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PHOTOGRAMMETRIC ENGINEERING & REMOTE SENSING — *The official journal for imaging and geospatial information science and technology*


The magnitude 7.8 and 7.5 earthquakes that struck southern Türkiye and western Syria on February 6, 2023, caused widespread destruction in both countries

# 2023 ASPRS International Technical Symposium

**June 12-16, 2023**
**VIRTUAL**

**ASPRS is happy to announce the dates of its virtual conference. The 2023 ASPRS International Technical Symposium will take place.**

**The symposium will consist of:**

- 15-minute oral presentations
- 5-minute Ignite-style presentations
- Poster Gallery
- Sustaining Member Vendor Spotlights
- ASPRS Society Highlights

**Sessions will run each day from 10:00 AM to 6:00 PM Eastern Daylight Time (UTC - 4). All sessions will be recorded and made available on-demand to conference registrants. Presenters are eligible to submit full manuscripts for publication in the ISPRS Archives.**

**Interested in Presenting? For more information or to submit an abstract visit https://my.asprs.org/2023Symposium/2023-Symposium/Call-for-Abstracts.aspx**

- Submission deadline is May 1, 2023
- Presenters will be notified of acceptance by May 8, 2023
- Presenters must be registered for the conference by May 22, 2023 to be included in the conference program

**Registration Fees**

| | |
|---|---|
| ASPRS Member | $150 USD |
| ASPRS Student Member | $ 50 USD |
| ASPRS Emeritus Member | $ 25 USD |
| Non Member | $250 USD |

**Sponsorship Opportunities**

- Vendor Spotlight/Product Demo
- Day Sponsor
- Session Sponsor
- Workshop Sponsor

***"We are happy to offer this educational opportunity to the geospatial community. Virtual events are an excellent way to exchanammunity without the cost and time constraints of travel," said Karen Schuckman, ASPRS Executive Director***

**https://my.asprs.org/2023Symposium/**

## ANNOUNCEMENTS

**Trimble's Applanix** Transitions to the Trimble Brand Identity - Company embraces new aesthetic look and feel, while providing same trusted quality and expertise.

As you may have realized from our building, our website, and other promotional items, Applanix Corporation has fully adopted the Trimble global brand identity including the Trimble logo, colour scheme, and other standards and templates. The name Applanix does live on, however, as the brand name of the Positioning and Orientation Systems (POS) product line we first introduced to the mobile mapping world back in the 1990s, including the POS AV, POS MV, POS LV, and POSPac. These are now known as the Applanix POS systems, i.e. Applanix POS AV, Applanix POSPac MMS, etc.

While the Trimble look and feel may seem new to some of you, Applanix is celebrating its 20th anniversary of becoming "A Trimble Company" this year, and this change is a branding matter only. There are no changes to the people, products, or services we provide. Customers can expect the same trusted quality, expert knowledge, and unparalleled product support across our entire portfolio of products as they have always had.

Trimble Applanix will continue its ongoing commitment to innovation and new product development within the mobile mapping and surveying industry, and will continue to leverage Trimble's connected ecosystem of capabilities, networks, and partnerships to bring added value and benefit to our customers.

We encourage customers to connect with us through all the same channels as before—including our website, www.applanix.com, and by locating us at upcoming trade shows and conferences as part of the Trimble Booth.

As we celebrate this milestone 20th anniversary with Trimble, we wish to express our ongoing gratitude to all of our customers who continue to rely on our products and solutions for pinpoint accuracy, efficiency, and ease of use in all of their mobile mapping, survey, and autonomy applications. We look forward to many more decades assisting companies, developers, manufacturers, surveyors, and engineers reach their project goals by providing inertial navigation solutions that they can depend on with confidence.

Although our logo and branding look has changed, please note that we continue to operate with the legal name Applanix Corporation.

**L3Harris Technologies** announced a $765 million contract from NASA to design and build the next-generation, high-resolution imager for NOAA's Geostationary Extended Observations satellite system.

The GeoXO Imager will provide advanced visible and infrared imagery, more precise observations and improved water vapor measurements to significantly improve the accuracy and timeliness of weather forecasting in the Western Hemisphere. The addition of two new spectral bands and enhanced spatial resolution will improve space-based severe weather monitoring as well as short-term weather predictions and wildfire tracking.

"This award demonstrates L3Harris' proficiency to advance mission-critical geostationary imagers for NOAA," said Ed Zoiss, President, Space and Airborne Systems, L3Harris. "We're honored to continue our role with NASA and NOAA as a key provider of geostationary capabilities by adding relevant mission value to our nation's next-generation weather architecture."

Slated to begin launching in 2032, the GeoXO mission will provide the mainstay of NOAA's geostationary observation through 2055.

"We're proud to be a part of NOAA's GeoXO observing system, supporting short-term forecasts, severe weather, and disaster monitoring to provide advanced warning to decision makers," said Rob Mitrevski, Vice President and General Manager, Spectral Solutions, L3Harris. "This program continues our 60-year heritage in this mission area, serving to protect the lives and personal property of our citizens."

From space to ground, L3Harris provides the Advanced Baseline Imager for space-based data collection on NOAA's GOES-R mission, as well as the GOES-R enterprise ground system providing downlink, data processing and distribution, and command and control of the four-satellite GOES-R constellation.

Ten years after completing the company's first shoreline mapping project, **NV5 Geospatial** announced today that it has mapped more than 26 million acres of North America's shoreline and riverine environments for more than 200 projects. The projects have spanned across North America from the Nuyakuk River in Alaska, Lake Tahoe in California, the Rio Grande in Texas, the entire coasts of South Carolina and North Carolina, Achigan River in Quebec, Chesapeake Bay in Maryland, and the Florida Keys. In 2022 alone, the company mapped and acquired topobathymetric lidar data for 14 projects including the Yellowstone River, Wyoming; Hells Canyon, Indiana; Revillagigedo Island, Alaska, and Iles de la Madeleine in Quebec.

In 2023, NV5 is already slated for a number of additional shoreline and riverine projects including a two year contract with the National Oceanic and Atmospheric Administration's

(NOAA) National Geodetic Survey to provide topobathymetric lidar, 4-band imagery, and mapping of 3,115 sq miles of the coastal Maine shoreline.

10 Years of Technological Innovation—NV5 Geospatial first mapped the shorelines and riverine environments in 2012 with the acquisition of high-resolution bathymetric lidar and natural color imagery for 34,051 acres of shoreline along the Sandy River, located in northwestern Oregon, to study the ever changing basin geomorphology. Today, topobathymetric lidar has a wide range of use cases, including shoreline and coastal intelligence, habitat restoration, floodplain modeling, volumetric analysis, infrastructure planning and engineering, and coastal zone management.

Topobathymetric lidar simultaneously measures and records three distinct surfaces – land, water, and submerged land using airborne laser-based sensors. While this technology shares some characteristics of traditional airborne lidar mapping, it also has significant differences that increase the understanding of the nearshore environment for improved marine resource mapping, benthic habitat mapping, shoreline delineation, nautical charting, and marine debris mapping.

Helping to Solve North America's Most Challenging Coastal and Riverine Issues—The following five projects provide a sampling of the work NV5 Geospatial has participated in over the last 10 years; Hurricanes Michael, Florida and Florence, North Carolina, Okanagan Lakes, British Columbia, Elbow River, Alberta, Canada, Florida Keys, Florida, and Platte River, Nebraska.

For more information, visit https://www.nv5.com/news/coastal-riverine-26millionacres/.

## ACCOMPLISHMENTS

**Esri** announced that Dr. Dawn Wright, the company's chief scientist, has been elected to the National Academy of Engineering (NAE). Dr. Wright is being honored by the Academy for her distinguished work applying geographic information system (GIS) technology to ocean science and developing GIS models for the oceans. In addition to her work as chief scientist of Esri, Dr. Wright has been a professor of geography and oceanography at Oregon State University since 1995 and was integral in building the first geospatial data models of the world's oceans. Having served on the Science Advisory Boards of both NOAA and the EPA, Wright joined Esri in 2011.

"It is truly an honor to be recognized by the National Academy of Engineering," said Wright. "Ocean exploration is impossible without the tools that enable scientific observation and understanding. It's been my privilege to help build some of the most innovative technologies allowing more insightful environmental data collection, and to be able to work with all the talented people at Esri."

On July 12, 2022, Wright served as mission specialist for a historic descent nearly 36,000 feet into the Pacific Ocean to capture images and data from the Challenger Deep, the deepest known point in the Earth's ocean. Wright was one of the few individuals—and the first Black person—to visit Challenger Deep, located within the Mariana Trench. The expedition produced an unprecedented series of detailed maps and data from the deepest place on Earth.

"Our technology has always been grounded in science, and Dawn Wright is one of the great scientists that has made our company so special," said Jack Dangermond, Esri founder and president. "She is both a keen observer of the natural world as well as someone building solutions to help solve some of its biggest challenges."

Founded in 1964, the NAE is a private, independent, nonprofit institution that provides engineering leadership in service to the nation. Its mission is to advance the welfare and prosperity of the nation by providing independent advice on matters involving engineering and technology, and by promoting a vibrant engineering profession and public appreciation of engineering. NAE membership is one of the highest professional honors accorded an engineer and is determined by current NAE members, including more than 2,000 senior professionals in business, academia, and government who are among the world's most accomplished engineers. It is the sibling organization of the National Academy of Sciences, to which Wright was elected as a member in 2021.

To view a full list of new members elected to the NAE, visit nae.edu/289843/NAENewClass2023.

## CALENDAR

- 22-24 May, **STRATUS Conference.** For more information, visit http://stratus-conference.com/.
- 12-16 June, **ASPRS 2023 International Technical Symposium.** For more information, visit https://my.asprs.org/2023Symposium/.
- 16-19 October, **GIS-Pro 2023**, Columbus, Ohio. For more information, visit www.urisa.org/gis-pro.

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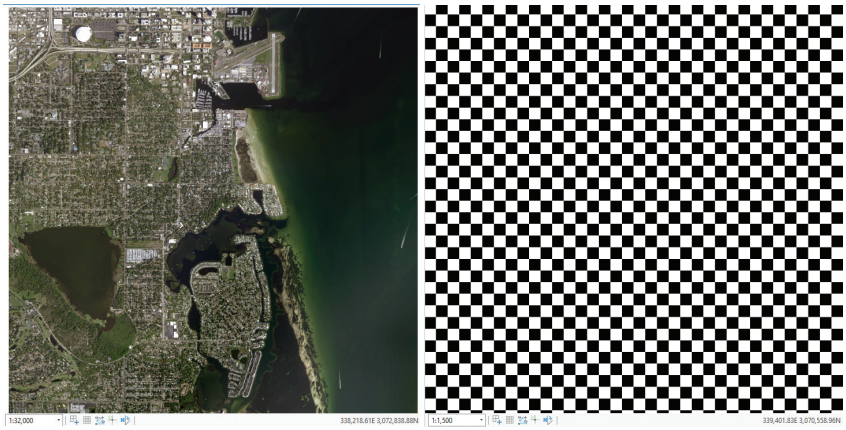



## COLUMNS



## ANNOUNCEMENTS



## DEPARTMENTS



## YEARBOOK





**See the Cover Description on Page 264**

# COVER DESCRIPTION

The magnitude 7.8 and 7.5 earthquakes that struck southern Türkiye and western Syria on February 6, 2023, caused widespread destruction in both countries.

