

**VIDEO STABILIZATION BASED ON
OPTICAL FLOW AND REGRESSION
ANALYSIS**

MSC IN COMPUTER SCIENCE



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

S. ASHADA KARUNARATHNA

**UNIVERSITY OF MORATUWA
SRI LANKA**

DECEMBER, 2007

Video Stabilization based on Optical Flow and Regression Analysis

S. Ashada Karunarathna



This dissertation was submitted to the
Department of Computer Science and Engineering

Of the
www.lib.mrt.ac.lk

University of Moratuwa

in partial fulfillment of the requirements of the
**Degree of MSc in Computer Science specializing in
Software Architecture**

Department of Computer Science and Engineering
University of Moratuwa
Sri Lanka

December, 2007

Video Stabilization based on Optical Flow and Regression Analysis

**I declare that the work included in the dissertation
in part or whole has not been submitted for any
other academic qualification at any institution.**



University of Moratuwa, Sri Lanka
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

.....
S. A Karunarathna(Candidate)

I certify the above statement of the candidate.

.....
Dr. Ajith Pasqual (Supervisor)

Abstract

Video stabilization is an important video enhancement technology which aims at removing annoying unwanted motion from videos which is being used by various vision applications as a pre-processing activity. Since jitter levels cannot always be fully determined by systems automatically without affecting to the desired camera movements, it is essential to provide an easy way for ordinary users to decide what to be considered as jitter.

A major problem of current general purpose software video stabilizers is removing some of the desired motions or leave undesirable motions in video streams because of the incapability in determining what to be considered as wanted/unwanted. This dissertation describes a practical software based solution for video stabilization that address this by providing a better control over to the user in determining level of stabilization willing to have in the output video.

The proposed system initially determines to level of jitter automatically and provides high flexibility to the user to change the level of the jitter to be eliminated using few user parameters before generating full frame based stabilized output. This process is backed up by set of graph outputs that can be easily understood by ordinary user.

Video is perceived as stable when the scene shown in consecutive frames has smooth flow over time. Based on this observation, proposed method removes horizontal and vertical undesirable movements while providing above flexibility using non-linear regression analysis based algorithm in iterative manner.

Acknowledgements

Having completed the MSc. Degree program at the Department of Computer Science and Engineering, University of Moratuwa, I would like to take this opportunity to thank those who helped me a lot in completing it at this level.

First of all, I would like to thank my supervisors, Dr. Jagath Samarabandu, University of Western Ontario, Canada and Dr. Ajith Pasqual, University of Moratuwa, Sri Lanka for the supervision and guidance despite having busy schedules. Ms. Vishaka Nanayakara, as Head of the Department of Computer Science and Engineering, made sure that I had sufficient time and resources for research work although the department was constrained by the lack of staff. Also I would like to thank Dr. Sanath Jayasena for conducting the subject Research Seminar and the knowledge helped me a lot when browsing through the published research papers.

My sincere thanks go to Codegen International (Pvt) Ltd for providing me the time for the research activities when ever needed.

I should be grateful to all the staff members of the Department of Computer Science and Engineering for giving valuable feed backs during the progress review sessions.

Finally I would like to thank my family for supporting me in every aspect in completing my degree program and the research successfully.

Table of Contents

1	Introduction	5
2	Literature Survey	8
2.1	Introduction	8
2.2	Existing Video Stabilization systems.....	8
3	Stabilization Scheme	14
3.1	Overview	14
3.2	Step 1 - Measure the transformations between adjacent frames.....	15
3.3	Step 2 - Estimation of desired camera movements	18
3.4	Step3 - Compensation of each frame for unwanted motion.....	21
3.5	Step4 - Reconstruction of undefined regions.....	22
3.5.1	Achieving higher accuracy	25
4	Software base Implementation	28
4.1	Functional requirements.....	28
4.1.1	Use case diagram	28
4.2	Detailed Design.....	29
4.2.1	Class diagram.....	30
4.2.2	Activity diagram	30
4.3	Choosing Software libraries.....	31
4.4	User interface	31
4.4.1	Processing Video	32
4.4.2	Generate Output Video	34
5	Experimental results and evaluation.....	37
5.1	Overview	37
5.2	Testing Strategy	37

5.3	Test input.....	37
5.4	Overview of results	38
5.4.1	Statistical Analysis.....	38
5.4.2	Perception of people	40
5.4.3	Performance Analysis.....	40
6	Conclusion and Future work	41
	References.....	43
	Appendix (A) – Lucas Kanade Optical Flow Estimation.....	46
	Appendix (B) – Contents of the CD-ROM.....	50



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

List of Figures

Figure 1 Regression analysis to smooth out the camera movement.....	21
Figure 2 Adjusting frame to remove unwanted movement.	22
Figure 3 Calculating Stripe position.....	26
Figure 4 Use case diagram.....	28
Figure 5 Class diagram.....	30
Figure 6 Activity diagram.....	30
Figure 7 User Interface - Main Panel (before processing).....	32
Figure 8 User Interface – Process Video Panel.....	32
Figure 9 Processing Mode - Frame with All Feature Points.....	33
Figure 10 Main Panel – After processing the video.....	34
Figure 11 Regression Analysis Graph – with Larger Noise Filter.....	35
Figure 12 Regression Analysis Graph – Smaller Chunk Size.....	36
Figure 13 Test results – Vertical component (For Input Video, Max filter size).....	38
Figure 14 Test results – Vertical component (For Output Video, Max filter size).....	39
Figure 15 Image Pyramid.....	48

List of Tables

Table 1 Algorithm overview.....	14
Table 2 Algorithm - Measure the transformations between adjacent frames.....	17
Table 3 Algorithm - Estimate the desired camera movements.....	19
Table 4 Algorithm – Iterative Regression Analysis.....	21
Table 5 Algorithm - Reconstruction of undefined regions.....	24
Table 7 Regression Analysis libraries evaluated.....	31
Table 8 Processing Mode details.....	33
Table 9 Test Input Videos.....	38
Table 10 Configuration of Test computers.....	40
Table 11 Performance table.....	40



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk