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GEOMATICS ENGINEERING

SCHULICH School of Engineering

UNIVERSITY OF CALGARY

DEPARTMENT OF GEOMATICS ENGINEERING

Geomatics News

Message from the Head

Dear Valued Readers:

This is my first message to you as the Department Head. I am honored for being selected to serve in this position especially after the excellent leadership from our previous Heads. I would like to start by acknowledging the outstanding efforts of Dr. Naser El-Sheimy during his Headship and congratulating him for the appointment as the Scientific Director of the Integrated Resource Management Center. I am quite excited about the potential and the leverage to the department from this new center.

One of the exciting moments in an academic unit is when you celebrate the ultimate achievements of your students: their graduation. In June, we had 55 students finishing their undergraduate and graduate degrees (39 BSc, 10 MSc., and 6 PhD). On behalf of the department, I would like to congratulate our graduates and wish them all the best in whatever endeavor they undertake and hope that they will promote the department wherever they are.

On another note, I would like to congratulate Dr. John Holmlund (Executive Chairman of the Board at Focus Corporation) for receiving an Honorary Doctorate of Laws Degree, The University of Calgary's highest academic honour, during the June Convocation Ceremony. Dr. Holmlund has been and continues to be a strong supporter of the Department and this degree is a testament of his distinguished achievements and leadership in Geomatics.

Finally, I would like to wish you all a relaxing but fruitful summer.

Dr. Ayman Habib
Professor and Head

Strategy Meeting June 05, 2009

Back row: L to R:
Mark Petovello, Kyle O'Keefe, Andrew Hunter, Bill Teskey, Alexander Braun, Danielle Marceau, Mike Barry, Gerard Lachapelle, Elizabeth Cannon.
Front Row L to R:
Xin Wang, Steve Liang, Quazi Hassan, Ayman Habib, Michael Sideris, Derek Lichti, Susan Skone, Naser El-Sheimy, JW Kim. Yang Gao

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Congratulations

- Congratulations to students who completed their graduate studies: Wouter van der Wal, PhD; Cameron Ellum, PhD; Glen MacGougan, PhD.

- Dr. Mark Petovello, Assistant Professor in the PLAN group, was awarded the APEGGA (Association of Professional Engineers, Geologists and Geophysicists of Alberta) Early Achievement Award. The award, presented at the APEGGA Summit Awards® Gala in Calgary, recognizes exceptional achievement in a person's early years of a professional career as an engineer, geologist or geophysicist.

Dr. Petovello received his BSc and PhD degrees in Geomatics Engineering from the

University of Calgary in 1998 and 2003 respectively. He worked for five years as a Senior Research Engineer in the department's PLAN group before becoming a faculty member in January 2008. Dr. Petovello has made significant contributions in a wide range of navigation-related areas including software GNSS receiver development, GPS/INS integration, GPS attitude determination, reliability analysis, dead reckoning and GPS/GLONASS integration. He has also been active in the navigation community and has served several positions within the U.S. Institute of Navigation and is a contributing editor of Inside GNSS magazine.

- The Department of Geomatics Engineering is pleased to announce that Dr. Ayman Habib will be appointed Head of the Department of Geomatics Engineering for a five year term commencing July 1, 2009.

Dr. Habib received a BSc and MSc in Civil Engineering from Cairo University, Egypt in 1986 and 1989, respectively, a MSc in Geodetic Science & Engineering from The Ohio State University in 1993, and a PhD in Geodetic Science & Engineering from The Ohio State University in 1994.

- Congratulations to Aiden Morrison and Saloomeh Abassian Nik who both received Top 5 Recognition; to Richard Ong who received the Session Award in Technology and Society I; and to Anshu Pahadia who received a Research Poster Prize at this year's campus-wide Graduate Student Association (GSA) conference held on campus on May 13-15, 2009.

- Kannan Muthuraman was awarded the "GEOIDE Communicator of Excellence" Award for his presentation on "Designing Robust GNSS Receivers of the Future" at the 11th Annual Scientific Conference of GEOIDE held in Vancouver, May 27-29. The presentation, co-authored by Cyrille Gernot and Aiden Morrison, focused on some of the research conducted in the PLAN Group under GEOIDE Project 34.

- PhD student Vidya Renganathan won the Canadian Geophysical Union Geodesy section Best Paper Award and an honourable mention in the Shell Canada Student poster award competition. Both awards were presented at the American Geophysical Union and Canadian Geophysical Union Joint Assembly 'The Meeting of the Americas' in Toronto, May 24-27, 2009. Vidya won the awards for her work on Arctic sea ice freeboard height retrieval from laser altimetry.