The initial earthquake emanated from a fault 18 kilometers (11 miles) below the land surface. The shallow depth meant the earthquake produced violent shaking that affected areas hundreds of kilometers from the epicenter. The first quake was followed by a 7.5 magnitude event about nine hours later, as well as hundreds of smaller aftershocks.

As news of the event spread, scientists at space agencies around the world—including NASA—began processing and analyzing satellite data relevant to the event.

"These were very large and powerful earthquakes that ruptured all the way up to the surface over a long series of fault segments," said Eric Fielding, a geophysicist at NASA's Jet Propulsion Laboratory. "This generated extremely strong shaking over a very large area that hit many cities and towns full of people. The rupture length and magnitude of the magnitude 7.8 earthquake was similar to the 1906 earthquake that destroyed San Francisco."

The preliminary damage proxy map above shows parts of the cities of Türkoğlu, Kahramanmaraş, and Nurdağı. Dark red pixels represent areas likely to have severe damage to buildings, homes, and infrastructure or changes to the landscape, while orange and yellow areas are moderately or partially damaged. Each pixel measures about 30 meters across (about the size of a baseball infield).

The Earth Observatory of Singapore - Remote Sensing Lab created the damage proxy map in collaboration with NASA's Jet Propulsion Laboratory and Caltech by processing data collected by the PALSAR-2 radar instrument on the Japan Aerospace Exploration Agency (JAXA) Advanced Land Observing Satellite-2 (ALOS-2) on February 8, 2023, and provided by Sentinel Asia. The satellite carries a synthetic aperture radar that sends pulses of microwaves toward Earth's surface and listens for reflections of those waves to map the landscape, including buildings. By comparing the February 8 data to observations made by the same satellite before the earthquake (on April 7, 2021, and April 6, 2022) scientists tracked the changes and began to identify areas that were likely damaged.

"The map covers only the central part of the affected area due to the narrow, 70-kilometer swath of the ALOS-2 fine-beam data used, but it includes the epicenters of both the magnitude 7.8 main earthquake and the magnitude 7.5 aftershock," said Fielding. "Note that the time intervals between the ALOS-2 acquisitions are up to a year apart, so the accuracy of the damage proxy map may be lower in areas of vegetation, such as in the mountains, due to seasonal variations." Some of the areas marked as damaged in vegetated areas may not have been damaged, and some areas showing no damage in vegetated areas may be damaged.

*NASA Earth Observatory images by Joshua Stevens, using Landsat data from the U.S. Geological Survey and ALOS-2 data from the Japan Aerospace Exploration Agency/JAXA and the Earth Observatory of Singapore Remote Sensing Lab. Story by Adam Voiland.*

*For full article and references, visit https://landsat.visibleearth.nasa.gov/view.php?id=150949*

*Landsat imagery courtesy of NASA Goddard Space Flight Center and U.S. Geological Survey*


## PHOTOGRAMMETRIC ENGINEERING & REMOTE SENSING

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All written correspondence should be directed to the American Society for Photogrammetry and Remote Sensing, PO Box 14713, Baton Rouge, LA 70898, including general inquiries, memberships, subscriptions, business and editorial matters, changes in address, manuscripts for publication, advertising, back issues, and publications. The telephone number of the Society Headquarters is 301-493-0290; the fax number is 225-408-4422; web address is www.asprs.org.

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**MEMBERSHIP.** Membership is open to any person actively engaged in the practice of photogrammetry, photointerpretation, remote sensing and geographic information systems; or who by means of education or profession is interested in the application or development of these arts and sciences. Membership is for one year, with renewal based on the anniversary date of the month joined. Membership Dues include a 12-month electronic subscription to *PE&RS*. Annual Individual Membership dues are $175.00 USD and Student Membership dues are $50.00 USD. A tax of 5% for Canada's Goods and Service Tax (GST #135123065) is applied to all members residing in Canada.

# GIS Tips & Tricks

Chad Lopez and Al Karlin, Ph.D.
CMS-L, GISP

## Checkerboards are for board games, not GIS!

Most GIS-users know that GIS software can be great on some days and very frustrating on others. The difference in behavior can occur for no apparent reason, which just adds to the irritation. That apparently erratic behavior, coupled with the desire of most GIS mapmakers to include digital imagery as a basemap, can add to the frustration level when the image layers do not behave properly.

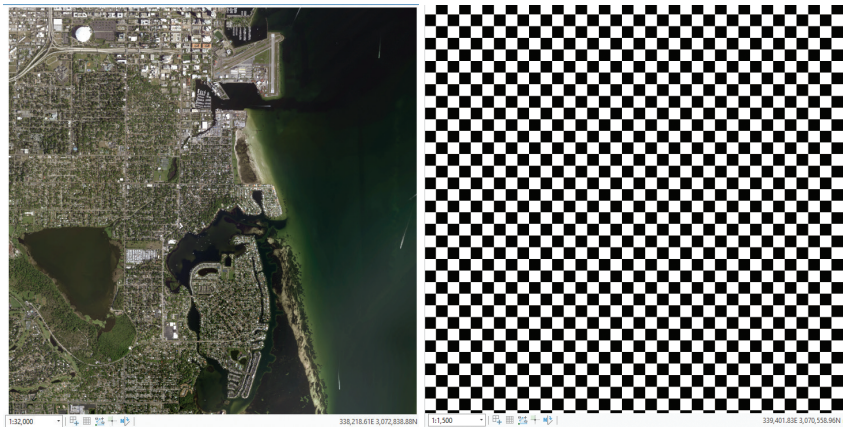

Figure 1. Mosaic Dataset viewed at a small scale (1:32,000; left) and the same Mosaic Dataset zoomed-in to a large scale (1:1,500; right) showing the checkerboard error.

A common format for managing and viewing basemap imagery in the Esri environment is as an Esri Mosaic Dataset in a file geodatabase. As can happen with all forms of geospatial data, you may encounter a mosaic dataset that displays properly one day, and the next day, it does not display as it should. This column identifies the two most common issues with displaying mosaic datasets; (1) the image draws correctly at small scales but disappears and presents a black & white checkerboard at larger scales (when you zoom in), and (2) the imagery draws correctly at large scales, but disappears and presents the black & white checkerboard at smaller scales (when you zoom out). The checkerboard display means that one or more mosaic dataset items are not accessible. Although Esri Mosaic Datasets may be displayed in other GIS environments, the "fixes" for Esri Mosaic Dataset issues illustrated below must be implemented in either the Esri Desktop or Pro environment. For convenience, we show only the ArcGIS Pro tools, but similar tools are also available in the ArcGIS Desktop environment.

### Tip #1 — The raster dataset appears normally at small scales, but it displays as a black & white checkerboard when you zoom-in.

This error generally happens as a result of the mosaic dataset losing connection with the source imagery data because either, (1) the pathway to the source imagery is no longer valid, or (2) the source imagery is no longer in the specified path. The imagery displays at small scales because the image overviews, which were constructed during the mosaic processing, are being displayed, not the actual source imagery. To fix the file path(s) to the source imagery, use the "Repair Mosaic Dataset Paths" tool in the Data Management | Raster | Mosaic Dataset toolbox. Enter the new pathway to the image source data into the "New Path" box as in Figure 2 and run the tool.

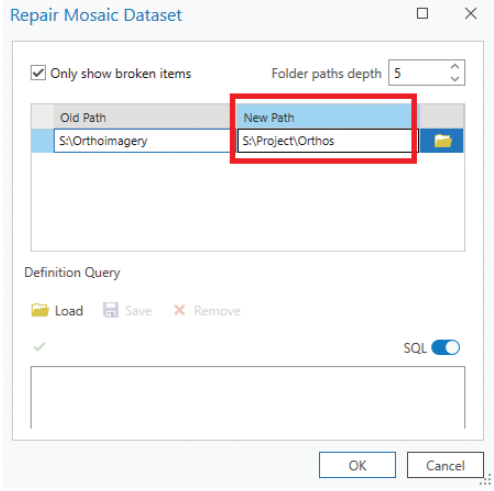


Figure 2. The "Repair Mosaic Dataset Paths" tool dialog in the Data Management Tools | Raster | Mosaic Dataset toolbox.

### Tip #2 — The raster dataset appears normally at large scales, but it displays as a black & white checkerboard when you zoom-out.

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0099-1112/22/265-266

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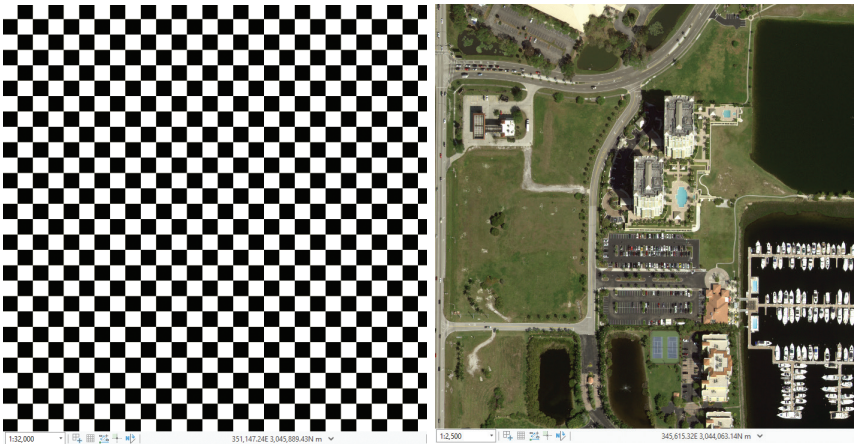

Figure 3. Mosaic Dataset viewed at a small scale (1:32,000; left) showing the checkerboard error, and the same Mosaic Dataset zoomed-in to a large scale (1:2,500; right).

**TIP #3 — Both/Either the "Repair Mosaic Dataset" and the Build Overviews" tools can also be accessed by right-clicking on the mosaic dataset within a Catalog Pane or View.**

**TIP #4 — Lastly, the "Analyze Mosaic Dataset" tool (Figure 5), also found in the Data Management | Raster | Raster Mosaic toolbox, is a general diagnostic tool with several "Advanced Options" which can help determine what kind of issue or issues there are with your mosaic dataset.**

This issue generally happens as a result of missing or corrupted overview items, not a file pathname as in Tip #1. Overviews which are built during the creation of the file geodatabase mosaic dataset are stored in a separate folder from the image data source. To fix invalid or corrupted overviews, simply build new ones to overwrite the old overviews using the "Build Overviews" tool, also in the Data Management | Raster| Mosaic Dataset toolbox, as in Figure 4 making certain to check the "Generate Overviews" checkbox.

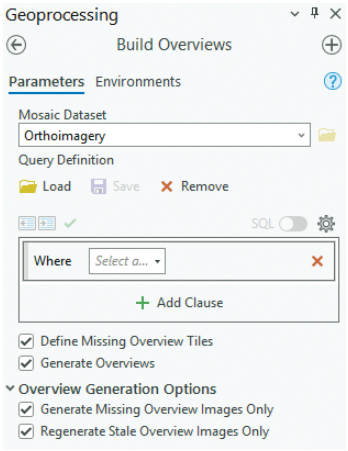


Figure 4. The "Build Overviews" tool dialog in the Data Management Tool | Raster | Mosaic Dataset toolbox.

