1.46
32 Drost	t-CVPR10-Edges	2019	Yes	No	-	-	ICP	-	-	RGB-D	0.550	0.515	0.500	0.851	0.368	0.570	0.671	0.375	87.56
33 CDP	Nv2_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	1.49
34 CDP	Nv2_BOP20 (RGB-only) 202	2020	0	6	<b>29</b> <sup>±</sup> Δ Ε	R∘@ 0.633s	ner	ma	σe	(Kec	en	σ₂h	wh	rid	0.473	0.102	0.722	0.532	0.93
35 Drost	st-CVPR10-3D-Edges	2019	Yes	No			IJP		190	2110	0.500	<u>g62</u> .469	<b>y</b> 04	0.852	0.373	0.462	0.623	0.316	80.05
36 Drost	st-CVPR10-3D-Only	i O i	)@	No	805	AR @ 0.22	8s n	ar i	mag	Je I	(GD	RN	PΡ	0.775	0.388	0.316	0.615	0.344	7.70
37 CDP	PN_BOP19 (RGB-only)	2020	No	Yes	Object	RetinaNet	<b>92 b</b>	RGB	Synt+rea.	RGB	0.479	0.569	0.490	0.769	0.327	0.067	0.672	0.457	0.48
38 CDP	Nv2_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	0.97
	ing 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	0.42
39 leapir	ing from 2D to 6D							RGB	PBR only	RGB	0.457	0.547	0.467	0.558	0.363	0.186	0.580	0.499	1.87
	IS-BOP20-PBR	2020	No	Yes	Dataset	-	-												
40 EPOS		1000000000	No Yes		Dataset	-	- ICP	-		D	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	1.38
40 EPOS 41 Drost	IS-BOP20-PBR	2019	Yes	No	Dataset - Dataset	- - MaskRCNN	- ICP ICP	- RGB-D			0.454 0.412	0.492 0.394	0.405 0.212			0.274 0.069			
<ul> <li>40 EPOS</li> <li>41 Drost</li> <li>42 Félix8</li> </ul>	S-BOP20-PBR t-CVPR10-3D-Only-Faster	2019 2019	Yes Yes	No Yes	-	- - MaskRCNN RetinaNet		-		RGB-D				0.851	0.377		0.529		55.78
40         EPOS           41         Drost           42         Félix&           43         Sund	IS-BOP20-PBR it-CVPR10-3D-Only-Faster &Neves-ICRA2017-IET2019	2019 2019 2019	Yes Yes No	No Yes Yes	- Dataset		ICP	- RGB-D	- Synt+real	RGB-D RGB-D	0.412	0.394	0.212	0.851	0.377 0.323	0.069	0.529 0.506	0.510	55.78 0.86
40         EPOS           41         Drost           42         Félix&           43         Sund           44         Zhiga	IS-BOP20-PBR it-CVPR10-3D-Only-Faster &Neves-ICRA2017-IET2019 dermeyer-IJCV19+ICP	2019 2019 2019	Yes Yes No No	No Yes Yes Yes	- Dataset Object	RetinaNet	ICP	- RGB-D RGB	- Synt+real Synt+real	RGB-D RGB-D RGB	0.412 0.398	0.394 0.237	0.212 0.487	0.851 0.614	0.377 0.323 0.281	0.069 0.158	0.529 0.506	0.510 0.505	55.78 0.86
40         EPOS           41         Drost           42         Félix&           43         Sund           44         Zhiga           45         Point*	IS-BOP20-PBR at-CVPR10-3D-Only-Faster &Neves-ICRA2017-IET2019 dermeyer-IJCV19+ICP ang-CDPN-ICCV19	2019 2019 2019 2019	Yes Yes No No	No Yes Yes Yes	- Dataset Object Object	RetinaNet	ICP ICP -	- RGB-D RGB RGB	- Synt+real Synt+real Synt+real PBR only	RGB-D RGB-D RGB RGB-D	0.412 0.398 0.353	0.394 0.237 0.374	0.212 0.487 0.124	0.851 0.614 0.757 0.673	0.377 0.323 0.281 0.257	0.069 0.158 0.070	0.529 0.506 0.470 0.556	0.510 0.505 0.422 0.308	55.78 0.86 0.51
40         EPOS           41         Drost           42         Félix&           43         Sund           44         Zhiga           45         Point           46         Pix2F	IS-BOP20-PBR at-CVPR10-3D-Only-Faster &Neves-ICRA2017-IET2019 dermeyer-IJCV19+ICP ang-CDPN-ICCV19 tVoteNet2	2019 2019 2019 2019 2020 2020	Yes Yes No No No	No Yes Yes Yes Yes	- Dataset Object Object Object	RetinaNet RetinaNet -	ICP ICP -	- RGB-D RGB RGB-D	- Synt+real Synt+real Synt+real PBR only	RGB-D RGB-D RGB RGB-D RGB	0.412 0.398 0.353 0.351	0.394 0.237 0.374 0.653	0.212 0.487 0.124 0.004	0.851 0.614 0.757 0.673 0.420	0.377 0.323 0.281 0.257 0.264	0.069 0.158 0.070 0.001	0.529 0.506 0.470 0.556 0.446	0.510 0.505 0.422 0.308 0.457	55.78 0.86 0.51 - 1.21
40         EPOS           41         Drost           42         Félix&           43         Sund           44         Zhiga           45         Point*           46         Pix2F           47         Sund	S-BOP20-PBR t-CVPR10-3D-Only-Faster &Neves-ICRA2017-IET2019 dermeyer-IJCV19+ICP ang-CDPN-ICCV19 tVoteNet2 Pose-BOP20-ICCV19	2019 2019 2019 2019 2020 2020	Yes Yes No No No No	No Yes Yes Yes Yes Yes	- Dataset Object Object Object	RetinaNet RetinaNet - MaskRCNN	ICP ICP -	- RGB-D RGB RGB-D RGB-D	- Synt+real Synt+real PBR only PBR+real	RGB-D RGB-D RGB-D RGB-D RGB	0.412 0.398 0.353 0.351 0.342	0.394 0.237 0.374 0.653 0.363	0.212 0.487 0.124 0.004 0.344	0.851 0.614 0.757 0.673 0.420 0.401	0.377 0.323 0.281 0.257 0.264 0.226	0.069 0.158 0.070 0.001 0.134	0.529 0.506 0.470 0.556 0.446	0.510 0.505 0.422 0.308 0.457 0.446	55.78 0.86 0.51 - 1.21 0.19

