3D Building Surface Reconstruction with Radiance Fields

The field of 3D reconstruction has had a great impact in industrial and XR applications since the appearance of algorithms such as Neural Radiance Fields[1] (NeRFs) or 3D Gaussian Splatting[2] from NVIDIA (3DGS), capable of generating realistic 3D reconstructions of scenes and objects with a simple recording of a video. However, challenges remain in reconstructing Buildings[3], Avatars[4] and Complex Objects[5], including floating object removal, spatial and temporal coherence, few-shot reconstruction, frustum parameterization, shading estimation, structural priors, fidelity of measurement tools, accurate texture reconstruction, traceability and the space-time sequences. Here we emphasize the usage of AI and surface completion models for mesh reconstruction given predictions from NeRFs and 3DGS.

This project focuses acquiring robust reconstructions of buildings in the context of virtual conference venues/omniconferences[6] and historical buildings[7] (i.e. taken from distinct orientations, devices and moments in time) in indoor and outdoor scenes. Here we include the usage of constrained[8] and unconstrained[9] structural priors as well as surface completion techniques[10] to increase the robustness and feasibility of building reconstructions. This focus will tackle the exploration of the capabilities on adapting and extending the current reconstruction algorithms and therefore integrating end-to-end architectures that solve the possible problems encountered with the distinct data characteristics.

Currently our team is developing tools[11] for benchmarking and improving the latest NeRF and 3DGS to address the specific challenges in Buildings, Complex Objects and Animatable Avatar reconstructions, with an emphasis on the issues present in structure-from-motion, full-body 3D reconstruction, 3D motion, adaptation to material characteristics, anomaly detection, among other challenges. The candidate student will delve into the fundamentals of NeRF, practical training, uses and possible improvements, comparing them with classic and SotA reconstruction techniques.

This project will be involved in both private and public projects under the supervision of grounded professionals in AI. It is desirable for the outcome from the experimentations to be published in a distinguished conference or journal.

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[1] https://www.matthewtancik.com/nerf
[2] https://repo-sam.inria.fr/fungraph/3d-gaussian-splatting/
[3] https://building3d.ucalgary.ca/reconstruction.php
[4] https://zju3dv.github.io/animatable_nerf/
[5] https://dorverbin.github.io/refnerf/
[6] https://www.livemedia.com/app/
[7] https://sangluisme.github.io/publications/historical_building/
[8] https://building3d.ucalgary.ca/reconstruction.php
[9] https://dust3r.europe.naverlabs.com/
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[11] https://github.com/dberga/nerfstudio