NOTICE OF UNIVERSITY ORAL

GEODESY AND GEOMATICS ENGINEERING

Master of Science in Engineering

Felipe Nievinski

Wednesday, September 24, 2008
@ 10:30 am

Head Hall – ADI Studio

Board of Examiners: **Supervisor:** **Dr. Marcelo Santos, Geodesy & Geomatics Eng**

Examining Board: **Dr. Richard Langley, Geodesy & Geomatics Eng**
Dr. Johannes Boehm, Geodesy & Geophysics, TU Vienna, Austria

Chair: **Dr. Peter Dare, Geodesy & Geomatics Eng**

Ray-tracing Options To Mitigate the Neutral Atmospheric Delay in GPS Applications

ABSTRACT

As the radio signals emanating from GPS satellites propagate through the Earth's electrically neutral (i.e., un-ionized) atmosphere, they suffer refraction. The effect of refraction on GPS timing measurements is a delay compared to what would be measured had the signal propagated in a vacuum. Equivalently, assuming vacuum speed of propagation, the apparent distance measured with GPS is larger than the geometrical distance between receiver and satellite. If not adequately mitigated, that delay corrupts estimates, such as receiver position, obtained from GPS observations. One way of quantifying the neutral atmosphere radio propagation delay is supposing the signal to be a ray, and tracing that ray along its path, from satellite to receiver, through a model for the atmosphere; we call such procedure ray-tracing, and it constitutes our main interest in this work. Ray-tracing has connections to many different subject areas. Among those, we see the present work falling under the umbrella of geodesy. More specifically, we see it situated along the thread of developments of the so-called mapping functions for radio space geodetic applications.

The main research contribution from this work is the identification, classification, and comparison of alternative models for the ray-path and the atmospheric structure employed in ray-tracing. It is a three-part contribution, parts that we now discuss. First we distinguished among the ray-tracing options known as atmospheric source, atmospheric structure, and ray-path model. Such distinction classifies the myriad of options available in ray-tracing in separate groups, disentangling aspects that are typically (sometimes arguably conveniently) lumped together. For example, a sentence such as ``this ray-tracer assumes spherical symmetry'' actually makes separate statements about the assumed ray-path and the atmospheric structure models. Secondly, we identified model alternatives within each of the three options above, namely, spherical concentric, spherical osculating, ellipsoidal, gradient, and 3d atmospheric structures; and zenith, straight-line, bended-2d, and bended-3d ray-path models. Thirdly, we compare experimentally different models. More specifically, we quantified the discrepancy in delay between different models and we also assessed their impact in GPS positioning. In addition to the three-part main contribution above, a secondary contribution is a classification of the delay mitigation techniques available in GPS, developed to support the design of the above mentioned GPS experiments.

Faculty Members and Graduate Students are invited to attend this presentation.