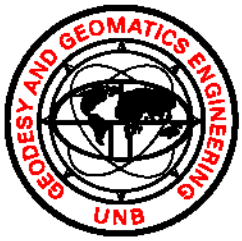
Graduate Seminar

&

Student Technical Conference



Thursday, November 16, 2017

Friday, November 17, 2017

Department of Geodesy and Geomatics Engineering

University of New Brunswick

The Department would like to welcome you to the

Fall 2017 Graduate Seminar & Student Technical Conference

When:

Thursday, November 16, 2017 at 9:40 am

Friday, November 17, 2017 at 10:00 am

Where:

Head Hall – Room H-301 (Thursday)

Head Hall – Room E-11 (Friday)

Department of Geodesy and Geomatics Engineering

Geodesy and Geomatics Engineering

Graduate Seminar and Student Technical Conference

Fall 2017

Chair: *Mike Bremner (MScE; year 2)*

Thursday, November 16, 2017 *(HH-301)*

09:40 **Welcome note**

09:45 **what3words Geocoding Extensions**

Wen Jiang (MScE; year 2)

10:00 **The RHEALPIX Discrete Global Grid System**

David Bowater (MScE; year 1)

10:15 **User Centered Design for Web-Mapping Applications: A Case Study with Ocean Mapping Data for Ocean Modelers**

Marta Padilla Ruiz (MScE; year 2)

10:30 **Rediscovering the Journey of an Abandoned Child: A GIS Approach**

Rajesh Tamilmani (MScE; year 2)

10:45 **Break**

11:00 **Time Synchronization Between Platforms for Indoor Positioning Using a Pseudo-Random Sequence**

Marco Mendonca (PhD; year 4)

11:15 **Static Testing and Analysis of the Tallysman Veraphase VP6000 GNSS Antenna**

Ryan Matthew White (PhD; year 2)

11:30 **Adaptive Band Selection for Pan-Sharpening of Hyperspectral Images**

Fatemeh Fathollahikalanpa (PhD; year 4)

11:45 **Wetland Detection in Optical Images Using Deep Convolutional Network**

Mohammad Rezaee (PhD; year 5)

12:00 **Neural Network Modelling of Sediments and Dissolved Oxygen Content in the Saint John River Using Landsat-8 OLI Imagery**

Essam Helmy Mahfouz Sharaf El Din (PhD; year 3)

12:15 **Closing Remarks**

Chair: *Alec Parise (MScE; year 1)*

Friday, November 17, 2017 *(E-11)*

10:00 **Prototyping a System for Visualizing Real-Time Streams of Geospatial Data**

Ryan Brideau (MScE; year 3)

10:15 **Discovering Traffic Accident Patterns in Space and Time Based on Connectivity of Graph**

Iyke Maduako (PhD; year 3)

10:30 **Bi-Partite Graphs for Regional Mobility Analytics in the Era of the Internet of Mobile Things**

Kaine Darrin Black (MScE; year 1)

10:45 **The Design of a Streaming Analytical Workflow for Processing Massive Transit Feeds**

Hung Cao (PhD; year 2)

Fall 2017 Graduate Seminar & Student Technical Conference

ABSTRACTS

You may contact the Authors for a copy of the full papers.

Department of Geodesy and Geomatics Engineering

what3words Geocoding Extensions

Wen Jiang

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Abstract

With the development of location-based services, the demanding for location data has been dramatically increased. Geocoded locations are useful in many GIS analysis, cartography and decision-making workflows. A reliable geocoding system that can effectively return any location on earth with sufficient accuracy is desired. This project is motivated by a need for a geocoding system that can be applied in applications for UNB campus.

Address-based geocoding has been used for decades. However, it presents limitation of address resources, address standardization and address database maintenance. This has sparked interest in developing alternative geocoding systems that using alphanumeric code as reference to location in recent years.