	# 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
5	1 GDRNPP-PBRReal-RGBD-MModel	2022	2 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
Ś	2 GDRNPP-PBR-RGBD-MModel	2022	2 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
5	3 GDRNPP-PBRReal-RGBD-MModel-Fast	2022	2 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	2 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	5 RADet+PFA-MixPBR-RGBD	2022	2 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
Š	6 RADet+PFA-MixPBR-RGBD-Fast	2022	2 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	2 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
ŗ	8 ZebraPoseSAT-EffnetB4 + ICP (DefaultD	2022	2 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	2 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
5	11 GDRNPP-PBRReal-RGBD-SModel	2022	2 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	2 No	Yes	Object	Default MaskRCNN (synt+real)	CIR	RGB-D	PBR+real	RGB-D	0.744	0.734	0.776	0.968	0.676	0.381	0.757	0.893	-
2	13 GDRNPP-PBRReal-RGB-MModel	2022	2 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	2 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	2 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
5	16 ZebraPose-SAT	2022	2 No	Yes	Object	FCOS	-	RGB	PBR+real	RGB	0.710	0.721	0.787	0.861	0.549	0.379	0.847	0.828	-
J	17 RADet+PFA-MixPBR-RGB	2022	2 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
D	18 GDRNPP-PBR-RGB-MModel		2 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
U.	19 CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020	) No	Yes	Dataset	Default MaskRCNN (synt+real)	~DeepIM+ICF	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	2 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	2 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	8
2	22 RADet+PFA-PBR-RGB	2022	2 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		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			Dataset	RetinaMask/MaskRCNN	ICP	RGB	-	RGB-D	0.620	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
	25 CosyPose-ECCV20-SYNT+REAL-1VIEW	2020		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
<u>,</u>	26 CRT-6D		2 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		RGB-D	0.591	0.588	0.512	0.820	0.390	0.351	0.695	0.780	4.844
			1.000	12.02								0.663							0.901
	28 ZTE_PPF	2022			Dataset		ICP	RGB	PBR+real	RGB-D	0.578		0.374	0.904	0.396	0.470	0.735	0.502	0.475
	29 CosyPose-ECCV20-PBR-1VIEW	2020	) No	Yes	Dataset Dataset	Default MaskRCNN (synt+real) Default MaskRCNN (pbr)	~DeepIM	RGB RGB	PBR+real	RGB-D	0.570	0.633	0.640	0.685	0.583	0.216	0.656	0.574	0.475
	29 CosyPose-ECCV20-PBR-1VIEW 30 Vidal-Sensors18	2020 2019	) No ) Yes	Yes No	Dataset -	Default MaskRCNN (pbr)	~DeepIM ICP	RGB -	PBR only	RGB D	0.570 0.569	0.633 0.582	0.640 0.538	0.685 0.876	0.583 0.393	0.216 0.435	0.656 0.706	0.574 0.450	3.220
	29         CosyPose-ECCV20-PBR-1VIEW           30         Vidal-Sensors18           31         CDPNv2_BOP20 (RGB-only & ICP)	2020 2019 2020	) No ) Yes ) No	Yes No	Dataset -	Default MaskRCNN (pbr)	~DeepIM ICP	RGB -	PBR only	RGB D	0.570 0.569 0.568	0.633 0.582 0.630	0.640 0.538 0.464	0.685 0.876 0.913	0.583 0.393 0.450	0.216 0.435 0.186	0.656 0.706 0.712	0.574 0.450 0.619	3.220 1.462
	CosyPose-ECCV20-PBR-1VIEW           Vidal-Sensors18           COPNv2_BOP20 (RGB-only & ICP)           COsyPose-ECCVPR10-Edges	2020 2019 2020 2019	) No ) Yes ) No ) Yes	Yes No Yes No	Dataset - Objec <b>RG</b> -	Default MaskRCNN (pbr) Besonly im	~DeepIM ICP	<sup>кдв</sup> - <b>es f</b> -	PBR only - UTC	RGB D TC RGB-D	0.570 0.569 0.568 0.550	0.633 0.582 0.630 0.515	0.640 0.538 0.464 0.500	0.685 0.876 0.913 0.851	0.583 0.393 0.450 0.368	0.216 0.435 0.186 0.570	0.656 0.706 0.712 0.671	0.574 0.450 0.619 0.375	3.220 1.462 87.568
	29         CosyPose-ECCV20-PBR-1VIEW           30         Vidal-Sensors18           31         CDPNv2_BOP20 (RGB-only & ICP)           32         Drost-CVPR10-Edges           33         CDPNv2_BOP20 (PBR-only & ICP)	2020 2019 2020 2019 2019	) No ) Yes ) No ) Yes ) No	Yes No Yes No Yes	Dataset - Objec <b>RG</b> - Object	Default MaskRCNN (pbr) - Besonly imp FCOS	~DeepIM ICP	RGB - <b>CS f</b> - RGB	PBR only PBR only	RGB D RGB-D RGB-D	0.570 0.569 0.568 0.550 0.534	0.633 0.582 0.630 0.515 0.630	0.640 0.538 0.464 0.500 0.435	0.685 0.876 0.913 0.851 0.791	0.583 0.393 0.450 0.368 0.450	0.216 0.435 0.186 0.570 0.186	0.656 0.706 0.712 0.671 0.712	0.574 0.450 0.619 0.375 0.532	3.220 1.462 87.568 1.491
	CosyPose-ECCV20-PBR-1VIEW           Vidal-Sensors18           I CDPNv2_BOP20 (RGB-only & ICP)           Drost-CVPR10-Edges           COPNv2_BOP20 (PBR-only & ICP)           COPNv2_BOP20 (RGB-only)	2020 2019 2020 2019 2019 2020 2020	No Yes No Yes Yes No No No	Yes No Yes No Yes Yes	Dataset - Object Object	Default MaskRCNN (pbr) - Beonly im FCOS FCOS	-DeepIM ICP ICP ICP	RGB - <b>PS f</b> RGB RGB	PBR only - - PBR only Synt+real	RGB D RGB-D RGB-D RGB	0.570 0.569 0.568 0.550 0.534 0.529	0.633 0.582 0.630 0.515 0.630 0.624	0.640 0.538 0.464 0.500 0.435 0.478	0.685 0.876 0.913 0.851 0.791 0.772	0.583 0.393 0.450 0.368 0.450 0.473	0.216 0.435 0.186 0.570 0.186 0.102	0.656 0.706 0.712 0.671 0.712 0.722	0.574 0.450 0.619 0.375 0.532 0.532	3.220 1.462 87.568 1.491 0.935
	CosyPose-ECCV20-PBR-1VIEW           Vidal-Sensors18           1 CDPNv2_BOP20 (RGB-only & ICP)           2 Drost-CVPR10-Edges           3 CDPNv2_BOP20 (PBR-only & ICP)           34 CDPNv2_BOP20 (RGB-only)           35 Drost-CVPR10-3D-Edges	2020 2019 2020 2019 2020 2020 2020 2020	<ul> <li>No</li> <li>Yes</li> <li>No</li> <li>Yes</li> <li>Yes</li> <li>No</li> <li>Yes</li> <li>No</li> <li>Yes</li> <li>Yes</li> </ul>	Yes No Yes No Yes No	Dataset - Object Object	Default MaskRCNN (pbr) - Beonly im FCOS FCOS	-DeepIM ICP ICP ICP	RGB - <b>PS f</b> RGB RGB	PBR only - - PBR only Synt+real	RGB D RGB-D RGB-D RGB	0.570 0.569 0.550 0.534 0.529 0.500	0.633 0.582 0.630 0.515 0.630 0.624 0.469	0.640 0.538 0.464 0.500 0.435 0.478 0.404	0.685 0.876 0.913 0.851 0.791 0.772 0.852	0.583 0.393 0.450 0.368 0.450 0.473 0.373	0.216 0.435 0.186 0.570 0.186 0.102 0.462	0.656 0.706 0.712 0.671 0.712 0.722 0.623	0.574 0.450 0.619 0.375 0.532 0.532 0.316	3.220 1.462 87.568 1.491 0.935 80.055
		2020 2019 2020 2019 2020 2020 2020 2020	<ul> <li>No</li> <li>Yes</li> <li>No</li> <li>Yes</li> <li>No</li> <li>No</li> <li>No</li> <li>Yes</li> <li>Yes</li> <li>Yes</li> </ul>	Yes No Yes No Yes No No	Dataset - Object Object - 2(	Default MaskRCNN (pbr) Besonly imp FCOS FCOS 20: 0.637	-DeepIM ICP ICP ICP - AR ((	RGB - RGB RGB - - OSY	PBR only - PBR only Synt+real	RGB D RGB-D RGB-D RGB	0.570 0.569 0.550 0.534 0.529 0.500 0.487	0.633 0.582 0.630 0.515 0.630 0.624 0.469 0.527	0.640 0.538 0.464 0.500 0.435 0.478 0.404 0.444	0.685 0.876 0.913 0.851 0.791 0.772 0.852 0.775	0.583 0.393 0.450 0.368 0.450 0.473 0.373 0.388	0.216 0.435 0.186 0.570 0.186 0.102 0.462 0.316	0.656 0.706 0.712 0.671 0.712 0.722 0.623 0.615	0.574 0.450 0.619 0.375 0.532 0.532 0.316 0.344	3.220 1.462 87.568 1.491 0.935 80.055 7.704
		2020 2019 2020 2019 2020 2020 2020 2019 2019	<ul> <li>No</li> <li>Yes</li> <li>No</li> <li>Yes</li> <li>No</li> <li>Yes</li> <li>No</li> <li>Yes</li> <li>Yes</li> <li>Yes</li> <li>No</li> </ul>	Yes No Yes Yes No No Yes	Dataset - Obje: R.G. - Object - 2( Object 2	Default MaskRCNN (pbr) - Beonly im FCOS FCOS	-DeepIM ICP ICP ICP - AR ((	RGB - RGB RGB - - OSY	PBR only - PBR only Synt+real	RGB D RGB-D RGB-D RGB	0.570 0.569 0.568 0.550 0.534 0.529 0.500 0.487 0.479	0.633 0.582 0.630 0.515 0.630 0.624 0.624 0.469 0.527 0.569	0.640 0.538 0.464 0.500 0.435 0.435 0.478 0.404 0.444 0.490	0.685 0.876 0.913 0.851 0.791 0.772 0.852 0.775 0.769	0.583 0.393 0.450 0.368 0.450 0.473 0.373 0.388 0.327	0.216 0.435 0.186 0.570 0.186 0.102 0.462 0.316 0.067	0.656 0.706 0.712 0.671 0.712 0.722 0.623 0.615 0.672	0.574 0.450 0.619 0.375 0.532 0.532 0.316 0.344 0.457	3.220 1.462 87.568 1.491 0.935 80.055 7.704 0.480
	CosyPose-ECCV20-PBR-1VIEW           30         Vidal-Sensors18           31         CDPNv2_BOP20 (RGB-only & ICP)           32         Drost-CVPR10-Edges           33         CDPNv2_BOP20 (PBR-only & ICP)           34         CDPNv2_BOP20 (PBR-only & ICP)           35         Drost-CVPR10-3D-Edges           36         Drost-CVPR10-3D-Only           37         CDPNv2_BOP19 (RGB-only)           38         CDPNv2_BOP20 (PBR-only & RGB-only)	2020 2019 2020 2019 2020 2020 2020 2019 2019	<ul> <li>No</li> <li>Yes</li> <li>No</li> <li>Yes</li> <li>No</li> <li>Yes</li> <li>No</li> <li>Yes</li> <li>No</li> <li>Yes</li> <li>Yes</li> <li>Yes</li> <li>Yes</li> <li>No</li> <li>No</li> <li>No</li> <li>No</li> </ul>	Yes No Yes Yes Yes No No Yes Yes	Dataset - Objer R.G - Object - Object - Object 2 Object 2	Default MaskRCNN (pbr) - Besonly imp FCOS - - - - - - - - - - - - -	-DeepIM ICP ICP ICP - AR ((	RGB - RGB RGB COS COS COS	PBR only - PBR only Synt+real PBR only PBR only	RGB D RGB-D RGB-D RGB C C C C C C C C C C C C C C C C C C C	0.570 0.569 0.550 0.534 0.529 0.500 0.487 0.479 0.472	0.633 0.582 0.630 0.515 0.630 0.624 0.469 0.527 0.569 0.624	0.640 0.538 0.464 0.500 0.435 0.478 0.404 0.404 0.444 0.490 0.407	0.685 0.876 0.913 0.851 0.791 0.772 0.852 0.775 0.769 0.588	0.583 0.393 0.450 0.368 0.450 0.473 0.373 0.388 0.327 0.473	0.216 0.435 0.186 0.570 0.186 0.102 0.462 0.316 0.067 0.102	0.656 0.706 0.712 0.671 0.712 0.722 0.623 0.615 0.672 0.722	0.574 0.450 0.619 0.375 0.532 0.532 0.316 0.344 0.457 0.390	3.220 1.462 87.568 1.491 0.935 80.055 7.704 0.480 0.978
		2020 2019 2020 2019 2020 2020 2019 2019	<ul> <li>No</li> <li>Yes</li> <li>No</li> <li>Yes</li> <li>No</li> <li>Yes</li> <li>No</li> <li>Yes</li> <li>Yo</li> <li>No</li> <li>Yes</li> <li>Yes</li> <li>No</li> <li>No</li> <li>No</li> <li>No</li> <li>No</li> <li>No</li> <li>No</li> <li>No</li> </ul>	Yes No Yes Yes Yes No No Yes Yes	Dataset - Objer R.G. - Object - Object - Object - Object Cbject - Object	Default MaskRCNN (pbr) Besonly imp FCOS FCOS 20: 0.637	-DeepIM ICP ICP ICP - AR ((	RGB RGB COSY RGB RGB RGB	PBR only - UITT PBR only Synt+real PBR only Synt+real	RGB D RGB-D RGB-D RGB D D RGB RGD RGB	0.570 0.569 0.568 0.550 0.534 0.529 0.500 0.487 0.479 0.472 0.471	0.633 0.582 0.630 0.515 0.630 0.624 0.469 0.527 0.569 0.624 0.525	0.640 0.538 0.464 0.500 0.435 0.478 0.404 0.404 0.404 0.400 0.407 0.403	0.685 0.876 0.913 0.851 0.791 0.852 0.775 0.769 0.588 0.751	0.583 0.393 0.450 0.368 0.450 0.473 0.373 0.388 0.327 0.327 0.473 0.342	0.216 0.435 0.186 0.570 0.186 0.102 0.462 0.316 0.067 0.102 0.077	0.656 0.706 0.712 0.671 0.712 0.722 0.623 0.615 0.672 0.722 0.722	0.574 0.450 0.619 0.375 0.532 0.532 0.316 0.344 0.457 0.390 0.543	3.220 1.462 87.568 1.491 0.935 80.055 7.704 0.480 0.978 0.425
		2020 2019 2020 2020 2020 2020 2020 2020	No           No           Yes           No           Yes           No           Yes	Yes No Yes Yes Yes No No Yes Yes Yes	Dataset - Object R.G. - Object - - Object 2 Object Object Object Dataset	Default MaskRCNN (pbr) - Besonly imp FCOS - - - - - - - - - - - - -	-DeepIM ICP ICP ICP - AR(( - - - -	RGB - RGB RGB COS COS COS	PBR only - UTT PBR only Synt+real PBR only PBR only Synt+real PBR only	RGB D RGB-D RGB D RGB RGB RGB RGB	0.570 0.569 0.568 0.550 0.534 0.529 0.500 0.487 0.479 0.472 0.471 0.457	0.633 0.582 0.630 0.515 0.630 0.624 0.469 0.527 0.569 0.624 0.525 0.525	0.640 0.538 0.464 0.500 0.435 0.478 0.404 0.404 0.444 0.490 0.407 0.403 0.467	0.685 0.876 0.913 0.851 0.791 0.772 0.852 0.775 0.769 0.588 0.751 0.558	0.583 0.393 0.450 0.368 0.450 0.473 0.373 0.388 0.327 0.473 0.342 0.342 0.363	0.216 0.435 0.186 0.570 0.186 0.102 0.462 0.316 0.067 0.102 0.077 0.102	0.656 0.706 0.712 0.671 0.712 0.722 0.623 0.615 0.672 0.622 0.722 0.658 0.580	0.574 0.450 0.619 0.375 0.532 0.532 0.316 0.344 0.457 0.390 0.543 0.543	3.220 1.462 87.568 1.491 0.935 7.704 0.480 0.978 0.425 1.874