- Dr. Naser El-Sheimy and his PhD Graduate Students on Convocation Day. Congratulations to Mahmoud El-Gizawy, Chris Goodall, Mohamed Youssef, Zainab Syed and Priyanka Aggarwal.

Alumni Voice

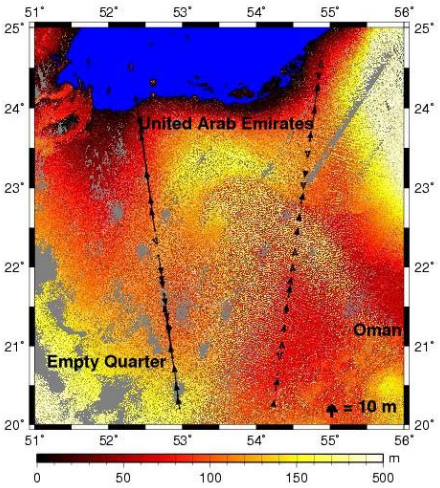
When I was deciding which undergraduate engineering program to specialize in, Geomatics was no doubt my first choice. Throughout the program, I was fascinated with all the advanced technologies and wide range of applications. I was also amazed how Geomatics, a field that might not be familiar to most people, can actually be found in many parts of our everyday life. I graduated in June 2003 and started my Master of Biomedical Engineering degree the following year. My thesis project focused on translating Geomatics image registration techniques to analyze 3D magnetic resonance imagery of knee joints. Since my Master's graduation in 2006, I have been working at Itres Research Ltd as a Geomatics Research Engineer. I am mainly responsible for the design and development of calibration systems for airborne hyperspectral pushbroom sensors, perform image analyses on high-resolution data, and work on R&D projects for new instruments and applications. I also get to travel to different parts of the world on airborne operations. Geomatics Engineering not only has provided me with all the technical knowledge for my Masters and my current position, it also allows me to explore this world in many new ways.

Rita Cheng, MSc '06

Research Spotlight

Sand Dune Tracking From Space

Article by Dr. Alexander Braun (Earth Observation)



Sand dune motion vectors between Nov 2005 and Mar 2006 derived from ICESat laser altimetry. Background shows SRTM digital elevation model.

Sand dune migration in arid environments poses hazards to infrastructure, transportation routes, agriculture and settlements. Recent developments of new oil and gas camps in the Empty Quarter of Saudi Arabia are particularly vulnerable to the migration of sand dunes. Recently, access roads were blown over by sand dunes and crews commuting by night have experienced fatal accidents as a result. While the proximity of the camps are now observed and monitored for sand dune migration, the vast majority of the worlds deserts are not. Recent attempts of tracking down sand dune flux from space have succeeded by analyzing pairs of ASTER satellite images in Chad (Vermeesch and Drake, 2008); however, remote sensing is rarely applied to sand dune motion.

PhD student Mohammed Dabboor and his supervisor Alexander Braun, both members the Earth observation group, took a different approach and used space geodetic data which detects the dune elevation change over time. The developed method takes ICESat laser altimetry profiles which cross the large linear dune fields of the Empty Quarter and compares the obtained elevation profiles at two different times, e.g. 6 months apart. The linear dunes are about 150-200 meters high with a wavelength of about 4 km. The under-sampling issue caused by only having a 170 meter along-track resolution to detect sand dune motion of a few meters was resolved by using the phase difference between two dune elevation profiles. This method was validated with synthetic data and is able to detect dune motion accurate to 5 meters which corresponds to the minimum sand motion in the study area over the time period of 6 months. The results show that different areas exhibit very different dune motions between 6 and 60 meters in 6 months. The reason for the differences lies in the fact that the wind regime governs sand transport and only strong winds can effectively move sand. It also depends on the grains size and composition of the sand layers.

The prevailing wind direction is quite stable and only shows seasonal changes, consequently, sand dunes migrate in the same direction for an extended period of time. Comparing the estimated dune motion vectors with wind direction and wind speed data from the study area confirms that the wind regime explains the sand motion over the 6 months and also over a 2 year time period. The developed method can be applied to determine sand dune migration vectors in sandy deserts across the globe. This application demonstrates how space geodetic missions can assist in natural hazard assessment and mitigation.

