3D geomarketing segmentation: A higher spatial dimension planning perspective

Geomarketing is a discipline which uses geographic information in the process of planning and implementation of marketing activities. It can be used in any aspect of the marketing such as price, promotion or geo targeting. The analysis of geomarketing data use a huge data pool such as location residential areas, topography, it also analyzes demographic information such as age, genre, annual income and lifestyle. This information can help users to develop successful promotional campaigns in order to achieve marketing goals. One of the common activities in geomarketing is market segmentation. The segmentation clusters the data into several groups based on its geographic criteria. To refine the search operation during analysis, we proposed an approach to cluster the data using a clustering algorithm. However, with the huge data pool, overlap among clusters may happen and leads to inefficient analysis. Moreover, geomarketing is usually active in urban areas and requires clusters to be organized in a three-dimensional (3D) way (i.e. multi-level shop lots, residential apartments). This is a constraint with the current Geographic Information System (GIS) framework. To avoid this issue, we proposed a combination of market segmentation based on geographic criteria and clustering algorithm for 3D geomarketing data management. The proposed approach is capable in minimizing the overlap region during market segmentation. In this paper, geomarketing in urban area is used as a case study. Based on the case study, several locations of customers and stores in 3D are used in the test. The experiments demonstrated in this paper substantiated that the proposed approach is capable of minimizing overlapping segmentation and reducing repetitive data entries. The structure is also tested for retrieving the spatial records from the database. For marketing purposes, certain radius of point is used to analyzing marketing targets. Based on the presented tests in this paper, we strongly believe that the structure is capable in handling and managing huge pool of geomarketing data. For future outlook, this paper also discusses the possibilities of expanding the structure.
3D Indoor Building Environment Reconstruction using Polynomial Kernel, Least Square Adjustment, Interval Analysis and Homotopy Continuation

Nowadays, municipalities intend to have 3D city models for facility management, disaster management and architectural planning. Indoor models can be reconstructed from construction plans but sometimes, they are not available or very often, they differ from 'as-built' plans. In this case, the buildings and their rooms must be surveyed. One of the most utilized methods of indoor surveying is laser scanning. The laser scanning method allows taking accurate and detailed measurements. However, Terrestrial Laser Scanner is costly and time consuming. In this paper, several techniques for indoor 3D building data acquisition have been investigated. For reducing the time and cost of indoor building data acquisition process, the Trimble LaserAce 1000 range finder is used. The proposed approach use relatively cheap equipment: a light Laser Rangefinder which appear to be feasible, but it needs to be tested to see if the observation accuracy is sufficient for the 3D building modelling. The accuracy of the rangefinder is evaluated and a simple spatial model is reconstructed from real data. This technique is rapid (it requires a shorter time as compared to others), but the results show inconsistencies in horizontal angles for short distances in indoor environments. The range finder horizontal angle sensor was calibrated using a least square adjustment algorithm, a polynomial kernel, interval analysis and homotopy continuation.

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3D Nearest Neighbour Search Using a Clustered Hierarchical Tree Structure
Locating and analysing the location of new stores or outlets is one of the common issues facing retailers and franchisers. This is due to assure that new opening stores are at their strategic location to attract the highest possible number of customers. Spatial information is used to manage, maintain and analyse these store locations. However, since the business of franchising and chain stores in urban areas runs within high rise multi-level buildings, a three-dimensional (3D) method is prominently required in order to locate and identify the surrounding information such as at which level of the franchise unit will be located or is the franchise unit located is at the best level for visibility purposes. One of the common used analyses used for retrieving the surrounding information is Nearest Neighbour (NN) analysis. It uses a point location and identifies the surrounding neighbours. However, with the immense number of urban datasets, the retrieval and analysis of nearest neighbour information and their efficiency will become more complex and crucial. In this paper, we present a technique to retrieve nearest neighbour information in 3D space using a clustered hierarchical tree structure. Based on our findings, the proposed approach substantially showed an improvement of response time analysis compared to existing approaches of spatial access methods in databases. The query performance was tested using a dataset consisting of 500,000 point locations building and franchising unit. The results are presented in this paper. Another advantage of this structure is that it also offers a minimal overlap and coverage among nodes which can reduce repetitive data entry.

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Automated Photogrammetric Image Matching with Sift Algorithm and Delaunay Triangulation

An algorithm for image matching of multi-sensor and multi-temporal satellite images is developed. The method is based on the SIFT feature detector proposed by Lowe in (Lowe, 1999). First, SIFT feature points are detected independently in two images (reference and sensed image). The features detected are invariant to image rotations, translations, scaling and also to changes in illumination, brightness and 3-dimensional viewpoint. Afterwards, each feature of the reference image is matched with one in the sensed image if, and only if, the distance between them multiplied by a threshold is shorter than the distances between the point and all the other points in the sensed image. Then, the matched features are used to compute the parameters of the homography that transforms the coordinate system of the sensed image to the coordinate system of the reference image. The Delaunay triangulations of each feature set for each image are computed. The isomorphism of the Delaunay triangulations is determined to guarantee the quality of the image matching. The algorithm is implemented in Matlab and tested on World-View 2, SPOT6 and TerraSAR-X image patches.
Classified and Clustered Data Constellation: An Efficient Approach of 3D Urban Data Management

The growth of urban areas has resulted in massive urban datasets and difficulties handling and managing issues related to urban areas. Huge and massive datasets can degrade data retrieval and information analysis performance. In addition, the urban environment is very difficult to manage because it involves various types of data, such as multiple types of zoning themes in the case of urban mixed-use development. Thus, a special technique for efficient handling and management of urban data is necessary. This paper proposes a structure called Classified and Clustered Data Constellation (CCDC) for urban data management. CCDC operates on the basis of two filters: classification and clustering.

To boost up the performance of information retrieval, CCDC offers a minimal percentage of overlap among nodes and coverage area to avoid repetitive data entry and multipath query. The results of tests conducted on several urban mixed-use development datasets using CCDC verify that it efficiently retrieves their semantic and spatial information. Further, comparisons conducted between CCDC and existing clustering and data constellation techniques, from the aspect of preservation of minimal overlap and coverage, confirm that the proposed structure is capable of preserving the minimum overlap and coverage area among nodes. Our overall results indicate that CCDC is efficient in handling and managing urban data, especially urban mixed-use development applications.

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Improving Nearest Neighbour Search in 3D Spatial Access Method

Nearest Neighbour (NN) is one of the important queries and analyses for spatial application. In normal practice, spatial access method structure is used during the Nearest Neighbour query execution to retrieve information from the database. However, most of the spatial access method structures are still facing with unresolved issues such as overlapping among nodes and repetitive data entry. This situation will perform an excessive Input/Output (IO) operation which is inefficient for data retrieval. The situation will become more crucial while dealing with 3D data. The size of 3D data is usually large due to its detail geometry and other attached information. In this research, a clustered 3D hierarchical structure is introduced as a 3D spatial access method structure. The structure is expected to improve the retrieval of Nearest Neighbour information for 3D objects. Several tests are performed in answering Single Nearest Neighbour search and k Nearest Neighbour (kNN) search. The tests indicate that clustered hierarchical structure is efficient in handling Nearest Neighbour query compared to its competitor. From the results, clustered hierarchical structure reduced the repetitive data entry and the accessed page. The proposed structure also produced minimal Input/Output operation. The query response time is also outperformed compared to the other competitor. For future outlook of this research several possible applications are discussed and summarized.

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Multidimensional Big Spatial Data Modeling Through A Case Study: Lte Rf Subsystem Power Consumption Modeling
This paper presents a case study for comparing different multidimensional mathematical modeling methodologies used in multidimensional spatial big data modeling and proposing a new technique. An analysis of multidimensional modeling approaches (neural networks, polynomial interpolation and homotopy continuation) was conducted for finding an approach with the highest accuracy for obtaining reliable information about a cell phone consumed power and emitted radiation from
streams of measurements of different physical quantities and the uncertainty ranges of these measurements. The homotopy continuation numerical approach proved to have the highest accuracy (97%). This approach was validated against another device with a different RF subsystem design. The approach modelled the power consumption of the validation device with an accuracy of 98%.