		2020 2019 2020 2020 2020 2020 2020 2020	No           No           Yes           No           Yes           No           Yes           No           Yes           No           Yes           No           Yes	Yes No Yes No Yes No Yes Yes Yes No	Dataset - Objer R.G. - Object - Object Object Object Object Dataset -	Default MaskRCNN (pbr) - Boonly imp FCOS 20: 0.637 0.728 PCOS 22: 0.728 - -	-DeepIM ICP ICP ICP - AR ICP - AR ( - - - - - - - - - - - - - - - - - -	RGB RGB COSY RGB RGB RGB RGB RGB	PBR only - PBR only Synt+real PBR only PBR only Synt+real PBR only -	RGB D RGB-D RGB-D RGB D RGB RGB RGB D	0.570 0.569 0.568 0.550 0.534 0.529 0.500 0.487 0.479 0.472 0.471 0.457 0.454	0.633 0.582 0.630 0.515 0.630 0.624 0.469 0.527 0.569 0.624 0.525 0.547 0.547	0.640 0.538 0.464 0.500 0.435 0.478 0.404 0.404 0.444 0.490 0.407 0.403 0.467 0.405	0.685 0.876 0.913 0.851 0.791 0.772 0.852 0.775 0.769 0.588 0.751 0.558 0.696	0.583 0.393 0.450 0.368 0.473 0.373 0.388 0.327 0.473 0.342 0.363 0.377	0.216 0.435 0.186 0.570 0.186 0.102 0.462 0.316 0.067 0.102 0.077 0.186 0.274	0.656 0.706 0.712 0.671 0.712 0.722 0.623 0.615 0.672 0.722 0.658 0.580 0.580	0.574 0.450 0.619 0.375 0.532 0.532 0.316 0.344 0.457 0.390 0.543 0.499 0.330	3.220 1.462 87.568 1.491 0.935 80.055 7.704 0.480 0.978 0.425 1.874 1.383
		2020           2019           2020           2019           2020           2019           2020           2019           2020           2019           2020           2019           2019           2019           2019           2020           2019	0         No           0         Yes           0         No           0         Yes           0         No           0         No           0         Yes           0         No           0         Yes           0         Yes           0         Yes           0         No           0         Yes           0         Yes	Yes No Yes No Yes No Yes Yes Yes No Yes	Dataset - Objer R.G. - Object - Object Object Object Object Dataset - Dataset	Default MaskRCNN (pbr) - Boonly imp FCOS FCOS 20: 0.637 022: 0.728 ??? - - MaskRCNN	-DeepIM ICP ICP ICP - AR (CP - - - - - - - - - - - - - - - - - - -	RGB RGB RGB RGB RGB RGB RGB RGB RGB RGB- RGB-	PBR only - UTT PBR only Synt+real PBR only Synt+real PBR only - Synt+real	RGB D RGB-D RGB-D RGB D RGB RGB RGB D RGB-D	0.570 0.569 0.568 0.550 0.534 0.529 0.500 0.487 0.479 0.472 0.471 0.457 0.454 0.412	0.633 0.582 0.630 0.515 0.630 0.624 0.469 0.527 0.569 0.624 0.525 0.547 0.492 0.394	0.640 0.538 0.464 0.500 0.435 0.478 0.404 0.404 0.404 0.400 0.407 0.403 0.467 0.405 0.212	0.685 0.876 0.913 0.851 0.791 0.772 0.852 0.775 0.769 0.588 0.751 0.558 0.696 0.851	0.583 0.393 0.450 0.368 0.473 0.373 0.388 0.327 0.473 0.342 0.363 0.377 0.323	0.216 0.435 0.186 0.570 0.186 0.462 0.462 0.316 0.067 0.102 0.077 0.186 0.274 0.069	0.656 0.706 0.712 0.671 0.712 0.722 0.623 0.615 0.672 0.722 0.658 0.580 0.603 0.603 0.529	0.574 0.450 0.619 0.375 0.532 0.532 0.316 0.344 0.457 0.390 0.543 0.499 0.330 0.510	3.220 1.462 87.568 1.491 0.935 80.055 7.704 0.480 0.978 0.425 1.874 1.383 55.780
		20200 2019 2020 2020 2020 2020 2020 2020	D         No           0         Yes           0         Yes           0         Yes           0         Yes           0         Yes           0         No           0         Yes           0         Yes           0         Yes           0         Yes           0         No           0         Yes           0         No	Yes No Yes No Yes No Yes Yes Yes No Yes Yes	Dataset - Objee R G Object Object - Object Object Object Object Dataset - Dataset Object Object	Default MaskRCNN (pbr) - Boonly imp FCOS FCOS 20: 0.637 022: 0.728 PCOS ??? - - MaskRCNN RetinaNet	-DeepIM ICP ICP ICP - AR ICP - AR ( - - - - - - - - - - - - - - - - - -	RGB RGB COSY RGB RGB RGB RGB RGB	PBR only PBR only Synt+real PBR only PBR only Synt+real PBR only Synt+real Synt+real Synt+real	RGB RGB-D RGB-D RGB-D RGB D RGB RGB RGB D RGB-D RGB-D RGB-D	0.570 0.569 0.568 0.550 0.534 0.529 0.500 0.487 0.479 0.472 0.471 0.457 0.454	0.633 0.582 0.630 0.515 0.630 0.624 0.469 0.527 0.569 0.624 0.525 0.547 0.492 0.394 0.237	0.640 0.538 0.464 0.500 0.435 0.478 0.404 0.404 0.444 0.490 0.407 0.403 0.467 0.405	0.685 0.876 0.913 0.851 0.791 0.772 0.852 0.775 0.769 0.588 0.751 0.558 0.696	0.583 0.393 0.450 0.368 0.473 0.373 0.388 0.327 0.473 0.342 0.363 0.377 0.323 0.323	0.216 0.435 0.186 0.570 0.186 0.102 0.462 0.316 0.067 0.102 0.077 0.186 0.274	0.656 0.706 0.712 0.671 0.712 0.722 0.623 0.615 0.672 0.722 0.658 0.580 0.580	0.574 0.450 0.619 0.375 0.532 0.532 0.316 0.344 0.457 0.390 0.543 0.499 0.330 0.510 0.505	3.220 1.462 87.568 1.491 0.935 80.055 7.704 0.480 0.978 0.425 1.874 1.383
		20200 2019 2020 2019 2020 2020 2020 2020	D         No           0         No           0         Yes           0         Yes           0         Yes           0         Yes           0         No           0         Yes           0         Yes           0         Yes           0         Yes           0         Yes           0         No           0         No           0         No           0         No           0         Yes           0         No           0         Yes           0         No           0         Yes           0         No           0         No           0         No	Yes No Yes No Yes No No Yes Yes Yes Yes Yes Yes	Dataset - Objee R G - Object Object - Object Object Object Dataset - Dataset Object Ob	Default MaskRCNN (pbr) - Boonly imp FCOS FCOS 20: 0.637 022: 0.728 ??? - - MaskRCNN	-DeepIM ICP ICP ICP - AR (CP - - - - - - - - - - - - - - - - - - -	RGB RGB RGB COSY RGB RGB RGB RGB RGB RGB- RGB-D RGB	PBR only PBR only Synt+real PBR only PBR only Synt+real PBR only Synt+real Synt+real Synt+real Synt+real	RGB RGB-D RGB-D RGB-D RGB D RGB RGB RGB RGB-D RGB-D RGB-D RGB	0.570 0.569 0.568 0.550 0.534 0.529 0.500 0.487 0.479 0.472 0.471 0.457 0.454 0.412 0.398	0.633 0.582 0.630 0.515 0.630 0.624 0.469 0.527 0.569 0.624 0.525 0.547 0.492 0.394	0.640 0.538 0.464 0.500 0.435 0.478 0.404 0.404 0.404 0.400 0.407 0.403 0.467 0.405 0.212 0.487	0.685 0.876 0.913 0.851 0.791 0.772 0.852 0.775 0.769 0.588 0.751 0.558 0.696 0.851 0.614	0.583 0.393 0.450 0.368 0.473 0.373 0.388 0.327 0.473 0.342 0.363 0.377 0.323	0.216 0.435 0.186 0.570 0.186 0.102 0.462 0.316 0.067 0.102 0.077 0.186 0.274 0.699 0.158	0.656 0.706 0.712 0.671 0.712 0.623 0.615 0.672 0.722 0.658 0.580 0.603 0.529 0.506	0.574 0.450 0.619 0.375 0.532 0.532 0.316 0.344 0.457 0.390 0.543 0.543 0.505 0.505 0.422	3.220 1.462 87.568 1.491 0.935 7.704 0.480 0.978 0.425 1.874 1.383 55.780 0.865
		2020 2019 2020 2019 2020 2019 2020 2020	D         No           0         No           0         Yes           0         Yes           0         Yes           0         Yes           0         No           0         Yes           0         Yes           0         Yes           0         Yes           0         Yes           0         No           0         No           0         No           0         No           0         Yes           0         No           0         Yes           0         No           0         Yes           0         No           0         No           0         No	Yes           No           Yes           No           Yes	Dataset - Objee R G Object Object - Object Object Object Object Dataset - Dataset Object Object	Default MaskRCNN (pbr) - Boonly imp FCOS FCOS 20: 0.637 022: 0.728 PCOS ??? - - MaskRCNN RetinaNet	-DeepIM ICP ICP ICP - AR (C - - - - - - - - - - - - - - - - - -	RGB RGB RGB COSY RGB RGB RGB RGB RGB RGB RGB RGB	PBR only PBR only Synt+real PBR only PBR only Synt+real PBR only Synt+real Synt+real Synt+real Synt+real	RGB RGB-D RGB-D RGB-D RGB C P C C C C C C C C C C C C C C C C C	0.570 0.569 0.568 0.550 0.534 0.529 0.500 0.487 0.479 0.472 0.471 0.457 0.454 0.412 0.398 0.353	0.633 0.582 0.630 0.515 0.630 0.624 0.469 0.527 0.569 0.624 0.525 0.547 0.492 0.394 0.237 0.374	0.640 0.538 0.464 0.500 0.435 0.478 0.404 0.404 0.404 0.400 0.407 0.403 0.467 0.405 0.212 0.487 0.124	0.685 0.876 0.913 0.851 0.791 0.772 0.852 0.775 0.769 0.588 0.751 0.558 0.696 0.851 0.614 0.757	0.583 0.393 0.450 0.368 0.473 0.373 0.388 0.327 0.473 0.342 0.363 0.377 0.323 0.281 0.257	0.216 0.435 0.186 0.570 0.186 0.102 0.462 0.316 0.067 0.102 0.077 0.186 0.274 0.699 0.158 0.070	0.656 0.706 0.712 0.671 0.712 0.623 0.623 0.615 0.672 0.722 0.658 0.580 0.603 0.529 0.506 0.506 0.470	0.574 0.450 0.619 0.375 0.532 0.532 0.316 0.344 0.457 0.390 0.543 0.499 0.330 0.510 0.505	3.220 1.462 87.568 1.491 0.935 7.704 0.480 0.978 0.425 1.874 1.383 55.780 0.865
		2020 2019 2020 2019 2020 2019 2020 2020	D         No           2         No           2         No           3         No           4         No           5         No           6         Yes           7         No           7         Yes           7         No           7         Yes           7         No           7         No           7         No           7         No           7         No           7         No           8         No           9         No           9         No	Yes           No           Yes           No           Yes	Dataset - Object Object - Object - Object Object Object Dataset - Dataset Object Objec	Default MaskRCNN (pbr) - Boonly imp FCOS FCOS D20: 0.637 D20: 0.728 PCOS ??? MaskRCNN RetinaNet RetinaNet RetinaNet - MaskRCNN	-DeepIM ICP ICP ICP - AR (C - - - - - - - - - - - - - - - - - -	RGB RGB RGB RGB RGB RGB RGB RGB RGB RGB	PBR only - PBR only Synt+real PBR only PBR only Synt+real PBR only - Synt+real Synt+real Synt+real PBR only PBR o	RGB RGB-D RGB-D RGB RGB RGB RGB RGB RGB-D RGB-D RGB-D RGB-D RGB-D RGB-D RGB-D	0.570 0.569 0.568 0.550 0.534 0.529 0.500 0.487 0.479 0.472 0.471 0.457 0.454 0.412 0.398 0.353 0.351 0.342	0.633 0.582 0.630 0.515 0.630 0.624 0.527 0.569 0.624 0.525 0.547 0.492 0.394 0.237 0.374 0.653 0.363	0.640 0.538 0.464 0.500 0.435 0.478 0.404 0.404 0.404 0.400 0.407 0.403 0.407 0.212 0.487 0.212 0.487 0.124 0.004 0.344	0.685 0.876 0.913 0.851 0.772 0.852 0.775 0.769 0.588 0.751 0.558 0.696 0.851 0.614 0.614 0.757 0.673 0.673	0.583 0.393 0.450 0.368 0.473 0.373 0.388 0.327 0.473 0.342 0.363 0.377 0.323 0.281 0.264 0.226	0.216 0.435 0.186 0.570 0.186 0.102 0.462 0.316 0.067 0.102 0.077 0.186 0.274 0.699 0.158 0.070 0.001	0.656 0.706 0.712 0.671 0.712 0.623 0.615 0.672 0.722 0.658 0.603 0.603 0.529 0.506 0.470 0.556 0.446	0.574 0.450 0.619 0.375 0.532 0.532 0.316 0.344 0.457 0.390 0.543 0.543 0.505 0.505 0.422 0.308 0.457	3.220 1.462 87.568 1.491 0.935 7.704 0.480 0.978 0.425 1.874 1.383 55.780 0.865 0.513 -
		20200 2019 20200 20200 20200 20200 20200 20200 20200 20200 20200 2019 2019	No           Ves           Ves      <	Yes           No           Yes           No           Yes           Yes	Dataset - Object Object - Object Object Object Dataset - Dataset Object	Default MaskRCNN (pbr) - Boonly imp FCOS FCOS 20: 0.637 020: 0.728 PCOS 2: 0.728 - - MaskRCNN RetinaNet RetinaNet -	-DeepIM ICP ICP ICP - AR (C - - - - - - - - - - - - - - - - - -	RGB RGB RGB COSY RGB RGB RGB RGB RGB RGB RGB RGB RGB RGB	PBR only PBR only Synt+real PBR only PBR only Synt+real PBR only Synt+real Synt+real Synt+real Synt+real PBR only	RGB RGB-D RGB-D RGB RGB RGB RGB RGB RGB-D RGB-D RGB-D RGB-D RGB-D RGB-D RGB-D RGB-D RGB-D RGB-D	0.570 0.569 0.568 0.550 0.534 0.529 0.500 0.487 0.479 0.472 0.471 0.457 0.454 0.412 0.398 0.353 0.351	0.633 0.582 0.630 0.515 0.630 0.624 0.469 0.527 0.569 0.624 0.525 0.547 0.492 0.394 0.237 0.374 0.653	0.640 0.538 0.464 0.500 0.435 0.478 0.404 0.404 0.404 0.400 0.407 0.403 0.407 0.212 0.487 0.212 0.487 0.124 0.004 0.344	0.685 0.876 0.913 0.851 0.791 0.772 0.852 0.775 0.769 0.588 0.751 0.558 0.696 0.851 0.614 0.614 0.757 0.673	0.583 0.393 0.450 0.368 0.473 0.373 0.388 0.327 0.473 0.342 0.363 0.377 0.323 0.281 0.267 0.264	0.216 0.435 0.186 0.570 0.186 0.102 0.462 0.316 0.067 0.102 0.077 0.186 0.274 0.699 0.158 0.070 0.001 0.001	0.656 0.706 0.712 0.671 0.712 0.623 0.615 0.672 0.722 0.658 0.580 0.603 0.529 0.506 0.470 0.556	0.574 0.450 0.619 0.375 0.532 0.532 0.316 0.344 0.457 0.390 0.543 0.543 0.543 0.505 0.505 0.422 0.308	3.220 1.462 87.568 1.491 0.935 7.704 0.480 0.978 0.425 1.874 1.383 55.780 0.865 0.513 - 1.215

