EE 367 Final Project: Survey of Video Stabilization Methods

Olivia Loh, olivia77@stanford.edu

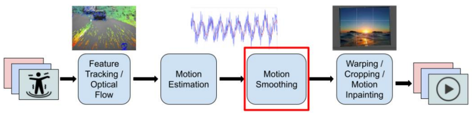
MOTIVATION

Video stabilization serves many purposes (filmmaking, vlogging, UAV) in reducing motion jitter to produce a smooth, cohesive video.

This project aims to survey iterative 2D video stabilization methods and compare them.

METHODOLOGY

STABILIZATION PIPELINE



STABILIZE CAMERA TRAJECTORY

Filtering

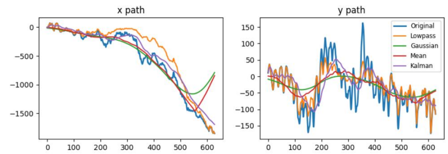
Previous research employ many signal processing techniques to denoise the camera trajectory [1]. This survey implements a variety of filters, as well as a hybrid filter combining Gaussian smoothing and Kalman filtering

L1 Optimization

A paper based on cinematic principles (zero 1st, 2nd, and 3rd derivatives of camera motion) proposed a linear programming framework to minimize the L1 norm of a residual derived from cinematic principles and impose proximity, inclusion, and saliency constraints [2].

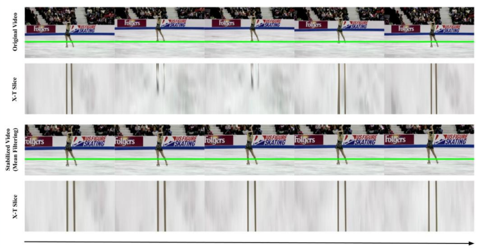
EXPERIMENTAL FINDINGS

FILTERING

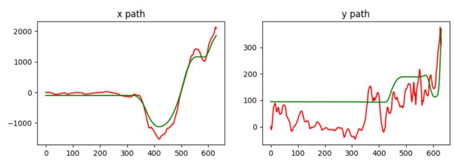


	Gaussian	Mean	Kalman	Hybrid
ITF (PSNR)	**27.12** dB	26.65 dB	23.02 dB	19.62 dB
GTF (PSNR)	12.14 dB	12.41 dB	12.35 dB	**12.61** dB
Crop Ratio (%)	93.57%	94.98%	97.19%	98.05%

*evaluated across DeepStab dataset



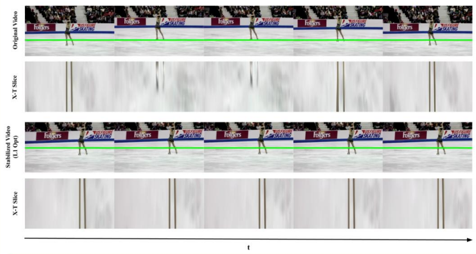
OPTIMIZATION



	L1 Optimization
ITF (PSNR)	25.18 dB
GTF (PSNR)	13.46 dB

*evaluated across DeepStab dataset

EXPERIMENTAL FINDINGS



CONCLUSION

- Simple filtering smoothes well, but loses more of input video information. Cannot handle extreme motion well.
- L1 Optimization still considered as state of the art method. Inclusion and proximity constraints ensure higher retention of input video information.
- Iterative methods are time efficient, can approx. real-time.
- Challenges in quantitatively evaluating video stabilization (VSQA). What defines a stable video? There is no ground truth. Few open-source datasets.
- Deep learning methods:
    - Target pipeline portions (optical flow, warping) [3].
    - Dynamic view synthesis methods (DynIBaR, NSFF) takes long to train [4,5].

REFERENCES

[1] Marcos Roberto e Souza, Helena de Almeida Maia, and Helio Pedrini. "Survey on Digital Video Stabilization: Concepts, Methods, and Challenges". In: ACM Comput. Surv. 55.3 (Feb. 2022). ISSN: 0360-0300. DOI: 10.1145/3494525. URL: https://doi.org/10.1145/3494525.

[2] Matthias Grundmann, Vivek Kwatra, and Irfan Essa. "Auto-directed video stabilization with robust L1 optimal camera paths". In: CVPR 2011. 2011, pp. 225-232. DOI: 10.1109/CVPR.2011.5995525.

[3] Yiming Wang et al. "Video stabilization: A comprehensive survey". In: Neurocomputing 516 (2023), pp. 205-230. ISSN: 0925-2312. DOI: https://doi.org/10.1016/j.neucom.2022.10.008. URL: https://www.sciencedirect.com/science/article/pii/S092523122201270X.

[4] Zhengqi Li et al. DynIBaR: Neural Dynamic Image-Based Rendering. 2023. arXiv: 2211.11082 [cs.CV].

[5] Zhengqi Li et al. Neural Scene Flow Fields for Space-Time View Synthesis of Dynamic Scenes. 2021. arXiv: 2011.13084 [cs.CV].