Workshop on Digital Topographic Analysis

Thursday, May 14, 2015
1:30 - 4:30 pm
402 Walter Library

Reception to follow

A series of talks by UMN and local industry specialists in LiDAR, TLS, and satellite imagery, brought to you by C³, U-Spatial, the Anthropology Department, the Earth Sciences Department, and the Heritage Collaborative.
Workshop on Digital Topographic Analysis: LiDAR, Satellite Imagery, Terrestrial Laser Scanning, and GIS

May 14, 2015
Digital Technology Center, Walter Library room 402

Program

1:30 – Introduction

1:45 – Joel Nelson: LiDAR in Minnesota: Where We Are and How We Got Here

2:10 – Joseph Knight: Land Classification using Image Objects and LiDAR


3:00 – Break

3:15 – Karen Gran: Geomorphic Change Detection and Site Documentation with Terrestrial Laser Scanning

3:40 – Paul Morin: How to See the World, the WHOLE World; The National Geospatial Intelligence Agency’s Commercial Imagery Program and the University of Minnesota

4:05 – Shashi Shekhar: From GPS and Google Maps to Spatial Computing

4:30 – Reception
Abstracts

• **LiDAR in MN - Where We Are and How We Got Here**
  by Joel Nelson

  Minnesota is a leader in geospatial information, and one of few states in the U.S. with complete LiDAR coverage. We'll go through some LiDAR examples for our state, along with applications of LiDAR nationwide, discussing how LiDAR is rapidly changing a number of disciplines.

• **Land Classification using Image Objects and Lidar**
  by Joseph Knight

  This seminar will provide an overview of land classification applications of object-based image analysis and lidar. The goal will be to demonstrate the practical value of incorporating these techniques into mapping efforts in various disciplines. Emphasis will be placed on the advantages to be gained from integrating multiple data types, such as optical imagery and the new Minnesota statewide lidar dataset, into a classification workflow. Recent research results will be used to illustrate current and potential application areas.

• **Non-Invasive Archaeological Site Assessment: A Combined Approach Using LiDAR and Sub-Surface Geophysical Survey**
  by David Maki

  The recent availability of light detection and ranging (LiDAR) data has revolutionized archaeological research in Minnesota and beyond. LiDAR allows us to identify archaeological resources over large spatial extents and recognize features that are difficult to perceive on the ground. LiDAR elevation data may also be combined with geophysical survey methods to better understand feature geometry and subsurface integrity. This presentation will introduce advanced LiDAR data processing and visualization methods for archaeological research, as well as discuss how LiDAR data may be combined with geophysical data to map archaeological features in three dimensions. These topics will be explored through presentation of a number of regional case studies.
• **Geomorphometric change detection and site documentation with terrestrial laser scanning**
  by Karen Gran

Terrestrial laser scanning (TLS), also known as ground-based lidar, provides a way to rapidly collect high-resolution topographic data of a surface while minimizing disturbance. While aerial lidar data provides spatial resolutions in the 1-3 m range, TLS can provide data at cm-scale or even mm-scale resolution over a more limited area. This talk will focus on the basic workflow associated with collection and analysis of TLS data, the range of instruments available, and potential uses in archaeology. Examples cover a range of applications from site documentation to using repeat TLS scans to detect and quantify geomorphic change on a surface over time.

• **How to see the world, the WHOLE world: The National Geospatial Intelligence Agency's Commercial Imagery Program and the U of M**
  by Paul Morin

Over the past 5 years, the Polar Geospatial Center (PGC) has worked to task, archive, and process commercial sub-meter satellite imagery for both poles. We now have near-seamless orthorectified and mosaicked panchromatic imagery for Alaska, Greenland, and Antarctica, with much of the rest of the available as well. This same imagery collected in stereo is also being used to produce 2-meter posting digital elevation models for all of Greenland and key areas of Antarctica, the Arctic and the earth's coastlines.

The challenge now is to apply this resource to the federally funded science community outside the poles. We have learned how to deal with an unexpected series of obstacles including crushing data flow, bizarre formats and an irregular collection schedule.

