# 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

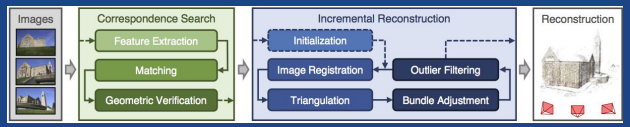



Figure 1: Incremental SfM pipeline [1]

**Global** SfM

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

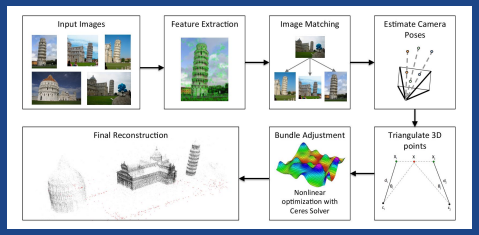
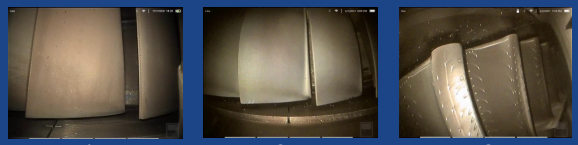



Figure 2: Global SfM pipeline [2]

## 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

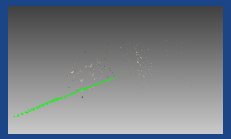


Figure 3: global sfm with SIFT

### Incremental SfM + MVS

- 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

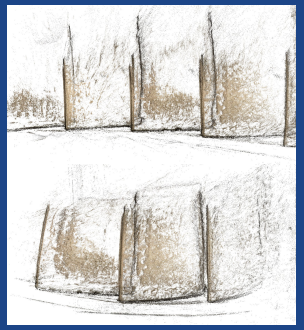


Figure 4: GT (top) and SG (bottom) SfM + MVS video 1

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.