How to tune a Random Forest for Real-Time Segmentation in Safe Human-Robot Collaboration?

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Problem Statement:

In the industrial scenario humans and robots often share the same workspace posing a lot of threats to human safety issues.
We focus on the:

- Intuitive and natural human-robot interaction.
- Safety considerations and measures in a shared work environment.
- The realization of cooperative process.
- The workflow optimization.

Related Work:

- This work builds on top of our previous work Sharma *et al.* [1,2,3] and Dittrich *et al.* [4] in order to improve segmentation performance.
- We use a random decision forest (RDF) for pixelwise object class labeling of human body-parts and industrial based components using depth measurements obtained from KINECT RGB-D ceiling sensor.

Acknowledgements:

- This work is supported by the BMBF funded project AMIKA and the EU project ROVINA.

References:

[1] V. Sharma, F. Dittrich, S. Yayilgan, and L. V. Gool. Improving Human Pose Recognition Accuracy Using CRF Modeling. In *CVPR Workshops*, 2015.

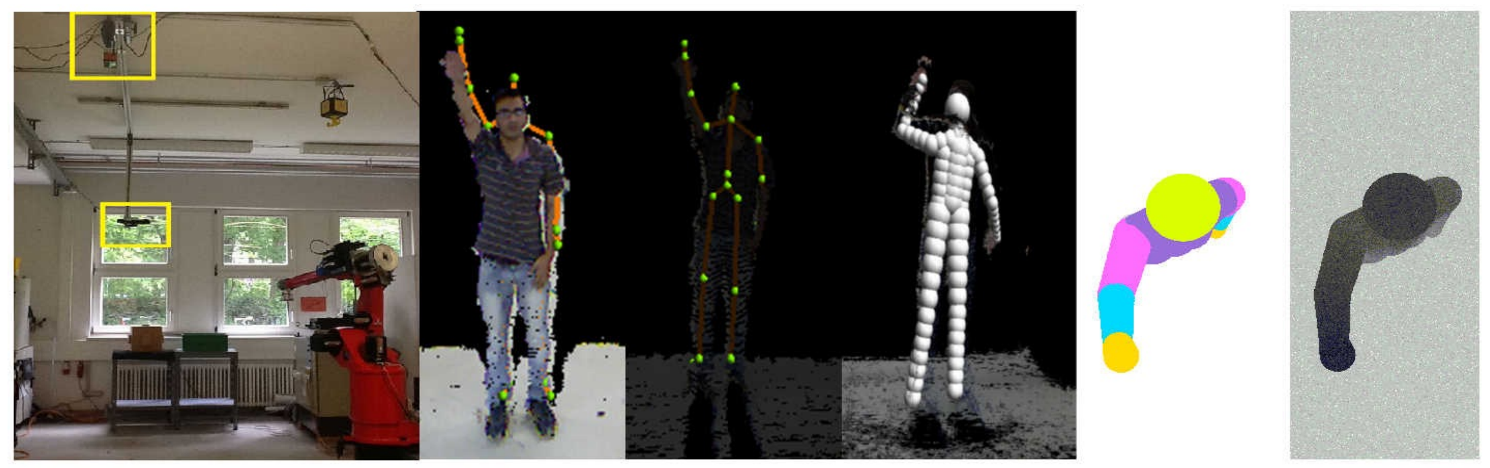
[2] V. Sharma, F. Dittrich, S. Yayilgan, and L. V. Gool. Efficient Real-Time Pixelwise Object Class Labeling for Safe Human-Robot Collaboration in Industrial Domain. In *ICML Workshops*, 2015.

