Evaluating Structure-from-Motion on shiny and non-textured surfaces in borescope videos

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1 - Introduction

- 3D reconstruction could be beneficial for **damage assessment** of jet engines.
- **Structure from Motion** (SfM) run on **borescope** videos of engines for reconstruction.
- Problem: Jet engines often contain **shiny and non-textured surfaces.**

Goal: **Evaluate** performance of SfM on borescope videos with shiny and non-textured surfaces

2 - SfM

Incremental SfM:

- Generally more **robust**, can take long with lots of noise/outliers

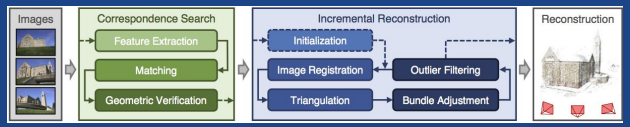

Figure 1: Incremental SfM pipeline [1]

Global SfM

- Potential for **speed and accuracy**, sensitive to outliers

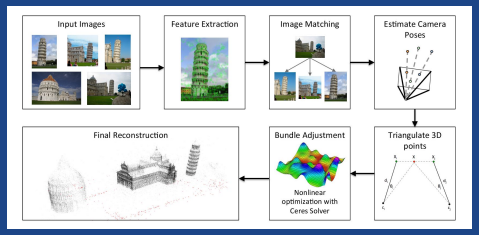

Figure 2: Global SfM pipeline [2]

3 - Experiments and results

- Experiments done on 3 different video
- SIFT feature detection used for global SfM
- **SIFT, SuperGlue (SG) and ground truth (GT)** feature detection used for Incremental SfM

1 2 3

Multi-View Stereo (MVS)

- Takes sparse point cloud and camera poses from SfM and creates a **dense model**

Model comparison

- Global SfM with SIFT could only create a sparse model for video 3

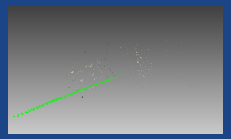

Figure 3: global sfm with SIFT

Incremental SfM + MVSZ

- **Good performance** on video 1 with SuperGlue and ground truth
- Video 2 only decent performance on ground truth
- SIFT, SuperGlue, and ground truth **identical** performance on video 3 with MVS

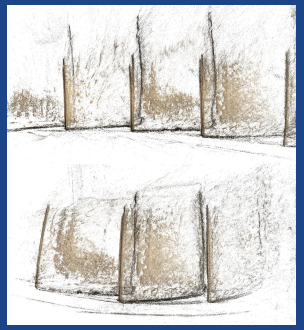

Figure 4: GT (top) and SG (bottom) SfM + MVS video 1

Figure 5: SfM + MVS model with SIFT

Damage visualisation

- **Large dents** clearly visible in GT, less clear using SuperGlue
- Inner part of blades not dense enough to visualize scratches

Figure 6: Damage in video, GT and SG (fLTR)

Data analysis

- Data analysis on sparse incremental SfM models

	#Points				Time (min)				Mean Reproj. Error (px)			
	SIFT	SG	LoFTR	GT	SIFT	SG	LoFTR	GT	SIFT	SG	LoFTR	GT
Video 1	716	1497	-	52409	2.0	1.7	-	14.78	0.58	1.28	-	1.35
Video 2	-	-	-	10283	-	-	-	20.8	-	-	-	1.35
Video 3	6924	4741	-	20782	14.1	22.0	-	45.2	1.09	1.41	-	1.28

4 - Conclusion

- Global SfM **underperforms** compared to incremental SfM using SIFT
- Good performance on videos with **low shininess or texture like grooves**
- Bad performance using SIFT and SuperGlue when surfaces are **shiny and low textured** (video 2)
- SfM has **potential** for utilization in damage assessment

5 - References

[1] Johannes L. Schönberger and Jan-Michael Frahm. Structure-from-motion revisited. 2016 IEEE Conference on Computer Vision and Pattern Recognition (CVPR), pages 4104–4113, 2016.

[2] Chris Sweeney, Tobias Höllerer, and M. Turk. Theia: A fast and scalable structure-from-motion library. Proceedings of the 23rd ACM international conference on Multimedia, 2015.