Graduate Seminar

&

Student Technical Conference

Wednesday, April 4th, 2012

Department of Geodesy and Geomatics Engineering

The organizer would like to welcome you to the

2012 Graduate Seminar & Student Technical Conference

Where:

E-11

With reception in E-52

When:

Wednesday, April 4th 2012

Seminar Organizer:

Shabnam Jabari

With special thanks to Sylvia Whitaker and all our volunteers

Department of Geodesy and Geomatics Engineering

Geodesy and Geomatics Engineering

Graduate Seminar and Student Technical Conference

E-11

Wednesday, April 4h, 2012

01:00 PM	Opening Remarks: Seminar Organizer

Session 1:

Session Chair: Evans Ralston

1:10 PM	Assessment of VGI quality to comply with Canadian Geospatial Data Infrastructure (CGDI) accuracy standards Andriy Rak
1:30PM	Automated Mid-Water Specific Object Detection with Multibeam Water Column Carlos Rubrio Marques
1:50PM	Study of EGM2008 Determined Geoidal Undulations at various Spherical Harmonic Degree and Orders Eduardo Infante
2:10PM	Object-based Moving Vehicle Extraction and Velocity Estimation Using WorldView-2 Imagery Bahram Salehi
2:30PM	Estimating sound speed uncertainty within a complex estuary using hydrodynamic modeling Ian Church

2:50PM	**Coffee Break**
Section 2:	
	Session Chair: Bahram Salehi
03:15 PM	Orientation estimation by inertial and magnetic sensing Hui Tang
03:35 PM	Proper environmental reduction for attenuation for multi-sectors sonars Rodrigo Carvalho
03:55 PM	Proper Integration of Observables from Multibeam Sonar Surveys. Travis Hamilton
4:15PM	4D Ionosphere Tomographic Modeling Using GPS and GLONASS Ground Measurements and Comparative Study of Results Wei Zhang
04:35PM	**Discussion and Closing Remarks**
04:40 PM	**Presentation of awards**
04:55 PM	**Reception (E-52)**

ACKNOWLEDGEMENTS

Graduate Student Paper Competition Awards

Sponsored by

Automated Mid-Water Specific Object Detection with Multibeam Water Column

Carlos Rubrio Marques
Supervisor: Dr. John Hughes Clarke

Abstract

We have reached a point where multibeam water column imaging can be used to see objects in the mid-water range. Knowing this, an algorithm was developed to detect targets in the water column and pick specific objects based on their attributes.

The search pattern used takes into account the water column characteristics, the pattern associated with the multibeam imaging geometry, including transmission and reception beam-width, pulse length, transmission sectors, slant range, transmission steering and vessel speed. A 3D search pattern is created using a cubic search box to isolate specific detections and another 3D match filter based on multibeam imaging geometry exclusively, is used to refine the results.

As there are a lot of both natural and unnatural features in the water column, the algorithm needed to be modified to recognize only the specific objects we want. With all the detections isolated already, the algorithm now takes advantage of the specific detailed geometry of the desired object, and consequently its own scattering field pattern, and picks up only the specific object requested while deleting all the unwanted detections.

Having detected the required object with this automatic algorithm, we can now in an easier and much more efficient way search through thousands of swaths, collected at different times, and precisely plot the resultant detections in a 3D image to see whether our objects have moved over time. Some example applications were selected, and a specific case study examined to track moorings in the Squamish project for monitoring underwater landslides.

Assessment of VGI quality to comply with Canadian Geospatial Data Infrastructure (CGDI) accuracy standards

Andriy Rak

Supervisors: Dr. David Coleman and Dr. Sue Nichols

Abstract

Authoritative geographic datasets are the source of accurate and reliable data. The process of acquiring, updating and maintaining such datasets using traditional approaches, requires both time and costly resources. As a result, data from such datasets costs a lot of money and, in many cases, is out of date because of the high cost to maintain such datasets. An alternative approach, which is more economic, to reliably create and update authoritative datasets is linked to its integration with Volunteered Geographic Information (VGI). Such integration of VGI with authoritative datasets brings about several questions, with VGI quality issues at the forefront. VGI quality is a primary issue that deter companies from incorporating VGI into their datasets. Due to the lack of research on this topic, companies consider it to be a better practice to exclude VGI as a viable option. If not properly managed, quality of VGI has the potential to reduce the importance of VGI before it reaches its' full potential.

This research will explore an alternative approach to reliably create and update authoritative geographic datasets by integrating VGI and authoritative datasets, providing up-to-date and inexpensive geographic datasets. Due to the increasing importance and value that VGI contributes to geographic information science, the need for further research into the VGI field is now emerging. Currently assessment of VGI quality has received insufficient attention by the scientific and professional communities. In order to overcome these shortcomings further research on VGI quality and its integration with authoritative datasets is required.

