ObjectNet3D: A Large Scale Database for 3D Object Recognition

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Recognizing the 3D Properties of Objects

- 3D location, 3D pose, 3D shape, etc.
- Applications

Robotics  Autonomous Driving  Augmented Reality
3D Annotation: 2D-3D Alignment
3D Annotation: 2D-3D Alignment
3D Annotation: 2D-3D Alignment
3D Annotation: 2D-3D Alignment
## Comparison with Previous Datasets

<table>
<thead>
<tr>
<th></th>
<th>Category</th>
<th>Instance</th>
<th>Non-centered objects</th>
<th>Dense viewpoint</th>
<th>3D Shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>3D Object [1]</td>
<td>10</td>
<td>100</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>EPFL Car [2]</td>
<td>1</td>
<td>20</td>
<td>×</td>
<td>✓</td>
<td>×</td>
</tr>
<tr>
<td>RGB-D Object [3]</td>
<td>51</td>
<td>300</td>
<td>×</td>
<td>✓</td>
<td>×</td>
</tr>
<tr>
<td>PASCAL VOC [4]</td>
<td>20</td>
<td>27,450</td>
<td>✓</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>KITTI [5]</td>
<td>3</td>
<td>80,256</td>
<td>✓</td>
<td>✓</td>
<td>×</td>
</tr>
<tr>
<td>PASCAL3D+ [6]</td>
<td>12</td>
<td>35,672</td>
<td>✓</td>
<td>✓</td>
<td>✓ 79</td>
</tr>
<tr>
<td>ObjectNet3D (Ours)</td>
<td>100</td>
<td>201,888</td>
<td>✓</td>
<td>✓</td>
<td>✓ 44,147</td>
</tr>
</tbody>
</table>

## Database Construction: Object Categories

- 100 rigid object categories

<table>
<thead>
<tr>
<th>Aeroplane</th>
<th>Cap</th>
<th>Filing cabinet</th>
<th>Lighter</th>
<th>Remote control</th>
<th>Suitcase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashtray</td>
<td>Car</td>
<td>Fire extinguisher</td>
<td>Mailbox</td>
<td>Rifle</td>
<td>Teapot</td>
</tr>
<tr>
<td>Backpack</td>
<td>Cellphone</td>
<td>Fish tank</td>
<td>Microwave</td>
<td>Road pole</td>
<td>Telephone</td>
</tr>
<tr>
<td>Basket</td>
<td>Chair</td>
<td>Flashlight</td>
<td>Motorbike</td>
<td>Satellite dish</td>
<td>Toaster</td>
</tr>
<tr>
<td>Bed</td>
<td>Clock</td>
<td>Fork</td>
<td>Scissors</td>
<td>Screwdriver</td>
<td>Toilet</td>
</tr>
<tr>
<td>Bench</td>
<td>Coffee maker</td>
<td>Guitar</td>
<td>Shoe</td>
<td>Toothbrush</td>
<td>Toothbrush</td>
</tr>
<tr>
<td>Bicycle</td>
<td>Comb</td>
<td>Hair dryer</td>
<td>Paintbrush</td>
<td>Shovel</td>
<td>Trash bin</td>
</tr>
<tr>
<td>Backboard</td>
<td>Computer</td>
<td>Hammer</td>
<td>Pan</td>
<td>Sign</td>
<td>Trophy</td>
</tr>
<tr>
<td>Boat</td>
<td>Cup</td>
<td>Headphone</td>
<td>Pen</td>
<td>Skate</td>
<td>Tub</td>
</tr>
<tr>
<td>Bookshelf</td>
<td>Desk lamp</td>
<td>Helmet</td>
<td>Pencil</td>
<td>Skateboard</td>
<td>Tvmonitor</td>
</tr>
<tr>
<td>Bottle</td>
<td>Dining table</td>
<td>Iron</td>
<td>Piano</td>
<td>Slipper</td>
<td>Vending machine</td>
</tr>
<tr>
<td>Bucket</td>
<td>Dishwasher</td>
<td>Jar</td>
<td>Pillow</td>
<td>Sofa</td>
<td>Washing machine</td>
</tr>
<tr>
<td>Bus</td>
<td>Door</td>
<td>Kettle</td>
<td>Plate</td>
<td>Speaker</td>
<td>Watch</td>
</tr>
<tr>
<td>Cabinet</td>
<td>Eraser</td>
<td>Key</td>
<td>Pot</td>
<td>Spoon</td>
<td>Wheelchair</td>
</tr>
<tr>
<td>Calculator</td>
<td>Eyeglasses</td>
<td>Keyboard</td>
<td>Printer</td>
<td>Stapler</td>
<td></td>
</tr>
<tr>
<td>Camera</td>
<td>Fan</td>
<td>Knife</td>
<td>Racket</td>
<td>Stove</td>
<td></td>
</tr>
<tr>
<td>Can</td>
<td>Faucet</td>
<td>Laptop</td>
<td>Refrigerator</td>
<td></td>
<td></td>
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<td></td>
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</tbody>
</table>
Database Construction: Object Categories

- 100 rigid object categories

Vehicles

Furniture
Filing cabinet  Fire extinguisher  Fridge  Fork  Guitar  Hair dryer  Hammer  Headphone  Iron  Jar  Kettle  Key  Keyboard  Knife  Laptop  Lighter  Microphone  Motorbike  Mouse  Paintbrush  Pen  Piano  Pillow  Plate  Pot  Printer  Racket  Refrigerator  Remote control  Mailbox  Microwave  Scissors  Screwdriver  Shoe  Shovel  Sign  Skateboard  Slipper  Sofa  Speaker  Spoon  Stapler  Stove  Suitcase  Teapot  T-shirt  Telephone  Toilet  Toothbrush  Train  Trash bin  Trophy  Tvmonitor  Vending machine  Washing machine  Watch  Wheelchair

Tools

Electronics

Container

Personal items
Database Construction: Images

- 2D images from the ImageNet database [1]

backpack  bed  bench  car  guitar  mailbox  scissors  teapot

Database Construction: 3D Shapes

- Trimble 3D Warehouse [1]
- ShapeNet database [2]

3D Shapes from Trimble 3D Warehouse 3D Shapes from ShapeNet

[1] https://3dwarehouse.sketchup.com
Database Construction: Annotation Demo
3D Pose Annotation Examples
Database Construction: Image-based 3D Shape Retrieval
Database Construction: Image-based 3D Shape Retrieval

Test Object

Rank 1

Rank 2

Rank 3

Baseline Experiments

- Object proposal generation
- 2D object detection
- Image-based 3D shape retrieval
- Joint 2D detection and continuous 3D pose estimation
Baseline Experiments

- Object proposal generation
  - Selective Search: Uijlings et al., IJCV, 2013.
  - EdgeBoxes: Zitnick et al., ECCV, 2014.
  - RPN: Ren et al., NIPS, 2015.

- 2D object detection

- Image-based 3D shape retrieval

- Joint 2D detection and continuous 3D pose estimation
A Network for Object Detection and Pose estimation

ObjectNet3D

- 100 object categories
- 90,127 images
- 201,888 objects
- 44,147 3D shapes
- 2D-3D alignments
- Baseline experiments on different recognition tasks