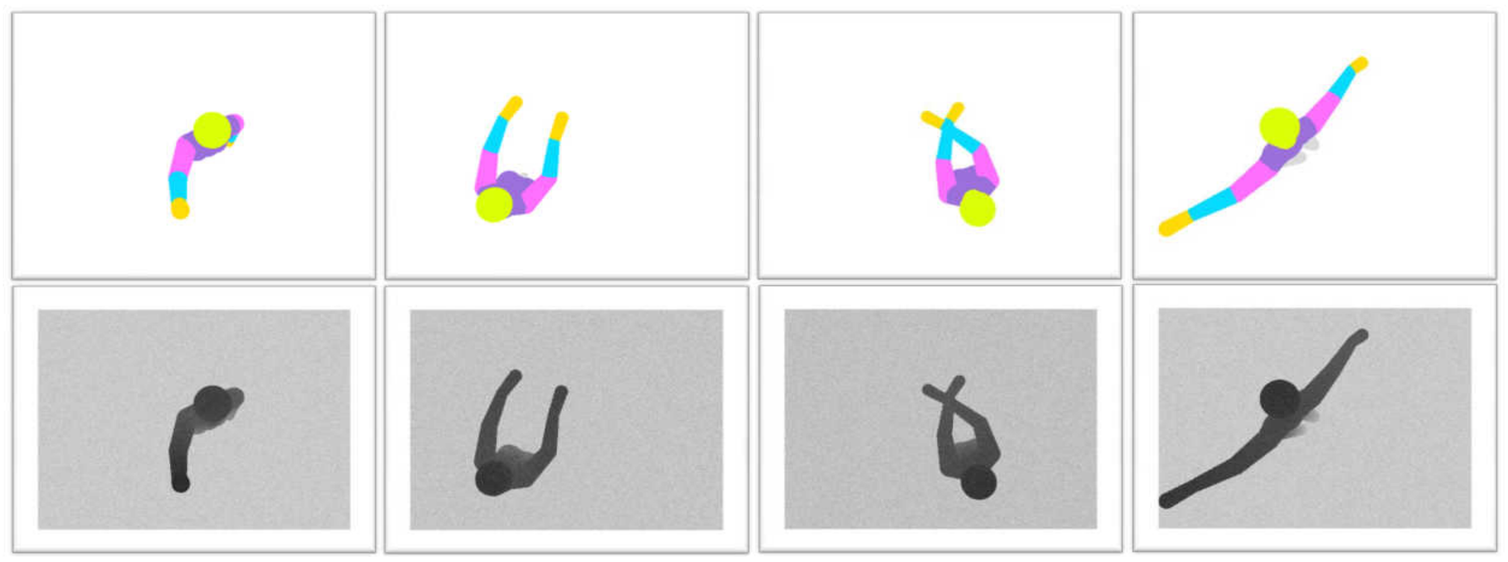
[3] V. Sharma, S. Yayilgan, and L. V. Gool. Scene Modeling using a Density Function Improves Segmentation Performance. KU Leuven, *Tech. Report*, 2015.

[4] F. Dittrich, V. Sharma, S. Yayilgan, and H. Woern. Pixelwise object class segmentation based on synthetic data using an optimized training strategy. In *ICNSC*, 2014.

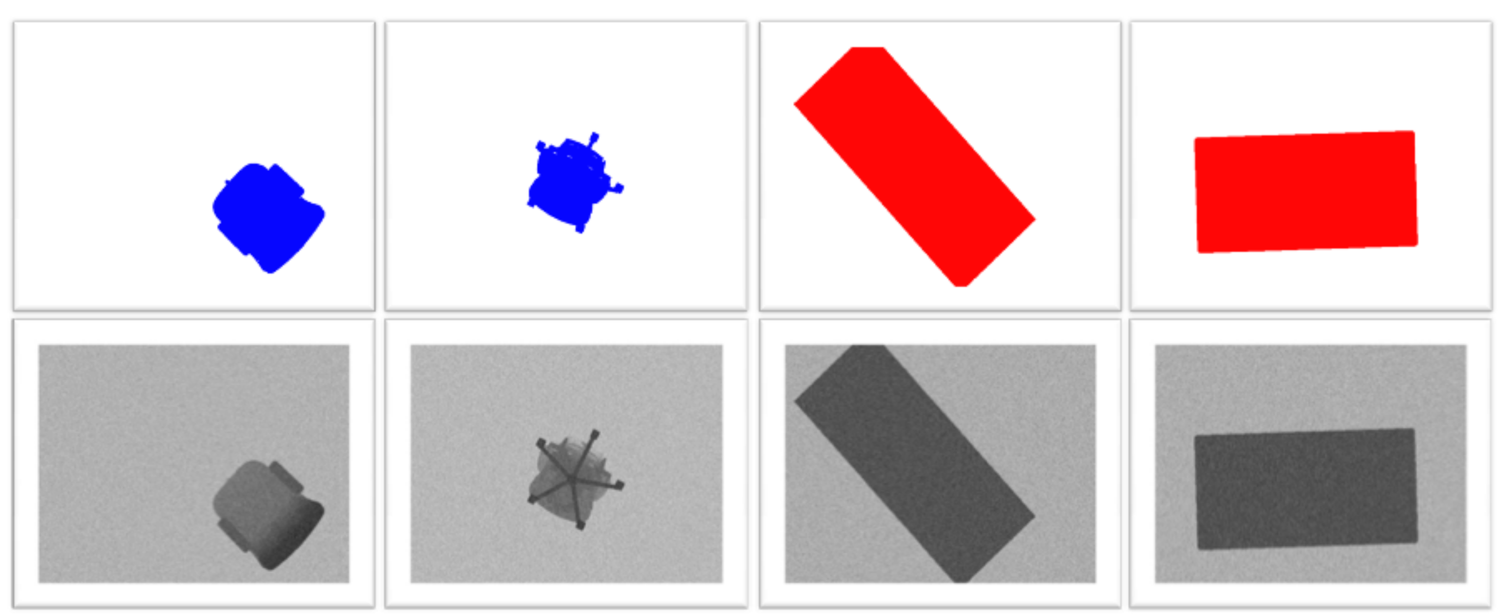
Data Collection:

