Geodesy and Geomatics Engineering
Semi-Annual Student Technical Conference

Dineen Auditorium – C13
Monday, November 22, 2004

1330 Opening Remarks

Session 1 Land Administration, GIS and GPS
Chair: Steven Dickie

1340 A Political Football: Indigenous Land Rights In Brazil
Meredith Hutchison

1400 Successful GIS Implementation in the Military
Rob Neild

1420 Modeling Reality for Multiple Representations Data Capture
Xiaolun Yi

1440 An Enhanced UNB Ionospheric Modelling Technique for SBAS: the Quadratic Approach
Hyunho Rho

1500 Coffee Break

Session 2 Geodesy and Remote Sensing
Chair: Reza Ghoddousi-fard

1520 Robustness Analysis of 2D Networks
Mustafa Berber

1540 Atmospheric Effets In The Three-Space Scenario For The Stokes-Helmert Method Of Geoid Determination
Huaining Yang

1600 An Evaluation Of Pan-Sharpened Multispectral Imagery For Land Cover Classification Using Ecognition's Object Oriented Approach
Travis Maxwell

1620 Radiometric Normalization of IKONOS Image Using QuickBird Image for Urban Area Change Detection
Gang Hong

1640 Closing Remarks

1645 Reception

A Political Football: Indigenous Land Rights in Brazil

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Since the colonisation of Brazil by the Portuguese in 1500, the indigenous people have faced an uphill battle to retain or regain the rights to their traditional lands. In Brazil today there are many competing interests for indigenous lands, including agricultural operations, latifundios, resource extraction, tourism and landless people. The resultant political pressure from these stakeholders has molded the way in which the Brazilian Constitution and Brazilian legislation recognize indigenous rights.

This paper will examine the conflicting interests in Brazilian native lands and the current administrative framework in place for indigenous groups to claim rights to their traditional lands. The management of indigenous rights in neighbouring countries will also be considered, and used to evaluate Brazil's present strategy for indigenous land rights, and recommend future directions.

Analyzing the Use of GIS in the Department of National Defence (DND) for Infrastructure Management (IM)

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Canada's DND spends billions of dollars on IM yearly. That means that new buildings, roads, power distribution lines, heating plants and the like are built on military bases or are operated and maintained each year. The challenge of managing this growing realty asset portfolio is becoming increasingly complex. Further complicating matters, the IM team is wrestling with capturing the corporate knowledge from the aging workforce as an impending wave of retirements threatens to further erode this knowledge base.

DND is turning to spatial technologies to meet the challenges of IM of its realty asset portfolio. In particular, Geographic Information Systems (GIS) have shown promise as a tool that can help DND to manage its infrastructure more efficiently. GIS has been implemented at a number of bases over the past few years and plans are in place to implement GIS at the remaining bases within the next few years. However, these implementations are not without their problems.

The purpose of this paper is to analyze the implementation of GIS and its use in the military IM community and to determine the following:

1. What, if any, quantifiable benefits exist that accrue back to the implementing organization?
2. What are the three most common pitfalls associated with GIS implementation for infrastructure management?
3. What are the best practices for GIS implementation?

A survey was developed based on the findings in the body of literature that investigates the critical success and failure factors for GIS implementation. This survey was sent to a number of bases and the preliminary results have been analyzed. This paper summarizes the work done to date.

Modeling Reality for Multiple Representations Data Capture

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An object can have more than one geometric representation. Traditionally this has been achieved by creation of different spatial databases and each geometric representation captured separately. With the newer database-driven approaches to digital map and GIS data production now becoming available, we postulate that it is possible to capture the multiple representations of specified features at the time of original collection in a manner that saves significant time and cost when compared with more mainstream digital map production methods now in practice.

Data capture is the process that converts world reality to geographical database. It involves many level design, classification and standard. The first step is modeling the reality. This paper will describe how to model the reality for multiple representations data capture. A pair of concepts Explicit Object and Implicit Object has been introduced for definition and representation of an object.

An Enhanced UNB Ionospheric Modelling Technique for SBAS: the Quadratic Approach

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Several satellite-based augmentation systems (e.g., WAAS, EGNOS, and CDGPS) have recently started operations and more are planed for the future. With a view towards further improving the accuracy of such systems, the associated ionospheric modeling technique is capturing the attention of the scientific community. As long as the ionosphere is the biggest error source in single-frequency GPS, the accuracy of ionospheric modeling remains a critical issue in satellite-based augmentation systems. In terms of modeling the ionosphere, the current UNB approach uses a bi-linear approximation and so ignores the non-linear spatial variation of the ionosphere over the monitoring stations. Efficiency and an acceptable level of accuracy are the main reasons for using a simplified linear model. However, we are left with the questions: Is the linear model sufficient to explain the temporal and spatial variations of the ionosphere? What are the effects of ignoring the non-linear spatial variations in the ionosphere especially under geomagnetic storm conditions?

To provide answers to these questions, we have extended the UNB ionospheric modeling technique from bi-linear to the quadratic form. As the quadratic model is far more sensitive to the distribution of the ionospheric pierce points (IPPs) than the linear model, we have mainly used data from the U.S. Continuously Operating Reference Stations (CORS) network and the International GPS Service (IGS) network. With this relatively dense combined network, we have minimized data gaps. A data set spanning one month from October 25 to November 25, 2003 has been used to generate statistics. On October 29, 30, 31 and November 20, 21, 2003, there were significant geomagnetic disturbances.