Comparing with other geocoders, what3words (w3w) has advantages in the simple format of code (using three words); it is less error-prone; easier to remember and multiple languages are supported. However, its fixed resolution and lack of consideration of the third dimension are limitations. In order to better support geographic applications with special requirements, e.g. for UNB campus, w3w geocoding system needs to be extended. This paper proposes extensions of w3w in two aspects – variable-resolution and third dimension support. A geocoding processing tool that implements these extensions, and applications utilizing this geocoder will be programmed in the next phase.

The tools developed by this project are expected to provide benefits to UNB campus' facility management, emergency evacuation management, route navigation research, survey points database management, and other location-based applications.

The rHEALPIX Discrete Global Grid System

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Abstract

The geographic grid has several issues that have been highlighted in applications including climate modelling, numerical weather prediction, and oceanography. For example, cell centroids are not equal distances apart, cells do not have equal area and cells surrounding the poles are actually triangles, not quadrilaterals. A Discrete Global Grid System (DGGS) helps to solve many of these issues. While a single DGGS cannot currently provide the solution to all modern day geospatial applications they can be optimized to meet many global geospatial needs including processing, analysis, visualization, and modelling.

In general, DGGSs that have a planar square grid mirror the geographic grid closely than hexagonal or triangular based DGGSs. Currently, the DGGS most aligned with the Open Geospatial Consortium that adopts this approach is rHEALPix. Although the rHEALPix DGGS is well defined, little implementation or research has occurred with regards to visualization, modelling and analysis of geographic entities such as points, lines and polygons. This paper highlights key features of the rHEALPix DGGS, and possible areas of future research with consideration given towards Canadian use.

User Centered Design for Web-Mapping Applications: A Case Study with Ocean Mapping Data for Ocean Modelers

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Abstract

Technological innovations in the last few years offer a new digital medium for map making, opening a wide range of possible interactions between the user and the map interface. Nowadays, web-mapping applications are a common way to deliver geographic data through the internet, where different map layers from different sources can be combined into a single interactive environment. Within the ocean mapping community, there is a demand for visualizing and downloading data online; for navigation, engineering, natural resources, ocean modelling or habitat mapping purposes. Since it was established, the Ocean Mapping Group (OMG) at the University of New Brunswick (UNB) have been collecting several ocean mapping datasets to serve the scientific community, delivering their data online using a web mapping tool. However, the existing web-mapping applications are simple data repositories for data download, and the user point of view and context of use is not usually considered. In this research, a User-Centred Design (UCD) approach is proposed for the development of a web-mapping application to deliver the OMG ocean mapping data, considering only one kind of ocean mapping users, ocean modelers. UCD involves users in the design process and follows iterative evaluations till their needs and expectations are met. A work domain analysis is conducted as the first stage of the proposed UCD methodology, setting the web-application objectives, defining the user profile and user case scenarios, conducting an informal interview with an ocean modeler, performing a competitive analysis between existing ocean web-mapping applications and proposing an online survey to be conducted by ocean modelers. The results help to understand user needs and tasks, and will allow to determine the required application functionalities and content, as the next steps to complete the UCD process for the development of the web mapping application.

Rediscovering the Journey of an Abandoned Child: A GIS Approach

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Abstract

A decade ago no one would have imagined looking at the top view of their home on a digital screen. Digital mapping and visualization techniques have seen major growth over the years and this has extended the geospatial analysis capabilities of computers beyond imagination. The top international bestseller book "A Long Way Home" narrates the story of a five-year-old child who boarded and got lost on a train which took him thousands of miles away from his home and family. The abandoned child survived and wound up alone in Kolkata India, before ultimately, he was adopted by an Australian couple. At his age of thirty, he found his first home with persistent determination and ample of luck. He found his first home and family with only a handful of memories by using a revolutionary technology known as Google Earth. It almost took him seven years to rediscover his childhood home as Google Earth has limited capabilities with attribute and spatial analysis. Besides he was lacking GIS expertise this paper explores on utilizing online mapping tools for performing attribute and spatial analysis which might have made his search easier. The extensive exploration of ESRI Web Appbuilder technology has been an evidence that it is an easy-to-use application for non-GIS people. Users can quickly discover the locations by using the preconfigured widgets. The application built using Web AppBuilder makes it usable by people with limited GIS skills. The application developed for this research can be extended to other geographic regions as well.

