

An Approach to Automatic Road Vectorization of Raster Maps

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1 Introduction

Raster maps are widely available for many areas around the globe. The road network that commonly exists in raster maps is an important source of road vector data for the areas for which road vectors are not readily available. To extract the road vector data from raster maps, the first step is to extract the pixels that represent roads from the raster maps (i.e., the road raster layers in the raster maps) and then extract the road vector data from the road pixels. Since the roads usually overlap with other map features and raster maps very often contain noise introduced during the processes of image compression and scanning, the extraction of road pixels from raster maps is difficult. Moreover, for extracting the road vectors from road pixels, previous work commonly uses the thinning operator [6] or line grouping and parallel-line matching techniques [1] to obtain the skeletons of the connected objects composed of road pixels. The thinning operator is robust and requires no parameter tunings; however, the thinned lines (i.e., the skeletons) are usually distorted around the line intersections and hence the extracted road vectors are not accurate, especially when the thinning operator is applied on thick lines. On the other hand, the line grouping and parallel-line matching techniques require manual settings on various parameters to identify the skeletons, such as the maximum difference between the slopes of two line segments to be merged.

In this paper, we present an approach for extracting accurate road vector data from raster maps with no parameter tunings. We first utilize our previous techniques to extract the road pixels from raster maps [4] and generate a road raster layer that contains one-pixel width road lines representing the skeletons of the connected objects composed of the extracted road pixels [5]. Next, we employ the road-intersection template extraction technique [3] to identify road intersections and extract accurate road-intersection templates from the road raster layer. Finally, we trace the pixels of the road raster layer for extracting the road vectors and use the accurate road-intersection templates to avoid the distortions caused by the thinning operator around each intersection.

2 Road Pixel and Road Raster Layer Extraction

To extract the road pixels from raster maps, we utilize our technique in [4], which requires very little user input and is capable of handling various types of raster maps, especially scanned maps. Since raster maps often contain thousands of colors, our technique [4] first employs the Mean-shift and K-means segmentation methods to reduce the number of colors in the input raster map and then identifies the road colors from road areas labeled by the users. With the identified road colors, we can generate a color filter to extract the road pixels. Figure 1(a) shows a sample zoning map where the roads are not explicitly drawn but are shown as white areas between the parcels, and Figure 1(b) shows the extracted road pixels (black).

After we extract the road pixels, we identify the road format (i.e., single-line or parallel double-line roads) and the road width using the parallel-pattern tracing technique and then use the morphological operations (e.g., the erosion and dilation operators) to remove solid areas and reconnect lines [2, 5]. The number of iterations for applying the morphological operations is selected using the automatically identified format and road width. Figure 1(c) shows the results after we apply the morphological operations. To generate the road raster layer, we first erode the thick lines shown in Figure 1(c) using a binary erosion operator, which minimizes the distortions caused by the thinning operator that will be applied next. Then, the thinning operator is used to generate the road raster layer that contains one-pixel width road lines. Figure 1(d) shows the extracted road raster layer.

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Digital Geometry Algorithms Valentin E. Brimkov, Reneta P. Barneva, 2012-05-20 Digital geometry emerged as an independent discipline in the second half of the last century. It deals with geometric properties of digital objects and is developed with the unambiguous goal to provide rigorous theoretical foundations for devising new advanced approaches and algorithms for various problems of visual computing. Different aspects of digital geometry have been addressed in the literature. This book is the first one that explicitly focuses on the presentation of the most important digital geometry algorithms. Each chapter provides a brief survey on a major research area related to the general volume theme: description and analysis of related fundamental algorithms as well as new original contributions by the authors. Every chapter contains a section in which interesting open problems are addressed.

Analysis of Engineering Drawings and Raster Map Images Thomas C. Henderson, 2013-09-06 This book covers up to date methods and algorithms for the automated analysis of engineering drawings and digital cartographic maps. The Non Deterministic Agent System NDAS offers a parallel computational approach to such image analysis. The book describes techniques suitable for persistent and explicit knowledge representation for engineering drawings and digital maps. It also highlights more specific techniques e.g. applying robot navigation and mapping methods to this problem. Also included are more detailed accounts of the use of unsupervised segmentation algorithms to map images. Finally all these threads are woven together in two related systems NDAS and AMAM Automatic Map Analysis Module.