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### 3D Crisp Clustering of Geo-Urban Data

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### 3D Partition-Based Clustering for Supply Chain Data Management

Supply Chain Management (SCM) is the management of the products and goods flow from its origin point to point of consumption. During the process of SCM, information and dataset gathered for this application is massive and complex. This is due to its several processes such as procurement, product development and commercialization, physical
distribution, outsourcing and partnerships. For a practical application, SCM datasets need to be managed and maintained to serve a better service to its three main categories; distributor, customer and supplier. To manage these datasets, a structure of data constellation is used to accommodate the data into the spatial database. However, the situation in geospatial database creates few problems, for example the performance of the database deteriorate especially during the query operation. We strongly believe that a more practical hierarchical tree structure is required for efficient process of SCM. Besides that, three-dimensional approach is required for the management of SCM datasets since it involve with the multi-level location such as shop lots and residential apartments. 3D R-Tree has been increasingly used for 3D geospatial database management due to its simplicity and extendibility. However, it suffers from serious overlaps between nodes. In this paper, we proposed a partition-based clustering for the construction of a hierarchical tree structure. Several datasets are tested using the proposed method and the percentage of the overlapping nodes and volume coverage are computed and compared with the original 3D R-Tree and other practical approaches. The experiments demonstrated in this paper substantiated that the hierarchical structure of the proposed partition-based clustering is capable of preserving minimal overlap and coverage. The query performance was tested using 300,000 points of a SCM dataset and the results are presented in this paper. This paper also discusses the outlook of the structure for future reference.

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An amalgamation of 3D city models in urban air quality modelling for improving visual impact analysis
Geographical Information Systems (GISs) can be seen as a common tool to map and visualize the air quality index based on geographical locations. However, in urban areas, the area resolution for air quality models is less than 2 kilometres. Since the main emissions agent in urban areas is predominantly vehicular engines, the situation will become worse when pollutants are trapped between buildings and disperse inside the street canyon and move vertically to create a recirculation vortex. Studying and visualizing the recirculation zone in 3D visualization is conceivable by using 3D city models as physical data input. The Level of Details (LoD) in 3D city models (i.e. LoD1 and LoD2) ascertains the potentials of implementing air quality modelling for urban areas. Therefore, this research is focused towards investigating the integration of 3D city models in air quality modelling for urban areas. The results presented show the simplicity of using 3D city models as a physical data input in air quality modelling and the 3D air quality will improve insight for visual impact analysis (i.e. analysing the immersion of air circulation zone). The results are advantageous for city planners, architects, engineers and policy makers to design the street geometry (building height and width, green areas, pedestrian walks, roads width, etc.).

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Crisp Clustering Algorithm for 3D Geospatial Vector Data Quantization

In the next few years, 3D data is expected to be an intrinsic part of geospatial data. However, issues on 3D spatial data management are still in the research stage. One of the issues is performance deterioration during 3D data retrieval. Thus, a practical 3D index structure is required for efficient data constellation. Due to its reputation and simplicity, R-Tree has been receiving increasing attention for 3D geospatial database management. However, the transition of its structure from 2D to 3D has caused a serious overlapping among nodes. Overlapping nodes also occur during splitting operation of the overflow node N of M + 1 entry. Splitting operation is the most critical process of 3D R-Tree. The produced tree should satisfy the condition of minimal overlap and minimal volume coverage in addition with preserving a minimal tree height. Based on these concerns, in this paper, we proposed a crisp clustering algorithm for the construction of a 3D R-Tree. Several datasets are tested using the proposed method and the percentage of the overlapping parallelepipeds and volume coverage are computed and compared with the original R-Tree and other practical approaches. The experiments demonstrated in this research substantiated that the proposed crisp clustering is capable to preserve minimal overlap, coverage and tree height, which is advantageous for 3D geospatial data implementations. Another advantage of this approach is that the properties of this crisp clustering algorithm are analogous to the original R-Tree splitting procedure, which makes the implementation of this approach straightforward.
An overview of the applications for early warning and mapping of the flood events in New Brunswick

This paper gives an overview of the on-line flood warning implementation in the province of New Brunswick, Canada. The on-line flood warning applications are available via the “River Watch” website provided by the New Brunswick Department of Environment. Advanced GIS technology combined with hydrological modelling, provide a mapping and visualization tool that can be used by emergency managers and the general public to predict possible flood zones. The applications developed for “River Watch” support the processing of large amounts of digital terrain and hydrological data, which are then, quantified and displayed on digital maps allowing decision makers and the general population to comprehend and visualize the possible area and impact of the flooding. The WebGIS applications that are available from the “River Watch” web site provide snow reports and maps, flood warnings and interactive maps. The searchable historical database containing reports about the impact of past floods and estimated damages provides a valuable insight into the past of the province of New Brunswick and the motivation for development of the system for flood prediction and management.

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Authors: Mioc, D. (Intern), McGillivray, E. (Ekstern), Anton, F. (Intern), Mezouaghi, M. (Ekstern), Mofford, L. (Ekstern), Tang, P. T. (Ekstern)
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Comparative Analysis of Photogrammetric Methods for 3D Models for Museums
The goal of this paper is to make a comparative analysis and selection of methodologies for making 3D models of historical items, buildings and cultural heritage and how to preserve information such as temporary exhibitions and archaeological findings. Two of the methodologies analyzed correspond to 3D models using Sketchup and Designing Reality. Finally, panoramic photography is discussed as a 2D alternative to 3D. Sketchup is a free-ware 3D drawing program and Designing Reality is a commercial program, which uses Structure from motion. For each program/method, the same comparative analysis matrix has been used. Prototypes are made partly or fully and evaluated from the point of view of preservation of information by a museum.

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Spatial access method for urban geospatial database management: An efficient approach of 3D vector data clustering technique
In the last few years, 3D urban data and its information are rapidly increased due to the growth of urban area and urbanization phenomenon. These datasets are then maintain and manage in 3D spatial database system. However, performance deterioration is likely to happen due to the massiveness of 3D datasets. As a solution, 3D spatial index structure is used as a booster to increase the performance of data retrieval. In commercial database, commonly and widely used index structure for 3D spatial database is 3D R-Tree. This is due to its simplicity and promising method in handling spatial data. However, 3D R-Tree produces serious overlapping among nodes. The overlapping factor is important for an efficient 3D R-Tree to avoid replicated data entry in a different node. Thus, an efficient and reliable method is required to reduce the overlapping nodes in 3D R-Tree nodes. In this paper, we proposed a 3D geospatial data clustering to be used in the construction of 3D R-Tree and respectively could reduce the overlapping among nodes. The proposed method is tested on 3D urban dataset for the application of urban infill development. By using several cases of data updating operations such as building infill, building demolition and building modification, the proposed method indicates that the percentage of overlapping coverage among nodes is reduced compared with other existing approaches.

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The Dual Half-Arc data structure: towards the universal B-rep data structure

In GIS, the use of efficient spatial data structures is becoming increasingly important, especially when dealing with multidimensional data. The existing solutions are not always efficient when dealing with big datasets, and therefore, research on new data structures is needed. In this chapter, we propose a very general data structure for storing any real or abstract cell complex in a minimal way in the sense of memory space utilization. The originality and quality of this novel data structure is to be the most compact data structure for storing the geometric topology of any geometric object, or more generally, the topology of any topological space. For this purpose, we generalize an existing data structure from 2D to 3D and design a new 3D data structure that realizes the synthesis between an existing 3D data structure (the Dual Half-Edge (See Footnote 1) data structure) and the generalized 3D Quad-Arc data structure, (See Footnote 2) and at the same time, improves the Dual Half-Edge towards a simpler and more effective representation of cell complexes through B-rep structures. We generalize the idea of the Quad-Arc data structure from 2D to 3D, but instead of transforming a simple edge of the Quad-Edge data structure to an arc with multiple points along it, we group together primal edges of the Dual Half-Edge that have the same dual Half-Edge vertex tags (volume tags) into one Dual Half-Arc whose dual is the common Dual Half-Edge that have the same dual Half-Edge vertex tags (volume tags) into one Dual Half-Arc whose dual is the common Dual Half-Edge and primal faces corresponding to dual. This corresponds to grouping together straight line segment edges into arcs. This allows us to transform the Dual Half-Edge data structure into a 3D data structure for cell complexes with fewer Dual Half-Edges. Since the input/output operations are the most costly on any computer (even with solid state disks), this will result in a much more efficient data structure, where computation of topological relationships is much easier and efficient, like cell complex homologies (See Footnote 3) are easier to compute than their simplicial counterparts. This new data structure, thanks to its efficiency, could have a positive impact on applications that need near real time response, like mapping for natural disasters, emergency planning, evacuation, etc.