Time Synchronization Between Platforms for Indoor Positioning Using a Pseudo-Random Sequence

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Abstract

The indoor positioning research topic gained traction when satellite positioning systems usage became widespread. Different sensors and indoor positioning techniques are developed at a high pace, most of the times leaving the integration between them as a subject to be approached after the equipment are released. This paper explores the subject of time synchronization be-tween two independent indoor positioning platforms: an Arduino-based Inertial Measurement Unit and the camera-based system Vicon. Being the camera system a positioning reference with precision under the millimeter level, the Arduino platform can be assessed in terms of precision of its position output. The best way to compare two independent systems with independent time-frames, is to somehow synchronize their frames by the means of a clock offset and a drift. Since the behavior of a crystal oscillator varies with parameters such as temperature, pressure, humidity and power source, this synchronization task must be performed at every data collection. The approach of this study lies in the usage of a pseudo-random signal to perform a cross-correlation between both signals to estimate the offsets and drift parameters in a test-bed. The results show that the methods used are effective for the synchronization of two independent time-frames in collocates platforms. An offset between clocks is estimated within a hundredth of a second level, as well as a drift term as a function of the linear regression of the drift terms. For the drift term, only two points were identified, leaving the drift term estimated without redundancy. Even though the value is within an expected interval, it is recommended for future studies that even longer datasets are collected so more points are part of the drift estimation yielding in a more precise synchronization.

Static Testing and Analysis of the Tallysman Veraphase VP6000 GNSS Antenna

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Abstract

One often overlooked aspect of a GNSS receiver system is the selection of an appropriate GNSS antenna. While many currently-available antennas are capable of delivering reasonable geodetic-quality positioning, navigation, and timing (PNT) solutions, recent advances in GNSS antenna technology are helping to provide products with improved performance for PNT users. One such product is the Tallysman VeraPhase VP6000 GNSS antenna. With improved performance characteristics including very low cross-polarization, very low back radiation, very high phase-center stability, and a compact structure as well as sufficient bandwidth to receive all existing and currently-planned GNSS signals, the VP6000 will allow users to enhance the quality of their PNT solutions.

While the VP6000 antenna has been extensively tested using simulated GNSS data, further testing using GNSS observables collected in real-world environments is required in order to determine the actual performance enhancements associated with its novel design. Recently, kinematic tests of the antenna have been carried out by mounting it to the roof of a vehicle and making GNSS measurements in urban and suburban environments (White and Langley, 2017). Another area of interest is the performance of the VP6000's static data collection in high-multipath environments. As a means of assessing the antenna's capabilities in a static, high-multipath environment, the Tallysman VP6000 was used to track GNSS observables in an enclosed sports dome where the overhead steel support structure, concrete and steel flooring, and nearby lighting equipment were sure to introduce multipath errors.

Adaptive Band Selection for Pan-Sharpening of Hyperspectral Images

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Abstract

In Remote Sensing applications, it is needed to have a dataset which benefits from both high-spectral and high-spatial resolutions at the same time. In practice, such dataset is achievable through Pan-sharpening techniques, which involve fusing a high spatial resolution Panchromatic (Pan) image with a low spatial resolution multi-spectral (MS) or hyperspectral (HS) image. Among the proposed methods for Pan and MS fusion, Component Substitution (CS) methods have been widely used in practice, so as the UNB pan-sharpening algorithm. However, adopting such methods to HS pan-sharpening is challenging.

The vital principle in pan-sharpening methods is to select the bands of MS/HS image that have a common spectral coverage with that of the Pan image. However, in HS pan-sharpening, this principle dramatically reduces the number of spectral bands that can be pan-sharpened, since most of the HS spectral bands are beyond the spectral coverage of the Pan image.