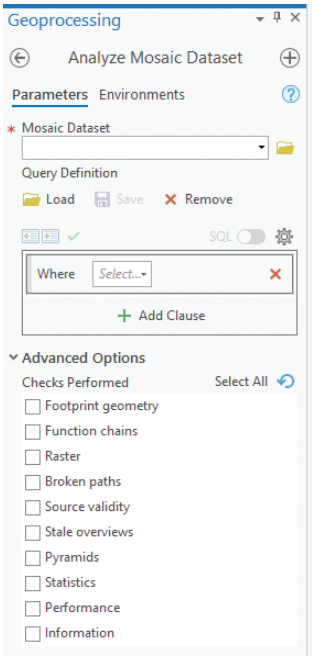


Figure 5. The "Analyze Mosaic Dataset" tool in the Data Management | Raster | Raster Mosaic toolbox has "Advanced Options" to help identify issues with Raster Datasets.

Send your questions, comments, and tips to GISTT@ASPRS.org.

*Chad Lopez is a senior geospatial analyst with Dewberry's Geospatial and Technology Services group in Tampa, Florida. He has over 20-years of experience and has worked with all aspects of remote sensing and serves as a resource for most GIS/Remote Sensing software.*

*Al Karlin, Ph.D., CMS-L, GISP is a senior geospatial scientist with Dewberry's Geospatial and Technology Services group in Tampa, FL. Al works with all aspects of Lidar, remote sensing, photogrammetry, and GIS-related projects. Al also teaches beginning map making at the University of Tampa.*

# *Ron Ondrejka*

*1933-2023*

Ron Ondrejka, ASPRS Fellow, Cold War Reconnaissance Expert, beloved husband, father, and grandfather, passed away on March 11th, 2023, at the age of 89 from a sudden illness.

## Early Life

Ron was raised in Milwaukee, Wisconsin. He grew up in a diverse area of the city and, in 1940 at the start of World War II, was a young lad of six. The diversity of Milwaukee led to an increased interest in both the war and military service. In the early 1950's, he graduated from high school, as class president, at a time when the military draft had been reinstated for the Korean War. He was offered the opportunity to sign up for three years and, at the end of his service, get a college education. He ended up in the U.S. Army Corps of Engineers and was sent to the mapping school at Fort Belvoir. After completing his training, he went to Korea and Japan where he supported the forces by updating maps from daily aerial photography. Every day, Ron would pick up the film from the aircraft, process it, and then interpret the imagery for changes. Details included locations of the North Korean and Chinese forces, as well as the location of the U.S. forces. This information was then relayed to the troops. He also managed to become the Far East Small Bore Rifle Champion during his enlistment.

With his well-developed interest in surveying and mapping, Ron returned to the U.S. where, using the GI-Bill, he began his formal education at the University of Wisconsin - Madison. There, he chose to study geodesy, photogrammetry and surveying under Amron Katz, a "super authority," later said to be one of the founders of the National Reconnaissance Office (NRO). While at the university, someone talked about a place called ITC. He continue. using the GI Bill and studied at ITC in the Netherlands. There, Ron completed his Master's of Science in Photogrammetry under the famous Dr. Willem Schermerhorn, who became the Netherlands Prime Minister after WWII.

## Itek

On returning to the U.S., Ron was recruited by a company called Itek which grew out of Boston University. There he became the assistant to Dr. Claus Aschenbrenner. What Ron did not know at the beginning was that Itek was deep in the reconnaissance business and was super-secret. This is very ironic if you knew Ron because he liked to talk.

At Itek, Ron's initial responsibility covered aerial and satellite mapping applications with the U.S Army Topographic Center at Fort Belvoir, St. Louis, Missouri, and wherever else classified mapping activity was going on. The Itek Optical Bar Camera (OBC) was used on both the U-2 and the SR-71. One should note that the U.S. Air Force just retired the OBC camera in 2022.

Ron was involved in troubleshooting interesting problems across a range of mapping technologies. In one case, the cameras flown on spy satellites had horizon cameras to show the attitude of the spacecraft but the horizon images were fuzzy. Ron discovered the cameras being used were heating up where the filter frame was squeezing the filter and cracking the lenses.

## Growing Responsibility

As the Korean War came to an end, Ron took over as the lead photogrammetrist at ITEK after Claus Aschenbrenner retired. In the 1960's, Ron worked on the panoramic cameras on the Corona satellites which was followed by the more sophisticated Hexagon series. (Perkin-Elmer made the panoramic camera for Hexagon, Itek made the 9x18" mapping camera.) At that time, the Corona and Hexagon Programs were well established with polar-orbiting satellites launched from California to go over the South Pole. In case there were any difficulties, they would crash in the ocean and not over land. If they were working properly when they reached the South Pole, you were in business and the satellite panoramic film cameras would then capture the areas of interest. Then, as the spacecraft got closer to Hawaii, it would slow down, turn

around, eject the film bucket so that the camera film package, which was attached to a parachute, could be grabbed as it was descending. The U.S. Air Force would then zip in, snag the bucket in mid-air, land, turn over the film, and ITEK would process it. The satellites always landed in the ocean at the same place so the Russians and Chinese would always be there in international waters hoping to get hold of the film canisters. With the film in hand, the whole idea was to get the film to Fort Belvoir and other places to be processed and interpreted so targeting maps could be updated.

For Hexagon, the Itek 9×18 inch mapping camera was dual use: 1) in NASA ER-2 aircraft for such things as forest inventory or. 2) hardened for use in spacecraft for security missions such as the Hexagon satellite. As noted above, the satellites were polar orbiting – as the earth turned, new areas were presented to be captured and you could turn the camera on and off to cover only the areas of interest. There were horizon cameras with short focal lengths for attitude and over time the focal length of the frame cameras increased. While Hexagon with longer focal length cameras came after Corona, Corona was the work-horse – and it was dual purpose – for spy satellites and uses such as the Apollo Moon Program where a 24-inch camera was used. Interestingly, none of the systems used for Apollo was ever lost. When he was lecturing to the University of Wisconsin students Ron was asked how they could tell which system was which – between the classified military and civilian 24-inch cameras. His response was: "we painted them different colors." In other words, there was no difference!

Itek also built the CCD cameras used in the Viking Lander Mission to Mars. Ron was at the Paris Air Show in 1976 when the first pictures came back. In typical Ondrejka humor, he would point to the first surface photograph of Mars on his office wall and remark, "we never did see anything move on the surface of Mars!"

## ASPRS

When Ron came back from the Korean War and as he was getting into civilian applications of mapping, he was introduced to the American Society of Photogrammetry (ASP) by Dr. Claus Aschenbrenner at Itek. Ron developed all kinds of reasons to attend the ASP meetings such as networking with peers. Given the involvement of Itek in the spy satellite business and related systems, another reason for attending was the importance of politicians who were funding these major reconnaissance and mapping programs since ASP held many of the meetings in the Washington, DC area.

The significant growth of the ASP was because the imagery, initially for military applications, was being used by corporations, universities, and various government institutions.

Everyone started to realize that this tool helped them be more efficient in their activities whether it was earth sciences or military applications.

Ron noted that once a satellite was launched by NASA, the Air Force, or someone else, the interest was in extracting information from the data. You not only had to have a good device taking a picture – you also had to have a good reason for taking the picture. It was this extraction of data that promoted ASP activity and involvement.

Ron grew up in Wisconsin, near Lake Michigan, and returned to his roots. He was very active for decades with the Great Lakes Region of ASPRS and with remote sensing colleagues from around the world. He was particularly active with the Primary Data Acquisition Division (PDAD). Persons wishing to remember Ron are asked by his family to contribute to the ASPRS Western Great Lakes Scholarship Fund.

Direct contributions to the ASPRS WGL Scholarship Fund can be made by contacting:

Colin Lee, ASPRS WGL Treasurer
Email. colin.lee@state.mn.us
Work. 651 366 3433

More information about the ASPRS Western Great Lakes Region can be found at. http://wgl.asprs.org/

Ron will be deeply missed by his wife, son, grandchild, and countless remote sensing friends and colleagues from around the world. His stories, laughter, and kindness will live on in the hearts of all who knew him. Along the way, he may have helped prevent another global conflict.

**Brian Huberty, Remote Sensing Advisor**
Sharedgeo.org
ASPRS Western Great Lakes Region
http://wgl.asprs.org/2023/03/remembering-ron-ondrejka/

Ron Ondrejka out fishing on Big Lake, WI with granddaughter Meridian.

# Call for *PE&RS* Special Issue Submissions

## Special Issue on the Scholarship and Impacts of Professor Nina S. N. Lam

### Expected Date for Publication: 2024


### Special Issue Editors

**Michael Leitner (mleitne@lsu.edu)**
**Jane Read (jaread@syr.edu)**


This special issue recognizes Professor Nina S. N. Lam's ~45 years of contribution to Geographic Information and Environmental Sciences. From her first publications on spatial/areal interpolation methods in the early 1980s, she evolved into an internationally recognized scholar known for her leadership in diverse research areas, from scale, resolution, and fractals to environmental health, disaster resilience, and sustainability. Professor Lam, who currently holds the E. L. Abraham Distinguished Professor of Louisiana Environmental Studies title, has been the recipient of many honors and awards, including the inaugural Carolyn Merry Mentoring Award from the UCGIS (2016), being named a Fellow of both the AAG (2020) and the UCGIS (2016), as well as being named a LSU Rainmaker, recognizing one of the top 100 research and creative faculty (2008), and the LSU Distinguished Faculty Award (2006). Her legacy in research, teaching, and service continues through her many students, who are actively contributing to Geographic Information Science (GISc) in academia, government, and the private sector, including the second co-guest editor of this special issue.

This special issue celebrates the outstanding scholarly work of Professor Lam. We invite original contributions from her students, collaborators, and anyone impacted and influenced by her work. Topics covered should be broadly situated within remote sensing, disaster/environmental sciences, sustainability, environmental health, and GISc, including but not limited to subjects related to her research and impact. Please contact special issue editors for questions and suggestions.

Interested authors should send a manuscript title and short abstract (about 250 words, including the authors' names and affiliations) to the special issue editors (mleitne@lsu.edu; jaread@syr.edu) by July 15, 2023 (see complete publication timeline below).

Manuscript length should be around 5,000-6,000 words. All submissions will be subject to standard *PE&RS* peer review processes. See Instructions for authors (https://www.asprs.org/asprs-publications/pers/pers-instructions-for-authors-submitting-a-manuscript-for-peer-review). All submissions should be made online at the Photogrammetric Engineering and Remote Sensing Manuscript Central site (https://www.editorialmanager.com/asprs-pers/). Authors must select "Special Issue" when they reach the "Article Type" step in the submission process and identify the "Scholarship and Impacts of Professor Nina S. N. Lam Special Issue" in their cover letter. New users should first create an account. Once logged on to the site, submissions should be made via the Author Dashboard. Online user guides and access to a help desk are available on this website.