#	Method	Year PPF	DNNmodels per	Det./seg.	Refine.	Train. im.	type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
5 🛛	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
í I	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
5	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
1	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	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
į 🛛	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
2	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
<u>ا</u> د	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
51	0 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
2	1 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
	2 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	-
2	3 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
. 1	4 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
į	5 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
	6 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	-
í I	7 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
ا ر	8 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
0	9 CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020 No	Yes Dataset	Default MaskRCNN (synt+real)	~DeepIM+ICF	RGB	PBR+real	RGB-D	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
. 2	ZebraPoseSAT-EffnetB4 (PBR_Only)	2022 No	Yes Object	FCOS	(2)	RGB	PBR only	RGB	0.670	0.721	0.723	0.717	0.545	0.410	0.882	0.691	-
2 🛛	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	-
3 4	2 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
2	3 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
) <u> </u>	4 Koenig-Hybrid-DL-PointPairs	2020 Yes		RetinaMask/MaskRCNN	ICP	RGB	Synt+real		0.639	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
- 1	5 CosyPose-ECCV20-SYNT+REAL-1VIEW	2020 No	Yes Parset	Default laskRCNN (synt+red)	DeepIM	fro	PBR+re			0.633	0.728	0.823	0.583	0.216	0.656	0.821	0.449
2 🛛	6 CRT-6D	2022 No								0.660	0.644	0.789	0.537	0.208	0.603	0.752	0.059
נ	7 Pix2Pose-BOP20_w/ICP-ICCV19	102 つう つ		thods were	liciloar	rnin	PBR+real			$n^{0.58}$	RGE	2 \ <sup>.820</sup>	0.390	0.351	0.695	0.780	4.844
2	8 ZTE_PPF			Gafd MMR NN(Yr Clar)			SRUI					J.904	0.396	0.470	0.735	0.502	0.901
2	9 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
~	0 Vidal-Sensors18	2019 Yes		-	ICP	-	-	D	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
3	1 CDPNv2_BOP20 (RGB-only & ICP)	2020 No	Yes Object	FCOS	ICP	RGB	Synt+real		0.568	0.630	0.464	0.913	0.450	0.186	0.712	0.619	1.462
	2 Drost-CVPR10-Edges	2019 Yes		-	ICP	-	•	RGB-D	0.550	0.515	0.500	0.851	0.368	0.570	0.671	0.375	87.568
- 6	3 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
3		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
- 11	5 Drost-CVPR10-3D-Edges	2019 Yes		•	ICP	-	-	D	0.500	0.469	0.404	0.852	0.373	0.462	0.623	0.316	80.055
	6 Drost-CVPR10-3D-Only	2019 Yes		-	ICP	-	-	D	0.487	0.527	0.444	0.775	0.388	0.316	0.615	0.344	7.704
3	7 CDPN_BOP19 (RGB-only)	2020 No	Yes Object	RetinaNet	-	RGB	Synt+real		0.479	0.569	0.490	0.769	0.327	0.067	0.672	0.457	0.480
	8 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
	9 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
	0 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
- 12	1 Drost-CVPR10-3D-Only-Faster	2019 Yes	Yes Dataset	- MaskRCNN	ICP ICP	-	-	D	0.454			0.696		0.274	0.603		
- 6	2 Félix&Neves-ICRA2017-IET2019				ICP	RGB-D	Synt+real		0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
	3 Sundermeyer-IJCV19+ICP		Yes Object Yes Object	RetinaNet		RGB	Synt+real		0.398	0.237	0.487 0.124	0.614	0.281	0.158	0.506	0.505	0.865
- 12	Zhigang-CDPN-ICCV19     PointVoteNet2	2019 No 2020 No		RetinaNet	- ICP	RGB RGB-D	Synt+real		0.353 0.351	0.374	0.124	0.757	0.257 0.264	0.070	0.470 0.556	0.422	0.513
- 12	6 Pix2Pose-BOP20-ICCV19		Yes Object Yes Object	- MaskRCNN		RGB-D	PBR only PBR+real		0.351	0.853	0.004	0.673	0.264	0.001	0.556	0.308	1 215
									0.342		0.344			0.134	0.446		1.215 0.196
	SingleMultiPathEncoder-CVPR20	2021 No 2020 No	Yes Object Yes All datasets	RetinaNet MaskRCNN		RGB RGB	Synt+real Synt+real		0.280	0.146	0.304	0.401	0.217 0.175	0.067	0.346	0.446	0.196
	9 DPOD (synthetic)		Yes Scene		-	RGB	Synt+real Synt	RGB	0.241	0.217	0.310	0.334		0.007	0.293	0.289	0.186
11	J Dr OD (synthetic)	2019 140	Tes Scene		-	ROB	Synt	ROB	0.101	0.109	0.001	0.242	0.130	0.000	0.200	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
5 [	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
5 L	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
ק	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
<u>'</u>	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	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
ן ג	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
2	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
ا ب	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
5 I	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
5 L	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 -	-
3	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
. I	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
1	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
5	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 -	-
í I	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
υĿ	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
0	19	CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020	No	Yes	Dataset	Default MaskRCNN (synt+real)	~DeepIM+ICF	RGB	PBR+real	RGB-D	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
E L	20	ZebraPoseSAT-EffnetB4 (PBR_Only)	2022	No	Yes	Object	FCOS	20	RGB	PBR only	RGB	0.670	0.721	0.723	0.717	0.545	0.410	0.882	0.691 -	-
Ľ	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 -	2
5	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
Ę	23	SurfEmb-PBR-RGB	2021	No	Yes		Default MaskRCNN (synt+real)		RGB	PBR only		0.650	0.663	0.735	0.715	0.588	0.413	0.791	0.647	8.891
ן י	24	Koenig-Hybrid-DL-PointPairs	2020	Yes	Yes	-GDR	NPP dom	inate	es B		20	20/39	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
2	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
ן ב	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
- 11		Drost-CVPR10-Edges	2019		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		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
- 8		CDPNv2_BOP20 (RGB-only)	2020		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
		Drost-CVPR10-3D-Edges	2019		No	-	-	ICP	-	-	D	0.500	0.469	0.404	0.852	0.373	0.462	0.623	0.316	80.055
		Drost-CVPR10-3D-Only	2019		No	-	-	ICP	-	-	D	0.487	0.527	0.444	0.775	0.388	0.316	0.615	0.344	7.704
- 8		CDPN_BOP19 (RGB-only)	2020		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
- 8		CDPNv2_BOP20 (PBR-only & RGB-only)	2020		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
		eaping from 2D to 6D	2020		Yes	Object	???	-2	RGB	Synt+real	RGB	0.471	0.525	0.403	0.751	0.342	0.077	0.658	0.543	0.425
- 8		EPOS-BOP20-PBR	100000000	No		Dataset	•	-	RGB	PBR only	RGB	0.457	0.547	0.467	0.558	0.363	0.186	0.580	0.499	1.874
- 8		Drost-CVPR10-3D-Only-Faster		Yes		-	-	ICP	-		D	0.454	0.492		0.696		0.274	0.603	0.330	1.383
- 8		Félix&Neves-ICRA2017-IET2019				Dataset	MaskRCNN	ICP	RGB-D	Synt+real		0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	55.780
		Sundermeyer-IJCV19+ICP				Object	RetinaNet	ICP	RGB	Synt+real		0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
		Zhigang-CDPN-ICCV19				Object	RetinaNet	-	RGB	Synt+real		0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
- 8		PointVoteNet2				Object	-	ICP	RGB-D	PBR only		0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308 -	-
		Pix2Pose-BOP20-ICCV19	2			Object	MaskRCNN	-	RGB	PBR+real		0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
		Sundermeyer-IJCV19		No		Object	RetinaNet	-	RGB	Synt+real		0.280	0.146	0.304	0.401	0.217	0.101	0.346	0.446	0.196
		SingleMultiPathEncoder-CVPR20		No		All datasets	MaskRCNN	-	RGB	Synt+real		0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
1	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	modele per	Det./seg.	Refine.	Train. im.	type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	HB	YCB-V	Time
5 [	1 GDRNPP-PBRReal-RGBD-MModel	2022	No	Yes	Object	OLOX	~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
i I	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
5	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	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
į I	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
2	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
51	0 SurfEmb-PBR-RGBD	2021	No	Yes	Detect	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
2	11 GDRNPP-PBRReal-RGBD-SModel	2022	No	Yes	Dataset	OLOX	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
	2 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	-
, I	3 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
: E	I4 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
į į	I5 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
Į I	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	-
íľ	17 RADet+PFA-MixPBR-RGB	2022	No	R	aso	ns for usin	gnt	her	Ime	th	ods	7.745	0.778	0.839	0.600	0.353	0.841	0.806	3.019
	8 GDRNPP-PBR-RGB-MModel	2022	No	Yes	Object	YOLOX	500	RGB	PBR only	RGB	0.702	0.713	0.796	0.752	0.623	0.448	0.869	0.713	0.284
٥	9 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	1	RGB	PBR only	RGB	0.670	0.721	0.723	0.717	0.545	0.410	0.882	0.691	1
2	PFA-cosypose G	2)2	2Λ	P	Patron	entries tra	in a	net	MO		ner	<b>o</b> h	vier	1.837	0.596	0.246	0.712	0.807	÷
5	22 RADet+PFA-PBR-RGB	2022	No 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	M	n	re≈inf	erenceme	mor	v®ar	no otr	rair	nime	s ctaiar	ne	0.715	0.588	0.413	0.791	0.647	8.891
)	24 Koenig-Hybrid-DL-PointPairs	2020	Yes	Yes	Dataset	erencesyme RetinaMask/MaskRCNN			Synt+real	RGB-D	0.63	0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
- 1	25 CosyPose-ECCV20-SYNT+REAL-1VIEW	2020		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
ונ	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	4	-	ICP	1	4	D	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
	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
	GDPNv2_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
	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
	CDPNv2_BOP20 (PBR-only & RGB-only)	2020	No	Yes	Object	FCOS	ī	RGB	PBR only	RGB	0.472	0.624	0.407	0.588	0.473	0.102	0.722	0.390	0.978
	<b>39</b> leaping from 2D to 6D	2020	No	Yes	Object	???	1	RGB	Synt+real	RGB	0.471	0.525	0.403	0.751	0.342	0.077	0.658	0.543	0.425
-	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
-	1 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
-	3 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	-
1	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
	18 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
4	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
u o	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
Ę	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
at	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
N	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
ali	5	RADet+PFA-MixPBR-RGBD	2022		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
U	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
<u> </u>	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
L L	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
ect	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	Datasat	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
qo	11	GDRNPP-PBRReal-RGBD-SModel	2022	No	Yes	Dataset	OLOX	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		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
9	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
N	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
6	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	-
15	17	RADet+PFA-MixPBR-RGB	2022	No	R	easo	ns <sup>d</sup> for usir	o nt	her	me	th	ods	<b>?</b> .745	0.778	0.839	0.600	0.353	0.841	0.806	3.019
b l	18	GDRNPP-PBR-RGB-MModel	2022	No	Yes	Object	YOLOX	500	RGB	PBR only	RGB	0.702	0.713	0.796	0.752	0.623	0.448	0.869	0.713	0.284
<b>60</b>	19	CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020	No	Yes	Dataset	Default MaskRCNN (synt+real)	~DeepIM+ICF	RGB	PBR+real	RGB-D	0.698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
en	20	ZebraPoseSAT-EffnetB4 (PBR_Only)	2022	No	Yes	Object	FCOS	21	RGB	PBR only	RGB	0.670	0.721	0.723	0.717	0.545	0.410	0.882	0.691	4
l≡∣	21	PFA-cosypose	2)2	AS	P	P≊ton	entries tra	in a	net	WO	rk I	ner	ob	ojec	- 1.837	0.596	0.246	0.712	0.807	Ξ
a	22	RADet+PFA-PBR-RGB	2022	No No											0.732	0.600	0.353	0.841	0.648	3.497
ב	23	SurfEmb-PBR-RGB	2021	L'm	ήO	re∞inf		mor	l∕rar	no oti	rair	hing	o thir	ne	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	0.63	D 0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
<b>P</b>	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
0 0	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
ן מ	27	Pix2Pose-BOP20_w/ICP-ICCV19	2120	)@1	Yes	PFA >	™®®DRNPP \	when	⊦tra	PBR+real	g⊧p	er	dat	tase	1.820	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	@B-[`		- 0.663	0.374	0.904	0.396	0.470	0.735	0.502	0.901
	29	CosyPose-ECCV20-PBR-1VIEW	2020		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		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		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
		Drost-CVPR10-Edges	2019		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		Yes		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		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
	30	Drost-CVPR10-3D-Edges	2019		No		-	ICP	-	-	D	0.500	0.469	0.404	0.852	0.373	0.462	0.623	0.316	80.055
	30	Drost-CVPR10-3D-Only	2019		No	Object	PotinaNat	ICP	- RGB	Sunttroot	-	0.487	0.527	0.444	0.775	0.388	0.316	0.615	0.344	7.704 0.480
	38	CDPN_BOP19 (RGB-only) CDPNv2 BOP20 (PBR-only & RGB-only)	2020		Yes	Object Object	RetinaNet FCOS	-	RGB	Synt+real PBR only	RGB	0.479	0.624	0.490	0.588	0.327	0.007	0.872	0.457	0.480
	30	leaping from 2D to 6D	2020		Yes Yes	Object	???	-	RGB	Synt+real	RGB	0.472	0.624	0.407	0.566	0.342	0.102	0.658	0.543	0.425
	40	EPOS-BOP20-PBR	2020			Dataset	-		RGB	PBR only	RGB	0.457	0.525	0.467	0.558	0.363	0.186	0.580	0.499	1.874
	41	Drost-CVPR10-3D-Only-Faster		Yes			-	ICP	-	-	D	0.454		0.407	0.696			0.603		
		Félix&Neves-ICRA2017-IET2019				Dataset	MaskRCNN	ICP	RGB-D	Synt+real		0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	
	_	Sundermeyer-IJCV19+ICP				Object	RetinaNet	ICP	RGB	Synt+real		0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
		Zhigang-CDPN-ICCV19				Object	RetinaNet	-	RGB	Synt+real		0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
	_	PointVoteNet2				Object	-	ICP	RGB-D	PBR only		0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
		Pix2Pose-BOP20-ICCV19				Object	MaskRCNN	-	RGB	PBR+real		0.342	0.363	0.344	0.420		0.134	0.446	0.457	1.215
		Sundermeyer-IJCV19				Object	RetinaNet	-	RGB	Synt+real		0.280	0.146	0.304	0.401	0.217	0.101	0.346	0.446	
								-									0.067			0.186
		DPOD (synthetic)				Scene	-	-:	RGB	Synt	RGB	0.161	0.169	0.081	0.242			0.286	0.222	
		SingleMultiPathEncoder-CVPR20 DPOD (synthetic)				All datasets Scene	MaskRCNN -	-	RGB RGB	Synt+real Synt		0.241 0.161	0.217 0.169	0.310 0.081	0.334 0.242	0.175 0.130		0.293 0.286	0.289 0.222	