Benefits of GPS-GLONASS

Article by Dr. Gerard Lachapelle and Mr Richard Ong (Positioning, Navigation and Wireless Location)

The current GPS constellation of 32 satellites provides a high level of performance to users. Yet, as the use of GPS becomes more pervasive, performances never seem to be sufficient to meet increasingly demanding applications. Centimetre-level accuracy requires the use of carrier phase measurements and resolution of associated integer ambiguities. Success is a function of the number of satellites and their geometry and duration of observations. Users have become used to the current high number of satellites, which exceeds the minimum number of 24 guaranteed by the U.S. Department of Defense. For many applications, including cm-level positioning, this advantage is significant. Given that the use of additional satellites is always preferable, the question arises as to the gain that might be achieved using GLONASS simultaneously with GPS. The Russian GLONASS has been in existence for nearly as long as GPS but until the past few years, its number of satellites has varied widely. However, in recent years, thanks to a renewed commitment by the Russian government, the number of satellites has been of the order of 15 to 20. High performance equipment manufacturers such as NovAtel Inc now offer users combined GPS-GLONASS equipment. Users who operate under obstructed line-of-sight conditions due to

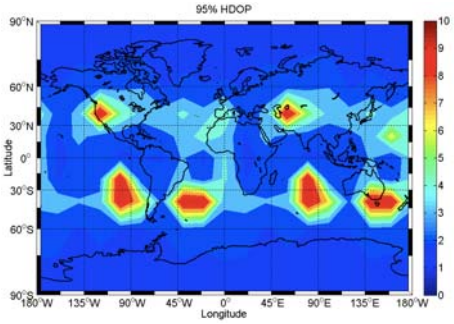


Figure 1: HDOP for a 19-Satellite GPS Constellation

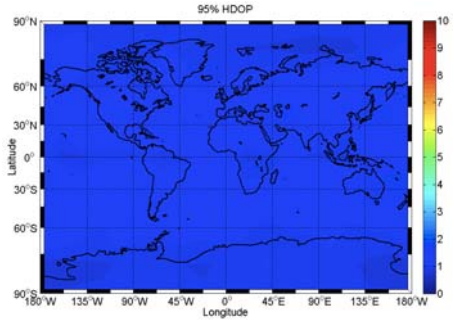


Figure 2: HDOP for a Combined 19-Satellite GPS and 16-Satellite GLONASS Constellation

foliage and terrain usually find significant advantages. This is also the experience of the PLAN Group for applications in mountainous areas.

The above question is now becoming relevant from another aspect given a recent report by the U.S. Government Accountability Office that discusses a worst case satellite replenishment scenario whereby the number of operational GPS satellites might drop to below 24 in the

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next two years due to procurement delays. Part of the answer is given in Figures 1 and 2, which show the horizontal dilution of precision (HDOP) at the 95 percentile level for a depleted, 19 satellite GPS constellation and a 19+16 GPS-GLONASS constellation. The figures were obtained by computing HDOP values on a 20 degree grid at time intervals of one minute for 24 hours and calculating the 95 percentile values at these points. An elevation mask of 5˚ was used. An HDOP value greater than 5 is generally considered poor and the current GPS constellation typically yields values around 2. Other parameters such as reliability, not shown here due to space limitation, are revealing large differences between GPS and GPS-GLONASS, demonstrating the advantages of the combined approach. The differences for precise carrier phase positioning are also significant.

The PLAN Group is actively pursuing research in this area, including the development of a GLONASS component to its GNSRx™ GNSS software receiver. Results are posted on http://plan.geomatics.ucalgary.ca/research.php as they become publicly available.

Department Activities

- The Geomatics department BBQ in May was an opportunity to thank Dr. Naser El-Sheimy as he stepped down from the role of Department Head, and also to welcome Dr. Ayman Habib as the new Department Head of Geomatics Engineering.
- Derek Lichti was promoted to Associate Professor effective April 1, 2009.
- Dr. Kyle O'Keefe has accepted the position of the Associate Head of Undergraduate Studies effective July 01
- Campus Fair June 06. Thanks to Dr. Quazi Hassan for coordinating the Geomatics exhibit.
- Ana and Juliano Kersting had a baby boy (Lucas) born on May 04, 2009. As Ana's birthday was May 5th, the baby was by far the greatest birthday gift she has ever received.
- John Holmlund, Executive Chairman of the Board at Focus Corporation, gave the convocation address after receiving an Honorary Doctor of Laws Degree, the University of Calgary's highest academic honour.

Coming Events

- Schulich Engineering Stampede Breakfast—July 09 from 8-10am
- ENGO 501: Field Survey Camp, August 17—27, 2009
- ENGO 638 GNSS Receiver Design, August 17—28, 2009
- Fall 2009 classes resume on Tuesday September 08, 2009
- Department Picnic September 27 at Bowness Park

Sites to Visit:

- *http://www.apegga.org/*
- *http://www.insidegnss.com/*
- *http://www.itres.com/index.php*
- *http://plan.geomatics.ucalgary.ca/research.php*