Study of EGM2008 Determined Geoidal Undulations at various Spherical Harmonic Degree and Orders

Eduardo Infante

Supervisor: Dr. Langley

Abstract

Geoidal undulations are of great importance in physical geodesy as they relate a mathematically best fit ellipsoid with the geoid which is the standard surface upon which all true heights are measured to. Conventionally, geoidal undulations are obtained through levelling. If one knows the deflections of the vertical at the geoid, the ellipsoidal height, and the orthometric height of a point on the surface the Earth, it is possible to find the ellipsoid-geoid separation. Newer methods of obtaining gravity observations (e.g.: satellite gravimetry) have allowed scientists to gather enough information to develop global geoid models based on spherical harmonic expansions. The purpose of this project was to use the latest geoid model, EGM2008, at different degrees/orders of the spherical harmonic expansions to find the level of convergence for a set of 22 points in New Brunswick's high precision network (HPN). The project revolved around NGA's Harmonic Synthesis WGS84 application.

A C++ script capable of splitting up the input files containing the normalised coefficients was created. Since the main goal of the project was to use the EGM2008 model, varying the degrees and orders by multiples of 10, it was of great importance to create a script that would split the input files at the desired degree/order. These modified input files were then ran through a Windows batch file that among many things ran the hsynth_WGS84 executable. These files were then brought into MATLAB for plotting purposes.

Object-based Moving Vehicle Extraction and Velocity Estimation Using WorldView-2 Imagery

Bahram Salehi

Supervisor: Dr. Yun Zhang and Dr. Ming Jong

Abstract

Because of the sub-meter spatial resolution of very high resolution (VHR) optical satellite imagery, vehicles can be identified in this type of imagery. Further, because there is a time lag in image collection between the Panchromatic (Pan) and multispectral (MS) sensors onboard VHR satellites, a moving vehicle is observed by the satellite at slightly different times. Consequently, its velocity information including speed and direction can be determined. The higher spatial resolution and more spectral bands of WorldView-2(WV2) imagery, compared to those of previous VHR satellites such as QuickBird and GeoEye-1, together with the new sensors' configuration of WV2, i.e., 4 bands on each side of the Pan sensor (MS1 and MS2), adds an opportunity to improve both moving vehicles extraction and the velocity estimation. In this paper, a novel processing framework is proposed for the automatic extraction of moving vehicles and determination of their velocities using single-pass WV2 imagery. The approach contains three major components: a) object-based road extraction, b) moving vehicle extraction from MS1 and MS2, and c) velocity estimation. The method was tested on two different areas of a WV2 image, a high speed and a low speed traffic zone. The method resulted in a correctness of 92% and a completeness of 77% for the extraction of moving vehicles. Furthermore, the estimated speeds and directions are very realistic and are consistent with the speed limits posted on the roads. The results demonstrate a promising potential for automatic and accurate traffic monitoring using a single image of WV2.

Estimating sound speed uncertainty within a complex estuary using hydrodynamic modeling

Ian Church

Supervisors: Dr. John Hughes

Abstract

Hydrodynamic tidal models are currently being constructed for ports and harbours around the world to simulate the amplitude and phase of the tides and build spatially varying tidal datums. As surface fluctuations are the primary interest, these models use an isodensity assumption (barotropic), which ignores sub surface conditions of estuarine circulation. By extending the reach of the model to capture the three dimensional density distribution (baroclinic), the structure and variability of the physical properties of the water column can be monitored.

A project has begun in the Port of Saint John, New Brunswick, to model the estuarine dynamics that drive sediment resuspension for prediction of dredging requirements. To initialize and validate the model, temperature, salinity and current velocity data was collected simultaneously throughout the area from a survey vessel (the CSL Heron) using an MVP-30 and a pole mounted ADCP. Using these observations, and detailed bathymetry, a three dimensional baroclinic hydrodynamic model was constructed for the Port of Saint John. The temporal and spatial distribution of temperature and salinity within the water column structure can be extracted from model output to calculate sound speed structure throughout the model domain.

The modelled temporal oceanographic structure can be used to evaluate the sound speed sampling requirements for a hydrographic survey, examine potential depth errors introduced from collecting an insufficient quantity and distribution of sound speed casts, and generate modelled sound speed profiles for use in data processing. Using three dimensional baroclinic models to estimate the oceanographic structure of an estuary will allow for improved survey planning and could minimize refraction errors associated with an inability to properly sample the local water mass.

Orientation Estimation by Inertial and Magnetic Sensing

Hui Tang

Supervisor: Dr. Don Kim

Abstract

Orientation (i.e., roll, pitch and yaw) estimation has been involved in many fields: human body segment tracking, pedestrian localization, and of interest here, navigation of man-made vehicles (e.g., a mobile robot). Amongst many technologies that have been considered to address this problem, the use of inertial measurement unit (IMU) (i.e., gyroscopes and accelerometers) as well as magnetometers, based on micro-electro-mechanical system (MEMS) has become the most promising practice in terms of self-contained, compact, robust and accurate.

Given initial orientation, gyroscopes determine instantaneous orientation by integrating accurate angular velocity measurements. However, it is well known that the gyroscopes suffer from a relatively small but time-variant sensor bias which leads to accumulated errors in the estimated orientation for a long-term operation.