#	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

#	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
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- 3. Pose refinement
- Therefore, BOP 2022:
- Measures COCO metrics (AP) of detection / segmentation

#	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

## Therefore, BOP 2022:

- Measures COCO metrics (AP) of detection / segmentation
- Provides the best detections from BOP 2020 (CosyPose)

#	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
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## Therefore, BOP 2022:

- Measures COCO metrics (AP) of detection / segmentation
- Provides the best detections from BOP 2020 (CosyPose)

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

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	# Method	Year	PPF	DNN	models per	Det./seg.	Refine.	Train. im.	type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD I	НB	YCB-V	Time
22	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
20	3 GDRNPP-PBRReal-RGBD-MModel-Fast	2022	No	Yes	Object	VOLOX	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
Ð	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
50	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
en	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
allo	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
la		2022	No	Yes	Object	Default MaskRCNN (synt+real)	CP	RGB	PBR+real	RGB-D	0.765	0.752	0.727	0.948	0.652	0.527	0.883	0.866	0.500
Ч,	9 RADet+PFA-PBR-RGBD	2022	No	Yes	Dataset	Extended FCUS	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
Р	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
BO	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	2 2	P.		Dah	ilds on sti	nng	VO	PB (+) a	RGA	ate	cti	and	0.850	0.545	0.410	0.882	0.830	0.250
	15 ZebraPoseSAT-EffnetB4 (DefaultDetection)	2022	No	Yes	Object	Default MaskRCNN (synt+real)	Ung	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 hut perf	rr	m	Tes		ISO with De	fault	RGB	ter	tior	าราf	ror	nia	20	VPo	se	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	2	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	-	<b>2</b> 1	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		Dataset	-		RGB	PBR only	RGB	0.457	0.547	0.467	0.558	0.363	0.186	0.580	0.499	1.874
		2019				-	ICP	-		D	0.454	0.492		0.696		0.274	0.603		
	42 Félix&Neves-ICRA2017-IET2019				Dataset	MaskRCNN	ICP		Synt+real		0.412	0.394	0.212	0.851	0.323	0.069	0.529	0.510	
					Object	RetinaNet	ICP		Synt+real		0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
			_		Object	RetinaNet	-		Synt+real		0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
					Object	-	ICP				0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
	46 Pix2Pose-BOP20-ICCV19				Object	MaskRCNN	-		PBR+real		0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	
	47 Sundermeyer-IJCV19				Object	RetinaNet	-		Synt+real		0.280	0.146	0.304	0.401	0.217	0.101	0.346	0.446	
	48 SingleMultiPathEncoder-CVPR20				All datasets	MaskRCNN	-		Synt+real		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: 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.