**Timeline for publication of *PE&RS* Special Issue**

| | |
|---|---|
| **Manuscript Proposal Deadline (Title and Abstract)** | July 15, 2023 |
| **Submission Deadline** | January 31, 2024 |
| **Information about Acceptance** | On a rolling basis |
| **Submission of Revised Manuscript Deadline** | June 30, 2024 |
| **Publication in *PE&RS*** | 2024 |

# Journal Staff



# NEW ASPRS MEMBERS

ASPRS would like to welcome the following new members!

Jason Armbrust
Prosenjit Barman
Gleyn Edward Bledsoe, Ph.D.
Scott Chapman
Jake Anthony Chauvin
Evan William Cizler
Leeann Deslauriers
Kamila Dilmurat
Ameer Faisal, P. E.
Daniel Granda, P. E.
Yunyi Guan
Nicholas Daniel Hestand
Travis James Hoffman
Ronikka A. Hubert
Daniel Huseman
Yufang Jin
Drew Michael LeBoeuf
Jiawei Li
Pengfei Ma
Travis Martin
Michael Mercincavage
Robert Morse
Landon Michael Neil
Stephanie Padilla
Ethan Roberts
Taurai Justice Sadzauchi
Sumana Sahoo
Kelly L. Soverns
Greg Taillacq
Mark Topping
Reece D. Toups
My Thu Tran
Heidi Tubbs
Gregory Wehrli
Tim Wright
Molan Zhang

FOR MORE INFORMATION ON ASPRS MEMBERSHIP, VISIT
**HTTP://WWW.ASPRS.ORG/JOIN-NOW**

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## ASPRS Staff Directory

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# ASPRS ANNUAL CONFERENCE 2023

at Geo Week February 13-15, 2023 Denver, CO, US

## ASPRS Presidential Address

*Lorraine B. Amenda*

## ASPRS Awards Program 2023

*Society Awards*
*Region Awards*
*Roger Hoffer Membership Award*
*Outstanding Paper Awards*
*Scholarships*

## Geo Week Joint Awards

*ASPRS Fellow Award*
*Estes Memorial Teaching Award*
*The ASPRS Lifetime Achievement Award*
*ASPRS Photogrammetric Award (Fairchild)*
*The ASPRS Outstanding Technical Achievement Award*
*The International Educational Literature Award (IELA)*
*George E. Brown, Jr. Congressional Honor Award*

## Annual Business Meeting and Installation of Officers

*Recognition of Retiring Council Chairs*
*Installation of New Council Chairs*
*Recognition of Retiring Division Directors*
*Installation of New Division Assistant Directors*
*Recognition of Retiring President*
*Installation of Officers*
*Presentation of Birdseye Citation and President's Key to Retiring President*

# ASPRS PRESIDENTIAL ADDRESS

## A Path to ASPRS Leadership

February 15, 2023

**Lorraine B. Amenda, PLS, CP**


There are probably as many paths to leadership positions in ASPRS as there are folks in those positions. I personally feel that mine is a somewhat improbable path. Following my High School graduation in Coalinga, CA, in 1982 I had no clear sense of what I wanted for my future other than no longer living in Coalinga. My original plan was to attend community college in Southern California while rooming with my sister who had just graduated from Pepperdine University. As the summer was ending, that plan fell apart and I ended up living with my grandmother and attending Fresno City College.

I primarily took business and secretarial courses, with a side of Calculus for fun. I expect I'm the only student there who ever took typing, shorthand, and calculus during the same semester! After 3 semesters I got a full-time job as the Administrative Assistant for the United Way of Fresno County. Fresno is an affordable place to live, but a support position at a non-profit didn't really provide enough funds to support myself comfortably. After 2 ½ years I decided to go back to college full-time in preparation to start a professional career. I originally expected to study business, probably accounting then took a detour into engineering. After 1 more year at Fresno City College to finish Calculus and work on engineering prerequisites, I decided to attend the Engineering Open House at Fresno State to see what options were available. A presentation from the Surveying Engineering (now Geomatics) program had some very interesting activities – including close-range photogrammetric mapping of horses. I decided to give it a try with a potential fall-back to Civil Engineering. After 3 years at Fresno State, I graduated with honors and a B.S. in Surveying Engineering and a job with the aerial mapping group at Towill, Inc., in San Francisco – where I continue working today, nearly 33 years later.

During my final semester at Fresno State I was debating between photogrammetry and field surveys, not making a final decision until the end of the year. I also attended the ASPRS/ACSM join conference held at the Denver Convention Center, where we are right now. I had joined ASPRS and ACSM as a student member that year. Then, like many students, decided to let my membership lapse when I received my first billing statement for a full membership. About 10 years later while attending the CSUF Geomatics Engineering Conference in January 2000 one of my co-workers was approached to help revitalize the Northern California Region of ASPRS that had been dormant for a couple of years. She asked me if I would do it with her, and I agreed. At that time we thought we were agreeing to join ASPRS and attend a few meetings. Apparently what we had agreed to was being a candidate for the Region's Board of Directors. At the conclusion of the election, I was a Region Director and my co-worker ended up leaving Towill to work with her husband on his newly established surveying business, never joining ASPRS or attending a Region meeting. I joined ASPRS and began my long stretch of involvement with ASPRS, primarily at the Region Level.

After a few years I moved from a Director to the National Director that represented the Northern California Region on the National Board of Directors. I was part of the core group that merged the Northern California Region (Northern California, Northern Nevada, and Hawaii) with the Southwest US Region (Southern California, Southern Nevada, and Arizona) to form the Pacific Southwest Region. Shortly after that I moved over to the Region's Secretary-Treasurer position and finally into the Region President position. While I was PSW Region President, I became involved with the Region Officers Council and stepped into the Deputy Chair position. Very shortly thereafter the Council Chair stepped down, and I was suddenly the Chair of the ROC at the point where it was still trying to find its

footing. I finished the remainder of the term for the Chair who stepped down and then finished my own two-year term, also agreeing to serve as the ASPRS Secretary during the final year of that term – that may have been one ASPRS job too many! It was at that point that I was invited to run for the ASPRS Vice Presidency.

ASPRS involvement can offer many different things depending upon your level of involvement as well as your individual circumstances. For me, ASPRS has become a place where I've been able to expand my professional network, which would otherwise be pretty limited since I've worked for the same employer for my entire career; particularly when you factor in that Towill has a pretty high rate of employees that have been there for 25 years or more. ASPRS has also been a place where I've been able to develop my public speaking/presentation skills and have become comfortable leading meetings prior to the time where that regularly became part of my day job.

ASPRS has had a lot of changes to make in the past few years as the world has shifted on-line and the nature of professional organizations have had to adapt. We have navigated many of the hurdles to come our way, and we know there are more coming our way soon, some that we can predict and others that will come as a surprise. But even as we adapt to these changes, ASPRS will continue to provide leadership in the adoption of new technologies or the application of our core technologies to even more users. There is also a need for the local programming made available by the ASPRS Regions – both in-person and increasingly on-line; especially as we emerge from COVID. Region sponsored technical sessions and conferences are a place where you can network with other geospatial professionals in your geographic area as well as learn what geospatial activities the local firms are utilizing.

Leadership at ASPRS can start with something as simple as volunteering to attend a local presentation sponsored by your Region or showing up at a meeting of one of the Technical Divisions. That one small step could be the start of a road that would lead you to be ASPRS President somewhere down the line. It just takes one small step followed by another small step that comes your way. Where will your own ASPRS path lead?

Outgoing ASPRS President Chris Parrish congratulating newly sworn in President Lorraine B. Amenda.

# ASPRS AWARDS PROGRAM 2023

**Denver, Colorado • February 13–15, 2023**

## AWARDS AND SCHOLARSHIPS

Through the ASPRS Foundation, ASPRS provides support to undergraduate and graduate student members of the society through their Scholarship program, and recognizes professionals who are contributors to the field of spatial and image sciences. Awards for Outstanding Papers, Professional Achievement, and Service activities are determined by committee selection; scholarships and academic awards are also determined by committee selection but are chosen from current applications. A comprehensive review of the awards program is available on the ASPRS webpage: https://www.asprs.org/education/asprs-awards-and-scholarships.

## Society Awards

### ASPRS Presidential Citations

**Rae Kelley**
For outstanding work as Director of Publications, including important changes to *PE&RS* that benefit authors, readers, and subscribers.

**John McCombs**
For supporting the society through meritorious service as ASPRS Treasurer.

**Purpose:** First awarded in 1992, Presidential Citations are presented by the ASPRS President to members of ASPRS and other societies, family members, and friends in recognition of special, personal, and meritorious contributions to the operation or advancement of the Society and its interests during the presidential year.

**Donor:** ASPRS. The Presidential Citation is a certificate.

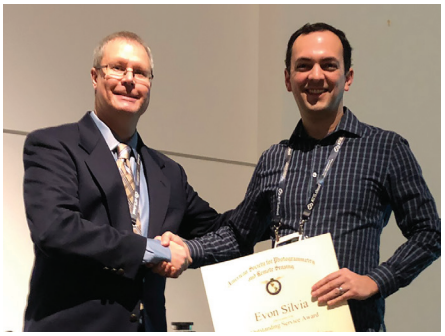
John McCombs (right) receiving the ASPRS Presidential Citiation from outgoing ASPRS President Chris Parrish.

### ASPRS Outstanding Service Award

**Lauren McKinney-Wise**
For development of new bylaws and operating procedures templates for student chapters, streamlining the process for creating new student chapters, and supporting the awards program.

**Evon Silvia**
For outstanding work as Chair of the ASPRS LAS Working Group, including publication of Version 2 of the LAS Topobathy Domain Profile.

**Qassim Abdullah, Colin Lee, Riadh Munjy, Josh Nimetz, Michael Zotlek**
For serving on the committee developing Edition 2 of the ASPRS Positional Accuracy Standards for Digital Geospatial Data.



Evon Silvia (right) receiving the ASPRS Outstanding Service Award from outgoing ASPRS President Chris Parrish.

Qassim Abdullah (left) and Josh Nimetz (right) receiving the ASPRS Outstading Service Award from outgoing ASPRS President Chris Parrish.

**Jim Gillis, Jeff Irwin, Jamie Gillis, Davic Kuxhausen, Colin Lee, Kyle Ince, Michael Zarlengo**
For serving on the Survey Addendum Working Group working on the Positional Accuracy Standards.

**Purpose:** Established in 1991, The Outstanding Service Award is given in recognition of outstanding and unusual efforts in helping ASPRS develop and carry out its program over a sustained period. Recipients have performed outstanding service at the chapter, regional, or national level. Awardees' service includes any activities, including professional, that have helped the Society achieve its goals and objectives.

**Donor:** ASPRS. The Outstanding Service Award consists of a certificate.

## Region Awards

**Region of the Year: Florida Region**

**Region Web Site and Newsletter of the Year: Gulf South Region**

## Roger Hoffer Membership Award

**Honorable Mention: Karen Schuckman**

**Purpose:** First awarded in 1968 as the ASPRS Ford Bartlett Membership Award (which was originally sponsored by the firm of Lockwood, Kessler, and Bartlett, Inc.) to honor members for actively promoting membership in ASPRS. This award now marks the exceptional efforts of ASPRS Past President Roger Hoffer in managing the Membership Committee and recruiting hundreds of student members.

