# Geodesy and Geomatics Engineering
# Semi-Annual Student Technical Conference

*Dineen Auditorium – C13*
*Thursday, December 8, 2005*

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|---|---|
| 9:30 | Opening Remarks |
| **Session 1** | **Ocean Mapping and GIS** |
| | Chair: Meredith Hutchison |
| 9:40 | Identification of Instabilities in the Saint John River Estuary, NB<br>*Nicole Delpeche* |
| 10:00 | Feature Skeletonization from Scanned Maps using Voronoi Diagrams<br>*Ojaswa Sharma* |
| 10:20 | The Design of a GIS-Enabled Online Social Networking Tool for Public Participation<br>*Jianfeng Zhao* |
| **10:40** | **Coffee Break** |
| **Session 2** | **GPS** |
| | Chair: Peter McRae |
| 10:50 | Further Developments in Range-Extended GPS Kinematic Positioning using Numerical Weather Prediction Models<br>*Felipe Nievinski* |
| 11:10 | Dual-Frequency GPS Precise Point Positioning with CDGPS Corrections<br>*Hyun-Ho Rho* |
| 11:30 | A New Approach for Mitigating Low-Frequency Carrier-Phase Multipath in GPS-RTK, based on Between-Receivers Dynamics and an Effective Reflector<br>*Luis Serrano* |
| 11:50 | Closing Remarks |
| 12:00 | Reception |

# Identification of Instabilities in the Saint John River Estuary, NB

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A statically stable flow that is influenced by a velocity shear is known to create two types of instabilities at the interface: Kelvin-Helmholtz waves and Holmboe waves (see Figure 1). Kelvin-Helmholtz waves are known to be stationary waves that roll up, forming cats-eye features with less dense fluid carried at the vortex (the eye). Holmboe waves move with the flow and are characterized as being cusp like. The growth rate of the Holmboe waves are known to be much slower than that of the Kevin-Helmholtz waves, however they both may eventually break which results in the mixing of flows with different densities.

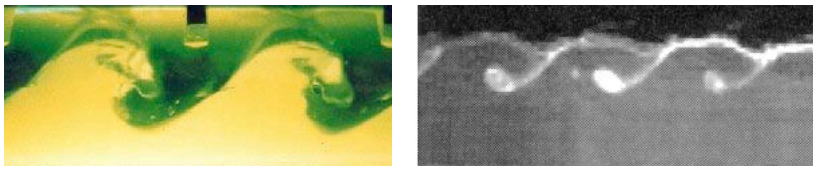

Figure 1: Lab experiments of Kelvin-Helmholtz waves (left image) and Holmboe waves (right image)

Oceanographic studies of density, velocity and acoustic volume backscatter were performed in Long Reach (a section of the Saint John River Estuary) in September 2004 over a full tidal cycle. The survey results indicate highly stratified and statically stable conditions. At the time period of maximum shear (on the rising tide), observations show a decrease in density at the lower interface layer and the acoustic volume backscatter images illustrate the plunging of the pycnocline from the lower interface into the adjacent bottom layer.

To determine the type of instability that may be the source of mixing observed at the interface, a linear stability analysis was performed. This analysis employs the use of the Taylor-Goldstein Equation, an algorithm that is based on piecewise approximation of the density and velocity profile. This paper presents the results of the linear stability analysis using the density and velocity data collected. The results from this analysis suggest the presence of Holmboe waves rather than any other type.

# Feature Skeletonization From Scanned Maps using Voronoi Diagrams

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Automation is of key importance in the field of Geographic Information Systems. A few crucial processes like digitisation are very time consuming and are ideal candidates for automation. In this paper, we will discuss a Voronoi Diagram and Delaunay Triangulation based approach for skeletonization and boundary (Crust) extraction of map features from scanned images. The boundary and skeleton thus obtained can be used to create vector maps with exact topology, in a GIS environment.

A survey of skeletonization techniques reveals a number of raster algorithms. One persistent problem with these algorithms is lack of topology. In our research, we use Voronoi diagram and the dual Delaunay Triangulation to extract the skeleton of various objects present in a colour, scanned map. A Voronoi diagram is a special kind of tessellation in space and is the dual of the well-known Delaunay triangulation. Past research in this field has been successful in computing the boundary of objects (known as Crust) and a subset of the object's skeleton. This subset comprises of major portions of the actual skeleton, but is broken around the vertices of the skeleton with acute angles. Here, we would like to propose an algorithm to extract a connected skeleton from the Voronoi Diagram of a sampled object. This algorithm is recursive in nature and takes full advantage of the Quad-Edge data structure. The resulting skeleton is not the ideal skeleton, but it is good enough for vectorization in a GIS environment. Since the algorithm is detrimental for linear objects, we propose to recover lost portions of the skeleton by combining it with previous subset of skeleton. Functioning of the algorithm will be presented in the paper and will be justified by a few examples. This algorithm has been implemented in an interactive GUI application.