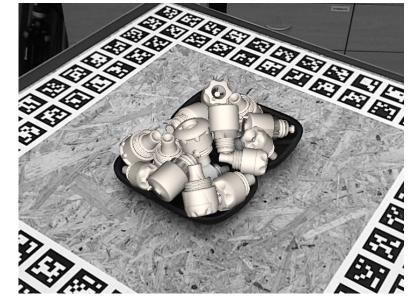
# **Object poses estimated by GDRNPP**<sup>[1]</sup>



[1] Image courtesy Xingyu Liu 54

# **Object poses estimated by GDRNPP**<sup>[1]</sup>





# **Sponsors of BOP 2022 Awards**

Donated \$4000 (each \$2000)

# Meta **NIANTIC**

# M	lethod	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 G	DRNPP-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
<b>2</b> G	DRNPP-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
<b>3</b> G	DRNPP-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
<b>4</b> G	DRNPP-PBF / RGBD-M. CofficialDet	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 R	ADet+P	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 R/	ADet AlixPBR-RGBD-Fast	2022 No Yes	Dataset	Extended FCOS	PFA	RGB		RGB-D	0.771	0.792	0.779	0.958	0.671	0.460	0.860	0.880	0.639
7 R		2022 No Y 5	i set	verallE		RG			68	0.729	0.708	0.966	0.733	0.536	0.863	0.843	1.336
8 Ze	eb eSAT-EmietBa - ICr (DefaultL)	2022 No Yes	Object	Default MaskRCMN (synt+real)	ICF	RGB	PBR+real	RGB-D	0.765	0.752	0.727	0.948	0.652	0.527	0.883	0.866	0.500
9 R/		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 St		2021 NGD	RNP	P-PBRReal	ERGE	10-r	ЛΜ		0.758	0.760	0.828	0.854	0.659	0.538	0.866	0.799	9.048
11 G	SDRN - ARReal-RGBD-SModel				Dupin acture	R.C.J	DDD world	DOD D		0.757	0.856	0.906	0.680	0.356	0.864	0.817	0.556
12 0		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 G		2022 NX Yes		iu, Ruida Zł	nang	Che		$nn\sigma$	σΪΪ	nσ	7h	and	r R		0.869 P <b>N</b> =2	0.825	0.229
	ebraPoseSAT-EffnetB4 ebraPoseSAT-EffnetB4 (DefaultDetection)	2022 No. Yos	Direct		10115,	RGB	PBR+real	6	5070	8	0.769	8	0.507	0-417	0.887	0.830	0.250
	ebraPose-SAT ebraPose-SAT	2022 NE Va	liwen	rcTang, Xiqu	ian Li	ang		σνί	Tar	$10^{\circ}$	Xia	otic	ηn <sub>4</sub>	Che	pnσ	0.816	0.200
	ADet+PFA-MixPBR-RGB	2022 No Yes	Dataset	Extended ECOS		RGB	PBR+real		0.709	<b>'8</b> '	0.778	0.839	0.600	0.353	····8/	0.806	3.019
	DRNPP-PBR-RGB-MModel	2022 NYUK	ang J	Zhang, Gu	Nang	<sub>-</sub> Xic	ngv	an	$\sigma$ $li$	0.713	0.796	0.752	0.623	0.448	0.869	0.713	0.284
	cosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2022 No Yes	Dataset	Default MaskRCNN (synt+real)	~DeepIM+ICP		PBR±real	RGB-D	0,698	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
	ebraPoseSAT-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	-
	FA-cosypose				PFA	RGB-D	PBR+real	RGB	0.664	0.714	0.738	0.837	0.596	0.246	0.712	0.807	-
	ADet+PFA-PBR-RGB	2022 NAW	ard	money: \$5	00	RGB	PBR only	RGB	0.663	0.745	0.719	0.732	0.600	0.353	0.841	0.648	3.497
	urfEmb-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 K	oenig-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
<b>25</b> C	osyPose-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
<b>26</b> CI	RT-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
<b>27</b> Pi	ix2Pose-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 Z	TE_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
<b>29</b> Co	osyPose-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
<b>30</b> Vi	idal-Sensors18	2019 Yes No	-	-	ICP	-	-	D	0.569	0.582	0.538	0.876	0.393	0.435	0.706	0.450	3.220
<b>31</b> C	DPNv2_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
	Prost-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
	DPNv2_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
	:DPNv2_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
	Irost-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
	Irost-CVPR10-3D-Only	2019 Yes No	-	- DetineNet	ICP	-	-	D	0.487	0.527	0.444	0.775	0.388	0.316	0.615	0.344	7.704
	DPN_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
	DPNv2_BOP20 (PBR-only & RGB-only)	2020 No Yes 2020 No Yes	Object Object	FCOS ???	-	RGB	PBR only	RGB RGB	0.472	0.624	0.407	0.588	0.473	0.102	0.722	0.390	0.978
a second second	eaping from 2D to 6D POS-BOP20-PBR	2020 No Yes 2020 No Yes	Object Dataset			RGB RGB	Synt+real PBR only	RGB	0.471	0.525	0.403	0.751	0.342	0.077	0.580	0.543	1.874
	rost-CVPR10-3D-Only-Faster	2010 Voc No	-		ICP	-		D	0.454	0.402	0.467	0.696	0.377	0.274	0.602	0.220	1 202
	élix&Neves-ICRA2017-IET2019	2019 Yes No 2019 Yes Yes		- MaskRCNN	ICP	- RGB-D	- Synt+real	BGB-D	0.454	0.492	0.405	0.851	0.323	0.274		0.530	
	undermeyer-IJCV19+ICP	2019 Yes Yes		RetinaNet	ICP	RGB-D	Synt+real		0.398	0.237	0.487	0.614	0.323	0.158	0.525	0.505	0.865
	higang-CDPN-ICCV19	2019 No Yes		RetinaNet	-	RGB			0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	
	ointVoteNet2	2010 No Yes		-	ICP	RGB-D		RGB-D	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
	ix2Pose-BOP20-ICCV19	2020 No Yes		MaskRCNN	-	RGB	PBR+real	RGB	0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
	undermeyer-IJCV19	2021 No Yes		RetinaNet	-	RGB	Synt+real	RGB	0.280	0.146	0.304	0.401	0.217	0.101	0.346	0.446	0.196
	ingleMultiPathEncoder-CVPR20	2020 No Yes		MaskRCNN			Synt+real		0.241	0.217	0.310	0.334	0.175		0.293	0.289	0.186
48 Si		ZUZUTNU Tres	All uatabeta	Maskronn	-	RGB	Synthear	INGD I	0.241	0.217	0.0101	0.0011	0.170	0.067	0.2951	0.2001	0.100

#	Method	Year	PPF	DNN	models per	Det./seg.		Refine.	Train. im.	type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	НВ	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		0.921	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		0.906	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		0.960	0.676	0.469		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		0.880	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		0.866	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		0.826	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		a.	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	2022	No	Yes	Object	FCOS	لمهيد	-	RGB	PBR+real	RGB	0.710	0.721	0.787	0.861	0.549	0.379	0.847	0.828	-
17	RADet+PF	2022	No	Yes	Dataset	Extended FCOS	لمهيد	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 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 V ECCV BY OF D IVIE V	2020	No	12	est B	estrR	Otere D	~De pin Hor			et	<b>A</b> O		0.701	0.939	0.647	0.313	0.712	0.861	13.743
20	Zebar eSAT-F & ALOnly)	2022	No	Y_s	U., of				RCB	PLK Jry	- 36			0.723	0.717	0.545	0.410	0.882	0.691	-
21	PFA 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 A-PBP B	2022	No	Yes	Dataset					PBR only	RGB	0.663	0.745	0.719	0.732	0.600	0.353	0.841	0.648	3.497
23	Surfe 41 R-RGB	2021					seal	JKUP		<b>NIO</b>		0.650	0.663	0.735	0.715	0.588	0.413	0.791	0.647	8.891
24	Koenig-Hyp, PL-PointPairs	2020			Dataset	RetinaMask/MaskRC	NN	ICP	RGB	Synt+real	RGB-D	0.639	0.631	0.655		0.430	0.483	0.651	0.701	0.633
25	CosyPose-Euch NT IVIEW	2020		Yes	Dataset	Default MaskRCNN ( Ugult Ruid	(synt+real)	~DeepIM	Ch	PBR+real	RGB	0.637	0.633	0.728 一 <b>フ</b> ム	0.823	0.583	0.216	0.656	0.821	0.449
26	CRT-6D	2022		ШĮ	gyu L	lu, Kulu	Ut+rZal [	iung,	-CI I	епус	ing	guu	IIIg	<b>_</b> 211	ung	5,°D	Ovve	$EII^{03}$	0.752	0.059
27	Pix2Pose-BOP20_w/ICP-ICCV19	2020	No	Yes			Viau		RGB	PBR+real	RGB-D	0.591	0.588	0.512 Vio		0.390		0.695	0.780	4.844
28		2022		$u_{r}$	jivveri	Tang	ліци	UII LI	ung	, JIII	gyr	-rui	Ig,	ΛΙϤ	Οιη		LIIE	пg,	0.502	0.901
29 30	CosyPose-ECCV20-PBR-1VIEW	2020				Zhang, (		Mana			RGB (AD)	$\overline{\sigma}_{0.570}$	0.583	0.640	0.876	0.565	0.216	0.000	0.574	3.220
31	Vidal-Sensors18 CDPNv2 BOP20 (RGB-only & ICP)	2019		uκ	ung z	Liiuiig,	gu v	vung	, ЛЮ	iiigy	ung	5 1	0.582	0.538	0.913	0.393	0.435	0.706	0.450	1.462
32	Drost-CVPR10-Edges		Yes	No	Object	1003			KGB	Synthear	RGB-D	0.550	0.515	0.404		0.368	0.180	0.671	0.375	87 568
33	CDPNv2_BOP20 (PBR-only & ICP)		No		Object	- FCOS			- RGB	- PBR only	RGB-D	0.534	0.630	0.435		0.450	0.186	0.712	0.532	1.491
34	CDPNv2_BOP20 (RGB-only)	2020	NA	W	ard	money	· \$1	00	RGB	Synt+real	RGB	0.529	0.624	0.433		0.473	0.100	0.712	0.532	0.935
35	Drost-CVPR10-3D-Edges	2019	Yes	No	aru	noney	• •		-	-	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		No	-	-		ICP	-	-	D	0.487	0.527	0.444		0.388	0.316	0.615	0.344	7.704
37	CDPN_BOP19 (RGB-only)	2020			Object	RetinaNet		-	RGB	Synt+real	-	0.479	0.569	0.490		0.327	0.067	0.672	0.457	0.480
38	CDPNv2_BOP20 (PBR-only & RGB-only)	2020			Object	FCOS			RGB	PBR only	RGB	0.472	0.624	0.407		0.473	0.102	0.722	0.390	0.978
39	leaping from 2D to 6D	2020		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
	Félix&Neves-ICRA2017-IET2019				Dataset	MaskRCNN		ICP	RGB-D	Synt+real	RGB-D	0.412	0.394			0.323	0.069	0.529	0.510	
43	Sundermeyer-IJCV19+ICP	2019	No	Yes	Object	RetinaNet		ICP	RGB	Synt+real		0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
44	Zhigang-CDPN-ICCV19				Object	RetinaNet		-	RGB	Synt+real		0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
	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
											4									
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