**Donor:** ASPRS. A member is eligible to receive the Award after sponsoring ten or more members in one year. Each recipient receives a hand-engrossed certificate and a one-year membership in the Society. An Honorable Mention is awarded to those who sponsor at least five new members.

Outgoing ASPRS President Chris Parrish presenting the Roger Hoffer Membership Award to Karen Schuckman (right).

Outgoing ASPRS President Chris Parrish presenting the ASPRS Outstanding Service Award to Davic Kuxhausen (center) and Jeff Irwin (right).


Outgoing ASPRS President Chris Parrish presenting the Region of the Year Award to Florida Region officer Matthew LaLuzerne (right).


Outgoing ASPRS President Chris Parrish presenting the Region of the Year Award to Florida Region representative Jeffrey Lovin (right).


Outgoing ASPRS President Chris Parrish presenting the Region Web site and Newsletter of the Year Award to Cody Condron (right).

## Outstanding Paper Awards

### The Esri Award for Best Scientific Paper in GIS

**1st Place**
Ravi Peters, Balázs Dukai, Stelios Vitalis, Jordi van Liempt, and Jantien Stoter for "Automated 3D Reconstruction of LoD2 and LoD1 Models for All 10 Million Buildings of the Netherlands." *PE&RS*, 88(3): 165–170.

**2nd Place**
Steven Spiegel, Casey Shanks, and Jorge Chen for "Effectiveness of Deep Learning Trained on SynthCity Data for Urban Point-Cloud Classification". *PE&RS*, 88(2): 113-120.

**3rd Place**
Feilin Lai and Xiaojun Yang for "Improving Land Cover Classification over a Large Coastal City Through Stacked Generalization with Filtered Training Samples." *PE&RS*, 88(7): 451–459.

**Purpose:** Established in 1991, the fully endowed Esri Award honors individuals who publish papers of scientific merit that advance our knowledge about GIS technology.

**Donor:** Esri, Inc. through the ASPRS Foundation. The First-Place award includes a cash award of $1,500 and a certificate; Second Place is a cash award of $900 and a certificate; Third Place is a cash award of $600 and a certificate.

### John I. Davidson President's Award for Practical Papers

**1st Place - Tie**
Xuzhe Duan, Qingwu Hu, Pengcheng Zhao, and Shaohua Wang for "A Low-Cost and Portable Indoor 3D Mapping Approach Using Biaxial Line Laser Scanners and a One-Dimension Laser Range Finder Integrated with Microelectromechanical Systems." *PE&RS*, 88(5): 311–321.

**1st Place - Tie**
Thomas R. Loveland, Martha C. Anderson, Justin L. Huntington, James R. Irons, David M. Johnson, Laura E. P. Rocchio, Curtis E. Woodcock, and Michael A. Wulder for "Seeing Our Planet Anew: Fifty Years of Landsat." *PE&RS*: 88(7): 429-436.

**Purpose:** The John I. Davidson President's Award for Practical Papers was established in 1979 to encourage and commend individuals who publish papers of practical or applied value in *PE&RS*.

**Donor:** The ASPRS Foundation in memory of ASPRS Past President John I. Davidson. The First-Place award includes a cash award of $1,000 and a certificate; Second Place is a cash award of $600 and a certificate; Third Place is a cash award of $400 and a certificate.

Steven Spiegel (right) accepting The Esri Award for Best Scientific Paper in GIS (2nd Place) from incoming ASPRS President Lorraine B. Amenda.

Christopher McGinty accepting the John I. Davidson President's Award for Practical Papers (Loveland, *et. al*) from incoming ASPRS President Lorraine B. Amenda on behalf of the winners.

### Talbert Abrams Award

**Grand Award:**
Itiya Aneece and Prasad S. Thenkabail for "New Generation Hyperspectral Sensors DESIS and PRISMA Provide Improved Agricultural Crop Classifications." *PE&RS*, 88(11): 715-729.

Incoming ASPRS President Lorraine B. Amenda presenting the Talbert Abrams Award to Itiya Aneece (center) and Prasad S. Thenkabail (right).

**First Honorable Mention:**
Clement E. Akumu and Sam Dennis for "Urban Land Cover/Use Mapping and Change Detection Analysis Using Multi-Temporal Landsat OLI with Lidar-DEM and Derived TPI." *PE&RS*, 88(4): 245-253.

**Second Honorable Mention:**
Thomas R. Loveland, Martha C. Anderson, Justin L. Huntington, James R. Irons, David M. Johnson, Laura E. P. Rocchio, Curtis E. Woodcock, and Michael A. Wulder for "Seeing Our Planet Anew: Fifty Years of Landsat." *PE&RS*: 88(7): 429-436.

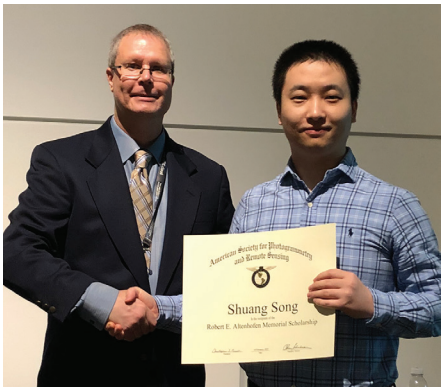
**Purpose:** The Talbert Abrams Award was established in 1945 to encourage the authorship and recording of current, historical, engineering, and scientific developments in photogrammetry. The Award is determined from papers published in the Photogrammetric Engineering and Remote Sensing (*PE&RS*) journal.

**Donor:** The ASPRS Foundation. The award consists of a certificate and a check for $4,000 for the Grand Award, and a certificate for the First and Second Honorable Mentions.

Christopher McGinty (right) accepting the Talbert Abrams Award (2nd Honorable Mention) from incoming ASPRS President Lorraine B. Amenda on behalf of the winners.

## Scholarships

### Robert E. Altenhofen Memorial Scholarship




Shuang Song (right) accepting the 2023 Robert E. Altenhofen Memorial Scholarship from outgoing ASPRS President Chris Parrish.

**2023 recipient: Shuang Song**
Shuang Song earned a bachelor's degree from the School of Geographical Sciences at Guanghzhou University, China, an M. Eng. in photogrammetry and remote sensing from Wuhan University, China, and is currently a doctoral candidate in photogrammetry and remote sensing in the Department of Civil, Environmental, and Geodetic Engineering at The Ohio State University. Song has demonstrated a strong alignment with the criteria of Robert E. Altenhofen Memorial Scholarship with his strong background in rigorous photogrammetric concepts. Song's research focuses on mesh modeling from unstructured point clouds and its application to fuse multi-source 3D data to generate geospatially coherent datasets for reality-based modeling. Song also seeks to bring photogrammetry and image processing into other fields and has collaborated with researchers in anthropology, chemical engineering, public health, and civil engineering. Song has already built a strong publication record, including one book chapter, two journal papers, and multiple top-tier conference proceedings, with two additional journal papers under review.

**Purpose:** First given in 1986, the Robert E. Altenhofen Memorial Scholarship is intended to encourage and commend college students who display exceptional interest and ability in the theoretical aspects of photogrammetry.

**Donor:** The ASPRS Foundation. This award was originally established by Mrs. Helen Altenhofen as a memorial to her husband, Robert E. Altenhofen, past president of ASPRS. He was an outstanding practitioner of photogrammetry and made notable contributions to mathematical aspects of the science. The Altenhofen Scholarship consists of a certificate, a check for $2,000, and a one-year membership renewal in the Society.

### Abraham Anson Memorial Scholarship

**2023 recipient: Not awarded this year**

**Purpose:** To encourage students who have an exceptional interest in pursuing scientific research or education in geospatial science or technology related to photogrammetry, remote sensing, surveying, and mapping to enter a professional field where they can use the knowledge of their discipline to excel in their profession.

**Donor:** This award is presented by the ASPRS Foundation from funds donated by the Anson bequest and contributions from the Society and the Potomac Region as a tribute to Abe Anson's many contributions to the field of photogrammetry, remote sensing, and long, dedicated service to the Society. The award consists of a certificate, a check for $2,000, and a one-year membership renewal in the Society.

## John O. Behrens Institute for Land Information (ILI) Memorial Scholarship

**2023 recipient: James Jones**

James Jones is an undergraduate student in geomatics at Nicholls State University (NSU). Jones works as an undergraduate research assistant in the NSU Geospatial Technology Lab completing projects such as geocoding electric meter locations for a local municipality, creating a geographic information system of the utility easements for a local utilities department, researching sugarcane quality using hyperspectral data, and identifying vegetation with hyperspectral unmanned autonomous system (UAS) data. Jones is currently working on a project to support the NSU police department. Jones has presented his research at multiple meetings including the University of Louisiana at Lafayette Fall Undergraduate Research Conference in 2021 and 2022. He is the recipient of Nicholls Scholars Academic Honors, the 2020 Morris P. Hebert Scholarship for academic excellence in Geomatics, and the 2022 ASPRS Abraham Anson Memorial Scholarship. He is active in serving the community through local church groups and has been recognized for his service with the Knights of Columbus award, Louisiana Boys State, Rotary Club Service Above Self Award and Diocesan Youth Leadership Award. He is also an active member of NSPS, LSPS and ASPRS.

**Purpose:** To encourage students who have an exceptional interest in pursuing scientific research or education in geospatial science or technology or land information systems/records to enter a professional field where they can use the knowledge of this discipline to excel in their profession.

**Donor:** This award is presented by the ASPRS Foundation from funds donated by the (now dissolved) Institute for Land Information (ILI). The John O. Behrens ILI Memorial Scholarship was established by the ILI as a tribute to the many contributions of Mr. John O. Behrens to the field of geographic and land related information and technology. Mr. Behrens was a founder of the ILI and the author of many articles about the value of spatial information, land assessment and taxation, and land information policy. The Award consists of a certificate, a check for $2,000, and a one-year membership renewal in the Society.

## Robert N. Colwell Memorial Fellowship

**2023 recipient: Minho Kim**

Minho Kim is a doctoral candidate in Landscape Architecture and Environmental Planning at the University of California, Berkeley. His dissertation topic is "Towards Transformative Resilience in the Wildland-Urban Interface (WUI): Combining High-Resolution Remote Sensing and Machine Learning-based Fire Spread Simulation." Kim plans to generate vegetation fuel maps and natural hazard information at unprecedented high spatial resolution, create a machine learning-based fire spread simulation model, and develop geospatial measures of wildfire risk for individual homeowners and communities. Kim's fire spread simulator will be applicable to different regions around the world, and will be capable of making timely updates based on changing local fuel conditions. Kim's ability to translate remote sensing and GIS into practical applications is demonstrated by the patent that he shares with colleagues based on his study on forecasting photovoltaic power generated from solar farms in Korea that combined meteorological data, sun geometry and time variables, and in-situ data with geostationary satellite images in a deep neural network. Kim's success as a teaching assistant for seven different geospatial courses led to his appointment as the lead instructor for a large multidisciplinary GIS course at UC Berkeley. He is quickly becoming a very versatile teacher who provides inclusive mentorship to students from diverse social, educational, and ethnic backgrounds. Kim's remote sensing skills and overall expertise have led to lead authorship of four peer-reviewed articles in top-tier journals.