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Child cancer follow-up ontology and information system
An increase in chronic diseases in Danish healthcare can be explained by the corresponding increase of population longevity. Health professionals will not be able to keep up with treating those diseases, due to the many existing and new cases of chronic diseases. This results in mistakes in treatment processes, compensations to patients due to medical negligence and duplication of work and effort. In order to address a solution for healthcare practitioners, a small subgroup of patients and diseases is chosen from all chronic diseases. Namely, children diagnosed with cancer. This research brings the methodology for child cancer treatment plan that produces an ontology to create a conceptual model and a database model. To construct the ontology, the “methontology” method is used as a structured approach for the ontology process. The method guides the ontology developer from scratch to building a complete model. The ontology is developed in two phases. In the first phase, research from other countries and process models are reviewed and the generic model is built from this research. The generic model is adapted to the ontology for the Danish hospitals including the NOPHO-ALL 2008 protocol. To develop the ontology, a data dictionary is first proposed. Then, the relationships between concepts are identified and verified: the oriented graph, where nodes are concepts and oriented edges are dependence relationships, where the definition of the concept at the origin of the edge depends on the concept at the destination of the edge, must be a directed acyclic graph. Finally, the ontology resulting from the previous steps is implemented in Protégé-OWL. The conceptual model follows directly and univocally from the ontology: an entity-relationship diagram in UML notation. © 2013 WIT Press.
Improving 3D spatial queries search: newfangled technique of space filling curves in 3D city modeling

The advantages of three dimensional (3D) city models can be seen in various applications including photogrammetry, urban and regional planning, computer games, etc. They expand the visualization and analysis capabilities of Geographic Information Systems on cities, and they can be developed using web standards. However, these 3D city models consume much more storage compared to two dimensional (2D) spatial data. They involve extra geometrical and topological information together with semantic data. Without a proper spatial data clustering method and its corresponding spatial data access method, retrieving portions of and especially searching these 3D city models, will not be done optimally. Even though current developments are based on an open data model allotted by the Open Geospatial Consortium (OGC) called CityGML, its XML-based structure makes it challenging to cluster the 3D urban objects. In this research, we propose an opponent data constellation technique of space-filling curves (space-filling curve) for 3D city model data representation. Unlike previous methods, that try to project 3D or n-dimensional data down to 2D or 3D using Principal Component Analysis (PCA) or Hilbert mappings, in this research, we extend the Hilbert space-filling curve to one higher dimension for 3D city model data implementations. The query performance was tested using a CityGML dataset of 1,000 building blocks and the results are presented in this paper. The advantages of implementing space-filling curves in 3D city modeling will improve data retrieval time by means of optimized 3D adjacency, nearest neighbor information and 3D indexing. The Hilbert mapping, which maps a subinterval of the [0, 1] interval to the corresponding portion of the d-dimensional Hilbert’s curve, preserves the Lebesgue measure and is Lipschitz continuous. Depending on the applications, several alternatives
are possible in order to cluster spatial data together in the third dimension compared to its clustering in 2D.

### Review of Spatial Indexing Techniques for Large Urban Data Management

Pressure on land development in urban areas causes progressive efforts in spatial planning and management. The physical expansion of urban areas to accommodate rural migration implies a massive impact to social, economical and political situations of major cities. Most of the models used in managing urban areas are moving towards sustainable urban development in order to fulfill current necessities while preserving the resources for future generations. However, in order to manage large amounts of urban spatial data, an efficient spatial data constellation method is needed. With the ease of three dimensional (3D) spatial data usage in urban areas as a new source of data input, practical spatial data indexing is necessary to improve data retrieval and management. Current two dimensional (2D) spatial indexing approaches seem not applicable to the current and future spatial developments. Therefore, the objective of this paper is to review existing spatial data indexing approaches for managing large urban area datasets. Each approach will be reviewed and discussed according to the current spatial data scenarios. In addition, a 3D spatial data indexing method will be discussed as an alternative for organizing 3D spatial data.

### RF subsystem power consumption and induced radiation emulation

The thesis introduces a novel approach towards the emulation of the RF subsystem power consumption when transmitting a LTE signal. The RF subsystem which is made up of analog components has not been covered by the status quo emulation methodologies which are compatible with digital circuits. Though the study of the RF subsystem architectures revealed numerous architectures with different impacts on power consumption, we have decided to consider the RF subsystem as a black box.

The RF subsystem power emulation has been studied for the telecommunication technology Long Term Evolution (LTE). Given the fact that major power consumptions of wireless devices are largely functions of sequences of protocol/ logical activities, it is this technology that provided the inputs to the RF subsystem as a black black box which are Tx power, carrier frequency and signal bandwidth. The physical environmental variable temperature has also proven to be very influential on power consumption. These inputs also do constitute to the input parameters of the emulation methodology.

The emulation methodology has been proven to be a mathematical mapping between the input parameters and a
A predefined mathematical model. For the mathematical model, multivariate modeling approaches were analyzed for an approach with the least modeling error and complexity. Herein, the homotopy continuation numerical approach proved to have the least modeling error of 3%. The RF subsystem power consumption has been emulated with accuracies of 84% ±2.25% and 94.3% ±2.25% on different devices.
Level Sets and Voronoi based Feature Extraction from any Imagery

Polygon features are of interest in many GEOProcessing applications like shoreline mapping, boundary delineation, change detection, etc. This paper presents a unique new GPU-based methodology to automate feature extraction combining level sets, or mean shift based segmentation together with Voronoi skeletonization, that guarantees the extracted features to be topologically correct. The features thus extracted as object centerlines can be stored as vector maps in a Geographic Information System after labeling and editing. We show application examples on different sources: paper maps, digital satellite imagery, and 2D/3D acoustic images (from hydrographic surveys). The application involving satellite imagery shown in this paper is coastline detection, but the methodology can be easily applied to feature extraction on any king of imagery. A prototype application that is developed as part of this research work.

LTE RF subsystem power consumption modeling

This paper presents a new power consumption emulation model, for all possible scenarios of the RF subsystem, when transmitting a LTE signal. The model takes the logical interface parameters, Tx power, carrier frequency and bandwidth between the baseband and RF subsystem as inputs to compute the power consumption. An analysis of modeling approaches was conducted and the modeling approach with the least sum of squared errors is used to compute the emulation model. The neural networks applying the Pseudo-Gauss Newton algorithm for optimization proved to have the least sum of squared errors. This approach was validated against a real life scenario with a relative error of 5.77%.
Map Updates in a Dynamic Voronoi Data Structure

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Non-Spatial and Geospatial Semantic Query of Health Information

With the growing amount of health information and frequent outbreaks of diseases, the retrieval of health information is given more concern. Machine understanding of spatial information can improve the interpretation of health data semantics. Most of the current research focused on the non-spatial semantics of health data, using ontologies and rules. Utilizing the spatial component of health data can assist in the understanding of health phenomena. This research proposes a semantic health information query architecture that allows the incorporation of both non-spatial semantics and geospatial semantics in health information integration and retrieval.

