HIGHLY OPTIMIZED LANDMARK LOCALIZATION IN MEDICAL IMAGES

Major D., Schulze F., Hladůvka J., Bühler K. - VRVis
{major, schulze, hladuvka, buehler}@vrvis.at

vrvis
zentrum für virtual reality und visualisierung forschungs-gmbh

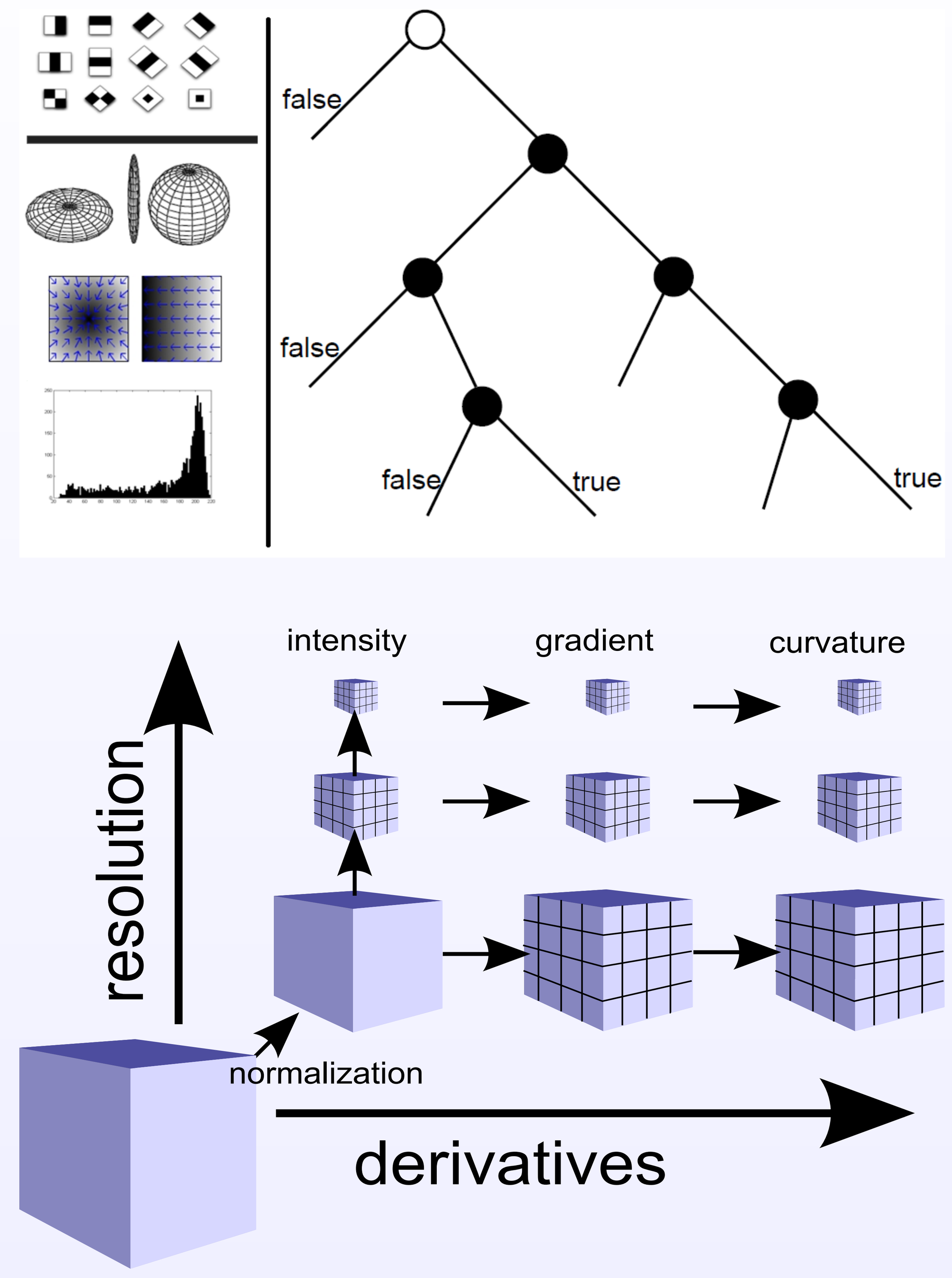
Abstract

Rapid and memory efficient detection of structures and landmarks in medical 3D image data is a key component for many medical applications. Having these goals in mind, we developed a highly optimized classifier using probabilistic boosting trees (PBT). Memory efficiency was achieved applying a block cache data structure. Tests on real world clinical datasets showed that our optimized approach outperforms standard setups of the classifier even in an environment with limited memory resources. Our current work deals with the selection of an optimal set of candidates from different detectors for the localization of anatomical landmarks.

