

Technical Report
SMU-EE-TR-1981-12 ✓
CNR Contract Number N00014-79-C-0494 ✓
June 14, 1981

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RESEARCH PROGRESS ON
IMAGE SEGMENTATION*

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by

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*The support of the Statistics and Probability Program of the Office of Naval Research on this work is gratefully acknowledged.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
	AD-A202 827	
4. TITLE (and Subtitle)	5. TYPE OF REPORT & PERIOD COVERED	
6 Research Progress on Image Segmentation.	9 Technical Report	
	6. PERFORMING ORG. REPORT NUMBER	
	14 SMU-EE-TR-81-12	
7. AUTHOR(s)	8. CONTRACT OR GRANT NUMBER(s)	
10 C. H. Chen	13 NO 014-79-C-0494	
9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
Electrical Engineering Department Southeastern Massachusetts University North Dartmouth, MA 02747		NR 042-422
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE
Statistics and Probability Program Office of Naval Research, Code 436 Arlington, VA 22217		July 14, 1981
		13. NUMBER OF PAGES
		12 29
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report)
11 24 JUN 84		UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report)		
APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)		
Statistical image segmentation, relational approach to image segmentation, structural-syntactic approach to image segmentation.		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)		
A survey of recent progress on image segmentation is presented according to statistically based approaches such as the structural methods. Extensive list of literatures on image segmentation is also given.		

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1 N 0101-LP-014-6001

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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1. Introduction

Image segmentation in image processing refers to computer oriented techniques that partition the image into meaningful parts or regions. It is a major function of the low level processing in computer vision. A large amount of research efforts has been devoted to this topic in the past ten years while much more progress is expected in the next decade. Several good survey articles on image segmentation have been published. Fu and Mui [1] reviewed three major approaches to image segmentation, namely, the characteristic feature thresholding, edge detection, and region extraction. The paper also provided 97 references.

So far the image-segmentation techniques are application dependent. A priori information about the type of images is essential to a successful segmentation. For the application in cytology, Ranade and Prewitt [2] compared five segmentation algorithms: two of which are histogram based, another two are quadtree based and the remaining one is the relaxation method. Other references include the surveys by Zucker [3], and Rixeman and Arbib [4], which discussed various techniques, and by Kanade [5] which gave a unified view of the segmentation problem. More complete list of references is in the Appendix.

In this brief report, research progress is reviewed according to the statistically based and the non-statistically based approaches to the segmentation. This dichotomy reflects our view that most segmentation problems can be treated as a statistical problem while many others are more suitably treated by the nonstatistical

methods including the relational methods and the syntactic-structural methods. With this view our emphasis is placed on the application independent and task independent aspects of image segmentation.

2. Statistically-Based Image Segmentation

The most familiar statistical image segmentation procedure is by thresholding the gray scale picture. The optimal thresholds can be determined or approximated statistically. The thresholding methods followed by other post-processing procedures such as gap filling, etc. are the most practical approach to image segmentation. The next statistical segmentation approach is via spatial clustering which is considered as an unsupervised pattern classification. Image segmentation can be performed with pixel classification [6-9]. The supervised segmentation generally performs better than the unsupervised segmentation. For the images with additive noise, statistical boundary estimation [10] can provide region extraction. Segmentation can also be considered as an estimation problem [11] in which regions are grown with the aid of estimated parameters. Furthermore, the homogeneity and common characteristics of a region can be tested statistically with, e.g., F-statistic, K-S test, etc.

Although contextral analysis in statistical pattern recognition [12] is difficult, simple statistical-spatial models can be very effective in segmentation. The fundamental limitation of the statistical approaches is that the image information content is not entirely statistical except for the purely random noise image.

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Even for the textured images for which the statistical models are effective, structural information can be very important. It is necessary to develop a structural model in some images and estimate its parameters with the aid of the statistical methods.

3. Relational Approach to Image Segmentation

In this approach, the nonstatistical relationships are established between segments or regions. The segments can be as small as pixels. The best example of the relational approach is the quadtree structure proposed by Rosenfeld [13]. The region/edge coordination is performed locally so that the noise points which may be present elsewhere in the image have no effect on this coordination. The coordination process is important to the relational approach in general. Semantic information can also be utilized in the relational approach. The relaxation method in image segmentation needs good initial conditions. The region information obtained from analysis of the histogram of the original image can be used to initialize the class membership indices. Such indices can be probabilistic relations to be estimated recursively.

4. Structural-Syntactic Approach

The basic units of structure in images are primitives. Grammatical rules can be established such that the image can be described by a language. This formal approach in structural analysis is called the syntactic approach. In general, any method which exploits the structure of the images is a structural approach.