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On-line early warning system for evacuation of socially vulnerable population during flooding

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Organisations: National Space Institute, Geodesy, University of New Brunswick, New Brunswick Emergency Measures Organization, New Brunswick Department of Environment
Authors: Mioc, D. (Intern), Moreiri, K. K. (Ekstern), Nkhwanana, J. N. (Ekstern), Nikerson, B. (Ekstern), McGillivray, E. (Ekstern), Morton, A. (Ekstern), Tang, P. (Ekstern)
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Planning a new ski lift system in Sisimiut (Greenland)

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Visualization of the Impact of the Catastrophic Flooding Events

The use of advanced tools for computation and modelling of natural hazards can be combined with a GIS that has the capability of decision support and advanced visualization to produce models, that will represent the risks of natural hazards and man-made disasters in the form of risk maps, where the risks are categorized and quantified. Very large amounts of data can be processed, quantified and displayed on digital maps, allowing decision makers to assess the situation rapidly and take appropriate actions. Furthermore, these processes can be automated, enabling near real time access to the risk maps. This can greatly help decision makers with the emergency measures and mitigation in most of the cases. In this article, we present a case study about mapping of flood risks due to a dam burst showing risk maps of flood hazards and available emergency facilities and their significance for risk prevention and mitigation.

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Development and challenges of using web-based GIS for health applications

Web-based GIS is increasingly used in health applications. It has the potential to provide critical information in a timely manner, support health care policy development, and educate decision makers and the general public. This paper describes the trends and recent development of health applications using a Web-based GIS. Recent progress on the database storage and geospatial Web Services has advanced the use of Web-based GIS for health applications, with various proprietary software, open source software, and Application Programming Interfaces (APIs) available. Current challenges in applying Web-based GIS for health, such as data heterogeneity, data privacy and confidentiality, powerful processing abilities, and appropriate data representation to users are also discussed. The continuous development of Web-based GIS for health applications will further enhance disease surveillance, health care planning, and public health participation.

Exact computation of the Voronoi Diagram of spheres in 3D, its topology and its geometric invariants

In this paper, we are addressing the exact computation of the Delaunay graph (or quasi-triangulation) and the Voronoi diagram of spheres using Wu’s algorithm. Our main contribution is first a methodology for automated derivation of invariants of the Delaunay empty circumcircle predicate for spheres and the Voronoi vertex of four spheres, then the application of this methodology to get all geometrical invariants that intervene in this problem and the exact computation of the Delaunay graph and the Voronoi diagram of spheres. To the best of our knowledge, there does not exist a comprehensive treatment of the exact computation with geometrical invariants of the Delaunay graph and the Voronoi diagram of spheres. Starting from the system of equations defining the zero-dimensional algebraic set of the problem, we are following Wu’s algorithm to transform the initial system into an equivalent Wu characteristic (triangular) set. In the corresponding system of algebraic equations, in each polynomial (except the first one), the variable with higher order from the preceding polynomial has been eliminated (by pseudo-remainder computations) and the last polynomial is a polynomial of a single variable. By regrouping all the formal coefficients for each monomial in each polynomial, we get polynomials that are invariants for the given problem. We rewrite the original system by replacing the invariant polynomials by new formal coefficients. We repeat the process until all the algebraic relationships (syzygies) between the invariants have been found by applying Wu’s algorithm on the invariants.
Flood Progression Modelling and Impact Analysis

People living in the lower valley of the St. John River, New Brunswick, Canada, frequently experience flooding when the river overflows its banks during spring ice melt and rain. To better prepare the population of New Brunswick for extreme flooding, we developed a new flood prediction model that computes floodplain polygons before the flood occurs. This allows emergency managers to access the impact of the flood before it occurs and make the early decisions for evacuation of the population and flood rescue. This research shows that the use of GIS and LiDAR technologies combined with hydrological modelling can significantly improve the decision making and visualization of flood impact needed for emergency planning and flood rescue. Furthermore, the 3D GIS application we developed for modelling flooded buildings and infrastructure provides a better platform for modelling and visualizing flood situations than previously done in 2D maps. All parts of a building could be studied in detail in the event of flooding. This provides a better tool for analyzing and preparing for emergency measures. It also presents a photo-realistic situation that can easily be understood. Public administrators who may not be familiar with GIS analytical tools like Query Languages, can still understand technical discussions on flood analysis through the use of 3D models, which are close to reality.

RF power consumption emulation optimized with interval valued homotopies

This paper presents a methodology towards the emulation of the electrical power consumption of the RF device during the cellular phone/handset transmission mode using the LTE technology. The emulation methodology takes the physical environmental variables and the logical interface between the baseband and the RF system as inputs to compute the emulated power dissipation of the RF device. The emulated power, in between the measured points corresponding to the discrete values of the logical interface parameters is computed as a polynomial interpolation using polynomial basis functions. The evaluation of polynomial and spline curve fitting models showed a respective divergence (test error) of 8% and 0.02% from the physically measured power consumption. The precisions of the instruments used for the physical measurements have been modeled as intervals. We have been able to model the power consumption of the RF device operating at 5MHz using homotopy between 2 continuous power consumptions of the RF device operating at the bandwidths 3MHz and 10MHz.
Towards introducing a Geocoding Information System for Greenland

Arctic Basemaps In Google Maps

The Ocean Mapping Group has been collecting data in the Arctic since 2003 and there are approximately 2,000 basemaps. In the current online storage format used by the OMG, it is difficult to view the data and users cannot easily pan and zoom. The purpose of this research is to investigate the advantages of the use of Google Maps, to display the OMG's Arctic data. The map should should load the large Arctic dataset in a reasonable time. The bathymetric images were created using software in Linux written by the OMG, and a step-by-step process was used to create images from the multibeam data collected by the OMG in the Arctic. The website was also created using Linux operating system. The projection needed to be changed from Lambert Conformal Conic (useful at higher Latitudes) to Mercator (used by Google Maps) and the data needed to have a common colour scheme. After creating and testing a prototype website using Google Ground overlay and Tile overlay, it was determined that the high resolution images (10m) were loading very slowly and the ground overlay method would not be useful for displaying the entire dataset. Therefore the Tile overlays were selected to be used within Google Maps. Tile overlays used for this project proved to be useful for large datasets because they cut the image into many different tiles and load only the part of the image (tile) within the map window bounds.
Early Warning And On-Line Mapping For Flood Events

Kinetic Line Voronoi Operations and Their Reversibility
In Geographic Information Systems the reversibility of map update operations has not been explored yet. In this paper we are using the Voronoi based Quad-edge data structure to define reversible map update operations. The reversibility of the map operations has been formalised at the lowest level, as the basic algorithms for addition, deletion and moving of spatial objects. Having developed reversible map operations on the lowest level, we were able to maintain reversibility of the map updates at higher levels as well. The reversibility in GIS can be used for efficient implementation of rollback mechanisms and dynamic map visualisations. In order to use the reversibility within the kinetic Voronoi diagram of points and open oriented line segments, we need to assure that reversing the map commands will produce exactly the changes...
in the map equivalent to the previous map states. To prove that reversing the map update operations produces the exact reverse changes, we show an isomorphism between the set of complex operations on the kinetic Voronoi diagram of points and open oriented line segments and the sets of numbers of new / deleted Voronoi regions induced by these operations, and its explanation using the finite field of residual classes of integers modulo 5: $\mathbb{F}_5 = \mathbb{Z}/5\mathbb{Z}$. We show also an isomorphism between the set of complex operations on the kinetic Voronoi diagram of points and open oriented line segments and the set of differences of new and deleted Quad-Edge edges induced by these operations, and its explanation using the commutative ring $\mathbb{Z}_{15} = \mathbb{Z}/15\mathbb{Z}$. We show finally the application of these theoretical results to the logging of a kinetic line Voronoi data structure. © 2010 Springer-Verlag.

General information
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Organisations: Geodesy, National Space Institute, Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling, University of Glamorgan, Universite Laval
Authors: Mioc, D. (Intern), Anton, F. (Intern), Gold, C. (Ekstern), Moulin, B. (Ekstern)
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Online mapping and querying health data

A spatial component for health data can support spatial analysis and visualization in the investigation of health phenomena. Therefore, the utilization of spatial information in a Semantic Web environment will enhance the ability to query and to represent health data. In this paper, a semantic health data query and representation framework is proposed through the formalization of spatial information. We include the geometric representation in RuleML deduction, and apply ontologies and rules for querying and representing health information. Corresponding geospatial built-ins were implemented as an extension to OO jDREW. Case studies were carried out using geospatial-enabled RuleML queries for respiratory disease information. The paper thus demonstrates the use of RuleML for geospatial-semantic querying and representing of health information.