This paper investigates the feasibility of incorporating the HS bands, that are beyond the spectral coverage of the Pan image, in the fusion procedure. An adaptive band selection method is proposed that can select the spectral bands for pan-sharpening based on the statistical measurements between Pan and the HS bands. EO-1 satellite images are used for the experiment. UNB Pan-sharpening method and two popular CS methods (Principal Component Analysis and Gram-Schmidt) are used for pan-sharpening. Results show that with the adaptive band selection, even those bands that are beyond the Pan range, can be fused to produce pan-sharpened bands that have the same spectral signature as that of the original HS bands. As a lateral result, it is also observed that the UNB method was more successful in preserving the spectral fidelity of the original HS images compared to PCA and GS. To conclude, with the proposed approach, it is possible to maintain both high spectral and high spatial resolution in one HS dataset which is a valuable input for the next applications such as classification.

Wetland Detection in Optical Images Using Deep Convolutional Network

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Abstract

Wetlands are one of the important habitats for different species. They are degraded due to anthropogenic and natural processes. Canada has one of the richest lands that contain different types of wetland in it and yet, in some regions, there are no protected areas for them due to lack of information about their location. Different research has been conducted to detect wetlands using optical, Radar, or multi-sensor images. In all the cases, the images are not enough to detect the wetlands, since they have similar spectral characteristics. Therefore, a big portion of these papers is dedicated to manually designing proper features for detecting wetland, which is tedious and time-consuming. In this study, we focused on substituting an automatic feature generation method using a GoogLenet deep network for detecting wetlands in two optical images (RapidEye with 5 *m* spatial resolution) in the Avalon area. During the training process, the network generates some features in each hidden layer for detecting the desired objects. The features should highlight distinctive information from each object, so at the end, they can identify each class from the rest. The network is general in terms of the types of input data (optical, Radar, or both). Using the GoogLenet network, a 94% overall accuracy and 92% kappa coefficient were obtained, which is more than other methods in the same area using optical images (83%) and SAR images (92%). The highest confusion error was observed between the bog and fen, while the lowest error was for water class (deep and shallow). The Swamp class also had high confusion error due to the little training data we had for it.

Neural Network Modelling of Sediments and Dissolved Oxygen Content in the Saint John River Using Landsat-8 OLI Imagery

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Abstract

Surface water quality has been deteriorated because of the presence of various types of pollutants generated from human, agricultural, and industrial activities. Thus, mapping concentrations of both optical and non-optical surface water quality parameters (SWQPs), such as total suspended solids (TSS) and dissolved oxygen (DO), is critical for providing the appropriate treatment to water bodies. Traditionally, concentrations of SWQPs have been measured through intensive field work. Recently, quite a lot of studies have attempted to retrieve concentrations of SWQPs from satellite imagery using regression techniques. However, the relationship between concentrations of SWQPs and satellite multispectral data is too complex to be modeled accurately using regression techniques. Therefore, our study attempts to develop an artificial intelligence modelling method for mapping the concentrations of both optical and non-optical SWQPs from satellite imagery. In this context, a remote sensing framework based on the back-propagation neural network (BPNN) is developed for the first time to quantify the concentrations of TSS and DO from Landsat-8 satellite imagery. Compared to existing studies, significant correlation between the Landsat-8 surface reflectance and concentrations of SWQPs was achieved and the coefficient of determination (R^2) reached 0.93 for both TSS and DO. These findings indicate that the developed Landsat-8-based-BPNN framework is capable of developing highly accurate models for retrieving concentrations of different SWQPs from the Landsat-8 imagery.

Prototyping a System for Visualizing Real-Time Streams of Geospatial Data

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Abstract

As geospatially distributed sensors and smart technologies are becoming more common, new techniques are needed to process and visualize their streams of unbounded spatiotemporal data. This paper prototypes an emerging approach for simplifying the required architecture to support both live and historical analysis and visualization for this type of data. It is accomplished by treating all data as an unbounded stream of events throughout the data architecture, while allowing one to unify the live and historical aspects.

The prototype architecture geographically bins incoming geotagged tweets from the public Twitter stream and stores them in the streaming, distributed database *RethinkDB.* An interactive web map-based visualization allows a user to aggregate and visualize the popularity of hashtags in geographic space at varying zoom levels and for any point in time, live or historical. The visualization is designed such that it dynamically updates as new data arrives and as the time window over which the aggregation is performed moves forward in time.