- Human body-parts*: head, body, upper-arm (Uarm), lower-arm (Larm), hand, and legs*.
- Poses and shape*: sitting, standing, walking, working, dancing, swinging, boxing, tilting, bending, bowing, and stretching* with combinations of angled arms, single and both arms and other combinations.
- Human height range: 160-190 cm.



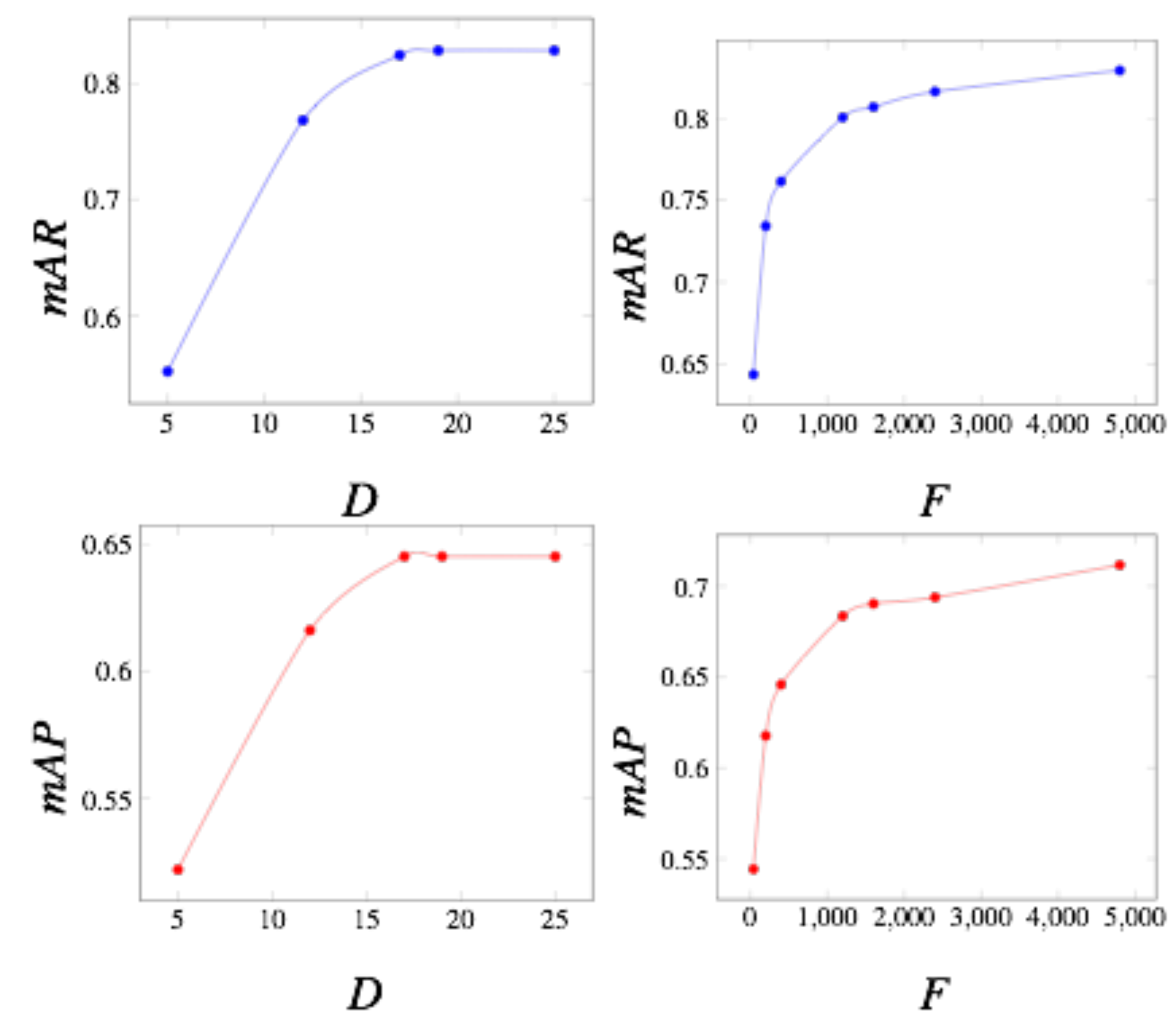


- For chair, table, plant and storage object classes, 4 instances were chosen for each object class which are: *executive chair with and without handles; conference rectangular table and conference round table; shrubs, flowers and plants within pot; small sized shelves and wardrobes* based on industrial workspace and office domain.
- The height range of industrial grade object classes is between 70-90 cm.