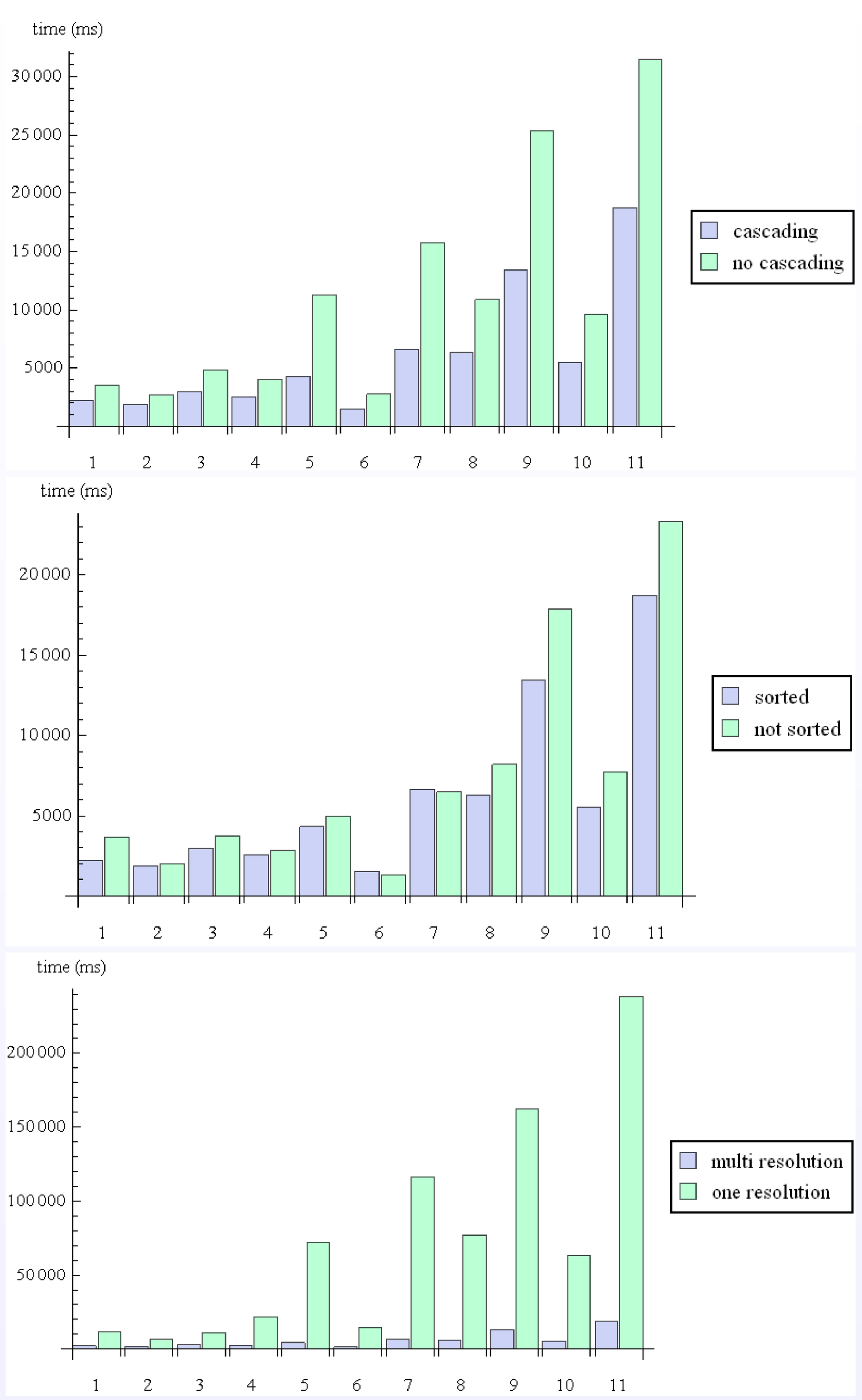
Highly Optimized Detection Framework

For anatomical structure detection in medical 3D image data, we train a voxel-wise target-structure/background classifier with the following characteristics [1]:

- It uses a **PBT** which holds a linear combination of weak classifiers (i.e. Haar-like features, structure tensors) at each tree node.
- Top levels of the tree use **cascading** considering only samples classified as target-structure at subsequent levels.
- **Classifiers** are **sorted** ascending after their computational costs.
- Classification is applied from low-to-high **resolutions**.
- Using an on demand **cached block** data structure helps to keep the memory footprint manageable.

