Internship in ESA's Advanced Concepts Team
On
Scene Representation Networks using LiDAR point cloud

European Space Research and Technology Centre
ESA ESTEC

Candidates interested are encouraged to visit the ESA website: www.esa.int/gsp/ACT/

Topic description

Scene Representation Networks (SRNs) are a type of neural network used to represent a scene implicitly as a continuous, differentiable function that maps a 3D world coordinate to a feature-based representation of the scene properties at that coordinate [1]. This type of network allows thus to generate views of a scene from unseen positions. In the literature, SRNs are trained with real-world images and showed impressive results [2]. One can assume that using a LiDAR point cloud, which embeds 3D information of the world coordinates, would improve the quality of the representation learned by these models. LiDAR (Light Detection and Ranging) systems allow fast and accurate measurements. Various applications use LiDAR, such as autonomous vehicles [2], atmospheric studies [3], landing site identification [4], or rendezvous maneuver and automatic docking [5].

In this context, this internship is aimed at building a dataset of synthetic LiDAR data based on 3D models of real satellites and to to assess different architectures of SRNs using the simulated LiDAR point cloud to segment the satellite parts and, for example, identify damages.

A direct application of such a method is the inspection of satellites in orbit to evaluate their status and plan their maintenance. The satellites in orbits are exposed to spatial debris that might damage them and thus reduce their lifespan. To maintain the satellites all along with their mission, inspection, and automatic identification of eventual damages are of great interest.

Candidate's tasks

- Identify datasets
- Train and Assess different SRN architecture
- Explore other Machine Learning based solution
- Study the impact of generated vs. real data

The ideal candidate

Mandatory:

- Strong programming skills in Python.
- Understanding of Supervised Learning and Artificial Neural Architectures.

Desirable:

• Familiarity with LiDAR point cloud data.

References

[1] Sitzmann, V., Zollhöfer, M., & Wetzstein, G. (2019). Scene representation networks: Continuous 3D-structure-aware neural scene representations. https://papers.nips.cc/paper/8396-scene-representation-networks-continuous-3d-structure-aware-neural-scene-representations.pdf

[2] Sitzmann, V., Martel, J. N., Bergman, A. W., Lindell, D. B., & Wetzstein, G. (2020). Implicit neural representations with periodic activation functions. arXiv:2006.09661

[2] Wang, H., Wang, B., Liu, B., Meng, X., & Yang, G. (2017). Pedestrian recognition and tracking using 3D LiDAR for autonomous vehicle. https://doi.org/10.1016/j.robot.2016.11.014

[3] Return of the LIDAR, ESA webpage, https://www.esa.int/ESA_Multimedia/Images/2020/08/Return_of_the_LIDAR

[4] Lunar LiDAR, ESA webpage, https://www.esa.int/ESA_Multimedia/Images/2019/01/Lunar_lidar

[5] ATV-5 set to test new rendezvous sensors, ESA webpage, https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/ATV/ATV-5_set_to_test_new_rendezvous_sensors