

MASTER'S THESIS

Enhanced snakes algorithm for contour detection

Wong, Yin Yung

Date of Award:
1997

[Link to publication](#)

General rights

Copyright and intellectual property rights for the publications made accessible in HKBU Scholars are retained by the authors and/or other copyright owners. In addition to the restrictions prescribed by the Copyright Ordinance of Hong Kong, all users and readers must also observe the following terms of use:

- Users may download and print one copy of any publication from HKBU Scholars for the purpose of private study or research
- Users cannot further distribute the material or use it for any profit-making activity or commercial gain
- To share publications in HKBU Scholars with others, users are welcome to freely distribute the permanent URL assigned to the publication

Enhanced Snakes Algorithm for Contour Detection

WONG Yin Yung

A thesis submitted in partial fulfillment of the requirements
for the degree of
Master of Philosophy

March 1997

Hong Kong Baptist University

Abstract

This thesis presents a new algorithm, named as Enhanced Snakes Algorithm (*ESA*), for contour detection. The aim of this algorithm is to extend the flexibility and reliability of the active contour model (snake model) in detecting objects with variety shape.

In *ESA*, a split and merge procedure (*SMP*) is applied to the contour (detected from the original snake model) for splitting it into small pieces (segments) and pushing the segments near the concave parts on the objects. More precisely, this procedure involves the location of control points for splitting, the determination of the blowing direction, and the application of the normal force to the segments. Accordingly, a novel terminating criterion, called Contour Length Criterion (*CL-Criterion*), is employed to provide a reliable termination on the recursive iteration of the snake model. The measurement on the new criterion is based on the relative change of the curve length.

By applying our proposed algorithm, we can enjoy more success on object contour detection with arbitrary shape. In particular, the results are more accurate for the objects with concave parts that cannot be located by employing the original snake model only. Furthermore, our *ESA* is more reliable in dealing with noisy images.

Finally, a set of images is selected to evaluate the algorithm and the results are encouraging.

Table of Contents

Abstract	i
Acknowledgments	ii
Table of Contents	iii
List of Tables	vi
List of Figures	vii
List of Symbols	ix
1 Introduction	1
1.1 Introduction	1
1.2 Motivation	3
1.3 Contributions	4
1.4 Thesis Overview	4
2 Active Contour Model	6
2.1 Introduction	6
2.2 Snake Model	7
2.2.1 Basic Concept	7
2.2.2 Internal Spline Energy	8
2.2.3 Image Energy	9
2.2.4 External Constraints	11
2.3 Numerical Solution	12
2.4 Properties of the Model	14
2.5 Literature Review on Snake Model	16
2.6 Limitations of the Model	18
2.6.1 Contour Detection on Concave Object	18
2.6.2 Terminating Criterion for the Model	20
2.6.2.1 Measurement on the Curve Displacement	20
2.6.2.2 Measurement on the Change of Image Energy	24

3	Enhanced Snakes Algorithm	26
3.1	Introduction	26
3.2	Notations	27
3.3	Overview of the Proposed Algorithm	31
4	Split and Merge Procedure	35
4.1	Introduction	35
4.2	Split Process	36
4.2.1	Part One: Location of Control Points	36
4.2.2	Part Two: Determination of Blowing Direction	39
4.2.3	Part Three: Application of Normal Force	42
4.2.3.1	The Scaling Function $k_e(s)$	42
4.2.3.2	Construction of $k_e(s)$	44
4.3	Merge Process	48
4.4	Analysis on the Scaling Function $k_e(s)$	49
4.4.1	Convergent Rate on Segments Affected by $k_e(s)$	50
4.4.2	Adaptation on Handling Various Segments	52
5	Contour Length Criterion	56
5.1	Introduction	56
5.2	Contour Length Criterion	57
5.2.1	Mathematical Definition	57
5.2.2	Two-phase Convergence Property	59
5.2.3	Averaging Property	65
5.3	Comparison on Existing Terminating Criteria	67
5.3.1	Cohen's Terminating Criterion	67
5.3.2	Leymarie's Terminating Criterion	68
5.3.3	Results on Real Images	69
6	Experimental Results	75
6.1	Introduction	75
6.2	Experimental Results and Discussion	76

7	Conclusions and Future Work	87
7.1	Conclusions	87
7.2	Future Work	89
7.2.1	Parameters Determination	89
7.2.2	Multiple Objects Detection	89
	Appendix	90
	References	96
	Vita	102