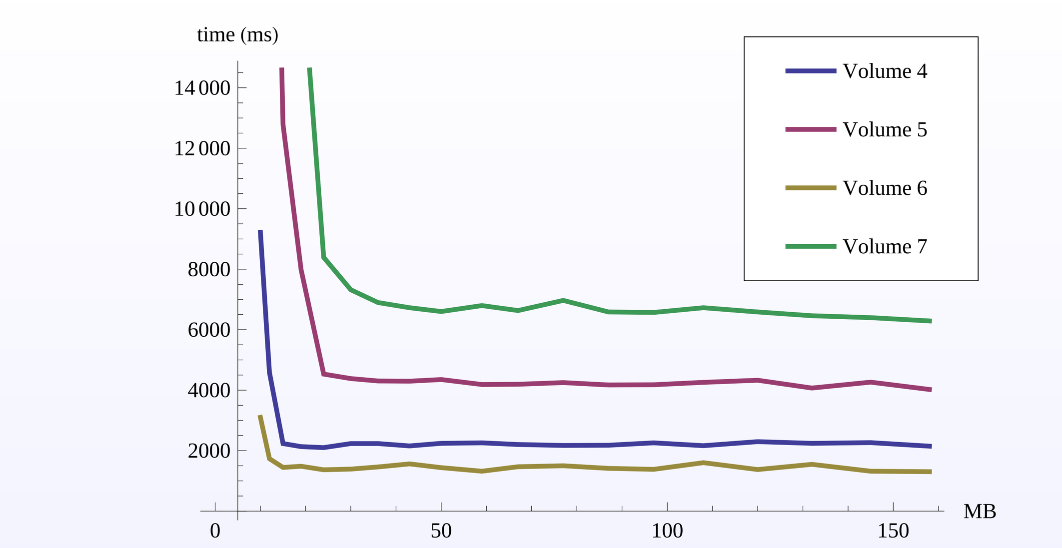


Detection Speed-up



Detection time performance on 11 CT volumes - optimized vs. standard setups.

Detection Memory Needs

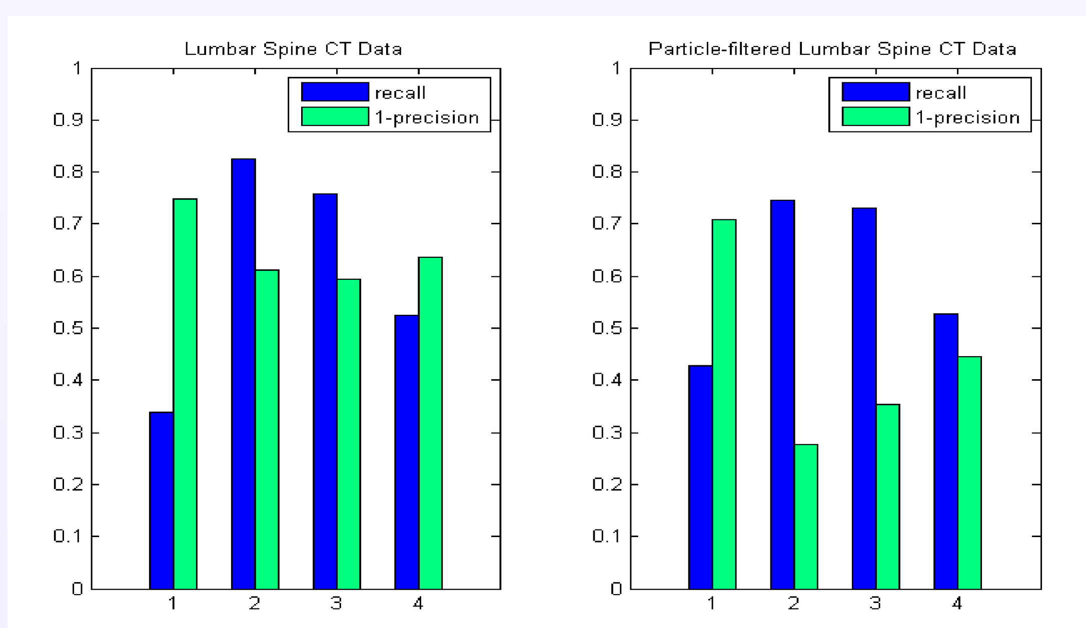


Time performance/memory bound relationship on 4 CT volumes.