# The Design of a GIS-Enabled Online Social Networking Tool for Public Participation

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Public Participation Geographic Information Systems (PPGIS) concentrates on the ease-of-use Geographic Information Systems (GIS) by the general public and aims at involving the citizen in a decision-making process. Research efforts have focused on making spatial decision-making tools available to the users on a web-based environment. However, simply making these tools available and accessible cannot satisfy the participation needs of the users during planning process. Users are not willing to participate because of the "Rational Ignorance".

To date, relatively little effort has been put into addressing the building and organizing of community of in PPGIS research. It is the aim of this research to design and implement a prototype system to show that with the integration of Web-GIS and social networking tool, the public will be more willing to participate in the decision making process. This research also proposes that the use of online social networking may provide a possible direction for transition from issue-based planning to the next generation of person-based planning process.

# Further Developments in Range-Extended GPS Kinematic Positioning using Numerical Weather Prediction Models

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We have been investigating the use of Numerical Weather Prediction (NWP) models to predict the radio propagation delay due to the Earth's neutral atmosphere. To validate those predicted delays we used data from the Princess of Acadia project to form two kinematic baselines to the same rover station, installed on a ferry. The shorter baseline provides a benchmark solution, against which the longer baseline solutions are compared to. We evaluated two prediction models in addition to NWP, Saastamoinen and UNB3.

The results for the specific baselines investigated (DRHS-BOAT short, CGSJ-BOAT long) show no significant improvement using NWP. Our conclusions are that (i) NWP is no worse than currently used, well established, prediction models (Saastamoinen, UNB3), and (ii) to use the Princess of Acadia datasets to validate tropospheric-delay prediction models, one should process only the portions in which the ferry is closer to Saint John (CGSJ) than to Digby (DRHS), so as to have a benchmark baseline CGSJ-BOAT that is both shorter *and* has a smaller height offset than the test baseline DRHS-BOAT.

# Dual-frequency GPS Precise Point Positioning with CDGPS Corrections

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The goal of the research described in this paper is the design of a GPS dual-frequency data processing technique capable of producing high-accuracy positioning results with CDGPS (the Canada-wide Differential GPS Service) corrections.

As the CDGPS provides the corrections which referenced to the C1 observable and in addition to the GPS navigation message corrections, there exist a satellite clock referencing issues to properly use the corrections to the different GPS observable. As long as a satellite instrumental bias exists between the measurements, this issue should be properly counted on the observation model.

To account for the satellite clock referencing issue, the effects of the satellite instrumental biases have been precisely investigated and the observation equations for the different observables assuming the source of corrections is CDGPS have been developed. With the developed observation model, we found about a 0.84 m level of improvement in the horizontal position fixes and improvements of about a 1.46 m in the vertical position component when the instrumental biases were correctly taken into account.

The presented results could serve as a baseline for further improvements to GPS dual-frequency precise point positioning with CDGPS corrections.

# A New Approach for Mitigating Low-Frequency Carrier-Phase Multipath in GPS-RTK, Based on Between-Receivers Dynamics and an Effective Reflector

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Most of the carrier-phase specular mitigation techniques developed for static applications takes advantage of the deterministic and correlated behaviour of the low-frequency multipath error. This correlation is induced by the reflector(s) in the vicinity and the satellite-antenna(s) relative geometry. The proximity of several antennas is used, for instance, to augment the observability and estimate the common static multipath effects at closely-spaced antennas. These station-dependent multipath errors may also be decorrelated using a moving antenna(s) by means of a robot, knowing that the antenna(s) random motion shifts the systematic site-dependent multipath error to a high-frequency (decorrelated) multipath error.

Multiple site antennas and multipath decorrelation through antenna random motion, although applied to static or station-calibration techniques, have several limitations and shortcomings when we try to apply them to kinematic applications, where the antenna(s) is (are) positioned on a rover. In this paper, we describe how the synergy of these approaches is used to develop a new multipath observable (between antennas) that should clearly represent and absorb all the multipath spectra in kinematic scenarios.

Once the observable is sought, its geometric parameterization, in order to an effective or virtual reflector (between the antennas and the satellite), is recovered and the carrier-phase multipath error is mitigated for each antenna.