Overall, the prototype serves its purpose by demonstrating that such architectures are possible, but remains limited in its ability to scale as not all the services are horizontally scalable, and it lacks support for advanced time windowing and geoanalytic use cases. Future work will incorporate many aspects of the prototype outlined here, but will build upon them to create a more general framework that can be used in a wider range of scenarios involving unbounded spatiotemporal data analysis and visualization.

Discovering Traffic Accident Patterns in Space and Time Based on Connectivity of Graph

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Abstract

Analysis of the dynamic relationship between traffic accident events and road network topology through space-time-varying graph model offers a new approach to identifying, ranking and profiling traffic accident blackspots and segments. While previous studies on traffic accident hot spots analysis have mostly focused on methods are based on local or global spatial statistics where spatial point clusters are discovered based on spatial dependence of accident locations. A limitation arises from the premise that these methods are usually based on analysis that is constrained to a small portion of the planar 1-D or 2-D Euclidean space rather than the entire network space. Therefore, in this paper, we adopt an approach that is dependent on the interactions that exist between traffic accident events and the road network topology within the entire network space. In other words, the analysis is based on the entire graph connectivity of the network that emerges from the space-time-varying relationship between road network and traffic accident events. A simple but extensible traffic accident space time-varying graph (STVG) model is developed and implemented in this study. Traffic accident blackspots and segments were identified and ranked in space and time using time-dependent degree and PageRank centrality graph metrics. This study offers urban traffic accident analysts with a new approach to identify, rank and profile accident-prone areas in space and time at different scales.

Bi-Partite Graphs for Regional Mobility Analytics in the Era of the Internet of Mobile Things

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Abstract

The Internet of Things (IoT) has been well established as the next major innovation in terms of the internet and connected devices. The IoT will consist of static sensors, sensors that remain in a fixed location, as well as mobile sensors, sensors that are in motion during their operation. These mobile sensors create a subclass of the IoT which is referred to as the Internet of Mobile Things (IoMT). Devices in the IoMT will have to communicate with one another in order to achieve a common goal. How these devices determine which other devices they will communicate with is the problem addressed in this paper. The methodology used here consists of three major components; the construction of mobility neighborhoods, the utilization of bi-partite graphs to represent the network, and the clustering of the bi-partite graph using the Louvain community detection algorithm to partition the network into communities of high modularity. This methodology is implemented using a dataset based on vehicle trajectories on a 600 meter strip of Highway 101 in the United States. The preliminary results show that the methodology can be used to find clusters of vehicles with a high modularity along the strip of highway. These means that the network has high intra-cluster relationships and low inter-cluster relationships, which supports the idea of communication in the IoMT happening within the clusters themselves. These results are preliminary and case specific to the vehicles on the highway, however the general methodology could be applied to any network of IoMT devices.

The Design of a Streaming Analytical Workflow for Processing Massive Transit Feeds

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Abstract

Retrieving and analyzing transit feeds relies on working with analytical workflows that can handle the massive volume of data streams that are relevant to understand the dynamics of transit networks which are entirely deterministic in the geographical space in which they take place. In this paper, we consider the fundamental issues in developing a streaming analytical workflow for analyzing the continuous arrival of multiple, unbounded transit data feeds for automatically processing and enriching them with additional information containing higher level concepts accordingly to a particular mobility context. This workflow consists of three tasks: (1) stream data retrieval for creating time windows; (2) data cleaning for handling missing data, overlap data or redundant data; and (3) data contextualization for computing actual arrival and departure times as well as the stops and moves during a bus trip, and also performing mobility context computation. The workflow was implemented in a Hadoop cloud ecosystem using data streams from the CODIAC Transit System of the city of Moncton, NB. The *Map()* function of MapReduce is used to retrieve and bundle data streams into numerous clusters which are subsequently handled in a parallel manner by the *Reduce()* function in order to execute the data contextualization step. The results validate the need for cloud computing for achieving high performance and scalability, however, due to the delay in computing and networking, it is clear that data cleaning tasks should not only be deployed using a cloud environment, paving the way to combine it with fog computing in the near future.

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