Geospatial-Enabled RuleML in a Study on Querying Respiratory Disease Information

A spatial component for health data can support spatial analysis and visualization in the investigation of health phenomena. Therefore, the utilization of spatial information in a Semantic Web environment will enhance the ability to query and to represent health data. In this paper, a semantic health data query and representation framework is proposed through the formalization of spatial information. We include the geometric representation in RuleML deduction, and apply ontologies and rules for querying and representing health information. Corresponding geospatial built-ins were implemented as an extension to OO jDREW. Case studies were carried out using geospatial-enabled RuleML queries for respiratory disease information. The paper thus demonstrates the use of RuleML for geospatial-semantic querying and representing of health information.

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Authors: Gao, S. (Ekstern), Boley, H. (Ekstern), Mioc, D. (Intern), Anton, F. (Intern), Yi, X. (Ekstern), Oldfield, E. (Ekstern)
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On kinetic line Voronoi operations and finite fields

In this paper, we show an isomorphism between the set of complex operations on the kinetic Voronoi diagram of points and open oriented line segments and the sets of numbers of new / deleted Voronoi regions induced by these operations, and its explanation using the finite field of residual classes of integers modulo 5: $F_5 = \mathbb{Z}/5\mathbb{Z}$. We show also an isomorphism between the set of complex operations on the kinetic Voronoi diagram of points and open oriented line segments and the set of differences of new and deleted quad-edge edges induced by these operations, and its explanation using the finite field $F_{15} = \mathbb{Z}/15\mathbb{Z}$. We show finally the application of these theoretical results to the logging of a kinetic line Voronoi data structure.

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On the isomorphism between the medial axis and a dual of the Delaunay graph

In this paper, we show a graph isomorphism between a dual graph of the Delaunay graph of the sampled points and the medial axis of the sampled features. This dual graph captures the fact that two Delaunay triangles share two vertices or an edge. Then, we apply it to the computation of the medial axis of the features selected in an image. The computation of the medial axis of images is of interest in applications such as mapping, climatology, change detection, medicine, etc. This research work provides a way to automate the computation of the medial axis transform of the features of color 2D images. In color images, various features can be distinguished based on their color. The features are thus extracted as object borders, which are sampled in order to compute the medial axis transform. We present also a prototype application for the completely automated or semi-automated processing of (satellite) imagery and scanned maps. Applications include coastline extraction, extraction of fields, clear cuts, clouds, as well as heating or pollution monitoring and dense forest mapping among others.

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Authors: Sharma, O. (Intern), Anton, F. (Intern), Mioc, D. (Intern)
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The measurement of Geospatial Web Service quality in SDIs

Currently, increasingly large number of Geospatial Web Services are being built in Spatial Data Infrastructures (SDIs). Although services make it easy for users to access desired information, the quality of Geospatial Web Services will greatly affect the willingness of users in access of these services. Therefore, in order to improve the use of service-oriented architecture for distributed geospatial data sharing, proper measurement of the Geospatial Web Service quality is highly valuable. In this paper, we propose to evaluate Geospatial Web Service quality from Geospatial Web Service activities and Geospatial Service usage. The Geospatial Web Service activities contain four layers: Geospatial Web Service commitment, Geospatial Web Service description, Geospatial Web Service process, and Geospatial Web Service outcome layers. To measure Geospatial Web Service quality score, we consider both objective measurement and subjective measurement. Objective measurement is generated from the comparison of actual service performance with application requirements. Subjective measurement determines users’ attitudes towards the consumption of services. In conclusion, this study brings new perspective in evaluating Geospatial Web Services in SDIs. It provides a solution to calculate the Geospatial Web Service quality score from both objective and subjective measurement.

Towards building a geo-service broker

Most national Spatial Data Infrastructures (SDI) were built based on a clearinghouse concept. The concept requires all of the service providers to maintain a Web (map) service recourse which leads to duplication of efforts from data collectors. The objectives of developing a geo-service broker are to make data services and other services within an SDI centrally organized, available and accessible to consumers. A geo-service broker offers a centralized and harmonized view on resources. The objective of this research is to investigate how a geo-service broker is built as a tool for intelligent search and information retrieval in the semantic Web for better service delivery of geo-services over the Internet.
Towards Web-based representation and processing of health information

Background: There is great concern within health surveillance, on how to grapple with environmental degradation, rapid urbanization, population mobility and growth. The Internet has emerged as an efficient way to share health information, enabling users to access and understand data at their fingertips. Increasingly complex problems in the health field require increasingly sophisticated computer software, distributed computing power, and standardized data sharing. To address this need, Web-based mapping is now emerging as an important tool to enable health practitioners, policy makers, and the public to understand spatial health risks, population health trends and vulnerabilities. Today several web-based health applications generate dynamic maps; however, for people to fully interpret the maps they need data source description and the method used in the data analysis or statistical modeling. For the representation of health information through Web-mapping applications, there still lacks a standard format to accommodate all fixed (such as location) and variable (such as age, gender, health outcome, etc) indicators in the representation of health information. Furthermore, net-centric computing has not been adequately applied to support flexible health data processing and mapping online. Results: The authors of this study designed a HEalth Representation XML (HERXML) schema that consists of the semantic (e.g., health activity description, the data sources description, the statistical methodology used for analysis), geometric, and cartographical representations of health data. A case study has been carried on the development of web application and services within the Canadian Geospatial Data Infrastructure (CGDI) framework for community health programs of the New Brunswick Lung Association. This study facilitated the online processing, mapping and sharing of health information, with the use of HERXML and Open Geospatial Consortium (OGC) services. It brought a new solution in better health data representation and initial exploration of the Web-based processing of health information. Conclusion: The designed HERXML has been proven to be an appropriate solution in supporting the Web representation of health information. It can be used by health practitioners, policy makers, and the public in disease etiology, health planning, health resource management, health promotion and health education. The utilization of Web-based processing services in this study provides a flexible way for users to select and use certain processing functions for health data processing and mapping via the Web. This research provides easy access to geospatial and health data in understanding the trends of diseases, and promotes the growth and enrichment of the CGDI in the public health sector.

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A methodology for automated cartographic data input, drawing and editing using kinetic Delaunay/Voronoi diagrams

This chapter presents a methodology for automated cartographic data input, drawing and editing. This methodology is based on kinematic algorithms for point and line Delaunay triangulation and the Voronoi diagram. It allows one to automate some parts of the manual digitization process and the topological editing of maps that preserve map updates. The manual digitization process is replaced by computer assisted skeletonization using scanned paper maps. We are using the Delaunay triangulation and the Voronoi diagram in order to extract the skeletons that are guaranteed to be topologically correct. The features thus extracted as object centrelines can be stored as vector maps in a Geographic Information System after labelling and editing. This research work can also be used for updates from sources that are either paper copy maps or digital raster images. A prototype application that was developed as part of the research has been presented. We also describe two reversible line-drawing methods for cartographic applications based on the kinetic (moving-point) Voronoi diagram. Our objectives were to optimize the user's ability to draw and edit the map, rather than to produce the most efficient batch-oriented algorithm for large data sets, and all our algorithms are based on local operations (except for basic point location). Because the deletion of individual points or line segments is a necessary part of the manual editing process, incremental insertion and deletion is used. The original concept used here is that, as a curve (line) is the locus of a moving point, then segments are drawn by maintaining the topology of a single moving point (abbreviated as MP hereafter, or the "pen") as it moves through the topological network (visualized as either the Voronoi diagram or Delaunay triangulation). This approach also has the interesting property that a "log file" of all operations may be preserved, allowing reversion to previous map states, or "dates", as required.

