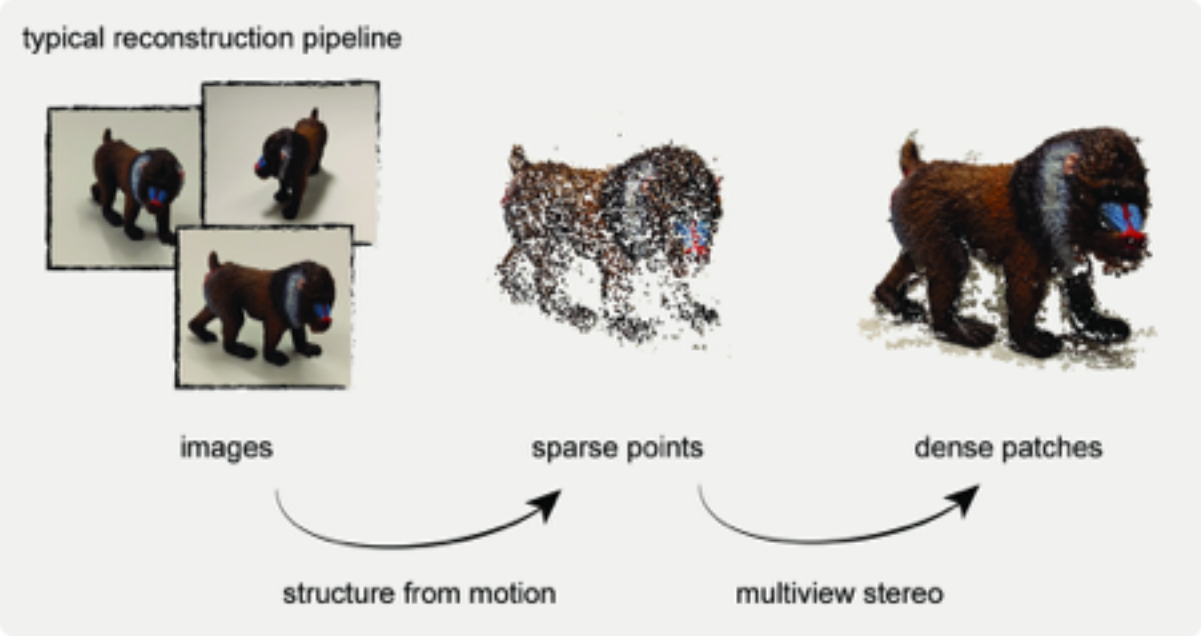
Progressive 3D Modeling All the Way

Recent work of Alex Locher, Michal Havlena and Luc Van Gool from the Computer Vision Lab at the ETH in Switzerland enables end to end progressive 3d reconstruction. The paper was presented on the International Conference on 3D Vision in Stanford California and won the best paper honorable mention award.

Creating 3D models out of 2D images

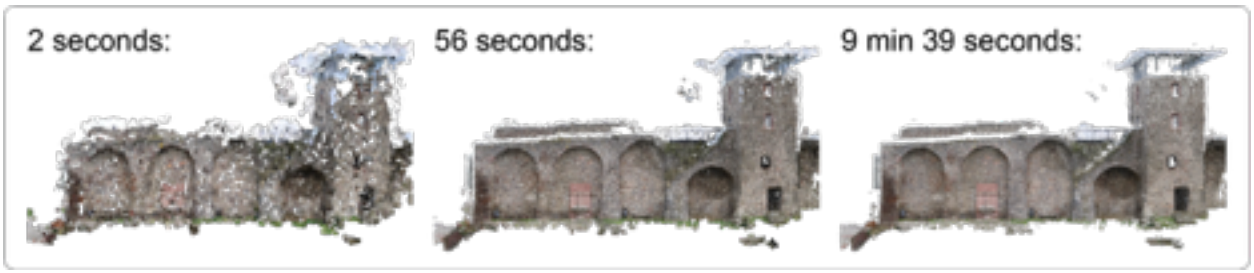
Mapping a real-world object into a virtual 3D model is one of the core concepts of the REPLICATE project. The underlying technology is called Structure from Motion (SfM) in which feature points are extracted from individual images of the same object and correspondences are established by image - to - image point matching. The triangulation of these points, followed by an bundle adjustment optimization delivers a sparse 3d point cloud. While these sparse point clouds capture the structure of the scene they are not very visually pleasing and not suited for direct application in AR/VR space. That's why in a second step, the sparse point cloud is densified and converted into a dense point cloud by a Multiview Stereo (MVS) algorithm.



What's the problem with classical pipelines?

