Master's Thesis in the Context of (Semantic) 3D Surface Reconstruction Using Satellite Images

In the department *Object Recognition* of the Fraunhofer Institute of Optronics, System Technologies and Image Exploitation (IOSB) we are working on the reconstruction of urban areas using multi-date satellite images. The corresponding three-dimensional models include not only texture information but also semantic labels. In order to manage the problem complexity, the task is decomposed into several, more controllable sub-problems. With the rapid advancement of computer vision there are frequently new possibilities available that allow to improve existing parts of our current processing pipeline.

Thus, we are offering several master's theses for improving specific sub-problems with current state-of-the-art techniques. Potential topics include (but are not necessarily limited to):

- **3D reconstruction / representation of satellite images** with Neural Radiance Fields [1, 3], Structure from Motion [5], or similar.

- **Semantic segmentation of satellite images** with SegFormers [4], Hierarchical Multi-Scale Attention [2], or similar.

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Requirements

- Enrolled in computer science or a similar field of study.
- Solid programming skills (preferably in python).
- High intrinsic motivation and interest to acquire knowledge of new methods reflecting the current state-of-the-art in computer vision.
- Experience relevant for the chosen topic (e.g. lecture attendance, seminars or internships in computer vision such as deep learning, structure from motion or similar).

Content of the master's thesis

The following outline represents a reference and might vary according to the selected topic:

- Literature search including the determination of current state-of-the-art methods and corresponding datasets.
- Adaptation of the selected methods to the domain of satellite images by addressing satellite-specific boundary conditions (if necessary).
- Integration of the (adapted) method into our framework.
- Quantitative evaluation of the developed method including a comparison with the baseline performance.
- Extension of the approach using own ideas to improve the quality of the obtained results.

What we offer

- The domain of the proposed thesis topics allow you to enhance your current skill set with scientific expertise in state-of-the-art computer vision methods.
- We offer support to publish your findings in a scientific paper (including conference attendance).
- Due to the current pandemic situation, we provide all required hardware components to work remotely.
- We also offer the option for topic-related student assistant / HiWi positions.

In case of identical qualifications, preference will be given to severely disabled candidates. The Fraunhofer-Gesellschaft is committed to providing equal career opportunities for men and women.

Contact & application

If you have any questions or would like to send us your application (including your **CV** and **Transcript of Records**), please contact: sebastian.bullinger@iosb.fraunhofer.de

References

[1] Dawa Derksen and Dario Izzo. Shadow neural radiance fields for multi-view satellite photogrammetry. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) Workshops*, 2021.

[2] Andrew Tao, Karan Sapra, and Bryan Catanzaro. Hierarchical multi-scale attention for semantic segmentation. *CoRR*, abs/2005.10821, 2020.

[3] Yuanbo Xiangli, Linning Xu, Xingang Pan, Nanxuan Zhao, Anyi Rao, Christian Theobalt, Bo Dai, and Dahua Lin. Citynerf: Building nerf at city scale. *arXiv preprint arXiv:2112.05504*, 2021.

[4] Enze Xie, Wenhai Wang, Zhiding Yu, Anima Anandkumar, Jose M Alvarez, and Ping Luo. Segformer: Simple and efficient design for semantic segmentation with transformers. *arXiv preprint arXiv:2105.15203*, 2021.

[5] Kai Zhang, Noah Snavely, and Jin Sun. Leveraging vision reconstruction pipelines for satellite imagery. In *Proceedings of the IEEE/CVF International Conference on Computer Vision (ICCV) Workshops*, 2019.