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A RuleML Study on Integrating Geographical and Health Information

To facilitate health surveillance, flexible ways to represent, integrate, and deduce health information become increasingly important. In this paper, an ontology is used to support the semantic definition of spatial, temporal and thematic factors of health information. The ontology is realized as an interchangeable RuleML knowledge base, consisting of facts and rules. Rules are also used for integrating geographical and health information. The implemented eHealthGeo system uses the OO jDREW reasoning engine to deduce implicit information such as spatial relationships. The system combines this with spatial operations and supports health information roll-up and visualization. The eHealthGeo study demonstrates a RuleML approach to supporting semantic health information integration and management.

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ISBN (Print): 9780415478052
Main Research Area: Technical/natural sciences

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Source: orbit
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Dynamic Street Network Analysis for Evacuation Planning in Flood Events

General information
Online GIS services for mapping and sharing disease information

Background Disease data sharing is important for the collaborative preparation, response, and recovery stages of disease control. Disease phenomena are strongly associated with spatial and temporal factors. Web-based Geographical Information Systems provide a real-time and dynamic way to represent disease information on maps. However, data heterogeneities, integration, interoperability, and cartographical representation are still major challenges in the health geographic fields. These challenges cause barriers in extensively sharing health data and restrain the effectiveness in understanding and responding to disease outbreaks. To overcome these challenges in disease data mapping and sharing, the senior authors have designed an interoperable service oriented architecture based on Open Geospatial Consortium specifications to share the spatio-temporal disease information. Results A case study of infectious disease mapping across New Brunswick (Canada) and Maine (USA) was carried out to evaluate the proposed architecture, which uses standard Web Map Service, Styled Layer Descriptor and Web Map Context specifications. The case study shows the effectiveness of an infectious disease surveillance system and enables cross-border visualization, analysis, and sharing of infectious disease information through interactive maps and/or animation in collaboration with multiple partners via a distributed network. It enables data sharing and users’ collaboration in an open and interactive manner. Conclusions In this project, we develop a service oriented architecture for online disease mapping that is distributed, loosely coupled, and interoperable. An implementation of this architecture has been applied to the New Brunswick and Maine infectious disease
studies. We have shown that the development of standard health services and spatial data infrastructure can enhance the efficiency and effectiveness of public health surveillance.

**General information**

State: Published
Organisations: National Space Institute, Geodesy, Department of Informatics and Mathematical Modeling, Image Analysis and Computer Graphics, University of New Brunswick, New Brunswick Lung Association
Authors: Gao, S. (Ekstern), Mioc, D. (Intern), Anton, F. (Intern), Yi, X. (Ekstern), Coleman, D. J. (Ekstern)
Number of pages: 12
Publication date: 2008
Main Research Area: Technical/natural sciences

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Scopus rating (2015): SJR 1.16 SNIP 1.171 CiteScore 2.69
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Scopus rating (2014): SJR 1.175 SNIP 1.459 CiteScore 2.87
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Scopus rating (2013): SJR 1.013 SNIP 1.276 CiteScore 2.55
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.906 SNIP 1.369 CiteScore 2.72
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BFI (2011): BFI-level 1
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ISI indexed (2011): ISI indexed no
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Scopus rating (2010): SJR 1.029 SNIP 1.244
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.842 SNIP 1.289
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BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.885 SNIP 1.024
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.938 SNIP 1.159
Scopus rating (2006): SJR 1.088 SNIP 1.474
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Scopus rating (2004): SJR 0.249 SNIP 0.541
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http://www.ij-healthgeographics.com/content/7/1/8
On-line street network analysis for flood evacuation planning

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Image Analysis and Computer Graphics, University of New Brunswick
Authors: Mioc, D. (Intern), Anton, F. (Intern), Liang, G. (Ekstern)
Number of pages: 21
Pages: 221-242
Publication date: 2008

Host publication information
Title of host publication: Remote Sensing and GIS Technologies for Monitoring and Prediction of Disasters
Publisher: Springer
Editor: Zlatanova, S.
ISBN (Print): 3540792589
Chapter: 13
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 209104
Publication: Research - peer-review › Book chapter – Annual report year: 2008

Ontology-based querying and visualization of geo-referenced health information

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling, University of New Brunswick, National Research Council of Canada, New Brunswick Lung Association
Authors: Gao, S. (Ekstern), Mioc, D. (Intern), Boley, H. (Ekstern), Anton, F. (Intern), Yi, X. (Ekstern)
Publication date: 2008

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Main Research Area: Technical/natural sciences
Conference: Joint ISCRAM-CHINA and Gi4DM Conference, Harbin, China, 04/08/2008 - 04/08/2008
Source: orbit
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2008

Polygon Feature Extraction from Satellite Imagery Based on Colour Image Segmentation and Medial Axis

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, National Space Institute, Geodesy
Authors: Sharma, O. (Intern), Mioc, D. (Intern), Anton, F. (Intern)
Pages: 235-240
Publication date: 2008
Conference: XXIst ISPRS Congress, Beijing, China, 03/07/2008 - 03/07/2008
Main Research Area: Technical/natural sciences

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Issue number: Part B3A
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The Canadian Geospatial Data Infrastructure and health mapping

Due to the recent outbreak of SARS and the danger of pandemic Bird Flu, the ability to strengthen health surveillance and disease control is a growing need among governments. The development of the Canadian Geospatial Data Infrastructure (CGDI) has shown great potential in many industries such as emergency management, public health, disaster relief, environmental impact assessment, transportation, and land information systems. In this paper, our aims are to use the CGDI and to identify its usability in supporting online health mapping. To identify the usability of the CGDI for health mapping, we employed nine usability metrics. We also designed an architecture based on the CGDI to support the basic functions for health mapping, and implemented an infectious disease simulation for New Brunswick and Maine. Within the CGDI framework, this research enabled cross-border health data visualization, integration, sharing, and exploring the spatio-temporal trends of an infectious disease outbreak through thematic maps. Based on the experience of the developers and the feedback from users, an evaluation of the usability matrix with the CGDI components (technical standards, national framework data, enabling technologies, and common data policies) was explored using this cross-border health mapping application. The use of the CGDI in health applications has a great potential in supporting effective and secure health data sharing and integration. Enrichment of the CGDI would further facilitate the data sharing and improve decision making efficiency and effectiveness.
A study of the usability of CGDI in health mapping

Due to the recent outbreak of SARS and Bird Flu, the ability to strengthen health surveillance and control is highly appreciated. Since the health problem is strongly referenced with spatial locations, integrating geospatial technology in health study could support better decision making. Right now, the development of CGDI has shown great potential in many fields like emergency management, public health, disaster relief, transportation, land information system. Our study is to use CGDI to support online mapping of infectious disease across New Brunswick and Maine and to identify the usability of CGDI for health mapping. New Brunswick and Maine are territorial neighbors which means there are significant volumes of goods and people traveling across our international border, thus infectious agents are likely to carry from one jurisdiction to the other. In this paper, with the purpose to make infectious disease information available to officials and public for better support of disease surveillance, we developed a data model for mapping, seamlessly integrating the spatial and health data across the New Brunswick and Maine border. Many factors such as map representation level, mapping variables, data diversity and privacy are considered in the infectious disease mapping. Using Web Map Service, it enables cross-border data integration, visualization, analysis, sharing and explores the spatio-temporal trends of infectious disease outbreak with multiple partners via a distributed access network through the CGDI framework. With the evolvement of CGDI and health study, it would further facilitate the health data sharing and improve decision making efficiency and effectiveness.
Decision Support for Flood Event Prediction and Monitoring

In this paper the development of Web GIS based decision support system for flood events is presented. To improve flood prediction we developed the decision support system for flood prediction and monitoring that integrates hydrological modelling and CARIS GIS. We present the methodology for data integration, floodplain delineation, and online map interfaces. Our Web-based GIS model can dynamically display observed and predicted flood extents for decision makers and the general public. The users can access Web-based GIS that models current flood events and displays satellite imagery and digital elevation model integrated with flood plain area. The system can show how the flooding prediction based on the output from hydrological modeling for the next 48 hours along the lower Saint John River Valley.