This talk will focus on the journey from a single scene to being able to generate 2m posting elevation models in near-real-time almost anywhere on earth.
From GPS and Google Maps to Spatial Computing
by Shashi Shekhar

From virtual globes (e.g., Google Maps) to global positioning system, spatial computing has transformed society via pervasive services (e.g., Uber and other location-based services), ubiquitous systems (e.g., geographical information system, spatial database management system), and pioneering scientific methods (e.g., spatial statistics). These accomplishment are just the tip of the iceberg and there is a strong potential for a compelling array of new breakthroughs such as spatial big data, localization indoors and underground, time-travel (and depth) in virtual globes, persistent monitoring of environmental hazards, accurate spatio-temporal predictive models, etc. For example, a McKinsey report projected an annual $600B saving from leveraging spatial big data (e.g., smart-phone trajectories) for novel eco-routing services to reduce wasted fuel, greenhouse gas emission and pollution exposure during unnecessary waits at traffic lights and in congestion.

However, many fundamental research questions need to be investigated to realize the transformative potential. For example, how can spatial big data (e.g., smart-phone trajectories) be mined without violating privacy? How can spatial statistical and machine learning algorithms be generalized to model geographic concepts (e.g., context, hot-spots, hot-features, doughnut-hole patterns), address spatio-temporal challenges (e.g., auto-correlation, non-stationarity, heterogeneity, multi-scale) and scale up to spatial big data? How can eco-routing address the new challenges, e.g., waits at traffic-signals violate the sub-path optimality assumption in popular A* and Dijkstra's algorithms?

This presentation shares a perspective on the societal accomplishments, opportunities, and research needs in spatial computing based on a recent community report following the Computing Community Consortium workshop titled From GPS and Virtual Globes to Spatial Computing -- 2020 held at the National Academies.
Speaker Biographies

Karen Gran
Associate Professor
Dept. of Earth and Environmental Sciences
University of Minnesota, Duluth

Dr. Gran is an Associate Professor in the Earth & Environmental Sciences Department at the University of Minnesota Duluth. Her research in fluvial geomorphology focuses on understanding how rivers respond to change over a variety of scales, from land use changes to post-glacial adjustments to volcanic eruptions. She uses both aerial lidar and terrestrial lidar extensively in her research. Prior to joining the faculty at UMD, Dr. Gran worked with the National Center for Earth-surface Dynamics at the St. Anthony Falls Laboratory to help start a new graduate program in Stream Restoration Science & Engineering. She has a Ph.D. in geology from the University of Washington, an M.S. in geology from the University of Minnesota, and a B.A. in geology from Carleton College.

Joseph F. Knight
Associate Professor
Remote Sensing and Geospatial Analysis Laboratory
Dept. of Forest Resources, University of Minnesota

Joe Knight is an Associate Professor in the Department of Forest Resources. Dr. Knight studies how changing land use affects both natural resources and humans. He uses geospatial science methods in applications such as: identifying and characterizing natural and anthropogenic landscape change, mapping and monitoring of wetlands, describing landscape-human interactions that lead to exposure to infectious diseases, and developing thematic accuracy assessment methods.

David Maki
Principal
Archaeo-Physics, LLP

David Maki co-founded Archaeo-Physics, LLC in 1998 after finishing his degree in Civil Engineering at the College of Science and Engineering, University of Minnesota. Archaeo-Physics is a consulting firm specializing in subsurface imaging of archaeological sites. The firm has enthusiastically embraced aerial LiDAR data analysis in recent years as these publically accessible data have become available. Prior to his work with Archaeo-Physics
Mr. Maki served as a staff scientist with the Institute for Minnesota archaeology from 1991 to 1998.

Paul Morin
Director
Polar Geospatial Center, University of Minnesota

Paul Morin manages the support of geospatial services for the National Science Foundation’s Office of Polar Programs. He was heavily involved with mapping for the Polar Geospatial Center’s predecessor, the Antarctic Geospatial Information Center (AGIC). He defines geospatial needs for the polar community, and does boutique projects. He has been in mapping and scientific visualization his entire career.

