Video Stabilization

Exploratory Project Report

MEMBERS

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CERTIFICATE

This is to certify that the Exploratory Project entitled "**Video Stabilization**" submitted by Divyansh Sharma (22095144), Kothapalli Santosh (22095054) and Deepaprakash K (22095031), to the Department of Electronics Engineering, Indian Institute of Technology (Banaras Hindu University) Varanasi, in partial fulfilment of the requirements for the award of the degree "Bachelor of Technology" in Electronics Engineering is an authentic work carried out at Department of Electronics Engineering, Indian Institute of Technology (Banaras Hindu University) Varanasi under my supervision and guidance on the concept vide project grant as acknowledged.

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DECLARATION

I hereby declare that the work presented in this project titled "**Video Stabilization**" is an authentic record of our own work carried out at the Department of Electronics Engineering, Indian Institute of Technology (Banaras Hindu University), Varanasi as requirement for the award of degree of Bachelors of Technology in Electronics Engineering, submitted in the Indian Institute of Technology (Banaras Hindu University) Varanasi under the supervision of Dr. Kishor P. Sarawadekar, Department of Electronics Engineering, Indian Institute of Technology (Banaras Hindu University) Varanasi. It does not contain any part of the work, which has been submitted for the award of any degree either in this Institute or in other University/Deemed University without proper citation.

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ABSTRACT

Undesired jitters are caused by unwanted and unintentional movements of our hands while holding a camera. Video stabilization algorithms aim to accomplish a stable video by either mechanically moving the camera's lens or leveraging some kind of algorithms in order to stabilize the video. Some use a combination of both above stated methods and are hence state of the art. Optical Video Stabilization is one such example which uses the mechanical movement of the lens in order to achieve a stable video. But, this cannot be used for recorded videos, thus in order to make it suitable for recorded videos as well Digital Video Stabilization can be used. One such algorithm which works on the basis of feature matching and applying transformation techniques for video stabilization has been explored here. This project involves keypoint corner detection in order to identify unique features of every scene captured by the camera, estimates an image transform between consecutive frames of the video and finally warps the frames according to the perspective frame of the previous frame. By exploiting these feature points, we can extract local information also called as descriptors about the surrounding area. The observations were significantly good and it was tested by viewing the un-stabilized. There was warping and cropping of the image which resulted in loss of information from the edges of the video, but the center of the video had all its information preserved along with stability. This algorithm-based stabilization technique proved to be very power efficient since it was also tested by running it on a PYNQ Z2 board and saving the stabilized video in an 'avi' format.

Contents

Chapter 1
INTRODUCTION

1.1 MOTIVATION

Due to unwanted jitters, destabilization occurs in videos, resulting in blurring and distortion, which detracts from the essence of using technology to capture them.This necessitates the need for video stabilization whose main purpose is to eliminate all unwanted movements to obtain a stable and good quality video. Power Constraint is a major factor in the domain of image processing. Hence, we need to make sure that these devices are able to perform the same task with the same speed as their superior counterparts. First, we discuss the existing technologies and challenges in this task, then we continue on with the problem statement, proposed solutions, results of the implemented solutions, and then we finally conclude with the challenges, conclusions and any possible future work regarding this task. The final implementation of this was performed on the PYNQ Z2 board. The final result was an 'avi' file which contained both original un-stabilized video and the stabilized resultant video in a split screen format.

1.2 EXISTING TECHNOLOGIES AND CHALLENGES

The smartphones these days already use the state of the art technology of OIS[1] and are able to produce high quality stable videos. However, having a high performance does not necessarily imply that we can achieve the same result on all the devices. The devices having low power capacity might not be able to run such high-end computations in them, hence the need to design algorithms with some simple computation techniques and almost similar efficiency. This will enable all devices to produce better results. The feature matching based algorithm comes to the rescue in these situations.

1.3 PROBLEM STATEMENT

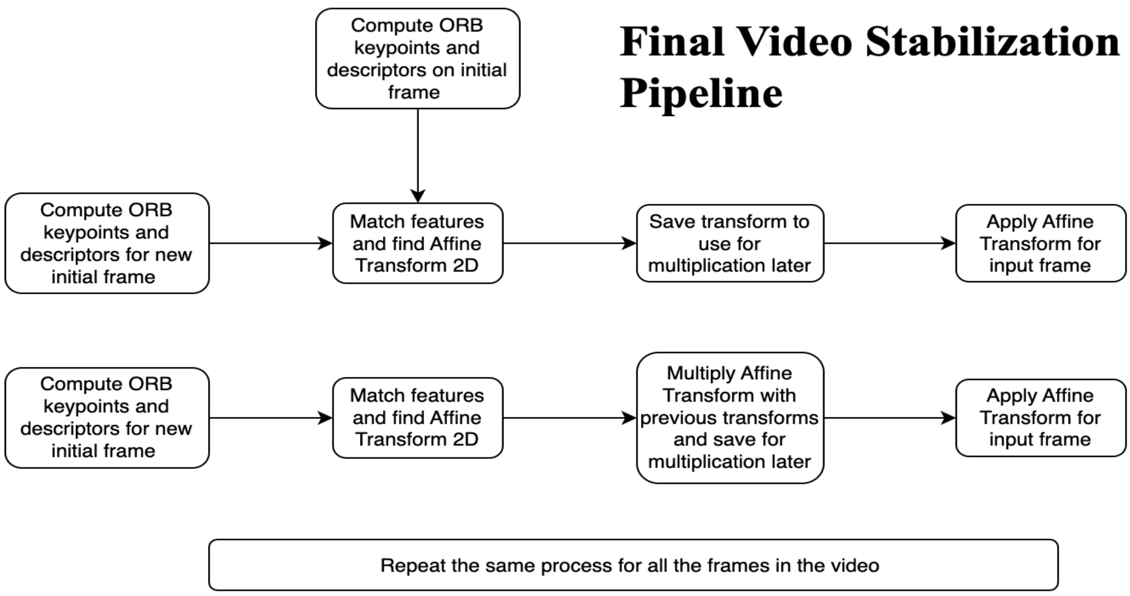
Designing a video stabilization system tailored for recorded videos to rectify camera motion distortions, enhancing playback quality and user experience. The project focuses on developing an effective algorithm capable of post-processing recorded footage to reduce shakes and jitters. By optimizing for accuracy rather than real-time performance, the solution aims to deliver superior stabilization results, elevating the quality of recorded videos for diverse applications.

