

# Deep learning-based Machine Vision for the Task of Grasping Chemical Hardware

Машинное зрение на основе глубокого обучения для захвата химического оборудования

## Coursework

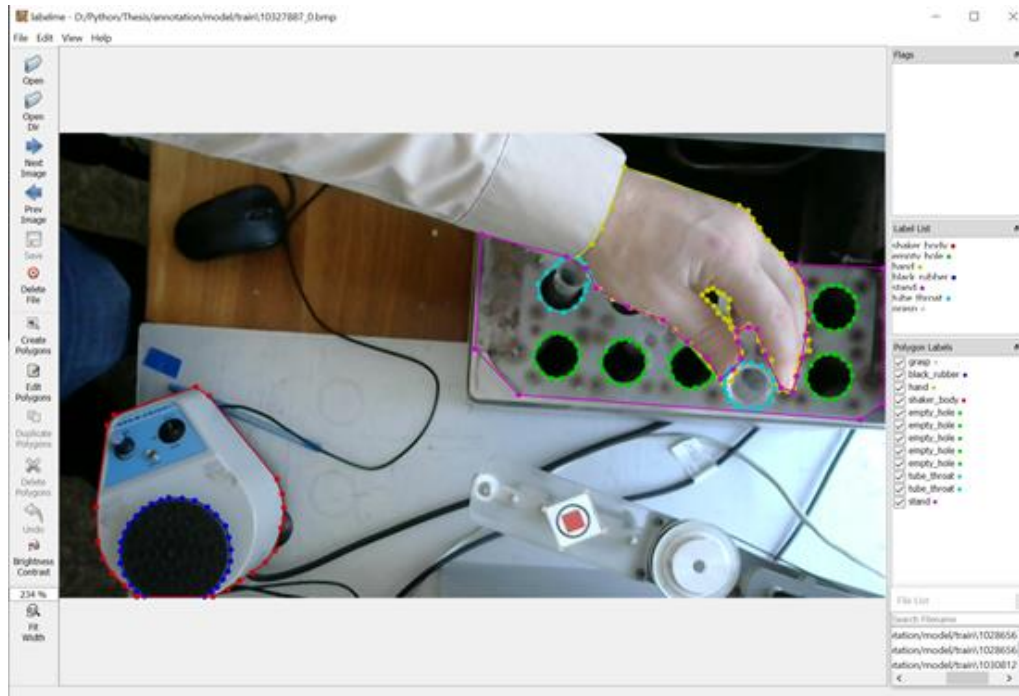
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# Dataset and data annotation

- Captured 60 images with a dimension of 640 by 480 pixels
- Data split ratio was 80/20
  - 48 train images
  - 12 test images
- Used LabelMe [1] for object annotations. Save into COCO JSON



Objects of interest	Number of annotations of train dataset
Black rubber	36
Empty hole	289
Grasp	36
Hand	54
Shaker body	39
Stand	50
Tube throat	129
<b>Total</b>	<b>633</b>

[1] <https://github.com/wkentaro/labelme>

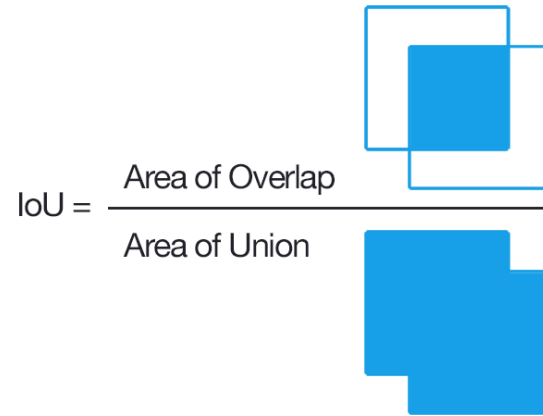
# Training

- Applied MMDetection for solving instance segmentation task [2]
- Used “cascade\_mask\_rcnn\_x101\_64x4d\_fpn\_1x\_coco”
  - Box average precision of 44.7
  - Model type: Cascade Mask R-CNN
  - Backbone: ResNeXt-101
- Applied a checkpoint for faster training
  - “cascade\_mask\_rcnn\_x101\_64x4d\_fpn\_1x\_coco\_20200203-9a2db89d.pth”
- Epochs: 100
- Learning rate: 0.02
- GPU Tesla V100
- Training took about 20 minutes