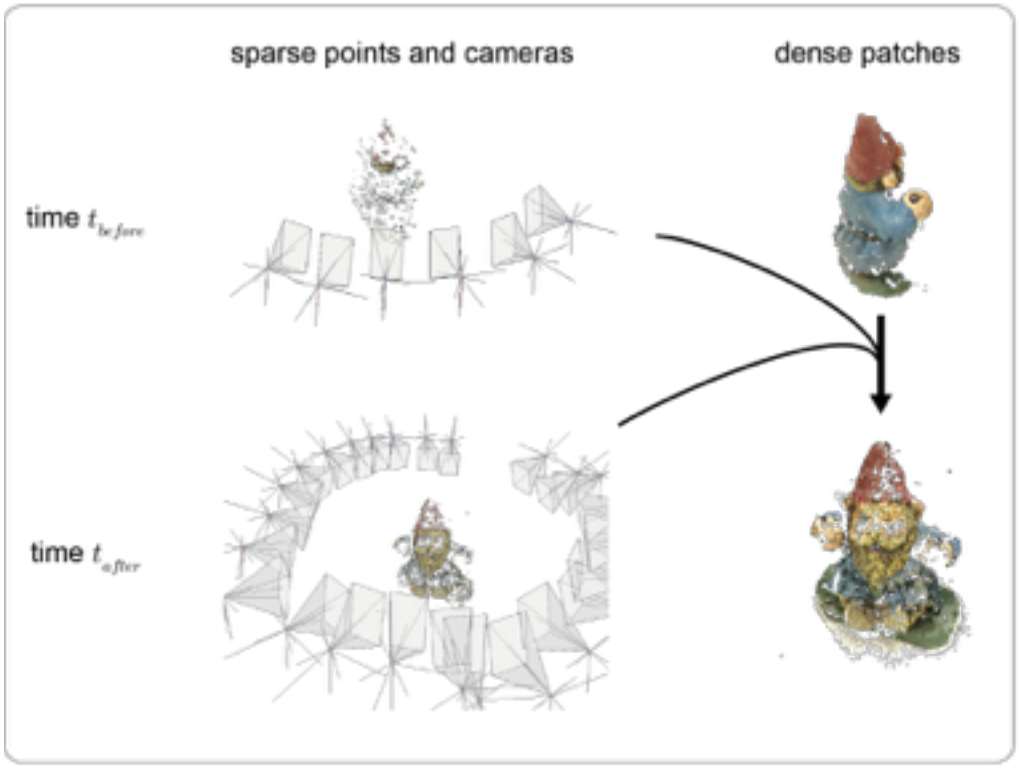
Classical reconstruction pipelines consider 3D reconstruction as a pure batch-processing task. It is assumed, that all images are available from start and the algorithm can work on them while providing a single output at the end. While the strategy generally leads to good results, it does not fit to the user centric scenario of REPLICATE, where images of a scene are gradually taken by potentially different users and the 3d model is built progressively. Users needs to have a feedback to the current reconstruction process as soon as possible, also enabling better model quality through being part of the reconstruction loop.

Incremental SfM pipelines [1] can deal to some extent with additional images and our recently proposed progressive solution for Multiview Stereo [2] delivers progressive output the more processing time is available.



Bridging the gap for progressive 3d modelling all the way

While both algorithms of the pipeline (SfM + MVS) can already deal with progressiveness on its own, the combination of both can still not be integrated in a fully progressive pipeline. As a result, the MVS algorithm would have to be re-run from scratch every time the sparse model changes and intermediate dense computations are lost.



In our work, we developed an effective algorithm to tackle this problem. The algorithm is able to adapt changes between consecutive sparse 3d point clouds and propagate them to the corresponding dense point cloud. This allows to reuse already computed results, leading to a speedup of up to one order of magnitude while maintaining the model quality. The algorithm uses the sparse 3d models of two time stamps and an early dense model as input and produces

the updated dense model as an output. More details on the algorithm itself are given in the paper [3].

3DV conference

The research was presented on the International Conference on 3D Vision in Stanford California on October 25th 2016 [3]. It received the best paper honorable mention award, sponsored by Google.

References

[1] Wu, Changchang. "VisualSFM: A visual structure from motion system." (2011).

[2] Locher, Alex, Michal Perdoch, and Luc Van Gool. "Progressive Prioritized Multi-View Stereo." *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*. 2016. http://www.vision.ee.ethz.ch/~alocher/pdf/locher_cvpr16_progressive_prioritized_mvs.pdf

[3] Locher, Alex, Michal Havlena, and Luc Van Gool. "Progressive 3D Modeling All the Way" *3DV*. 2016. http://www.vision.ee.ethz.ch/~alocher/pdf/locher_cvpr16_progressive_prioritized_mvs.pdf

CVL, Alex Locher, December 2016