**Purpose:** Established in 2006 to encourage and commend college/university graduate students or post-doctoral researchers who display exceptional interest, desire, ability, and aptitude in the field of remote sensing or other related geospatial information technologies, and who have a special interest in developing practical uses of these technologies.

**Donor:** This award is presented by the ASPRS Foundation, from funds donated by students, associates, colleagues, and friends of Robert N. Colwell. Over the course of more than a half century, Dr. Robert N. Colwell developed a reputation as one of the world's most respected leaders in remote sensing, a field that he stewarded from the interpretation of aerial photographs during World War II, to the advanced acquisition and analysis of many types of geospatial data from military and civilian satellite platforms. His career included nearly 40 years of teaching and research at the University of California, Berkeley, a distinguished record of military service reaching the rank of Rear Admiral, and prominent roles in private industry and as a consultant for many U.S. and international agencies. Among his many accolades, Dr. Colwell had the distinction of being one of the 25 Honorary Members of ASPRS. The Award consists of a certificate, a check for $8,000, and a one-year membership renewal in the Society.

## William A. Fischer Memorial Scholarship

**2023 recipient: Anuska Narayanan**

Anuska Narayanan is a doctoral student in the Department of Geography at the University of Florida specializing in sustainability and global environmental change. Narayanan previously earned M.S. and B.S. degrees in geographic information systems and environmental science, respectively, at the University of Alabama. Required coursework in GIS and remote sensing during her undergraduate degree introduced Narayanan to the value of geospatial sciences across a range of domains and led to her master's research that focused on quantifying the impacts of deforestation on hydrologic systems in the Amazon River Basin. She has presented her research at local, national, and international conferences and engaged in developing peer-reviewed publications. Narayanan has also gained experience through various internships and work as a GIS contractor as well as serving as a teaching assistant and guest lecturer. Narayanan is currently studying earth-climate interactions. Her training in geospatial technologies and techniques are enabling Narayanan to combine her multidisciplinary training in hydrology, land use analysis, and climatology boundaries in order to understand land-climate interactions. Narayanan aims to become a professor in geography with a focus on geospatial applications to share her passion and motivate the next generation of geospatial scientists.

**Purpose:** The William A. Fischer Scholarship facilitates graduate studies and career goals of a worthy student adjudged to address new and innovative uses of remote sensing data and techniques that relate to the natural, cultural, or agricultural resources of the Earth. It was established in 1984.

**Donor:** The ASPRS Foundation through individual and corporate contributions in memory of William A. Fischer. The William A. Fischer Memorial Scholarship consists of a certificate, a check for $2,000, and a one-year membership renewal in the Society.

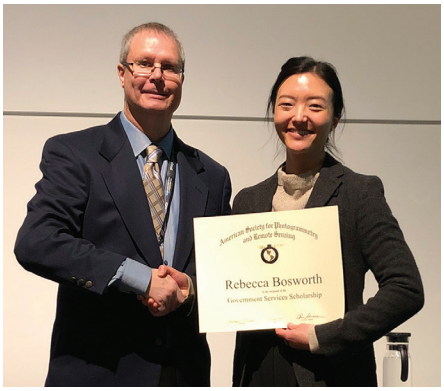
## Government Services Scholarship

**2023 recipient: Rebecca Bosworth**

Rebecca Bosworth is completing a Master of Science degree in Geographic Information Science and Technology at the University of Southern California (USC). Bosworth previously completed a Bachelor of Arts degree in Atmospheric Science at the University of California Berkeley. As an undergraduate student, Bosworth completed a summer internship at NASA Goddard Space Flight Center testing satellite sensors. This experience introduced the field of remote sensing and led to Bosworth becoming a U.S. Air Force Intelligence Officer. Bosworth's experience using remote sensing within defense operations motivated her application to the USC Spatial Science Institute to pursue her master's degree, which coincided with her transfer to the U.S. Space Force as Deputy Commander of the SATCOM Intelligence Operations Detachment. At USC, Bosworth pairs her professional experience with her formal education to focus on projects working with remote sensing technologies. She led a team of five graduate students to attain recognition for the Most Innovative Analysis at the 2022 Los Angeles Geospatial Summit Esri Student Map Competition. Bosworth's research focuses on improving disaster relief response timelines based on geospatial information using satellite remote sensing techniques. She seeks to utilize networks of small satellites in low earth orbit with high revisit rates that offer reliable data and promote space sustainability by reducing satellite congestion. Bosworth will apply her education towards continued service in the U.S. Space Force partnering with civil, government, and commercial partners to protect human security. Bosworth aims to use satellite remote sensing to detect indicators threatening human security and social justice, promote equitable solutions, and advance sustainable policies protecting vulnerable communities.

**Purpose:** The newly established Government Services Scholarship, awarded for the first time this year, encourages upper-division, undergraduate- and graduate-level college students to pursue a course of study in photogrammetry and related topics leading to a career in the geospatial mapping profession in the government sector (federal, state, or local) within the United States. The Award also encourages geospatial professionals already in government service to pursue advanced degrees and provides a preference to U.S. veterans.

**Donor:** The ASPRS Foundation through the support of an anonymous donor who is a long-time supporter of ASPRS and the ASPRS Foundation. The Government Services Scholarship consists of a certificate, a check for $7000, and a one-year membership renewal in the Society.




Rebecca Bosworth accepting the Government Services Scholarship from outgoing ASPRS President Chris Parrish.

## Francis H. Moffitt Memorial Scholarship

**2023 recipient: Oren Nardi**
Oren Nardi is pursuing his BS degree in Geospatial Science and Technology at Cal Poly Humboldt in Arcata, California. His interest in geospatial information science (GIS) stems from his volunteer work with the California Conservation Corps working on the rehabilitation of trail systems in the wilderness portions of Yosemite National Park. With his experiences in working outdoors Nardi gained an appreciation in the field of natural resources he began his academic pursuits in Forestry but ultimately changed majors to Environmental Science with a concentration in GIS. Through summer internships Nardi gained experience with GIS tools and began a keen interest in unmanned autonomous system (UAS) technology. He has subsequently earned his license to fly drones and intends to use UAS technology in his research. Nardi's long-term professional career goal in the geospatial field is to spearhead commercial-grade UAS applications into solving real-world questions such as monitoring landscape-based vegetation treatments.

**Purpose:** The award was first presented in 2008 with the purpose of encouraging upper-division, undergraduate-level, and graduate-level college students to pursue a course of study in surveying and photogrammetry leading to a career in the geospatial mapping profession.

**Donor:** The ASPRS Foundation from funds donated to the Foundation from former students, associates, colleagues, and friends of Francis Moffitt. The award consists of a certificate, a check for $9,000, and a one-year membership renewal in the Society.

## The Kenneth J. Osborn Memorial Scholarship

**2023 recipient: Not awarded this year**

**Purpose:** to encourage and commend college students who display exceptional interest, desire, ability, and aptitude to enter the profession of surveying, mapping, photogrammetry, or geospatial information and technology. In addition, the Award recognizes students who excel at an aspect of the profession that Ken demonstrated so very well, that of communications and collaboration.

**Donor:** The ASPRS Foundation from funds donated by the friends and colleagues of Kenneth J. Osborn. Recognized nationally and internationally, Ken was an outstanding practitioner of surveying, mapping, photogrammetry, and geospatial information and technology, and a great friend of the Society. As a professional cartographer with the U.S. Geological Survey, Ken made significant contributions to these fields. The award was first offered in 2005. The Award consists of a certification, a check for $2,000, and a one-year membership renewal in the Society.

## Ta Liang Memorial Award

Outgoing ASPRS President Chris Parrish presenting the Ta Liang Memorial Award to Sierra Melton (right).

**2023 recipient: Sierra Melton**
Sierra Melton is a doctoral candidate and research/teaching assistant in the Geosciences Department at the Pennsylvania State University, where she also completed a Master of Science degree. Melton was the recipient of a National Science Foundation (NSF) Graduate Research Fellowship that supported completion of her master's degree that focused on iceberg calving and meltwater drainage at the ice-cliff terminus of Helheim Glacier, Greenland. Melton has an extensive work and research experience record including internships with the National Geospatial-Intelligence Agency and NSF funded research experiences in the United States and abroad. Melton has communicated her research through peer-reviewed publications and presentations. Melton is motivated to employ remote sensing, photogrammetry, and geophysical and geodetic survey methods to study hydrological and glaciological processes impacted by climate and environmental change. This summer, she will travel to Helheim Glacier in southeast Greenland to conduct field research to support her doctoral research analyzing the glacier using remote sensing and numerical modeling approaches. Her research will include development of digital elevations models derived photogrammetrically from UAV data to study how glacier surfaces change as a result of fracture and calving events. Melton has also been active in service activities including mentoring undergraduate researchers, being a Local Science Partner ambassador with the American Geophysical Union, co-chairing the Colorado College Students for Environmental Action (EnAct) and serving as a mentor with the Colorado College Learning Initiative in the Mountains (CCLIM).

**Purpose:** To facilitate research-related travel by outstanding graduate students in remote sensing, including field investigations, agency visits, participation in conferences, or other travel that enhances or facilitates graduate research.

**Donor:** Individual and corporate contributions to the ASPRS Foundation in memory of Ta Liang, a skilled civil engineer, an excellent teacher, and one of the world's foremost air photo interpreters, the award consists of a certificate, a check for $2,000 grant, and a one-year membership renewal in the Society.

## Paul R. Wolf Memorial Scholarship

**2023 recipient: Sheng Tan**

Sheng Tan is presented the Paul R. Wolf Memorial Scholarship in recognition of his outstanding academic credentials and his plans and enthusiasm to become an education professional in surveying, mapping, photogrammetry, and related fields. Tan is currently a doctoral candidate in geomatics at Purdue University with a projected graduation date of May 2027. Tan has demonstrated a continued interest, dedication, enthusiasm, passion, and aptitude to become an education professional as exemplified by his outstanding work as a teaching assistant. Tan's career goal is to become a tenured teaching/research faculty member at a university, wishing to grow his skill set and continually learn new technologies in the geomatics field.

**Purpose:** To encourage and commend college students who display exceptional interest, desire, ability, and aptitude to enter the profession of teaching surveying, mapping, or photogrammetry.

**Donor**: the ASPRS Foundation from funds donated by the friends and colleagues of Paul R. Wolf. Recognized nationally and internationally, Dr. Wolf was an outstanding educator and practitioner of surveying, mapping, and photogrammetry and a great friend of the Society. As author, teacher, and mentor, Dr. Wolf made significant educational and academic contributions to these fields. The award was inaugurated in 2003 and includes a certificate, a check for $5,000, and a one-year membership renewal in the Society.

# Geo Week Joint Awards

## ASPRS Fellow Award

**2023 recipients: Amr Abd-Elrahman and Prasad Thenkabail**


Outgoing ASPRS President Chris Parrish presenting the ASPRS Fellow Award to Amr Abd-Elrahman.

**Amr Abd-Elrahman**

Dr. Amr Abd-Elrahman is recognized for his research contributions in artificial intelligence and machine learning and for his contributions to the Society. Amr Abd-Elrahman has developed and applied spatial analysis techniques for remote sensing datasets to address natural resource management and agricultural challenges using object-based image analysis of high-resolution imagery and image classification using machine and deep learning.