[2] [https://github.com/open-mmlab/mmdetection/tree/master/configs/cascade\\_rcnn](https://github.com/open-mmlab/mmdetection/tree/master/configs/cascade_rcnn)

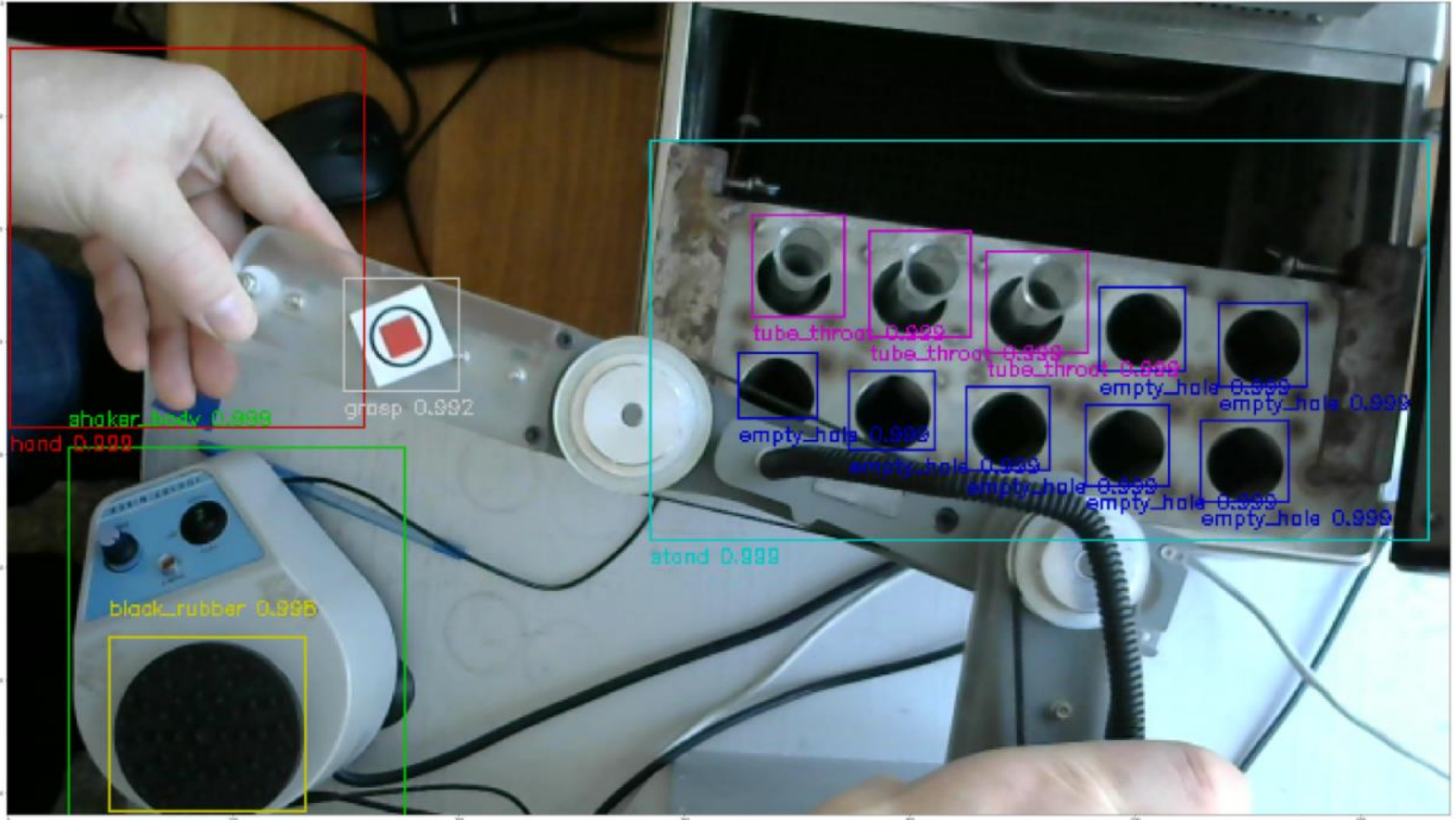
# Model Evaluation – Intersection-over-union (IOU)