1.4 Proposed Solutions

The initial steps in our video stabilization pipeline involve point feature detection and matching [5]. Renowned techniques for keypoint detection include SIFT and SURF [2][3]. However, due to their computational costs, ORB serves as a more economical alternative [4]. After extracting feature descriptors, we aim to derive a transformation to gauge motion between frames. Assuming no large sudden movements, a 2D model suffices, making affine transform a computationally cheaper option compared to homography.

Hardware Implementation

The above stated implementations were successfully implemented on the PYNQ Z2 board. The PYNQ-Z2 board is a development board designed for the Xilinx Zynq System-on-Chip (SoC). It falls under the umbrella of the PYNQ project, which aims to bring the benefits of programmable logic and accelerated computing to the Python programming language and ecosystem. The final output video was successfully saved and observed to have a stable quality.

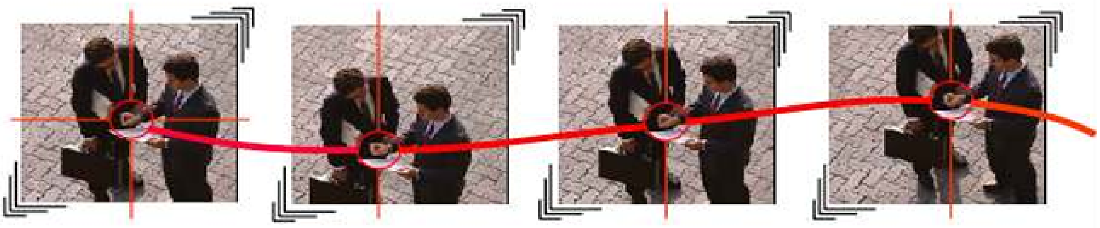


Chapter 2

RESULTS AND DISCUSSIONS

We successfully achieved video stabilization through our project, effectively mitigating camera motion and enhancing the overall viewing experience.

By analyzing motion patterns and applying correction mechanisms, we have successfully transformed shaky, unstable footage into smooth, stabilized video.



Un-stabilised video sequence

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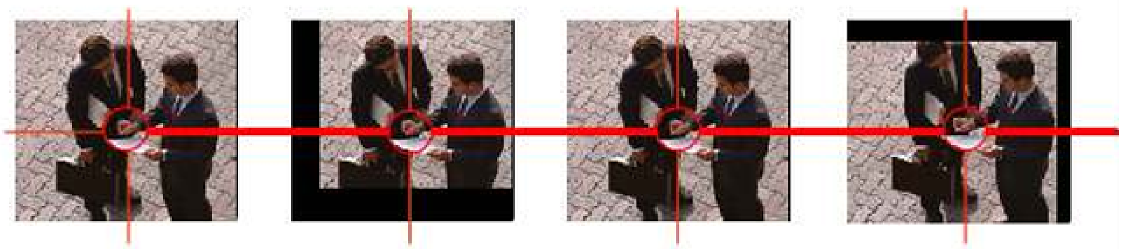

Stabilised video sequence

We explored the PYNQ board and successfully implemented our video stabilization algorithm on it. This allowed us to leverage its capabilities for enhanced performance and efficiency in our project. The observed results were very promising towards designing an algorithm for real time video stabilization on FPGAs such as the PYNQ board.

Chapter 3

CHALLENGES, CONCLUSIONS AND FUTURE SCOPE

3.1 CHALLENGES

This algorithm consumes less power compared to traditional methods such as OIS, making it suitable for scalability on lower-end devices. However, when implemented on the PYNQ board, we observed potential frame drops when aiming for real-time processing. This highlights the necessity for optimizing the algorithm for faster execution or accelerating the OpenCV functions within the code. Additionally, a significant challenge lies in the output video, which tends to occupy more memory than the input video, leading to inefficient memory utilization.

3.2 CONCLUSION

In conclusion, while we achieved our objectives in implementing video stabilization techniques, we recognized the need for further exploration to enable real-time stabilization. Given our time constraints, we focused on stabilizing recorded videos rather than real-time applications. However, our successful integration of the stabilization algorithm onto the PYNQ board offers promise for future real-time processing endeavors. Moving forward, dedicating more time to research will be crucial for advancing in this direction. Nonetheless, our project marks a significant step forward in video processing, setting the stage for future innovations in the field.

3.3 FUTURE SCOPE

In terms of future scope, there are several exciting avenues to explore. Firstly, further optimization and implementation of our video stabilization algorithm on FPGA (Field-Programmable Gate Array) platforms present a promising direction. By leveraging the parallel processing capabilities of FPGA, we can enhance the algorithm's efficiency and speed, paving the way for real-time stabilization even with high-resolution video streams.

Chapter 4

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