Abd-Elrahman is a Professor at the Gulf Coast Research and Education Center, School of Forest Resources and Conservation – Geomatics Program at the University of Florida (UF). Abd-Elrahman received B.Sc. and M.Sc. degrees in Civil Engineering from Ain Shams University in Cairo, Egypt in 1990 and 1994, respectively; and his Ph.D. in Civil Engineering in the Geomatics Program, with a minor in Computer and Information Engineering, from UF in 2001. Abd-Elrahman has advanced agricultural and natural resource monitoring through innovations in image classification, biophysical modeling, bathymetric mapping and machine and deep learning, especially using high-resolution imagery and lidar data acquired from UAS platforms.

Abd-Elrahman has secured over $7.1M in research funds from national and state agencies including the National Science Foundation, U.S. Department of Agriculture, U.S. Forest Service, National Oceanic and Atmospheric Administration, U.S. Army Corps of Engineers, National Institute of Food & Agriculture and the Florida Strawberry Research and Education Foundation. His work is published in top geospatial journals such as *Remote Sensing of Environment*, *ISPRS Journal of Photogrammetry and Remote Sensing, ISPRS International Journal of Geo-Information, GIScience & Remote Sensing, Remote Sensing, Sensors, Journal of Applied Remote Sensing, and the International Journal of Remote Sensing*. In recognition for his accomplishments in remote sensing, he recently received the Florida Surveying and Mapping Society Professional Excellence Award (2022), North American Colleges and Teachers of Agriculture Teaching Scholar Award (2022), and the UF College of Agricultural and Life Sciences 2022 Graduate Teacher/Advisor of the Year Award.

Abd-Elrahman is very active in ASPRS. In addition to teaching ASPRS workshops in object-based image analysis and machine and deep learning image classification, he has organized technical sessions and served as a panelist at several ASPRS conferences, served as the ASPRS Remote Sensing Application Division Director (2021–2023) and the ASPRS Education and Professional Development Committee Chair (2020–2023), and will become the ASPRS Vice-President at the 2023 Annual Conference.


Outgoing ASPRS President Chris Parrish presenting the ASPRS Fellow Award to Prasad Thenkabail.

**Prasad Thenkabail**

Dr. Prasad S. Thenkabail is recognized for his contributions to remote sensing science and his long-term commitment to the Society. Thenkabail is a leader in advancing remote sensing science and has been an exemplary presence in the global stage working in more than 25 countries.

Thenkabail is a Senior Scientist with the United States Geological Survey Western Geographic Science Center.

He conducts high impact research while being involved in applied research and remote sensing applications of great practical importance, including working for three International Institutes. Thenkabail has 146 peer-reviewed journal publications and has edited 9 books including the three-volume *Remote Sensing Handbook, Hyperspectral Remote Sensing of Vegetation*, and *Remote Sensing of Global Croplands for Food Security*. He received B.E. and M.E. degrees in civil engineering and hydraulics and water resources engineering, respectively, from Mysore University, India, and a Ph.D. in Agricultural Engineering from The Ohio State University. Thenkabail is Editor-in-Chief for *Remote Sensing,* an Associate Editor for *Photogrammetric Engineering and Remote Sensing* (*PE&RS*), chaired the International Society of Photogrammetry and Remote Sensing (ISPRS) Working Group VII (2013–2016), and is an editorial advisory board member for the ISPRS *Journal of Photogrammetric Engineering and Remote Sensing*. He also served as a member of the Landsat Science Team (2007–2011).

Thenkabail is an expert in remote sensing science with major contributions in hyperspectral data analysis and global food security support analysis data. Thenkabail pioneered original novel methodologies of hyperspectral data analysis of crops including development of full spectral analysis using such methods as quantitative spectral matching techniques, establishing optimal hyperspectral narrowbands that remove band redundancies to use ~20 to 30 optimal bands for the study of agriculture and vegetation, and creating new and unique hyperspectral vegetation indices. Thenkabail's work on global food security support analysis data led to production of the world's highest resolution global cropland product using multi-year Landsat 30 m data.

Thenkabail has been a member of ASPRS since 1988, an associate editor of *PE&RS* since 2017, has published award-winning papers in *PE&RS* (1994 Autometric Award as first author; 2008 ASPRS ERDAS award for best scientific paper in remote sensing as first author, 2018 ASPRS Davidson President's Award for practical papers as second author), and edited special issues for *PE&RS*.

**Purpose:** Started in 1992, the designation of Fellow is conferred on Society members who have been active for a total of at least ten years and who have performed exceptional service in advancing the science and use of the mapping sciences and related disciplines. It is awarded for professional excellence and for service to the Society.

**Donor:** ASPRS. The ASPRS Fellow Award includes a lapel pin and a certificate.

## The Estes Memorial Teaching Award

**2023 recipients: Randolph "Randy" Wynne and Timothy Warner**


Outgoing ASPRS President Chris Parrish presenting the Estes Memorial Teaching Award to co-recipient Randolph "Randy" Wynne.

**Randolph "Randy" Wynne**

Dr. Randolph H. Wynne is a Professor in the Forest Resources and Environmental Conservation Department at Virginia Tech. He also serves as a member of the Landsat Science Team and Co-Director of the Interdisciplinary Graduate Education Program in Remote Sensing. He teaches courses focused on the environmental and natural resources applications of remote sensing at the freshman, senior, and graduate levels. Wynne's research interests are in the applications of remote sensing to forestry, natural resource management, ecosystem ecology, and earth system science.

Wynne is a highly knowledgeable, dynamic, and engaging teacher. His impact on the field of remote sensing in higher education has been profound, and he has made contributions in many ways. These include undergraduate teaching, undergraduate research and career mentorship, graduate teaching and mentorship (and faculty mentorship), undergraduate and graduate curriculum development, professional engagement, and research leadership. Through his classes, he has directly taught thousands of students, and through the professional academic success of some of his graduate students (and their subsequent teaching programs) he has indirectly impacted many more. He is also the co-author of an undergraduate textbook that is used domestically and internationally at numerous schools with over 40,000 copies in print.

Wynne is energetic, generous with his time, highly knowledgeable, rigorous in his expectations, passionate about the subject, fast thinking and able to draw his

students into eager participation with course material. Student testimonials demonstrate that Wynne is well respected by his students. While he is very cutting-edge in his knowledge of emerging trends in the remote sensing community, he also has a good understanding of the practical needs of the professional forestry community, and as such is able to relate to a broad umbrella of students in our department. In addition to classroom teaching, Wynne has mentored 15 M.S. and 14 Ph.D. students, and 4 post-docs. His graduate students have gone on to faculty positions at prestigious universities (e.g., University of Georgia, Texas A&M, Rochester Institute of Technology), research scientist positions (e.g., Virginia Tech, and U. Minnesota), federal and state agencies (e.g., USFS, USGS, Oak Ridge National Labs, Montana DNRC, Alaska Div. of Forestry, and Virginia Cooperative Extension), and private companies (e.g., Shell Oil, and Wells Fargo).

Wynne has an impressive research record when measured by external grantsmanship, publication record (with his students in particular), impact factors, or citations. He has won the Society of American Foresters Award in Forest Science (2017), the Virginia Tech College of Natural Resources and Environment Diversity Award (2008), and a NASA New Investigator Award (2001). In work with his students, he has earned First Honorable Mention for the 2005 ASPRS Talbert Abrams Award for best 2004 article in Photogrammetric Engineering and Remote Sensing, Second Place in the ASPRS Leica Geosystems Award for Best Scientific Paper in Remote Sensing in 2006, First Place in the ASPRS ERDAS Award for Best Scientific Paper in Remote Sensing in 2008, and the High Performance Computing Best Paper Award in the 2011 Spring Simulation Multiconference, Boston, Massachusetts.

Wynne's students benefit by being taught by a well respected and well connected leader in the discipline. His teaching efforts will have a long standing impact on the profession of remote sensing as a result of the well trained and motivated students that he has prepared and launched into successful careers across the field.




Outgoing ASPRS President Chris Parrish presenting the Estes Memorial Teaching Award to co-recipient Timothy Warner.

**Timothy Warner**

Dr. Timothy A. Warner is a Professor Emeritus in the Department of Geology and Geography at West Virginia University (WVU). Warner taught at all levels from introductory to post-doctoral, in the disciplines of both geology and geography for over a quarter of a century. He also maintained a rigorous schedule of service and high research productivity. Warner's research interests include the spatial properties of remotely sensed images, lidar, high spatial resolution imagery, thermal imagery, machine learning classification, wildfire mapping, and information literacy with a particular interest in the use of remote sensing for promoting transparency and non-proliferation.

Warner is recognized as an exceptional teacher for the incredible kindness, generosity, and support he gave his students at WVU. He typically taught an annual Physical Geography course to more than 200 students alongside his introductory and advanced remote sensing courses. Student appreciation for Warner's teaching stemmed from both his creative style of teaching and the evolution of his courses to reflect changes within the discipline. Warner updated parts of his courses, or created entirely new courses, to ensure relevance of the material.

Warner mentored seven PhD students, five geology MS students, twenty-six geography MA students, and two post-doctoral researchers. He received the Outstanding Teacher Award in the Eberly College of Arts and Sciences at WVU, was a finalist for the West Virginia (the entire state) professor of the year, and earned the AmericaView Lifetime Achievement Award in 2019. In addition to classroom instruction, Warner also taught professional development courses and workshops for the International Atomic Energy Agency and the US Natural Resource Conservation Service, and held many scientific writing and publishing workshops.

He was also one of the originators of AmericaView, a nationwide remote sensing education, outreach, and research consortium and the PI for West Virginia View. AmericaView and West Virginia View have a strong focus in remote sensing, earth science, and geospatial education at the K-12, undergraduate, graduate, and professional levels.

While maintaining excellence in teaching and mentorship, Warner also served as an associate editor on editorial boards and, until recently, was editor-in-chief of the International Journal of Remote Sensing. He also received two Fulbright Scholarships to study and teach abroad. He published two books and has authored more than one-hundred peer-reviewed academic publications, many of which being co-authored or led by his students. Warner has an outstanding record as a scholar, mentor, and teacher who has made immense and long lasting contributions towards geographic education.

**Purpose:** To recognize individual achievement in the promotion of remote sensing and geographic information systems (GIS) technology and applications through educational efforts.

**Donor:** ASPRS with funding provided by the ASPRS Foundation and ASPRS. The Estes Memorial Teaching Award is made in honor of Professor John E. ("Jack") Estes, teacher, mentor, scientist, and friend of ASPRS. The award consists of a presentation plaque and a cash award of $3,000.

## The ASPRS Lifetime Achievement Award

**2023 recipients: James Campbell and Riadh Munjy**

**James Campbell**

Dr. James Campbell is a Professor in the Department of Geography at Virginia Tech. Campbell has pursued a career in geography, remote sensing, and spatial analysis through teaching, research, and community outreach. He has worked closely with students and faculty in forestry, geology, agronomy, and environmental sciences.