Detection of curves, lines, etc. is a structural approach that can accomplish image segmentation. In other images such as the acoustic ambiguity function, the inherent functional relation is a structure which is useful in extracting the region of interests. Thus the scope of the structural approach is very broad. Obviously the statistical and the structural approaches should be combined as much as possible to utilize fully the complex informational content of an image so that segmentation can be performed effectively. Major progress on the structural-syntactic approach to image segmentation has been reported recently at the Saratoga Springs Workshop [14]. The fundamental problem is the primitive selection which does not appear to have a formal solution. A feedback link has been suggested that allows the re-selection of primitives after making the decision based on the original primitives. Another interesting procedure suggests the joint use of the local and the global procedures. These directions remain to be explored.

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PUBLICATION-NAME : IEEE TRANS. SYSTEMS, MAN CYBERNET

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AUTHOR : LAI P. G. AND EHRICH R. W.

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KEY-WORDS : IMAGE SEGMENTATION

AUTHOR : LEBOUCHER G. AND LOWITZ G. E.

TITLE : WHAT A HISTOGRAM CAN REALLY TELL THE CLASSIFIER

PUBLICATION-NAME : PATTERN RECOGNITION 10

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KEY-WORDS : IMAGE SEGMENTATION

AUTHOR : LEMKIN P.

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PUBLICATION-NAME : COMPUTER GRAPHICS AND IMAGE PROCESSING 9

PAGE : 150-165

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 PUBLICATION-NAME : COMPUTER GRAPHICS AND IMAGE PROCESSING 10
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PUBLICATION-NAME : COMPUTER GRAPHICS AND IMAGE PROCESSING 10
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AUTHOR : SCLOVE S. L.
TITLE : APPLICATION OF THE CONDITIONAL
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PUBLICATION-NAME : PROC. 5TH INT. CONF. ON PATTERN RECOGNITION
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PUBLICATION-NAME : COMPUTER GRAPHICS AND IMAGE PROCESSING 4
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KEY-WORDS : IMAGE SEGMENTATION

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TITLE : IMAGE SEGMENTATION AND FEATURE EXTRACTION
PUBLICATION-NAME : IEEE TRANS. SYSTEMS, MAN, AND CYBERNETICS 8
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KEY-WORDS : IMAGE SEGMENTATION

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PUBLICATION-NAME : PROC. 3RD INT. JOINT CONF. PATTERN RECOGNITION
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AUTHOR : TOMITA F., YACHIIDA M. AND TSUJI S.
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PUBLICATION-NAME : PROC. 3RD 'IJCAI'
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KEY-WORDS : IMAGE SEGMENTATION

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KEY-WORDS : IMAGE SEGMENTATION

AUTHOR : TSUJI S. AND FUJIWARA R.
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PUBLICATION-NAME : PROC. 2ND INT. JOINT CONF. PATTERN RECOGNITION
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KEY-WORDS : IMAGE SEGMENTATION

AUTHOR : TSUJI S. AND TOMITA F.
TITLE : A STRUCTURAL ANALYZER FOR A CLASS OF TEXTURES
PUBLICATION-NAME : COMPUTER GRAPHICS AND IMAGE PROCESSING 2
PAGE : 216-231
PUBLICATION-DATA : 1973
KEY-WORDS : IMAGE SEGMENTATION

AUTHOR : VELASCO F. R. D. AND ROSENFELD A.
TITLE : SOME METHODS FOR THE ANALYSIS OF SHARPLY BOUNDED
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PUBLICATION-NAME : IEEE TRANS. SYSTEMS, MAN, AND CYBERNETICS 10
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KEY-WORDS : IMAGE SEGMENTATION

AUTHOR : WECHSLER H.
TITLE : A NEW LOW-LEVEL PROCEDURE FOR IMAGE SEGMENTATION

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 KEY-WORDS : IMAGE SEGMENTATION

AUTHOR : WECHSLER H. AND KIKODE M.
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 KEY-WORDS : IMAGE SEGMENTATION

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 PUBLICATION-NAME : PATTERN RECOGNITION, 9
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ANALYZER
PUBLICATION-NAME : PROC. INT. JOINT CONF. ARTIFICIAL INTELLIGENCE,
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KEY-WORDS : IMAGE SEGMENTATION

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TITLE : ERROR MEASURES FOR SCENE SEGMENTATION
PUBLICATION-NAME : PATTERN RECOGNITION 9
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KEY-WORDS : IMAGE SEGMENTATION

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TITLE : IMAGE SEGMENTATION BY UNSUPERVISED CLUSTERING
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KEY-WORDS : IMAGE SEGMENTATION

AUTHOR : YOUNG I. T. AND PASKOWITZ I. L.
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PUBLICATION-NAME : IEEE TRANS. BIOMED. ENGG BME-22
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KEY-WORDS : IMAGE SEGMENTATION

AUTHOR : ZUCKER S. W.
TITLE : REGION GROWING: CHILDHOOD AND ADOLESCENCE
PUBLICATION-NAME : COMPUTER GRAPHICS AND IMAGE PROCESSING 5
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KEY-WORDS : IMAGE SEGMENTATION

AUTHOR : ZUCKER S. W., ROSENFELD A. AND DAVIS L. S.
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