Performance analysis of interest point detection/matching on shiny and non-textured surfaces

A case study on aircraft engine borescope inspection videos

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Background

- Automated damage assessment in borescope inspection videos (See Figure 1)
- 3D models rely on interest point detection → good interest point detection / matching likely results in good 3D models
- Related work analyses algorithms in different environments → still unclear how these perform in these environments

Figure 1: A frame from one of the borescope inspection videos

Research Question

What interest point detection / matching algorithm performs best on shiny and non-textured surfaces as found in borescope inspection videos?

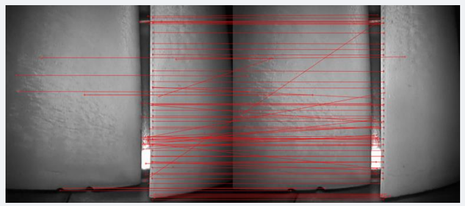

Figure 2a: Matches between two consecutive frames as computed by SIFT.

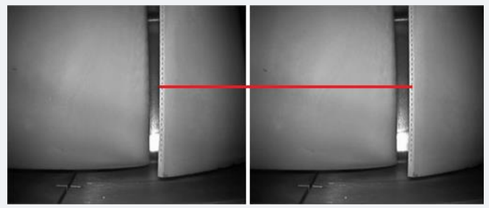

Figure 2b: An example of a relevant match

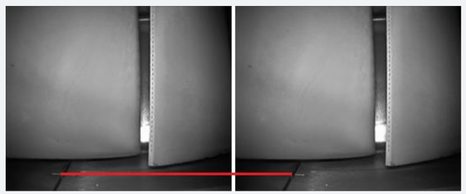

Figure 2c: An example of a irrelevant match

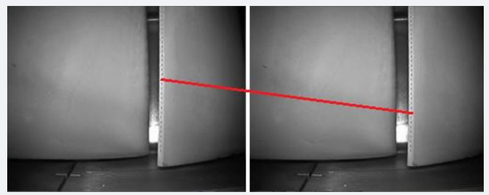

Figure 2d: An example of an incorrect match

Figure 2: Assessing individual matches on relevance and corectness

Method

- Compare both recent neural network and traditional approaches → SIFT, SuperGlue and LoFTR
- Evaluated on video segments of various borescope inspection videos
- Algorithms are assessed quantitatively by various metrics
  - Manual
  - Automated using RANSAC
- Qualitative assessment using SfM

Results

Algorithm	Avg # matches	% of irrelevant matches	% of correct matches	% of incorrect matches
SIFT	66.05	45	45	10
SuperGlue	555.89	37	62	1.0
LoFTR	5205.60	51	49	0.0

Table 1: results of manual assessment on the video found in figure 1

Algorithm	Avg # matches	Avg # correct matches	% of correct matches	% of incorrect matches
SIFT	63.40	51.54	81	19
SuperGlue	555.11	246.83	44	56
LoFTR	5205.60	4880.94	94	6.0

Table 2: results of automated assessment on the video found in figure 1

Figure 3: 3D model reconstructed with SfM using SIFT

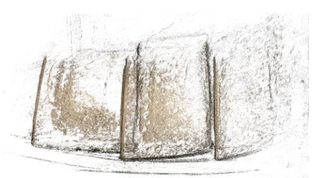

Figure 4: 3D model reconstructed with SfM using SuperGlue

- LoFTR detects more matches than SIFT and SuperGlue
- LoFTR has the lowest number of incorrect matches
- Qualitative results show that SuperGlue performs best with SfM

Conclusion

- *Neural network based approaches outperform traditional*
- *SuperGlue performing best in practice (SfM), LoFTR best according to metrics*
- *Test influence of different parameters*