#	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		0.722	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			0.676	0.469	0.869	0.888	2.317
6	RADet+PFA-M: PTA-RGBD-	2022	No	Yes	Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB-D	0.771	0.792	0.779		0.671	0.460	0.860	0.880	0.639
7	RCVPose CompleModel_Vivees	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	ZebraF	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		2022	No		Peset B	estefast	PFA	et h	PP or'	RGB-D	0.762	0.797	0.802		0.676	0.469	0.869	0.826	2.631
10		2021	No	Y_s	eset B	Sam KRC.NN (S.I. Cal)	Cus.D			RGB-D	0.758	0.760	0.828	0.854	0.659	0.538	0.866	0.799	9.048
11	GDR. / 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	Coul Prative e ne ner CV	2022	No	Yes	Object	Default MaskRCNN (synt+real)	CIR	RGB-D	PBR+real	RGB-D	9.741	0.734	0.776	0.968	0.676	0.381	0.757	0.893	
13	GDR 12 RRReal-RGB-MModel	2022		D	RNP	P-PBRReal	-KGE	3D-I	VIVI	ode	] - F	asi	0.786	0.831	0.623	0.448	0.869	0.825	0.229
14	ZebraPose	2022		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- 4 (P detection)	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	I N <b>X</b>	<b>in</b>	σγη	Default MaskRCNN (synt+real)	nang.	FGBhe	PNVC	ng	$\sigma_{IIO}$	Ing	7h	ang	$r_0 R$	OW	2 <b>n</b> 47	0.828	-
17	RADet+PFA-MixPBR-RGB	2022	No	Yes	Dataset	Extended FCOS	PFA O	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		Mas	liwen	volang, Xiqu	ian Li	ang		$\sigma_{VI}$	Tar	$\gamma g_{13}$	Xia	otia	7 <b>n</b> 23	Che	ng.	0.713	0.284
19	CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020	No	Yes	Dataset	Default MaskkCNN (synt+real)	~DeepIM+ICP	RGB	PBR+real	RGB-D	0.698	' <b>0/</b> 14	0.701	0.939	0.647	0.313	0.012	0.861	13.743
20	ZebraPoseSAT-EffnetB4 (PBR_Only)	2022		Пk	ang /	<b>Chang, Gu</b>	Nang	rcXiC	ngv	ang	$\boldsymbol{\tau}_0   \boldsymbol{j}_0$	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	Y/A	W	ard	money:⊳\$4	00	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	-	4	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
	Félix&Neves-ICRA2017-IET2019				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		0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
	Zhigang-CDPN-ICCV19				Object	RetinaNet	-	RGB	Synt+real		0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
	PointVoteNet2				Object	-	ICP	RGB-D		RGB-D	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
	Pix2Pose-BOP20-ICCV19				Object	MaskRCNN	-	RGB	PBR+real		0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
	Sundermeyer-IJCV19				Object	RetinaNet	-	RGB	Synt+real		0.280	0.146	0.304	0.401	0.217	0.101	0.346	0.446	0.196
	SingleMultiPathEncoder-CVPR20				All datasets	MaskRCNN	-	RGB	Synt+real		0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
	DPOD (synthetic)				Scene	-	-1	RGB	Synt	RGB	0.161	0.169			0.130	0.000	0.286	0.222	0.231
10			1.10	1.50							0.101	0.100	0.001	C.L.T.L	0.100	0.000	0.200		

#	Method	Year PPF	DNNmodels 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		0.921	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-MER A-RGBD	2022 No	Yes Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB-D	0.787	0.797		0.960	0.676	0.469		0.888	2.317
6	RADet+PI / BR-RGBD-Fas-	2022 No	Yes Dataset	Extended FCOS	PFA	RGB	PBR+real	RGB-D	0.771	0.792	0.779	0.958	0.671	0.460		0.880	0.639
7	RCVPr SingleModel_VIVO_PD	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	Zebri ASAT-E DI + Default	2022 No		est <sup>kr</sup> B er	nde	2Pr	COIC	RGB D	ra	in	ed		e		00	0.866	0.500
9	RAL TA-PBL.	2022 No	Yes Dataset	Extended - 205	-FX	RG	Phyoniy	RGB-D	0.102	6.757	0.802	0.355	0.076	6.469	0.800	0.826	2.631
10	Surth 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	GDR PBRB AL G D Mora	2022 No	DND	P-PBRReal	Droth 2diust		PPR+real	RGB-P	0.748	0.757	0.856	0.906	0.680	0.356	0.864	0.817	0.556
12	Coup Thive Refinement (CIR)					kg V/	WIU	lei	0.741	0.734	0.776	0.968	0.676	0.381	0.757	0.893	
13	GDRNPPA aal-RGB-MMode	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	2022 No	Yes Object	FCOS	ana	Ch	PBR+real		0.720	0.721	ープト	0.850	$-\frac{0.545}{D}$	0.410	0.882	0.830	0.250
15	ZebraPoseSAT-EnnetB4 (DefauitDetection)	2022 N	mgyu L	iu, Ruida Zl	iung,	FGB/ TE	гнус	лıg	guu	Шğ	26	ung	,0.D	Ovve	21.187	0.816	0.250
16	ZebraPose-SAT	2022 No		Tang, Xiqu	ian Li	ana			Ta	$n \sigma_{r}$	Via	otic	0.549 7 <b>D</b> ool	~h0	$n\sigma^{0.847}$	0.828	-
17	RADet+PFA-MixPBR-RGB	2022 N/)	u, jivver	Explores, AIGG		ung	וייני,	gyr	P CH	ığ,	ΛΙά	Oth		_1 <i>1</i> C	ıığ,	0.806	3.019
18	GDRNPP-PBR-RGB-MModel	2022 No 2020 No	ukang	Zhang, Gual	Nana	Xic	$h n \sigma l$	ian	$\sigma$ li	0.713	0.796	0.939	0.623	0.448	0.869	0.713	0.284
	CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020 No	unung z		vang		ingy	ung	5 9 10	0.714	0.701	0.939	0.545	0.313	0.712	0.691	13.743
20 21	ZebraPoseSAT-EffnetB4 (PBR_Only)	2022 No	Yes Dataset	MaskRCNN	- PFA	RGB-D	PBR+real	RGB	0.664	0.721	0.723	0.837	0.596	0.246	0.002	0.807	
21	PFA-cosypose 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 N		money: \$4	00	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		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		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	-	- 1	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
	Drost-CVPR10-3D-Only-Faster	2019 Yes		-	ICP	-		D	0.454	0.492	0.405	0.696	0.377	0.274	0.603		1.383
	Félix&Neves-ICRA2017-IET2019		Yes Dataset	MaskRCNN	ICP	RGB-D	Synt+real		0.412	0.394			0.323	0.069	0.529		
43			Yes Object	RetinaNet	ICP	RGB	Synt+real		0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
	Zhigang-CDPN-ICCV19		Yes Object	RetinaNet	-	RGB	Synt+real		0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
	PointVoteNet2		Yes Object	-	ICP	RGB-D	PBR only		0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
	Pix2Pose-BOP20-ICCV19		Yes Object	MaskRCNN	-	RGB	PBR+real		0.342	0.363		0.420	0.226	0.134	0.446	0.457	1.215
	Sundermeyer-IJCV19		Yes Object	RetinaNet	-	RGB	Synt+real		0.280	0.146		0.401	0.217	0.101	0.346	0.446	0.196
48	SingleMultiPathEncoder-CVPR20 DPOD (synthetic)	2020 No	Yes All datasets Yes Scene	MaskRCNN	-	RGB RGB	Synt+real Synt	RGB RGB	0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186
49		2019 100	res scene		-	KOD	Synt	INOB	0.101	0.169	0:081	0.242	0.150	0.000	0.200	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-PBF / RGBD-M. C 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 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 -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		2022 No Y 5	Set 5	est ube	in-S	<b>0</b> 32	ar res	GB-	Ae	Th		0.966	0.733	0.536	0.863	0.843	1.336
8	Zeb eSAT-EmnetBa - ICr (DefaultD)	2022 No Yes	Object	Default MaskRCNiv (s) It+real)	ICP	RGB	PBR+real	ר-KGB	0.765	0.752	0.127	0.948	0.652	0.527	0.883	0.866	0.500
9		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	Surft BR-P BI	2021 NGD	RNP	P-PBRReal	ERGE		ЛМ		1.758	0.760	0.828	0.854	0.659	0.538	0.866	0.799	9.048
11	GDRN CORREal-RGBD-SModel				Dupin actua	A.C.J	PDD wool			0.757	0.856	0.906	0.680	0.356	0.864	0.817	0.556
12	Coupled and Retinement (Ch)	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			iu, Ruida Zł	hang	Che		$n\sigma$	σιίο	inσ	-7h	and	ΣŔ		on l	0.825	0.229
14	ZebraPoseSAT-EffnetB4 ZebraPoseSAT-EffnetB4 (DefaultDetection)	2022 No Vos			101151	PGP	PREtroal	1180	50720		0.769			0-417	0.997	0.816	0.250
15	ZebraPose-SAT	2022 NO Tes	liwen	Fe <b>T</b> ang, Xiqu	ian Li	ang	lin	$\sigma_{Vi}$	Tar	ησ	Xia	otic	γn	Che	nσ	0.828	0.230
17	RADet+PFA-MixPBR-RGB	2022 NO Ves	Dataset	Extended ECOS		RGB	PBR+real	87'	0.709	<b>'8'</b>	0.778	0.839	0.600	0.353	''8'	0.806	3.019
18	GDRNPP-PBR-RGB-MModel	2022 NO 103	ang 7	Zhang, Gu	Nang	Xic	ingv	ian	σĬi	0.713	0.796	0.752	0.623	0.448	0.869	0.713	0.284
19	CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2022 No Yes	Dataset	Default MaskRCNN (synt+real)	~DeepIM+ICP			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				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 NAW	ard r	money: \$4	00	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	-	<del>.</del>	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	-	- DetineNet	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		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 2020 No Yes	Object	FCOS ???	-	RGB	PBR only	RGB RGB	0.472	0.624	0.407	0.588	0.473	0.102	0.722	0.390	0.978
39 40	leaping from 2D to 6D EPOS-BOP20-PBR	2020 No Yes 2020 No Yes	Object Dataset			RGB RGB	Synt+real PBR only	RGB	0.471	0.525	0.403	0.751	0.342	0.077	0.580	0.543	1.874
		2010 Voc No	1		ICP	ROB	1965	D	0.454	0.402	0.467	0.556	0.303	0.274	0.602	0.220	1 202
	Drost-CVPR10-3D-Only-Faster Félix&Neves-ICRA2017-IET2019	2019 Yes No 2019 Yes Yes		- MaskRCNN	ICP	- RGB-D	- Synt+real	BGB-D	0.454	0.492	0.405	0.851	0.323	0.274		0.510	
42	Sundermeyer-IJCV19+ICP	2019 No Yes		RetinaNet	ICP	RGB	Synt+real		0.398	0.237	0.487	0.614	0.323	0.009	0.506	0.505	0.865
	Zhigang-CDPN-ICCV19	2019 No Yes		RetinaNet	-	RGB			0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
	PointVoteNet2	2020 No Yes		-	ICP	RGB-D			0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
46		2020 No Yes		MaskRCNN	-	RGB			0.342	0.363	0.344	0.420	0.226	0.134	0.446	0.457	1.215
	Sundermeyer-IJCV19	2021 No Yes		RetinaNet	-	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		MaskRCNN	-	RGB	Synt+real		0.241	0.217	0.310	0.334	0.175	0.067	0.293	0.289	0.186