Feature Extraction and Simplification from colour images based on Colour Image Segmentation and Skeletonization using the Quad-Edge data structure

Region features in colour images are of interest in applications such as mapping, GIS, climatology, change detection, medicine, etc. This research work is an attempt to automate the process of extracting feature boundaries from colour images. This process is an attempt to eventually replace manual digitization process by computer assisted boundary detection and conversion to a vector layer in a GIS or a spatial database. In colour images, various features can be distinguished based on their colour. The features thus extracted as object border can be stored as vector maps in a GIS or a spatial database after labelling and editing. Here we present a complete methodology of the boundary extraction and skeletonization process from colour imagery using a colour image segmentation algorithm, a crust extraction algorithm and a skeleton extraction algorithm. We present also a prototype application for the semi-automated or completely automated processing of satellite imagery with an application to coastline extraction. Other applications include extraction of fields, clear cuts, clouds, as well as heating or pollution monitoring and dense forest mapping among others.
GIS Support for Flood Rescue
Under flood events, the ground traffic is blocked in and around the flooded area due to damages to roads and bridges. The traditional transportation network may not always help people to make a right decision for evacuation. In order to provide dynamic road information needed for flood rescue, we developed an adaptive web-based transportation network application using Oracle technology. Moreover, the geographic relationships between the road network and flood areas are taken into account. The overlay between the road network and flood polygons is computed on the fly. This application allows users to retrieve the shortest and safest route in Fredericton road network during flood event. It enables users to make a timely decision for flood rescue. We are using Oracle Spatial to deal with emergency situations that can be applied to other constrained network applications as well.

Reversibility of the Quad-Edge operations in the Voronoi data structure
In Geographic Information Systems the reversibility of map update operations have not been explored yet. In this paper we are using the Voronoi based Quad-edge data structure to define reversible map update operations. The reversibility of the map operations have been formalised at the lowest level, as the basic algorithms for addition, deletion and moving of spatial objects. Having developed reversible map operations on the lowest level, we were able to maintain reversibility of the map updates at higher level as well. The reversibility in GIS can be used for efficient implementation of rollback mechanisms and dynamic map visualisations.
The Voronoi diagram of circles made easy

Proximity queries among circles could be effectively answered if the Delaunay graph for sets of circles could be computed in an efficient and exact way. In this paper, we first show a necessary and sufficient condition of connectivity of the Voronoi diagram of circles. Then, we show how the Delaunay graph of circles (the dual graph of the Voronoi diagram of circles) can be computed exactly, and in a much simpler way, by computing the eigenvalues of a two by two matrix.

Map updates in a dynamic Voronoi data structure

In this paper we are using local and sequential map updates in the Voronoi data structure, which allows us to automatically record each event and performed map updates within the system. These map updates are executed through map construction commands that are composed of atomic actions (geometric algorithms for addition, deletion, and motion of spatial objects) on the dynamic Voronoi data structure. The formalization of map commands led to the development of a spatial language comprising a set of atomic operations or constructs on spatial primitives (points and lines), powerful enough to define the complex operations. This resulted in a new formal model for map updates, similar to "cellular encoding", where each update is uniquely characterized by the numbers of newly created and inactivated Voronoi regions. This research shows that the result of the formalization of the operations on the dynamic Voronoi data structure is a spatial language or a map grammar that is deterministic and reversible.
Map updates in a dynamic Voronoi data structure
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Three Dimensional Visualizations of Ocean Temperature Data Sampled with Moving Vessel Proler
In this paper we are using local and sequential map updates in the Voronoi data structure, which allows us to automatically record each event and performed map updates within the system. These map updates are executed through map construction commands that are composed of atomic actions (geometric algorithms for addition, deletion, and motion of spatial objects) on the dynamic Voronoi data structure. The formalization of map commands led to the development of a spatial language comprising a set of atomic operations or constructs on spatial primitives (points and lines), powerful enough to define the complex operations. This resulted in a new formal model for map updates, similar to "cellular encoding", where each update is uniquely characterized by the numbers of newly created and inactivated Voronoi regions. This research shows that the result of the formalization of the operations on the dynamic Voronoi data structure is a spatial language or a map grammar that is deterministic and reversible.
This paper presents a methodology to automate some parts of the manual digitization process. This includes replacing the manual digitization process by computer assisted skeletonization using scanned paper maps. In colour scanned paper maps various features on the map can be distinguished based on their colour. This research work utilizes the Delaunay triangulation and the Voronoi diagram in order to extract the skeletons that are guaranteed to be topologically correct. The features thus extracted as object centrelines can be stored as vector maps in a Geographic Information System after labelling and editing. Map updates are important in any Geographic Information System. Therefore, this research work can also be used for updates from sources that are either paper copy maps or digital raster images. A prototype application that is developed as part of the research has been presented.
An algorithm for centerline extraction using natural neighbor interpolation

Data caption and conversion are two of the most costly operations of any GIS, in terms of computer time and manual work needed for spatial data acquisition. They can represent up to 80 percent of the total implementation costs. Manual digitising is a very error prone and costly operation, especially due to the lack of explicit topology in commercial GIS systems. Indeed, each map update might require the batch processing of the whole map. Currently, commercial GIS do not offer completely automatic raster/vector conversion even for simple scanned black and white maps. Various commercial raster/vector conversion products exist for the skeletonisation or thinning of the pixels forming the line, but these approaches have shown difficulties with the extraction of good topology. The spatial feature extraction in raster/vector conversion systems is based on line tracing algorithms. In order to operate they need user defined tolerances settings, what causes difficulties in the extraction of complex spatial features, for example: road junctions, curved or irregular lines and complex intersections of linear features. The approach we use here is based on image processing filtering techniques to extract the basic spatial features from raster data. These spatial features can be used for the reconstruction of the image within the topological data structure - the Voronoi diagram. The novel part of this research is the definition of deterministic topological rules and algorithms for extracting the spatial features from the Voronoi data structure. These spatial features can then be represented in different spatial data structures that can be implemented in a GIS. In this research we use the topological approach to develop new algorithms and data structures for integrated raster/vector models leading to the improvement of data caption and conversion in GIS and to develop a software toolkit for automated raster/vector conversion. The approach is based on computing the skeleton from Voronoi diagrams using natural neighbour interpolation. In this paper we present the algorithm for skeleton extraction from scanned maps. We show that the skeleton extracted from the map features can approximate the centreline of the map object. We apply this algorithm directly on the Voronoi cells, for the extraction of complex spatial features. This research can lead to the improvement of current practices in spatial data acquisition reducing significantly the cost and amount of work needed.
A certified predicate for maintaining the topology of the Voronoi diagram for conics

Voronoi diagrams have not yet been generalised to all the conics. In this paper, we present a predicate for the certified maintenance of the topology of the Voronoi diagram for a set of conics in an incremental way.

General information
State: Published
Organisations: University of British Columbia, University of Calgary
Authors: Antón Castro, F. (Intern), Mioc, D. (Intern)
Pages: 180-186
Publication date: 2003

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Title of host publication: Proceedings of X Encuentros de Geometría Computacional
Editors: Márquez, A., Portillo, J.
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Main Research Area: Technical/natural sciences
Conference: X Encuentros de Geometría Computacional, Sevilla, 16 - 17 June, 01/01/2003
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2003

Progressive generalization methods in GIS

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State: Published
Organisations: Unknown
Authors: Anton, F. (Ekstern), Mioc, D. (Intern)
Publication date: 2003

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Title of host publication: Proceedings of ICA/ISPRS workshop in Map Visualizations and virtual environments
Main Research Area: Technical/virtual environments
Conference: ICA/ISPRS workshop in Map Visualizations and virtual environments, Stellenbosch, South Africa, August, 01/01/2003
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Spatio - temporal map updates in the Voronoi data structure

General information
State: Published
Organisations: Universite de Moncton, University of Glamorgan, Universite Laval, University of New Brunswick
Authors: Mioc, D. (Intern), Antón Castro, F. (Intern), Gold, C. M. (Ekstern), Moulin, B. (Ekstern)
Publication date: 2003

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Publication: Research › Article in proceedings – Annual report year: 2003

