

# Results of the BOP Challenge 2019

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5th International Workshop on Recovering 6D Object Pose  
ICCV 2019, October 28, Seoul, Korea

# BOP Challenge 2019

## Challenge description:

<https://bop.felk.cvut.cz/challenges/bop-challenge-2019/>

**Submission deadline:** October 21, 2019

## **197 submissions**

(one submission = results of one method on one dataset)

## **11 methods evaluated on all 7 core datasets**

(LM-O, T-LESS, TUD-L, IC-BIN, ITODD, HB, YCB-V)

**4.3K visits** by 1.4K users of the BOP websites at [bop.felk.cvut.cz](https://bop.felk.cvut.cz)

(since the launch on July 26, 2019)

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

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

**[2] Bertram Drost et al.**, *Model globally, match locally: Efficient and robust 3D object recognition*, CVPR 2010.

**[3] Pedro Rodrigues et al.**, *Deep segmentation leverages geometric pose estimation in computer-aided total knee arthroplasty*, Healthcare Technology Letters 2019.

**[4] Carolina Raposo et al.**, *Using 2 point+normal sets for fast registration of point clouds with small overlap*, ICRA 2017.

**[5] Martin Sundermeyer et al.**, *Augmented Autoencoders: Implicit 3D Orientation Learning for 6D Object Detection*, IJCV 2019.

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

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

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

[The scores were re-calculated on 27th January 2020.](#)

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Methods using depth

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

[2] **Bertram Drost et al.**, Model globally, match locally: Efficient and robust 3D object recognition, CVPR 2010.

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[4] **Carolina Raposo et al.**, Using 2 point+normal sets for fast registration of point clouds with small overlap, ICRA 2017.

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Methods based on Point Pair Features [2]

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CNN-based methods

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

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# **BOP Challenge 2019 Awards**

## **The Best Method on Individual Datasets**

LM-O, T-LESS, HB, IC-BIN, TUD-L:

**Vidal-Sensors18:** *Joel Vidal, Chyi-Yeu Lin, Xavier Lladó, Robert Martí, A Method for 6D Pose Estimation of Free-Form Rigid Objects Using Point Pair Features on Range Data, Sensors 2018.*

LM, IC-MI, ITODD, TYO-L:

**Drost-CVPR10-3D-Only / Drost-CVPR10-Edges:** *Bertram Drost, Markus Ulrich, Nassir Navab, Slobodan Ilic, Model globally, match locally: Efficient and robust 3D object recognition, CVPR 2010.*

YCB-V, RU-APC:

**Pix2Pose-BOP\_w/ICP-ICCV19:** *Kiru Park, Timothy Patten, Markus Vincze, Pix2Pose: Pixel-Wise Coordinate Regression of Objects for 6D Pose Estimation, ICCV 2019.*



# **BOP Challenge 2019 Awards**

## **The Best Open Source Method**

The best method on the 7 core datasets (LM-O, T-LESS, TUD-L, IC-BIN, ITODD, HB, YCB-V) whose source code is publicly available.

**Sundermeyer-IJCV19+ICP: Martin Sundermeyer, Zoltan-Csaba Marton, Maximilian Durner, Manuel Brucker, Rudolph Triebel, Augmented Autoencoders: Implicit 3D Orientation Learning for 6D Object Detection, IJCV 2019.**

<https://github.com/DLR-RM/AugmentedAutoencoder>





# **BOP Challenge 2019 Awards**

## **The Best Fast Method**

The best method on the 7 core datasets (LM-O, T-LESS, TUD-L, IC-BIN, ITODD, HB, YCB-V) with the average running time per image below 1s.

**Sundermeyer-IJCV19+ICP: Martin Sundermeyer, Zoltan-Csaba Marton, Maximilian Durner, Manuel Brucker, Rudolph Triebel, Augmented Autoencoders: Implicit 3D Orientation Learning for 6D Object Detection, IJCV 2019.**

Average time per image: 0.865 s



# **BOP Challenge 2019 Awards**

## **The Best RGB-Only Method**

The best method on the 7 core datasets (LM-O, T-LESS, TUD-L, IC-BIN, ITODD, HB, YCB-V) which uses only RGB channels of the test images.

**Zhigang-CDPN-ICCV19: Zhigang Li, Gu Wang, Xiangyang Ji, CDPN:**  
*Coordinates-Based Disentangled Pose Network for Real-Time RGB-Based 6-DoF Object Pose Estimation, ICCV 2019.*



# **BOP Challenge 2019 Awards**

## **The Overall Best Method**

The best method on the 7 core datasets (LM-O, T-LESS, TUD-L, IC-BIN, ITODD, HB, YCB-V).

**Vidal-Sensors18:** *Joel Vidal, Chyi-Yeu Lin, Xavier Lladó, Robert Martí, A Method for 6D Pose Estimation of Free-Form Rigid Objects Using Point Pair Features on Range Data, Sensors 2018.*

# What's Next?

The submission form for the BOP Challenge 2019 at [bop.felk.cvut.cz](http://bop.felk.cvut.cz) **stays open** to allow measuring the progress in the future.

**Snapshots of the leaderboards** will be presented and discussed at the next R6D workshops ([http://cmp.felk.cvut.cz/sixd/workshop\\_2019/](http://cmp.felk.cvut.cz/sixd/workshop_2019/)).

**A report** with an analysis of the BOP Challenge 2019 results is in preparation.

**Several new datasets** will soon be included in BOP.