# Video Stabilization(Classic Method) Project Proposal

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## Abstract

One of the most apparent video quality differences between professional and amateur level contents resides in camera motion stability, and while the industry has developed various optical sensors/equipment that specifically target in-motion-shooting stabilization, those approaches are sometimes unavailable, or impractical for non-professional content creators. In light of the obstacles above, this project aims to investigate a software-level solution to video stabilization. Prior research focused on developing video stabilization algorithm in two main branches: the neural network (object recognition) and classical video processing (trajectory prediction) methods. We decided to adopt the classical video processing path in this project for the following two reasons:

1. Neural network model training requires a large dataset, thus it is very difficult to find videos that come in prediction and ground truth pairs for the network to train on.

2. Classical video processing simplifies 3D content reconstruction into inter-frame 2D trajectory prediction, resulting in an algorithm that is both easy to understand and reasonably efficient.

## Related Work

1. Feature-based algorithm using Scale Invariant Feature Transform(Battiato et al. 2007)

2. This algorithm is inspired from 3D stabilization techniques to improve 2D reconstruction through maintaining low-rank constraints, i.e: to resolve the non-linear trajectory matrix optimization into linear within fixed number of frames.(Liu et al. 2011)

3. This algorithm refined the trajectory feature retrieving using ”adding”, ”linking”, and ”propagation” (Lee et al. 2009)

4. This algorithm utilizes in-built commercial gyroscope to enhance the accuracy of angle rotation in error measuring of trajectory estimation.(Karpenko et al. 2011)

5.Compute camera path P(t) to adhere to cinematographic characteristics, and cast the optimization to a constrained L1 minimization problem.(Grundmann, Kwatra, and Essa 2011)



## Structure and Process

### Objectives

- What video content is to be generated?
  **Solution:** With a random unprocessed short video from hand-held camera as the input, our algorithm is designed to remove as much unintentional camera jittering as possible and output processed video that maintains original quality.
- For what purpose and for what use?
  **Solution:** The algorithm is ideally light-weight and real-time responsive, thus could be incorporated into mobile devices or web-based streaming platform.

### Representation

- What are the concepts to be manipulated?
  **Solution:** Depending on the exact algorithm we adopt, core components and concepts utilized might involve feature extraction, trajectory estimation, and Least Squares loss function, etc.
- What input format is to be used?
  **Solution:** ideally videos with the same frame rate and resolution.

### Architecture

- What type(s) of fundamental technique is to be used?
  **Solution:** Our algorithm might be based on tracking SIFT features with modifications on model fitting and error estimation.

## Project Schedule

### Prepare

- Identify goals and distribute works.
- Deadline: Feburary 28th
- Responsibility: All members

### Literature search

- search related paper and learn different methods, might combine the useful methods for our own project.
- Deadline: March 10th
- Responsibility: All members

### Preprocess Data

- find suitable/shaky videos at 30fps and cut into clips that last a few seconds.
- Deadline: March 15th
- Responsibility: All members

### Implementation

- Implement selected researched versions of basic video processing architectures based on SIFT. Each algorithm should differ in trajectory feature extraction or mean error
- Deadline: April 15th.
- Responsibility: Each member will implement one version of SIFT-based architecture.

### Optimization

- Optimize the algorithm with different ways to identify the SIFT features and different error minimization methods. We may try explore the approaches that not be mentioned in the Reference materials.
- Deadline: May 1st
- Responsibility: All members

### Comparison Evaluation

- Evaluate and compare performance with a video stabilization tool that is out on the market. We would be using performance metrics such as PSF(Point Spread Function) and PSNR(Peak Signal-to-Noise Ratio) to assess and compare the performances.
- Deadline: May 8th
- Responsibility: All members

### Prepare Final presentation

- Collect and sort data. Finish final report and prepare PowerPoint for final presentation. Distribute role for final presentation.
- Deadline: May 12th

### Final presentation

- Code demo and final results presentation.
- Deadline: May 13th

## References


Battiato, S.; Gallo, G.; Puglisi, G.; and Scellato, S. 2007. Sift features tracking for video stabilization. In *14th international conference on image analysis and processing (ICIAP 2007)*, 825–830. IEEE.

Grundmann, M.; Kwatra, V.; and Essa, I. 2011. Auto-directed video stabilization with robust l1 optimal camera paths. 8.

Karpenko, A.; Jacobs, D.; Baek, J.; and Levoy, M. 2011. Digital video stabilization and rolling shutter correction using gyroscopes. *CSTR* 1(2):13.

Lee, K.-Y.; Chuang, Y.-Y.; Chen, B.-Y.; and Ouhyoung, M. 2009. Video stabilization using robust feature trajectories. In *2009 IEEE 12th International Conference on Computer Vision*, 1397–1404. IEEE.

Liu, F.; Gleicher, M.; Wang, J.; Jin, H.; and Agarwala, A. 2011. Subspace video stabilization. *ACM Transactions on Graphics (TOG)* 30(1):1–10.