On the other hand, accelerometers measuring the gravity vector provide tilt (i.e., roll & pitch) information and magnetometers sensing the Earth's magnetic vector give azimuth (i.e., yaw) information, which are drift-free and have good long-term performance. However, the estimates are usually noisy as body accelerations would easily contaminate the gravity measurement and the presence of magnetic anomalies generated by ferromagnetic materials will disturb the Earth's magnetic field measurements.

This paper focuses on designing a filter to fuse the orientation information provided by the three sensors, producing the best estimate of the orientation. For applications in an indoor environment, one challenging part of the filtering is to deal with the magnetic disturbances which corrupt the measurements of magnetometers causing significant orientation estimation errors. A new scheme was developed to handle this situation. Experimental tests have been conducted to validate the algorithm which shows improved performance.

Proper environmental reduction for attenuation for multi-sectors sonars

Rodrigo Carvalho
Supervisor: Dr. John Hughes Clarke

Abstract

Archived multibeam backscatter strength data is only as good as the data reduction. The Ocean Mapping Group (OMG) has a large number of historic multibeam backscatter datasets, for which attenuation reduction is not correct.

As we move towards more precise calibration of backscatter strength to get additional information about the nature of the seafloor, an automated algorithm has been developed to try to minimize bottom backscatter strength fluctuations caused by frequency specific environmental controls on attenuation. This algorithm goes through these large OMG datasets, utilizing either simultaneous CTD information or World Ocean Database (WOD) data to adjust backscatter strength values according to the difference between actual cumulative attenuation and the one used. This fully accounts for sector and beam particular frequencies.

Specific examples are presented of before and after correction for 70 to 100kHz and 300kHz data. Such a toolkit will ensure archived OMG multibeam backscatter strength data rectification and, as another application, allow future transit data collected by Brazilian Navy operations in the South Atlantic to be automatically corrected.

Proper Integration of Observables from Multibeam Sonar Surveys

Travis Hamilton

Supervisor: Dr. John Hughes Clarke and Dr. Jonathon Beaudoin

Abstract

Several measured parameters control the geographic launch vector (azimuth & depression angle) of each beam of a multibeam sonar. If any of the observations are externally logged (as opposed to being streamed into the sonar's computer interface during data collection), or erroneous, the need to recalculate the geographic launch vectors in post processing arises. Externally logged surface sound speed values, new sonar mount angles, faulty orientation data, or the application of new sound speed profiles are a few examples of when recalculation is required.

In order to greatly simplify the mathematics of calculating each geographic launch vector, an assumption is made that the centre of the transmit array at time of transmission, and the centre of the receive array at time of reception are concentric. In reality both arrays are often mounted in physically separate locations and the vessel continues to move between transmission and reception, causing the two arrays to have a three dimensional separation which enormously complicates the geometry of calculating the geographic launch vectors. Previously the resulting bias in depth, across track and along track positions has been minimal, and in many cases mere noise when compared to the angular / depth resolution of sonars, uncertainties from positioning / orientation measurement, and corrections for refraction. However as multibeam sonars have evolved, the array dimensions have grown and the transmit steering angles have increased, both causing larger biases which are proving to have adverse effects on the resulting bathymetric maps.

A fully rigorous calculation of the geographic launch vector has proven to be unattainable without the introduction of assumptions. The precise conditions under which the biases become detrimental are investigated as a first step towards finding which assumption(s) should be made to minimize the resulting biases.

4D Ionosphere Tomographic Modeling Using GPS and GLONASS Ground Measurements and Comparative Study of Results

Wei Zhang

Supervisor: Dr. Richard Langley

Abstract

Ionospheric modelling plays an important role in improving the accuracies of positioning and navigation, especially for the current civil aircraft navigation and single-frequency consumers in mass market because the ionospheric range delay is the largest error source after Selective Availability (SA) was turned off in May 2000. Most available models approximate the ionosphere to a single thin shell fixed at an altitude in the neighborhood of 350 km. This kind of model all assume the electrons in the ionosphere are concentrated in the thin layer that would introduce extra modeling errors up to several TECU (1 TECU = 10^{16} electrons/m^2).

To overcome the common drawback of such models, an alternative concept, a four-dimensional ionospheric tomographic modelling method is implemented to a local GPS/GLONASS reference networks in this paper. Different from the two-dimensional single thin shell ionospheric models where the variable to be modeled is the Total Electron Content (TEC), the variable to be modelled in this tomographic model is the electron density function. Because the major error source of deriving non-biased TEC from GPS and GLONASS data is Differential Code Bias (DCB), DCB is estimated with non-biased TEC simultaneously and analyzed as an indicator to evaluate the model in this paper. The results from GPS and GLONASS observations are compared each other and with corresponding values published by CODE (Centre for Orbit Determination in Europe). Based on the results of accuracy from GPS and GLONASS respectively, a reasonable strategy of incorporating GPS and GLONASS measurements to build up the ionospheric model is suggested.

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