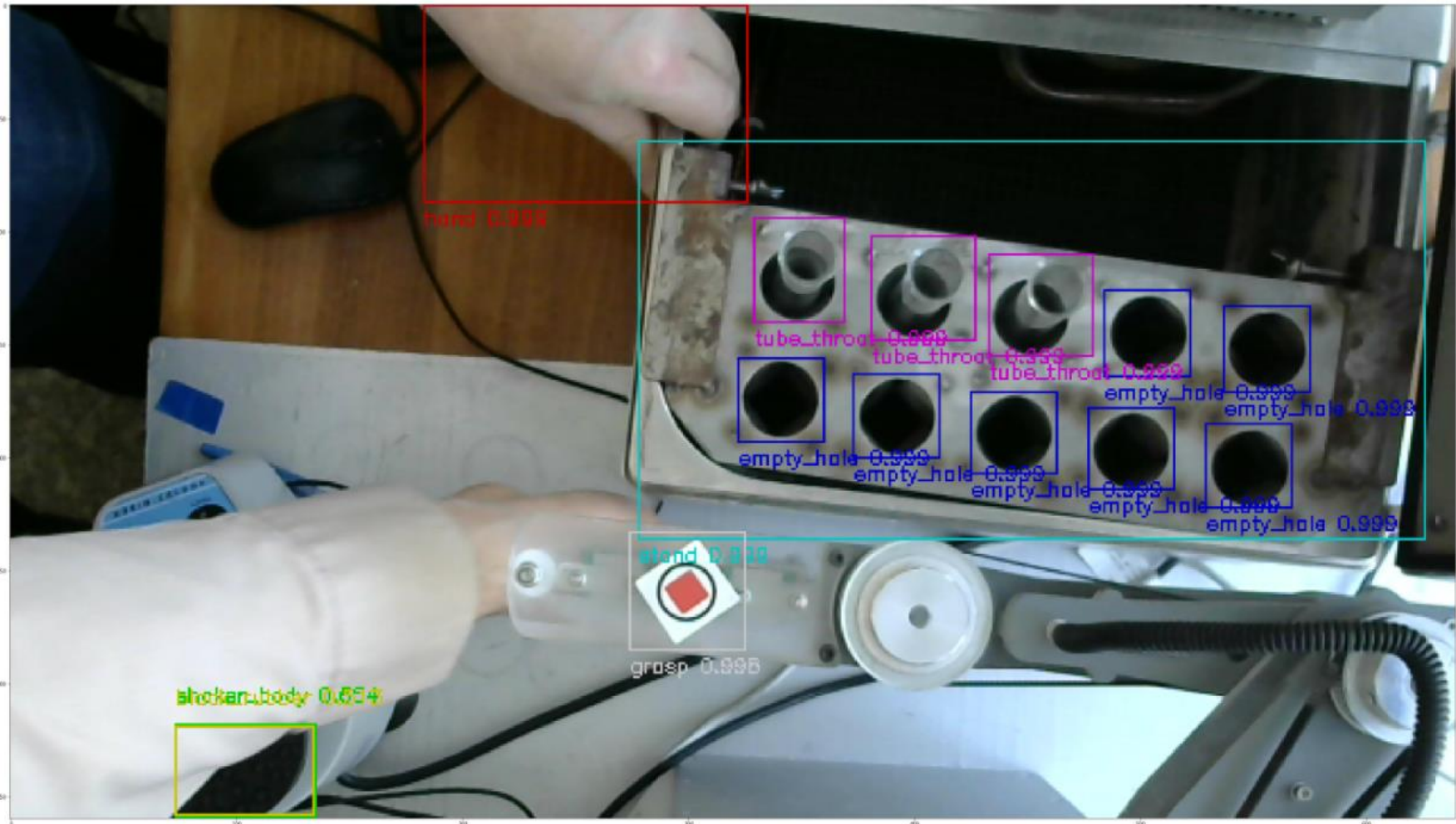
Objects	IOU ratio
Black rubber	0.902
Empty hole	0.929
Grasp	0.933
Hand	0.920
Shaker body	0.838
Stand	0.950
Tube throat	0.915