#	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			0.676	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		0.671	0.460	0.860		0.639
7	RCVPose 3D_Sin_Model_ YC PBR	2022	No	Yes	Dataset	-	ICP	RGB-D	PBR+real	RGB-D	0.768	0.729	0.708		0.733	0.536	0.863	0.843	1.336
8	ZebraPosr /tB4 + ICF D	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 BR-RGBD	2022	No	Yes	Dataset	Extended FCOS	PFA	RGB	PBR only	RGB-D	0.762	0.797	0.802		0.676	0.469	0.869	0.826	2.631
10		2021	No		Deteset	est were	Intor	GB )	PPS min	RGPD	<b>D</b> 5°	- C760		654	0.659	0.538	0.866	0.799	9.048
11		2022	No No	Ys	Ceset B	<u>est inc</u>		IGB	PD H e		D.74	0,		10	0.680	0.356	0.864	0.817	0.556
12	Coup //terative Refinement (CIR)	2022	No	Yes	Object	Default MaskRCNN (synt+real)	CIR	RGB-D	PBR+real	RGB-D	0.741	0.734	0.776		0.676	0.381	0.757	0.893	-
13	GDA PBRKP (G -M ode	2022	2 NC		<b>Prec</b>	terons/S	egn	rei		<b>MEL</b>	Dh	<b>1</b> 3	0.786	0.831	0.623	0.448	0.869	0.825	0.229
14	Zebr. Pal SAT-Emilete4	2022	No No	Yes	Object	FCOS	28.	RGB	PBR+reat	RGB	0.720	0.721	0.806	0.850	0.545	0.410	0.882	0.830	0.250
15	ZebraPose TEffnetB4 (DefaultPr / won)	2022	No 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-om	2022	N	'n	DND	P-PBRReal	-DCE		ЛКЛ			<b>\ff</b>	di87		0.549	0.379	0.847	0.828	•
17	RADet+PFA-MixP*KGB	2022	2 No		J	Extended Plancal	PLACE		Y LFL Yeur	yuq	J.70	L.7.15	Cla	11	<b>-1.300</b>	0.353	0.841	0.806	3.019
18	GDRNPP-PBR-RGB-MModel	2022		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		Yes		Up Ruida Zł		Ch	PBR+real	RGB-D	0.698	0.714	-76	0.939	$\tau^{0.6} \vec{D}$		0.712	0.861	13.743
20	ZebraPoseSAT-EffnetB4 (PBR_Only)	2022		H-I (	gyu Li	μ, καιάα Ζι	iung,		спус	лıg	guu	Шğ	<u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></u>	ung	5,0 D	Ovv	21.182	0.691	-
21	PFA-cosypose	2022	! No	Yes	Line Contract	Tang, Xiqu	PFA	RGB-D	PBR+real	RGB .	- <b>T</b> <sup>664</sup>	0.714	Vi0	n ti	0.596	$Cb^{246}$	0.712	0.807	-
22	RADet+PFA-PBR-RGB	2022	2 N 🔊	$u_{r}$	Jivven	⊧∞⊪απχ, λίγι		ung	78 <b>7 M</b> .I	gyr	10.041	<u>Ig</u> ,	ли	Om	1.100	$C_{II}e$	пg,	0.648	3.497
23	SurfEmb-PBR-RGB	2021	$\mathbb{N}$	Yes		Zhault MaskRCNN (Guttreal)	Nana		PBR only	RGB	$\tau^{0.650}$	0.663	0.735	0.715	0.588	0.413	0.791	0.647	8.891
24	Koenig-Hybrid-DL-PointPairs	2020		ur	ung 2	riviuisi8;rwu v	vung	RAIU				0.631	0.655	0.920	0.430	0.483	0.651	0.701	0.633
25	CosyPose-ECCV20-SYNT+REAL-1VIEW	2020		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			Dataset	Default MaskRCNN (synt+real)	Custom	RGB	PBR+real		0.599	0.660	0.644		0.537	0.208	0.603	0.752	0.059
27	Pix2Pose-BOP20_w/ICP-ICCV19	2020	No	Yes	Object	money:,\$2		RGB	PBR+real		0.591	0.588	0.512		0.390	0.351	0.695	0.780	4.844
28	ZTE_PPF	2022		N'A'				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		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		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)		No		Object	FCOS	ICP	RGB	Synt+real		0.568	0.630	0.464	0.913	0.450	0.186	0.712	0.619	1.462
32	Drost-CVPR10-Edges	2019	-	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)		No		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)		No		Object	FCOS	- ICP	RGB	Synt+real		0.529	0.624	0.478	0.772	0.473	0.102	0.722	0.532	0.935
35	Drost-CVPR10-3D-Edges	2019		No	-		ICP	-	-	D D	0.500	0.469	0.404	0.852	0.373	0.462	0.623	0.316	80.055
30	Drost-CVPR10-3D-Only	2019	No No	No Yes	Object	- RetinaNet		- RGB	Sunttract		0.487	0.527	0.444	0.775	0.388	0.316	0.615	0.344	7.704 0.480
29	CDPN_BOP19 (RGB-only) CDPNv2 BOP20 (PBR-only & RGB-only)	2020		Yes	Object Object	FCOS		RGB	Synt+real PBR only	RGB	0.479	0.569	0.490	0.588	0.327	0.007	0.722	0.457	0.480
30	leaping from 2D to 6D	2020		Yes	Object	???		RGB	Synt+real		0.472	0.624	0.407	0.566	0.473	0.102	0.658	0.543	0.978
40	EPOS-BOP20-PBR		No	Ves	Dataset	-	-	RGB	PBR only	RGB	0.457	0.525	0.467	0.558	0.363	0.186	0.580	0.499	1.874
	Drost-CVPR10-3D-Only-Faster		Yes			-	ICP	-	-	D			0.407		0.377			0.330	1 0 0 0
	Félix&Neves-ICRA2017-IET2019				Dataset	- MaskRCNN	ICP	- RGB-D	- Synt+real		0.412	0.394	0.212		0.323	0.069	0.529	0.510	
					Object	RetinaNet	ICP	RGB	Synt+real		0.398	0.237	0.487	0.614		0.158	0.506	0.505	0.865
	Sundermever-IJCV19+ICP	2010	I NO.	1 Yes							0.000	0.201	0.101	0.014	0.201	0.100	0.000	0.000	0.000
	Sundermeyer-IJCV19+ICP Zhigang-CDPN-ICCV19					RetinaNet	-	RGB	Synt+real	RGB	0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
44	Zhigang-CDPN-ICCV19	2019	No	Yes	Object	RetinaNet	-	RGB RGB-D	Synt+real PBR only		0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
44 45	Zhigang-CDPN-ICCV19 PointVoteNet2	2019 2020	No No	Yes Yes	Object Object	-	- ICP -	RGB-D	PBR only	RGB-D	0.351	0.653	0.004	0.673	0.264	0.001	0.556	0.308	-
44 45 46	Zhigang-CDPN-ICCV19 PointVoteNet2 Pix2Pose-BOP20-ICCV19	2019 2020 2020	No No No	Yes Yes Yes	Object Object Object	- MaskRCNN	- ICP -	RGB-D RGB	PBR only PBR+real	RGB-D RGB	0.351 0.342	0.653 0.363	0.004 0.344	0.673	0.264 0.226	0.001 0.134	0.556 0.446	0.308 0.457	- 1.215
44 45 46 47	Zhigang-CDPN-ICCV19 PointVoteNet2 Pix2Pose-BOP20-ICCV19 Sundermeyer-IJCV19	2019 2020 2020 2021	No No No No	Yes Yes Yes Yes	Object Object Object Object	- MaskRCNN RetinaNet	- ICP - -	RGB-D RGB RGB	PBR only PBR+real Synt+real	RGB-D RGB RGB	0.351 0.342 0.280	0.653 0.363 0.146	0.004 0.344 0.304	0.673 0.420 0.401	0.264 0.226 0.217	0.001 0.134 0.101	0.556 0.446 0.346	0.308 0.457 0.446	- 1.215 0.196
44 45 46 47 48	Zhigang-CDPN-ICCV19 PointVoteNet2 Pix2Pose-BOP20-ICCV19	2019 2020 2020 2021 2020	<ul> <li>No</li> <li>No</li> <li>No</li> <li>No</li> <li>No</li> <li>No</li> <li>No</li> </ul>	Yes Yes Yes Yes Yes	Object Object Object	- MaskRCNN	- ICP - - -	RGB-D RGB	PBR only PBR+real	RGB-D RGB RGB	0.351 0.342	0.653 0.363	0.004 0.344	0.673 0.420 0.401 0.334	0.264 0.226	0.001 0.134	0.556 0.446	0.308 0.457	- 1.215

#	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



# 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

#	Method	Year	Train. im.	type	Test im.	Avg.	LM-O	T-LESS	TUD-L	IC-BIN	ITODD	НВ	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



# 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

#	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		0.921	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		0.906	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		0.671	0.460		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-EffectB4 + 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		0.866	0.500
9	RADet+PF	2022	No	Yes	Dataset	Extended FCOS	PFA	RGB	PBR only	RGB-D	0.762	0.797	0.802	0.893	0.676	0.469		0.826	2.631
10	SurfEm -RGBD	2021	No	Yes	Dataset	Default MaskRCNN (synt+real)	Custom	RGB-D	PBR only	RGB-D	0.758	0.760		0.854	0.659	0.538		0.799	9.048
11	GDR & BRR DC S Del	2022	No		Dataset		C pth adjust	R/L		GB- GB-	.748	-0.1Z	n 856	0.906	0.680	0.356	0.864	0.817	0.556
12	Coro a terative D m at UR)	2022	No	Y s	Gect B		c RC -			GB- )	<u>/Ie</u>	6 4	00	0.968	0.676	0.381	0.757	0.893	-
13	GDF PBRReal-RGB-MModel	2022	No	Yes	Object	YOLOX	[-	RGB	PBR+real	RGB	0.728	0.713	0.786	0.831	0.623	0.448		0.825	0.229
14	Zeb SAT-P B 77	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	Zebreite SAT-underer (wendenedter /11	2022	N		Det+	PFA-MixPI	BR-R	d:11	BR+real	RGB	0.720	0.707	0.768	0.849	0.597	0.417	0.887	0.816	0.250
16	ZebraPos T	2022	No		Object	FCOS	-	RGB	PBR+real	RGB	0.710	0.721	0.787	0.861	0.549	0.379	0.847	0.828	-
17	RADet+Provent 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-RC MMOL	2022	NY	ar	rσ∞Hα	i, Rui Song,	Zhia	iang	рвк фу	RGII	noii	$\alpha \alpha^{3}$	0796	Ma	thie	0 448		0.713	0.284
19	CosyPose-ECCV20-SYNT+REAL-1VIEW-ICP	2020								Reb-D	0.098	0.714	0.701	0.939	0.647	0.313	0.712	0.861	13.743
20	ZebraPoseSAT-EffnetB4 (PBR_Only)	2022	NS	al	zman	n, Pascal Fi	ua Vi	nlin	PEPPy	RGB	0.670	0.721	0.723	0.717	0.545	0.410		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	Y¢A	W	ard i	money: \$4	00	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 MaskRCL (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			-	•	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		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		Yes	Object	RetinaNet	-	RGB	Synt+real		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		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		Yes	Object	???	-	RGB	Synt+real	RGB	0.471	0.525	0.403	0.751	0.342	0.077	0.658	0.543	0.425
	EPOS-BOP20-PBR		No		Dataset	-	-	RGB	PBR only		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		No	-	-	ICP	-		D	0.454	0.492	0.405	0.696	0.377	0.274	0.603	0.330	
	Félix&Neves-ICRA2017-IET2019	-	-	-	Dataset	MaskRCNN	ICP	RGB-D	Synt+real		0.412	-	0.212	0.851		0.069	0.529		55.780
	Sundermeyer-IJCV19+ICP	_			Object	RetinaNet	ICP	RGB	Synt+real		0.398	0.237	0.487	0.614	0.281	0.158	0.506	0.505	0.865
	Zhigang-CDPN-ICCV19				Object	RetinaNet	-	RGB	Synt+real		0.353	0.374	0.124	0.757	0.257	0.070	0.470	0.422	0.513
	PointVoteNet2				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		No		Object	MaskRCNN	-	RGB	PBR+real	RGB	0.342	0.363	0.344	0.420		0.134	0.446		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
	SingleMultiPathEncoder-CVPR20	_	_		All datasets	MaskRCNN	-	RGB	Synt+real		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



# **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

#	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



# 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

# **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