Joel Nelson
Manager, Soil and Landscape Analysis Laboratory
Dept. of Soil, Water, and Climate, University of Minnesota

Joel Nelson manages the Soil and Landscape Analysis Lab (SLAL) in the Dept. of Soil, Water, and Climate here at the U. As a graduate student, he had an opportunity to work with some early LiDAR data from southern Minnesota in 2001, and has been applying it to soil and water conservation research and problems ever since. In the past decade, he’s delivered more than 75 workshops on the topic, ranging from broad introductions, to hands-on training sessions which detail the use and application of LiDAR data. He’s provided various training sessions including “Basics of LiDAR” and “Terrain Analysis” statewide for many local, state, and federal GIS professionals while continuing work for the SLAL and its associated research group.

Shashi Shekhar
McKnight Distinguished University Professor
Dept. of Computer Science, University of Minnesota

Dr. Shekhar is a leading scholar in the area of Geographic Information Systems (GIS). He co-edited an Encyclopedia of GIS and co-authored a textbook on Spatial Databases. He received the IEEE-CS Technical Achievement Award and was elected Fellows of the IEEE and the AAAS. Shashi is a member of the Computing Community Consortium (CCC) Council, and a co-Editor-in-Chief of Geo-Informatica journal. Earlier, he served on National Academies' committees (Mapping Sciences, GEOINT Workforce) and co-organized a CCC workshop titled "From GPS and Virtual Globes to Spatial Computing 2020" to catalyze community research visions.
About the Sponsors

AEGIS
The Anthropological, Environmental and Geological Interdisciplinary Sciences group was founded in 2015 as an expansion of ASIG (the Anthropological Sciences Interdisciplinary Group), in recognition of the wide range of disciplines which share the common goal of applying cutting-edge scientific techniques to the study of the human past. Its goals are to provide a forum for the presentation of original research, and to provide training and professional experiences for graduate students. It accomplishes these goals by means of a lecture series, short courses and workshops, and paid internships.

The Anthropology Department
For nearly a century, the Department of Anthropology has prepared students in sociocultural anthropology, archaeology, biological anthropology, and linguistics. With 17 faculty members and about 60 graduate students, the department teaches over 2,200 undergraduate students each year. A lively community of scholars, faculty and students alike are engaged in research, teaching, and community outreach, connecting with numerous other departments throughout the University, and organizations beyond it.

C3
The C3 initiative is a joint effort by the College of Science and Engineering and the College of Liberal Arts. It seeks to support a robust interdisciplinary culture of Curiosity, Community, and Collaboration.

The Earth Sciences Department
The Department of Earth Sciences (www.esci.umn.edu) is part of the Newton Horace Winchell School of Earth Sciences within the College of Science and Engineering and supports fundamental research on processes that occur within the solid Earth, at its surface, and within its atmosphere through time. The Earth Science Department thrives though the dedication and enthusiasm of its 25 faculty, ~60 graduate students, ~75 undergraduate majors, and thousands of generously supportive alumni.
The Heritage Collaborative
The IAS Heritage Collaborative was established in 2011-12 to investigate the prospects for a formalized program of research and education, drawing upon the diverse perspectives about heritage at the University of Minnesota and prioritizing diversity, an interdisciplinary approach, and community-engaged heritage research and management.

U-Spatial
U-Spatial aids spatial thinking and collaboration for teaching and research across the University of Minnesota system. It is the Spatial Sciences and Systems Infrastructure for the University, supporting over 1,200 researchers across 150 departments and centers at the university. Services include a help desk, workshops, community events, and consulting. U-Spatial is primarily funded with $2.5 million over 2012-2017 from an OVPR Infrastructure Investment Initiative grant.

LiDAR shaded-relief image of the Biesterfeldt site, a northeastern plains village located in eastern North Dakota. Courtesy of David Maki.

Cover image credit:
Left image – Courtesy of Joseph Knight
Right image – Courtesy of Joel Nelson