Synthetic data for damage assessment in aircraft turbines

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Introduction

- Inside aircraft engine is difficult to inspect
- Components need to be in adequate condition to ensure safety
- Borescope videos allow technicians to inspect the propellor blades
- This time consuming and error prone task could potentially be solved with Computer Vision techniques
- SLAM and SfM are 3D reconstruction methods that could be used to measure damage.
- How can synthetic data assist?

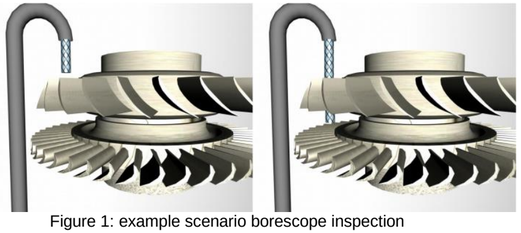

Figure 1: example scenario borescope inspection

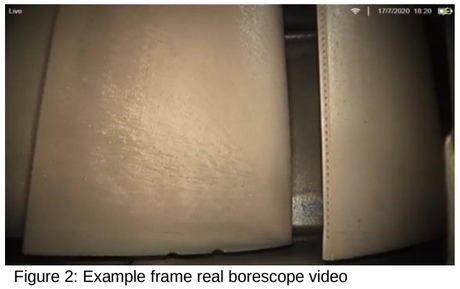

Figure 2: Example frame real borescope video

Research questions

> **How can synthetic data be created and used for borescope inspections of aircraft engines?**

> **How do SLAM and SfM compare on synthetic borescope videos of aircraft engines?**

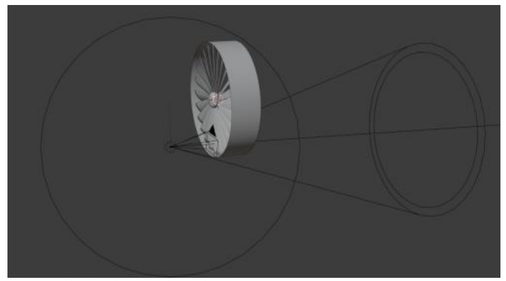

Figure 3: Testing setup Blender

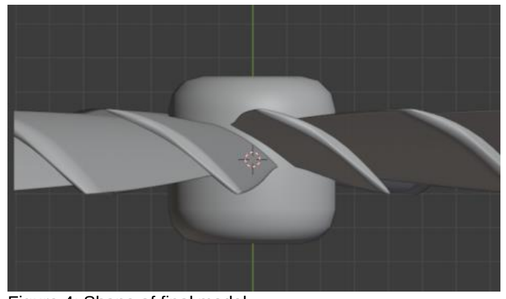

Figure 4: Shape of final model

Methodology

> Literature study on use cases and how to generate synthetic data.

> Manually modelling data to create synthetic borescope videos

> Run experiments on the synthetically generated videos to evaluate the data.

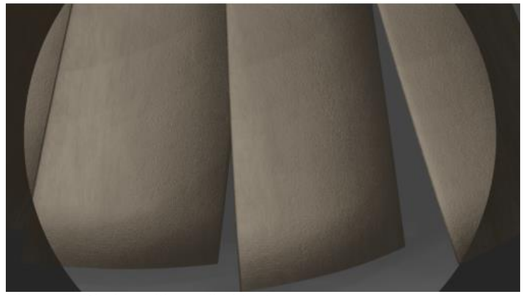

Figure 5: Blades with applied texture

Experiments

> **Experiment 1: different shapes for the propeller blades.**

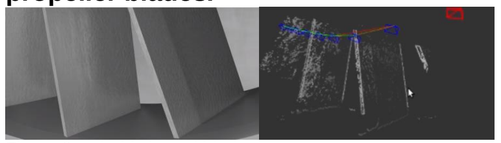

Figure 6: cuboid shaped blade

> **Experiment 2: different background textures.**

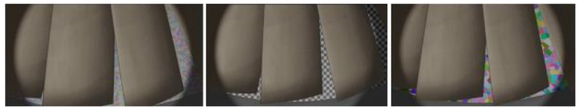

Figure 7: three frames of same model with different background textures

> **Experiment 3: lighting, texture and speed.**

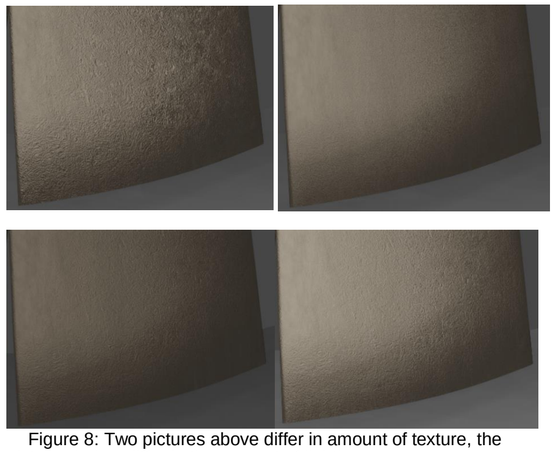

Figure 8: Two pictures above differ in amount of texture, the pictures below differ in the amount of lighting.

Results

Qualitatively the cuboid shaped blades performed a lot better than the rounder shaped ones.

	Gray	Noise	Checker	Voronoi	Metal	Real
SuperGlue	312	248	466	428	93	400-800
SIFT	612	560	1420	1254	577	1500
LoFTR	9980	-	-	-	-	5k

Table 1: number of interest points using different backgrounds and different feature detection algorithms.

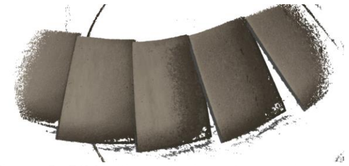

Figure 9: SfM with multi-view stereo, shows that although data of this study failed to act similar to real data, it is possible to produce good models

Conclusion & future work

> There are multiple possible applications for synthetic data in borescope damage assessment.
  - Improving interest point detection
  - Improving damage detection networks
  - Training personnel
  - Assess performance of algorithms

> This application requires mostly manual modelling

Experiments

> Although it's possible to create promising models of synthetic data using SLAM and SfM, the synthetic data generated in this study fails to consistently act similar to real data.