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Graphics Recognition

Methods and Applications

First International Workshop

University Park, PA, USA, August 10-11, 1995

Selected Papers



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Preface

Document image analysis is an exciting field of pattern recognition, in which much research activity is taking place, not only on optical character recognition (which is probably the first topic to come to mind when somebody mentions document analysis), but also on the analysis of physical and logical structures of scanned documents, and more generally the interpretation of the document's contents. One of the topical fields is *graphics recognition*, which deals with problems such as raster-to-vector techniques, recognition of graphical primitives from raster images of documents, recognition of graphic symbols in charts and diagrams, CAD conversion of engineering drawings or diagrams, analysis of maps, charts, line drawings, tables or forms, 3-D model reconstruction from multiple 2-D views, etc.

In August 1995, IAPR's¹ technical committee on graphics recognition (TC10) organized the First International Workshop on Graphics Recognition, at the Penn State University's Scanticon Conference Center. The goal of the workshop was to bring together researchers from around the world to assess the state of the art in the above-mentioned topics. The workshop attendance was limited to 75 persons, to promote closer interaction among participants.

The workshop was organized into five sessions; each of them began with an invited talk assessing the state of the art, followed by short research presentations and concluding with a panel discussion, to identify important open research problems and suggestions for future research directions. These panel discussions proved to be very interesting, with much interaction between the authors and all the other participants.

A keynote talk on the commercial value of graphics recognition technology was presented by Dr. Clifford Kottman of Intergraph. He strongly emphasized the need for standards, this being one of the keys for graphics recognition methods developed by researchers to really meet industry's expectations.

This book is a collection of selected papers from the workshop. At the end of the workshop, we submitted all the papers presented at the workshop to the review of two workshop participants, who were asked to judge the contribution with respect to both the paper itself and the presentation and the subsequent discussions. As a result of this process, many of the papers were thoroughly revised and improved, so much so that we feel that this book has become much more than mere post-workshop proceedings. However, we have mostly limited our work to the scientific editing; basically, the authors provided camera-ready copies and we haven't done much copy-editing.

The book is organized into several main topics. The first deals with low-level processing, vectorization, and segmentation of scanned graphics documents. O'Gorman's paper gives an overview of the state of the art in this domain. The two following papers address the important topic of performance characterization and evaluation of low-level processing methods such as thinning or corner detection. *Vectorization*, i.e. raster-to-vector conversion, is an important step in graphics recognition. Although the basic methodology is well known, there is room for many improvements. Chhabra et al.'s

¹ International Association for Pattern Recognition.

paper describes a specific method for detecting horizontal lines in very large drawings, working directly on run length codes. Rööslı and Monagan propose to add geometric constraint fitting to the vectorization process, in order to improve the quality of the result. Hori and Doermann propose a methodology for measuring the performances of vectorization algorithms. The next two papers deal with a specific application, that of analyzing forms. The last paper broadens the scope of low-level processing by proposing a method based on mathematical morphology for detecting dashed lines.

The second main topic of the book is symbol and diagram recognition. Blostein's introductory paper makes a broad review of the state of the art in this area. Messmer and Bunke present an efficient, error-tolerant method for finding subgraph isomorphisms between model graphs and a vectorized drawing; they also propose a learning algorithm for identifying new symbols which the system does not know yet. The two last papers present typical applications: recognition of logo-like graphics and interpretation of chemical structure diagrams.

A third area is that of map processing, i.e. the conversion of paper maps to some kind of GIS representation. Den Hartog et al. give an overview of work in this domain and present extensively their own research and propose a knowledge-base strategy which combines bottom-up and top-down processing. The next paper presents a method for region labeling in map processing. Myers et al. describe the approach they have developed for text and feature extraction. The last paper in this section addresses the crucial problem of the system design methodology in map processing, based on the authors' experience.

The interpretation of engineering drawings is also an important domain in graphics recognition. Four papers illustrate various aspects of this problem. Dori et al. describe the segmentation and recognition of dimensioning. Thomas et al. propose an approach combining low-level analysis and the use of higher-level information such as that conveyed by the textual content of the drawing, for instance. Capellades and Camps illustrate how functionality can be used in drawing interpretation, with a specific example, that of recognizing screws. Finally, Tomiyama and Nakaniwa propose a method for constructing 3D CAD models from three 2D views.

During the workshop, a contest to determine the best algorithm for detection of dashed lines in drawings was also organized. Formal performance evaluation protocols and metrics were used to test the accuracy of detection and representation of dashed lines. The paper by Kong et al. describes the performance analysis program developed for this contest. Many groups expressed interest in this contest and obtained test data but only one group completed their development and came to the workshop with a working program. The team headed by Dr. Dov Dori from Technion, Israel, received the award in this contest, and we have included in this book a paper written by this team and describing the program they submitted to the contest.

The book ends with a chapter summarizing the conclusions and recommendations from the numerous discussions and exchanges during the workshop. This chapter also includes more specific summaries of some of the sessions.

The workshop was supported by grants from the US Department of Defense and from industry. We owe special thanks to the contributing authors and to the reviewers of the papers. David Kosiba, who was responsible for local arrangements, worked hard to

make everything run very smoothly and pleasantly. Many thanks also to Sarah Jane Barrier (Penn State University) and to Isabelle Herlich (INRIA Lorraine & CRIN/CNRS) for efficient help with all the secretarial duties, both for the organization of the workshop and during the preparation of this book.

The workshop was deemed very successful by the participants, and we plan to organize future workshops of the same kind; the next will most probably be held in Summer 1997.

March 1996

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