Detection Accuracy

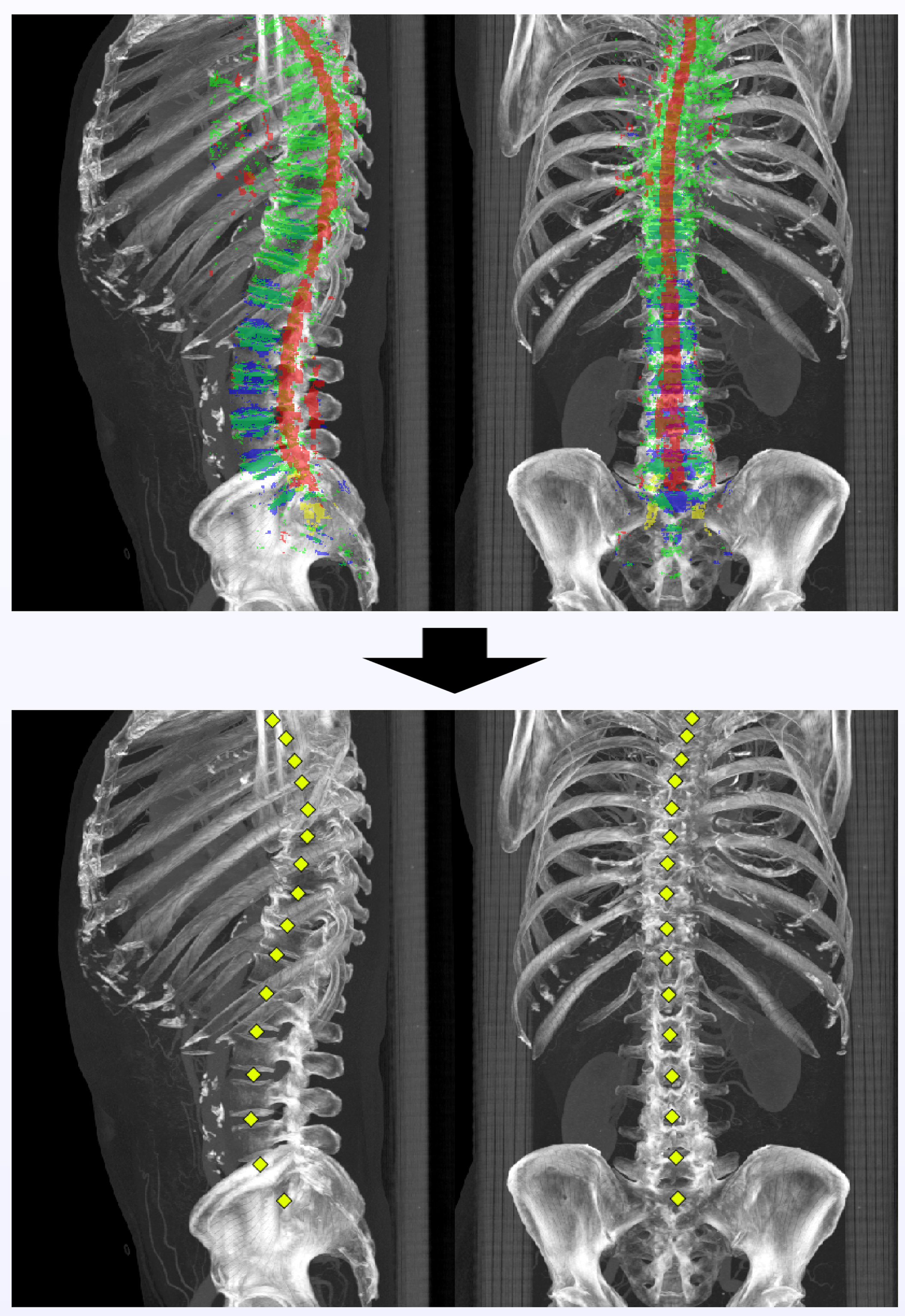
Training and *Testing*:

- 17 manually annotated spine CT volumes (4 for testing)
- **Target-structure**: lumbar intervertebral disc centers+proximity
- **Background**: randomly generated in the volume with safety margin to target-structure
- **Post-processing** by particle filtering or classifier posterior probabilities



Landmark Localization

Testing an image our trained detectors deliver multiple candidates for a (set of) landmark(s). In order to find an optimal set of candidates for the expected landmarks we apply a similar method described in [2].



Extracting intervertebral disc center points (yellow rhombi) from candidates of intervertebral disc detectors using other target-structure detectors (spinal canal, sacrum).

References

[1] Schulze F., Major D., Bühler K., Fast and Memory Efficient Feature Detection using Multiresolution Probabilistic Boosting Trees, in *Journal of WSCG*, 2011

[2] Donner R., Micušík B., Langs G., Bischof H., Sparse MRF Appearance Models for Fast Anatomical Structure Localisation, in *Proceedings of BMVC*, 2007