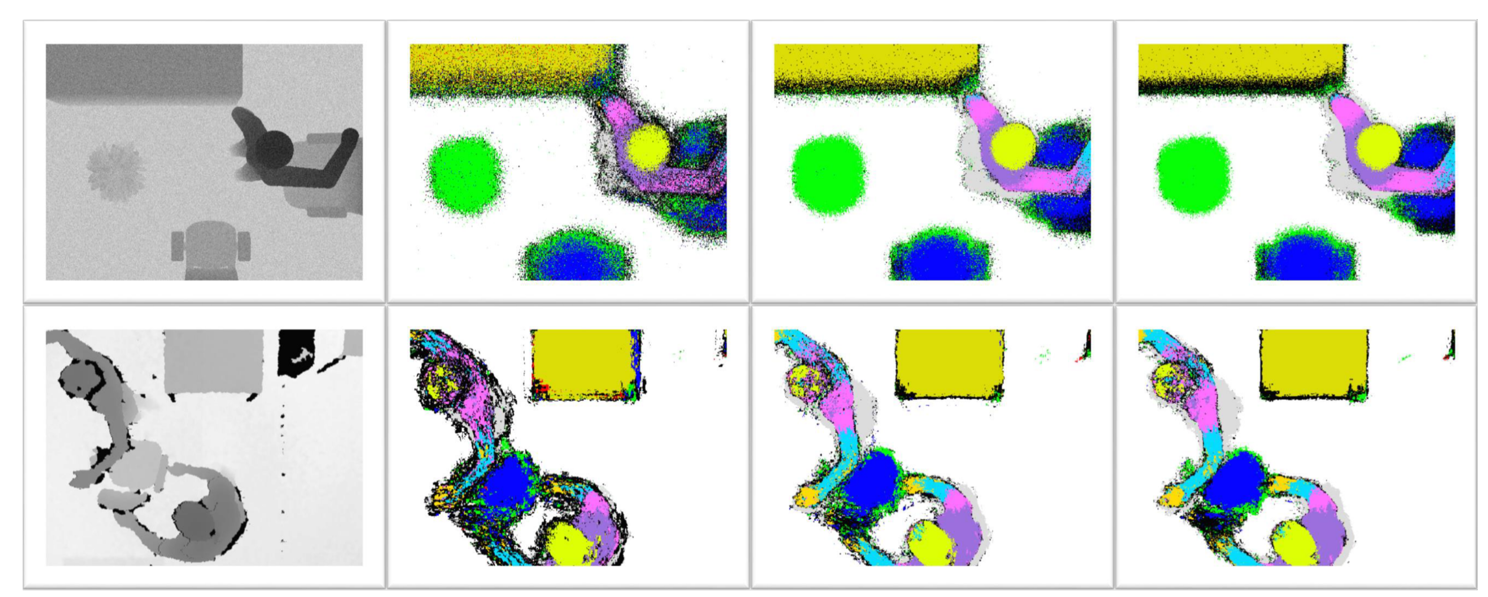


Segmentation Results:

- Segmentation results based on real-world test depth data.
- The graphs given below shows the effect of the number of training frames (F) and tree depth (D) on mean average recall (mAR) and precision (mAP) measures of pixelwise object class segmentation.



- Prediction results based on synthetic and real-world test data for a varying number of training frames. The first column shows the test depth data, and second, third, fourth columns show the corresponding prediction results respectively for F={40, **1600**, 4800} with a probability threshold of 0.4. Class predictions with a probability less than the threshold are colored black in the result images.



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