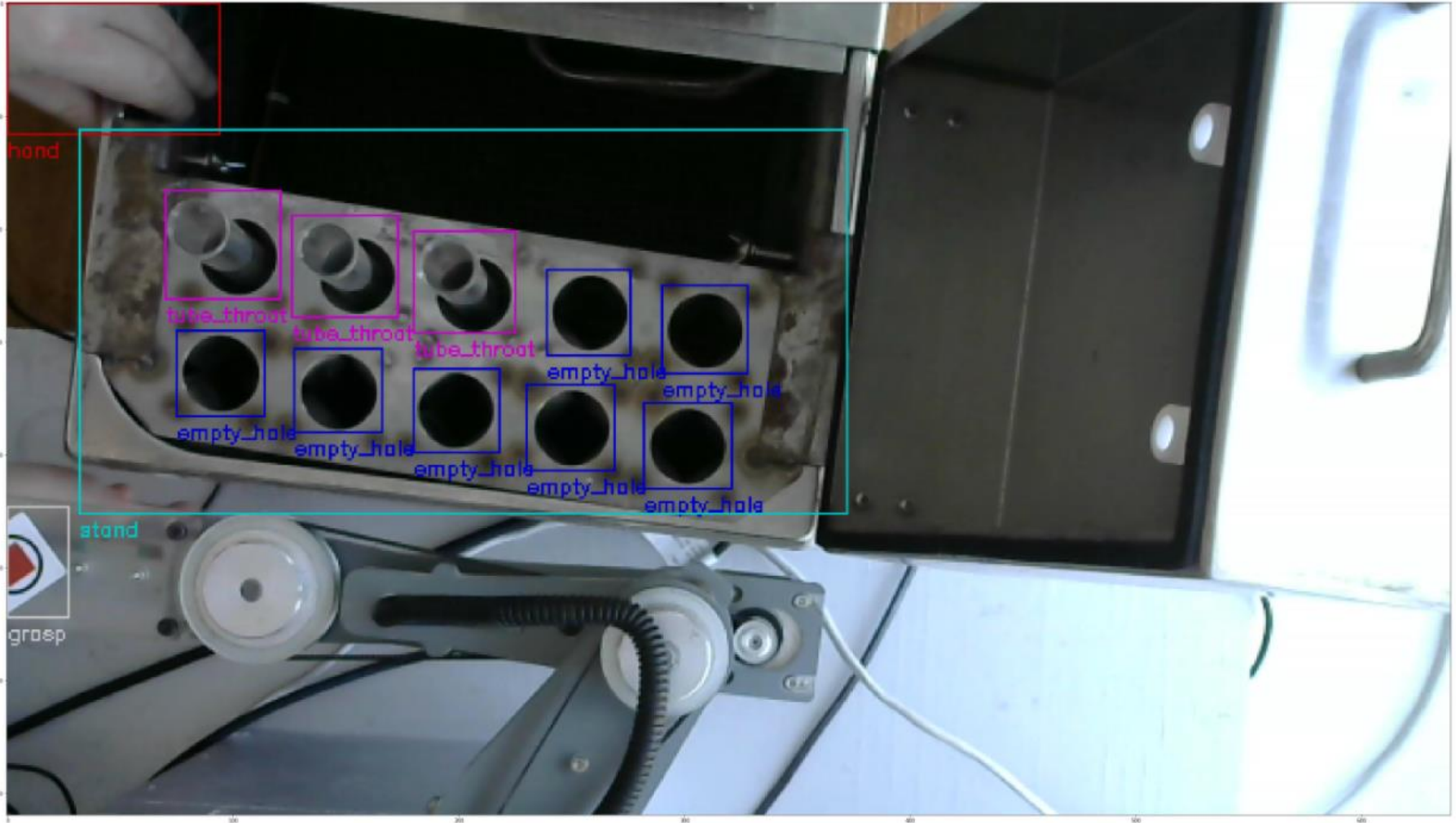


Source: <https://www.pyimagesearch.com/2016/11/07/intersection-over-union-iou-for-object-detection/>

- Threshold value of 0.3
- The result of object detection was greatly satisfied
- Shaker body showed poorer score than other objects because of, in the test images, their surface was partially blocked by other objects







# Conclusion

- MMDetection provides numerous model inference codes and trained weights, that facilitates the users to perform tasks
- We obtained the intersection-over-union scores over 0.9 on most objects
- The shaker body received the lowest score of 0.838 among the others. It can be improved with larger train dataset



# Contributions

- We show that instance segmentation task with deep learning approach can be performed and yielded satisfied results on MMDetection, an alternative tool apart of Tensorflow or Pytorch
- The chemical apparatus detectors can be developed further and applied with robotic arms such as SCARA (Selective Compliance Assembly Robot Arm) in order to automate the tasks

# References

[1] <https://github.com/wkentaro/labelme>

[2] [https://github.com/open-mmlab/mmdetection/tree/master/configs/cascade\\_rcnn](https://github.com/open-mmlab/mmdetection/tree/master/configs/cascade_rcnn)