Advances in Spatial Data Handling Sabine Timpf, Patrick Laube, 2012-11-02 This volume is based on the reviewed and edited proceedings of the International Symposium on Spatial Data Handling 2012 held in Bonn. The 15th SDH brought together scholars and professionals from the international GIScience community to present the latest research achievements and to share experiences in Geospatial dynamics, geosimulation and exploratory visualization.

Geographic Information Science Ningchuan Xiao, Mei-Po Kwan, Michael F. Goodchild, Shashi Shekhar, 2012-09-02 This book constitutes the refereed proceedings of the 7th International Conference on Geographic Information Science GIScience 2012 held in Columbus OH USA in September 2012. The 26 full papers presented were carefully reviewed and selected from 57 submissions. While the traditional research topics are well reflected in the papers, emerging topics that involve new research hot spots such as cyber infrastructure, big data, web based computing also occupy a significant portion of the volume.

Graphics Recognition Young-Bin Kwon, Jean-Marc Ogier, 2013-02-11 This book constitutes the thoroughly refereed post conference proceedings of the 9th International Workshop on Graphics Recognition GREC 2011 held in Seoul Korea September 15-16 2011. The 25 revised full papers presented were carefully selected from numerous submissions. Graphics recognition is a subfield of document image analysis that deals with graphical entities in engineering drawings, sketches, maps, architectural plans, musical scores, mathematical notation, tables and diagrams. Accordingly the conference papers are organized in 5 technical sessions covering the topics such as map and ancient

documents symbol and logo recognition sketch and drawings performance evaluation and challenge processing *Graphics Recognition: Algorithms and Systems* Karl Tombre, Atul K. Chhabra, 1998-04-08 This book constitutes the strictly refereed post workshop proceedings of the Second International Workshop on Graphics Recognition GREC 97 held in Nancy France in August 1997 The 34 thoroughly revised full papers presented were carefully selected for inclusion in the book on the basis of a second round of post workshop reviewing The book is divided into sections on vectorization and segmentation symbol recognition form processing map processing engineering drawings applications and systems performance evaluation and a graphics recognition contest *Graphics Recognition: Achievements, Challenges, and Evolution* Jean-Marc Ogier, Wenyin Liu, Josep Lladós, 2010-06-17 This book constitutes the Selected Papers of the 8th International Workshop on Graphics Recognition Achievements Challenges and Evolution held in La Rochelle France in July 2009 **A Methodology for Processing Raw LIDAR Data to Support Urban Flood Modelling Framework** Ahmad Fikri Bin Abdullah, 2020-10-29 The consequences of recent floods and flash floods in many parts of the world have been devastating One way to improving flood management practice is to invest in data collection and modelling activities which enable an understanding of the functioning of a system and the selection of optimal mitigation measures A Digital Terrain Model DTM provides the most essential information for flood managers Light Detection and Ranging LiDAR surveys which enable the capture of spot heights at a spacing of 0.5m to 5m with a horizontal accuracy of 0.3m and a vertical accuracy of 0.15m can be used to develop high accuracy DTM but needs careful processing before using it for any application This book presents the augmentation of an existing Progressive Morphological filtering algorithm for processing raw LiDAR data to support a 1D 2D urban flood modelling framework The key characteristics of this improved algorithm are 1 the ability to deal with different kinds of buildings 2 the ability to detect elevated road rail lines and represent them in accordance to the reality 3 the ability to deal with bridges and riverbanks and 4 the ability to recover curbs and the use of appropriated roughness coefficient of Manning's value to represent close to earth vegetation e.g grass and small bush **Open Source GIS: A GRASS GIS Approach** Markus Neteler, Helena Mitasova, 2008-01-17 Since the first edition of Open Source GIS A GRASS GIS Approach was published in 2002 GRASS has undergone major improvements This second edition includes numerous updates related to the new development its text is based on the GRASS 5.3 version from December 2003 Besides changes related to GRASS 5.3 enhancements the introductory chapters have been re-organized providing more extensive information on import of external data Most of the improvements in technical accuracy and clarity were based on valuable feedback from readers Open Source GIS A GRASS GIS Approach Second Edition provides updated information about the use of GRASS including geospatial modeling with raster vector and site data image processing visualization and coupling with other open source tools for geostatistical analysis and web applications A brief introduction to programming within GRASS encourages new development The sample data set used throughout the book has been updated and is available on the GRASS web site This book also