In this paper, we present the quantified differences between two approaches, the quadratic and bi-linear models, using data sets from both quiet days and days when the ionosphere is disturbed. We also discuss the advantages and disadvantages of the two approaches that we encountered during the research. Furthermore, we examine the differences between vertical TEC from the quadratic model and from WAAS at the specified ionospheric grid points. For WAAS, the current approach is to use a grid-based first order planar fit model. The WAAS results represent an independent data set for comparison and validation. The presented results could serve as a baseline for further improvements in the GPS-based ionospheric modeling techniques for satellite based augmentation systems.

Robustness Analysis of 2D Networks

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After geodetic networks are established, relevant measurements are made and point coordinates for the control points are estimated by the method of least squares. However, the method of least squares does not give any information about the robustness of networks. To measure robustness of a network the degree of deformation of displacements of individual points of the network is measured by strain. The strain technique is independent of adjustment constraints and reflects only the network geometry and accuracy of the observations. Furthermore, threshold values are needed to evaluate networks. These threshold values are going to enable us to evaluate the robustness of the network. If the displacements of individual points of the network are worse than the threshold values, we must redesign the network by changing the configuration until we obtain a network of acceptable robustness. This paper describes how to obtain the the displacements at the individual points of a network, employs the specifications of the Geodetic Survey of Division and shows the power of the technique on different geodetic networks.

Atmospheric Effets in the Three-Space Scenario for the Stokes-Helmert Method of Geoid Determination

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According to the Stokes-Helmert method for the geoid determination by Vaníček and Martinec (1994) and Vaníček et al. (1999), the Helmert gravity anomalies are computed at the earth surface. To formulate the fundamental formula of physical geodesy, Helmert's gravity anomalies are then downward continued from the earth surface onto the geoid. This procedure, i.e., the inverse Dirichlet's boundary value problem, is realized by solving the Poisson integral equation.

The above mentioned "classical" approach can be modified so that the inverse Dirichlet's boundary value problem is solved in the No Topography (NT) space (Vaníček et al., 2004) instead of in the Helmert (H) space. This technique has been introduced by Vaníček et al. (2003) and was used by Tenzer and Vaníček (2003) for the determination of the geoid in the region of the Canadian Rocky Mountains. According to this new approach, the gravity anomalies referred to the earth surface are first transformed into the NT-space. This transformation is realized by subtracting the gravitational attraction of topographical and atmospheric masses from the gravity anomalies at the earth surface. Since the NT-anomalies are harmonic above the geoid, the Dirichlet boundary value problem is solved in the NT-space instead of the Helmert space according to the standard formulation. After being obtained on the geoid, the NT-anomalies are transformed into the H-space to minimize the indirect effect on the geoidal heights. This step, i.e., transformation from NT-space to H-space is realized by adding the gravitational attraction of condensed topographical and condensed atmospheric masses to the NT-anomalies at the geoid.

The effects of atmosphere in the standard Stokes-Helmert method was intensively investigated by Sjöberg (1998 and 1999), and Novák (2000). In this presentation, the effect of the atmosphere in the three-space scenario for the Stokes-Helmert method is discussed and the numerical results over Canada are shown.

An Evaluation of Pan-Sharpened Multispectral Imagery for Land Cover Classification Using Ecognition's Object Oriented Approach

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The use of fine resolution pan-sharpened imagery in the place of coarser multispectral data is an attractive option for land cover classification. However, traditional pixel based classification techniques have difficulty dealing with the high information content brought about by the spatial resolution of modern satellite sensors. Often this difficulty becomes apparent in the so-called salt and pepper effect of the classified image. This problem is further emphasized when classifying pan-sharpened multispectral imagery as a result of the increased spectral variability over the original multispectral data. For these reasons it is difficult to examine classification accuracy and determine which data is more suited to the land cover classification task.

In general, the object oriented classification methodology is better able to deal with highly textured data. We hypothesize that an object oriented approach is better suited to reveal the true benefits of fused imagery in land cover classification. In pursuit of this goal, we propose to use eCognition, an object oriented classification application developed by Definiens Imaging GmbH, to test the classification accuracy achievable using both original multispectral and UNB pan-sharpened Quickbird imagery.

This report will serve to introduce the techniques of image fusion, segmentation and classification as background for the remainder of the discussion. In the context of ongoing research, some preliminary findings are presented. The paper closes by drawing some initial conclusions and recommendations for further study.

Radiometric Normalization of IKONOS Image Using QuickBird Image for Urban Area Change Detection

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Remotely sensed multitemporal, multisensor data are often required for change detection applications. A common problem associated with the use of these data is the grey value difference caused by non-surface factors such as different illumination, atmospheric, or sensor conditions. Such a difference makes it difficult to accurately detect changes using automatic methods. Effective image normalization is, therefore, important to reduce the radiometric influence caused by the non-surface factors and to ensure that the grey value difference between two temporal images reflects actual changes on the surface of the Earth.

A variety of image normalization methods, which include pseudoinvariant features (PIF), dark and bright set (DB), simple regression (SR), no-change set determined from scattergrams (NC), and histogram matching (HM), have been published in scientific journals. These methods have been tested with either Landsat TM data, MSS data or both, and show different results varying from authors to authors. However, whether the existing methods would be adopted for normalizing currently available high resolution multispectral satellite images, such as IKONOS and QuickBird, the question is still open because of the drastic change in spatial resolution and difference of available multispectral bands. In this research, the existing methods are introduced and employed to normalize the radiometric difference between IKONOS and QuickBird multispectral images taken in different years. Some improvements are introduced to overcome problems caused by band difference and to achieve more stable and better results. The normalized results are compared in terms of visual inspection and statistical analysis. The paper will provide readers with useful information on whether existing methods can be directly adopted for image normalization with very high resolution satellite images, a consideration of problems and some suggested improvements.