Spatio - temporal map updates in the Voronoi data structure

General information
State: Published
Organisations: Universite Laval, University of Glamorgan, Universite de Moncton, University of New Brunswick
Authors: Mioc, D. (Intern), Anton, F. (Intern), Gold, C. M. (Ekstern), Moulin, B. (Ekstern)
Publication date: 2003
An exact algebraic predicate for maintaining the topology of the Voronoi diagram for circles

General information
State: Published
Organisations: University of British Columbia, University of Calgary
Authors: Antón Castro, F. (Intern), Kirkpatrick, D. (Ekstern), Mioc, D. (Intern)
Pages: 72-76
Publication date: 2002

An exact predicate for the optimal construction of the Additively Weighted Voronoi diagram
Keyword: additively weighted voronoi diagram,power voronoi diagram,algebraic predicates

General information
State: Published
Organisations: French National Institute for Computer Science and Applied Mathematics, National Space Institute, University of British Columbia, University of Calgary
Authors: Antón Castro, F. (Intern), Boissonnat, J. (Ekstern), Mioc, D. (Intern), Yvinec, M. (Ekstern)
Pages: 4-7
Publication date: 2002

2D Image Reconstruction using Natural Neighbour Interpolation
In this paper we explore image reconstruction from irregularly spaced samples using natural neighbour interpolation. We sample the image irregularly using techniques based on the Laplacian or the derivative in the direction of the gradient. Local coordinates based on the Voronoi diagram are used in natural neighbour interpolation to quantify the neighbourliness of data sites. Then we use natural neighbour interpolation in order to reconstruct the image. The main result is that the image quality is always very good in the case of the sampling techniques based on the Laplacian.
Keyword: natural neighbour interpolation,irregularly spaced samples,local coordinates,image reconstruction

General information
State: Published
Organisations: University of British Columbia
Authors: Antón Castro, F. (Intern), Mioc, D. (Intern), Fournier, A. (Ekstern)
Pages: 263-269
Publication date: 2000
Dynamic Laguerre Diagrams Made Easy

General information
State: Published
Organisations: Unknown
Authors: Anton, F. (Ekstern), Mioc, D. (Intern)
Pages: 10-13
Publication date: 2000

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Title of host publication: Proceedings of the 16th European Workshop on Computational Geometry : EuroCG’00
Main Research Area: Technical/natural sciences
Conference: 16th European Workshop on Computational Geometry, Eilat, Israel, 13/03/2000 - 13/03/2000
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2000

Line Voronoi diagram based local coordinates and applications to Digital Terrain Modelling

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Organisations: University of British Columbia
Authors: Antón Castro, F. (Intern), Mioc, D. (Intern), Gold, C. (Ekstern)
Publication date: 2000

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Main Research Area: Technical/natural sciences
Conference: Journées de Géométrie Algorithmique, CIRM, Marseille, France, September, 01/01/2000
Source: orbit
Source-ID: 312364
Publication: Research › Article in proceedings – Annual report year: 2000

Visualization of the Nucleation and Growth of Particles
This article presents a method for the visualization of the nucleation and growth of particles based on an algorithm for the dynamic construction of additively weighted Voronoi diagrams. We use the Poisson point process in the dynamic additively Voronoi diagram to generate the Johnson-Mehl tessellation. The Johnson-Mehl model is a Poisson Voronoi growth model, in which nuclei are generated asynchronously using a Poisson point process, and grow at the same radial speed. Growth models produce spatial patterns as a result of simple growth processes and their visualization is important in many technological processes.

Keyword: Visualization of nucleation and growth of particles, Voronoi diagrams, growth models, Johnson-Mehl tessellations

General information
State: Published
Organisations: Hong Kong Polytechnic University, University of British Columbia, Universite Laval
Authors: Mioc, D. (Intern), Antón Castro, F. (Intern), Gold, C. (Ekstern)
Pages: 28-35
Publication date: 2000

Host publication information
Title of host publication: Proceedings of The 8-th International Conference in Central Europe on Computer Graphics, Visualization and Computer Vision’2000
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 312120
Publication: Research - peer-review › Article in proceedings – Annual report year: 2000
Visualization of the Nucleation and Growth of Particles
This article presents a method for the visualization of the nucleation and growth of particles based on an algorithm for the dynamic construction of additively weighted Voronoi diagrams. We use the Poisson point process in the dynamic additively Voronoi diagram to generate the Johnson-Mehl tessellation. The Johnson-Mehl model is a Poisson Voronoi growth model, in which nuclei are generated asynchronously using a Poisson point process, and grow at the same radial speed. Growth models produce spatial patterns as a result of simple growth processes and their visualization is important in many technological processes.
Keyword: Visualization of nucleation and growth of particles, Voronoi diagrams, growth models, Johnson-Mehl tessellations

General information
State: Published
Organisations: Hong Kong Polytechnic University, Universite Laval, University of British Columbia
Authors: Mioc, D. (Intern), Anton, F. (Intern), Gold, C. M. (Ekstern)
Pages: 28-35
Publication date: 2000

On the conversion of ordinary Voronoi diagrams into Laguerre diagrams
We present some geometric relationships between the ordinary Voronoi diagram, and the Voronoi diagram in the Laguerre geometry. We derive from these properties an algorithm for the conversion of ordinary Voronoi diagrams into Voronoi diagrams in the Laguerre geometry.

General information
State: Published
Organisations: University of British Columbia
Authors: Antón Castro, F. (Intern), Mioc, D. (Intern)
Pages: 150-153
Publication date: 1999

An algorithm for the dynamic maintenance and construction of Additively Weighted Voronoi diagrams

General information
State: Published
Organisations: Universite Laval, University of British Columbia, University of Calgary
Authors: Mioc, D. (Intern), Antón Castro, F. (Intern), Gold, C. (Ekstern)
Pages: 117-119
Publication date: 1998

An incremental algorithm for the computation of planar Johnson-Mehl tessellations

General information
Dynamic additively weighted Voronoi diagrams made easy

Local coordinates and interpolation in a Voronoi diagram for a set of points and line segments

Spatio-temporal change representation and map updates in a dynamic Voronoi data structure
Visualizing changes in a dynamic Voronoi data structure via time travel
In recent years there has been rapidly growing interest by the GIS community in new visualization methods for cartographic data. The visualization of map changes is important for several reasons: spatio-temporal analysis, process modelling, and animated maps. It is now widely recognized that current GIS software has no ability to maintain incremental change of spatiotemporal data, and therefore visualization of such data is limited to series of ‘snapshots’ of cartographic data (see [Peque94a]). The growing amount of research on spatio-temporal databases shows that today’s world of spatial data handling requires a dynamic and interactive environment for map visualization. In this paper we will present a conceptual approach for representing cartographic data changing in time and space. The approach emphasizes several research efforts: on the Voronoi spatial data structure, the reversibility of its map construction commands, and their applicability to map visualization and map animation.

General information
State: Published
Organisations: Universite Laval
Authors: Mioc, D. (Intern), Anton, F. (Ekstern), Gold, C. M. (Ekstern)
Pages: 263-269
Publication date: 1998

Host publication information
Title of host publication: Proceedings of The Sixth International Conference on Computer Graphics and Visualization in Central Europe
Main Research Area: Technical/natural sciences
Conference: International Conference on Computer Graphics and Visualization in Central Europe, Plzen City, Czech Republic, February, 01/01/1998
Source: orbit
Source-ID: 312124
Publication: Research - peer-review > Article in proceedings – Annual report year: 1998

Projects:

Emulated power and radiance minimization for safer cellular phones with longer lasting batteries
Department of Informatics and Mathematical Modeling
Period: 01/01/2010 → 25/10/2013
Number of participants: 6
Phd Student:
Musiige, Deogratius (Intern)
Supervisor:
Mioc, Darka (Intern)
Main Supervisor:
Antón Castro, Francesc/François (Intern)
Examiner:
Merayo, José M.G. (Intern)
De La Cruz Blas, Carlos A. (Ekstern)
Prasad, Ramjee (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: ErhvervsPhD-ordningen VTU
Project: PhD