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Description Approaches and Automated Generalization Algorithms for Groups of Map Objects Haowen

Yan,2019-01-04 This book focuses on the generalization of map features providing descriptions and classifying groups of map objects into six categories point clusters groups of contours road networks river networks continuous areal features and discrete areal features Discussing the methods and algorithms in map generalization in equal measure it also describes the approaches for describing map features The book is a valuable reference for graduates and researchers who are interested in cartography and geographic information science systems especially those in automated map generalization and spatial databases construction **Laser Scanning Systems in Highway and Safety Assessment** Biswajeet Pradhan,Maher

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traffic accident with little data based on the concept of transfer learning This book aims to help graduate students professionals decision makers and road planners in developing better traffic accident prediction models using advanced neural networks

IoT Sensors, ML, AI and XAI: Empowering A Smarter World Biswajeet Pradhan, Subhas Mukhopadhyay, 2024-10-24 This book uncovers and presents various real life applications in the areas of transportation smart cities manufacturing agriculture disaster management finance health care and in other areas by using cutting edge advanced Machine Learning ML techniques such as Deep Learning and Explainable AI XAI models using IoT sensor data The book provides various examples of analyzing large amounts of data detecting patterns and making predictions in real time applications and detailed case studies with practical solutions using various state of the art machine learning and IoT sensor data and all these aspects will benefit the stakeholders The book is useful for academics researchers upper undergraduate master and Ph D students engineers and practitioners in sensor IoT and AI ML technologies methods applications and related areas and it also offers valuable insights by suggesting future research directions and providing recommendations within the fields of AI and IoT

The Cross Section ,1988 **Advances In Dynamics, Instrumentation And Control - Proceedings Of The 2004 International Conference (Cdic '04)** Chun-yi Su, En-rong Wang, Rama B Bhat, Subhash Rakheja, 2004-10-18 This volume is a compilation of 50 articles representing the scientific and technical advances in various aspects of system dynamics instrumentation measurement techniques and control It serves as an important resource in the field The topics include state of the art contributions in the fields of dynamics and control of nonlinear hybrid stochastic time delayed and piecewise affine systems nonlinear control theory control of chaotic systems adaptive model predictive and real time controls with applications involving vehicular systems fault diagnostics and flexible and cellular manufacturing systems vibration suppression biomedical mobile robots etc The proceedings have been selected for coverage in Index to Scientific Technical Proceedings ISTP ISI Proceedings Index to Scientific Technical Proceedings ISTP CDROM version ISI Proceedings CC Proceedings Engineering Physical Sciences

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Open Source GIS Markus Neteler, Helena Mitasova, 2007-10-23 With this third edition of Open Source GIS A GRASS GIS Approach we enter the new era of GRASS6 the first release that includes substantial new code developed by the International GRASS Development Team The dramatic growth in open source software libraries has made the GRASS6 development more efficient and has enhanced GRASS interoperability with a wide range of open source and proprietary geospatial tools Thoroughly updated with material related to the GRASS6 the third edition includes new sections on attribute database management and SQL support vector networks analysis lidar data processing and new graphical user interfaces All chapters were updated with numerous practical examples using the first release of a comprehensive state of the art geospatial data set

Videometrics ,1997 *MultiMedia Modeling* Laurent Amsaleg, Gylfi Þór Guðmundsson, Cathal Gurrin, Björn Þór Jónsson, Shin'ichi Satoh, 2016-12-30 The two volume set LNCS 10132 and 10133 constitutes the thoroughly

refereed proceedings of the 23rd International Conference on Multimedia Modeling MMM 2017 held in Reykjavik Iceland in January 2017 Of the 149 full papers submitted 36 were selected for oral presentation and 33 for poster presentation of the 34 special session papers submitted 24 were selected for oral presentation and 2 for poster presentation in addition 5 demonstrations were accepted from 8 submissions and all 7 submissions to VBS 2017 All papers presented were carefully reviewed and selected from 198 submissions MMM is a leading international conference for researchers and industry practitioners for sharing new ideas original research results and practical development experiences from all MMM related areas broadly falling into three categories multimedia content analysis multimedia signal processing and communications and multimedia applications and services

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