As a native of Vermont, Campbell attended local schools, then Dartmouth College, before joining the U.S. Army. Campbell graduated from several service schools in the military and spent two years as an Aerial Survey Officer/ Photogrammetrist. After completing his military service, he enrolled in a Master of Science degree at the University of Kansas. He subsequently studied at the University of Nottingham in Britain before returning to the University of Kansas to complete his doctoral degree. In spring 2003, Campbell studied at the University of Rennes (France) as a guest faculty.

Campbell's recent interests focus on analysis of sequential imagery to examine human and environmental change in agricultural landscapes. His teaching has been devoted to developing student interests and skills in remote sensing, geomorphology, and spatial data analysis. Campbell is author of a leading remote sensing text, now in its 6th edition, and numerous refereed journal articles. He has successfully advised doctoral students who made significant research contributions in a wide range of journals, including *Remote Sensing, Urban Agriculture*, and *Forest Fragmentation*.

Campbell has been a long term contributor to ASPRS, including extensive committee service, and organization of a popular series of concise videos introducing topics such as aerial photography, lidar, and related topics. He was recognized by ASPRS with an Outstanding Service Award in 1994 and the Esri Award for Best Scientific Paper in Geographic Information Systems in 2016. Campbell was also recognized as an ASPRS Fellow in 1996 and received the SAIC Estes Memorial Teaching Award in 2014. Campbell has also been recognized by many other organizations. He was recognized with an AmericaView Lifetime Achievement Award, a Burr & Burton Academy Alumni Achievement Award, Virginia Tech's Alumni Award for Excellence in Undergraduate Academic Advising, an Outstanding Scholar in Geography from the Virginia Social Science Association, and an outstanding Service Medal from the Remote Sensing Specialty Group of the Association of American Geographers.

**Riadh Munjy**

Dr. Riadh Munjy is a Professor of Civil and Geomatics Engineering at California State University, Fresno (Fresno State). Munjy received a Master of Science in Civil Engineering in 1979, a Master of Science in Applied Mathematics in 1981, and a Ph.D. in Civil Engineering in 1982, all from the University of Washington. He has been a faculty member and an active researcher at Fresno State since 1982, attaining the rank of Professor in 1988. Munjy served as the Fresno State Geomatics Program Coordinator from 2012–2014, and the Chair of the Department of Civil and Geomatics Engineering from 2014–2022.

As a professor, Munjy has supervised hundreds of students studying in the field of geomatics, published numerous peer-reviewed papers in a wide range of technical journals in the field of photogrammetry. Munjy has over forty years of experience teaching courses in photogrammetry, GIS digital mapping, surveying and mapping, computer programming, and civil engineering. He has taught undergraduate and graduate students and has also provided workshops on diverse topics including interferometric radar mapping, GPS-controlled aerial triangulation, and close range photogrammetry.

Throughout his career, Munjy has served as a consultant to numerous national and international organizations, providing a diverse range of expertise in mapping and photogrammetry including software to support radar flight planning, orthorectification, and image management, specifications for GIS workstations, and software to

support photogrammetric adjustment and total station survey systems. Munjy's research interests are varied and include accident reconstruction using photogrammetry, close range and softcopy photogrammetry, and UAS mapping. He is a licensed civil engineer in California and a Certified Photogrammetrist. He has served as the chief scientist at CalGIS, Inc., Earth Data International, Inc., and Geomatics Technologies, LLC working on the development of the GeoSAR System. Munjy received the ASPRS Photogrammetric Fairchild Award in 2014 for his contribution to the science and art of photogrammetry in particular his work with camera self-calibration that led to the transition from conventional aerial triangulation to airborne-controlled aerial triangulation. Munjy is also credited with the introduction of the finite element approach for sensor calibration in photogrammetry, the introduction of an analytical approach to color balancing and enhancement of digital imagery, and the development of a full processing workflow for the GeoSAR system.

Munjy has been a long term supporter of ASPRS, providing service on multiple committees, serving as a *PE&RS* Associate Editor for theoretical and applied photogrammetry, and serving as the President of Pacific Southwest Region of ASPRS. In addition to the Photogrammetric Fairchild award, ASPRS presented Munjy with multiple meritorious service awards and he was named as a Fellow in 2020. Munjy has also been recognized by many other organizations including receiving a Faculty Award for Research Excellence at Fresno State four times, a Caltran Research Innovation Award, and the Halliburton Research Award .Munjy is an outstanding professional photogrammetrist whom the Society recognizes with the Lifetime Achievement Award for his excellent and far reaching achievements.

The ASPRS Lifetime Achievement Award (formerly the Honorary Lifetime Achievement Award and the Honorary Member Award) is the highest award an ASPRS member can receive, and there are only 25 living Lifetime Achievement Awardees of the Society at any given time. Candidates are chosen by a Nominating Committee made up of the past five recipients of the award and chaired by the most recent recipient.

**Purpose:** Initiated in 1937, this life-time award is given in recognition of individuals who have rendered distinguished service to ASPRS and/or who have attained distinction in advancing the science and use of the geospatial information sciences. It is awarded for professional excellence and for at least 20 years of service to ASPRS and consists of a plaque and a certificate.

**Donor:** ASPRS

## ASPRS Photogrammetric Award (Fairchild)

**2023 recipient: John Dolloff**


ASPRS President Chris Parrish presenting the ASPRS Photogrammetric Award (Fairchild) to John Dolloff.

John Dolloff has over 40 years of experience in geospatial science and remote sensing, specializing in photogrammetry and applications of advanced linear algebra, estimation theory, and probability and statistics. He is currently employed as a senior scientist at KBR and was previously employed at BAE Systems and its legacy companies where he was a Technical Director and an Engineering Fellow. He holds a Bachelor's degree in Mathematics and a Master's degree in Applied Mathematics.

Dolloff invented the Replacement Sensor Model (RSM) and the Metric Information Network (MIN). RSM is operational today and provides full functionality (ground-to-image relationship, adjustability, predicted accuracy) equivalent to an arbitrary but original (physical) sensor model from which it is generated. As such, a "down-stream" user only requires the use of one sensor model (RSM) for exploitation of those imaging systems that provide corresponding RSM support data. The MIN sequentially fuses information from various image block adjustments into a self-generating and expanding network of ground control points that generally increases in area of coverage and that also increases in accuracy. The network also includes a rigorous full error covariance matrix for all points, including the cross-covariances (correlations) between all point pairs.

Dolloff's experience in the earlier phase of his career concentrated on tracking and navigation systems and aided his insight into future photogrammetric applications. In particular, he supported the development of Phases 0 and I of the NAVSTAR GPS system, including the design and implementation of algorithms that controlled and synchronized pseudo-lite time bases (or clocks) to each other

in real-time and to initial GPS satellites as they became available – transitioned to be operational at the Inverted Range Control Center, Yuma Proving Grounds, for the testing of early GPS receivers. Dolloff also designed and implemented numerous Kalman Filters for the real-time tracking of vehicles, ships, and aircraft for other navigation systems.

**Purpose:** The Photogrammetric Fairchild Award is designed to stimulate the development of the art of aerial photogrammetry in the United States. Practicability is the essence of the Award and is the basis for the review of all candidates.

**Donor:** ASPRS. The award consists of an engraved presentation plaque.

## The ASPRS Outstanding Technical Achievement Award

**Not awarded this year**

**Purpose:** This grant is designed to reward the developer[s] of a specific breakthrough technology that causes quantum advances in the practice of photogrammetry, remote sensing or geographic information systems in the United States.

**Donor:** In 2011, the ASPRS Foundation received a generous individual donation from Lifetime Achievement Awardee and ASPRS Fellow Clifford W. Greve to endow a new Outstanding Technical Achievement Award. The Award was first given in 2012 and is fully endowed at the $8,000 level. This Award consists of a silver presentation plaque mounted on a wood panel and a check for $8,000.

## The International Educational Literature Award (IELA)

**Not awarded this year**

**Purpose:** to improve the quantity and quality of the literature in the library of the recipient Institution that deals with the mapping sciences (i.e., photogrammetry, remote sensing, GIS, and related disciplines).

**Donor:** ASPRS. The Award consists of the following: A set of manuals published by ASPRS; A five-year e-subscription to Photogrammetric Engineering & Remote Sensing; Proceedings of the annual conference for a five-year period.

## George E. Brown, Jr. Congressional Honor Award

**Not awarded this year**

**Purpose:** This award was established in honor of Congressman George E. Brown, Jr., and the contributions he made to advance the benefits of imagery and geospatial information to society. The award is given periodically to recognize members of the U.S. Congress whose leadership and personal efforts have advanced the science, engineering, application, education, and commerce of imaging and geospatial information.

**Donor:** ASPRS

# Annual Business Meeting and Installation of Officers

## Recognition of Retiring Council Chairs
David Stolarz, Committee Chairs Council
Madeline Stewart, Early Career Professional Council
Lauren McKinney-Wise, Student Advisory Council

## Installation of New Council Chairs
Youssef Kaddoura, Early Career Professional Council
Oscar Duran, Student Advisory Council

## Recognition of Retiring Division Directors
Greg Stensaas, Primary Data Acquisition Division
Amr Abd-Elrahman, Remote Sensing Applications Division

## Installation of New Division Directors
Srini Dharmapuri, Primary Data Acquisition Division
Tao Liu, Remote Sensing Applications Division

## Installation of New Division Assistant Directors
Ravi Soneja, Primary Data Acquisition Division
Matt Elious, Professional Practice Division
Indu Jeyachandran, Remote Sensing Applications Division

## Recognition of Retiring President
Jason Stoker, Immediate Past President

## Installation of Officers
Amr Abd-Elrahman, Vice-President
Bandana Kar, President-Elect
Lorraine Amenda, President

## Presentation of Birdseye Citation and President's Key to Retiring President
Lorraine Amenda
Christopher Parrish, Immediate Past-President

**Purpose:** The Col. Claude H. Birdseye President's Citation was established in 1965 as a tribute to one of the founders and the first president of the Society. Each year at the Annual Convention it is conferred on the outgoing president in recognition of her/his contributions to the Society.

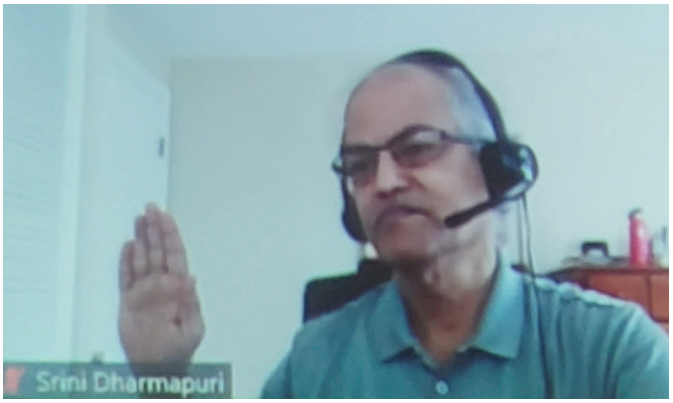
**Donor:** ASPRS. The Birdseye Citation carries with it a gold Past President's Key, and a certificate. The retiring President will also receive the Presidential Gavel mounted on a walnut plaque.

Amr Abd Elrahman is sworn in as ASPRS Vice President

Chris Parrish is sworn in as ASPRS Immediate Past-President by President Lorraine Amenda

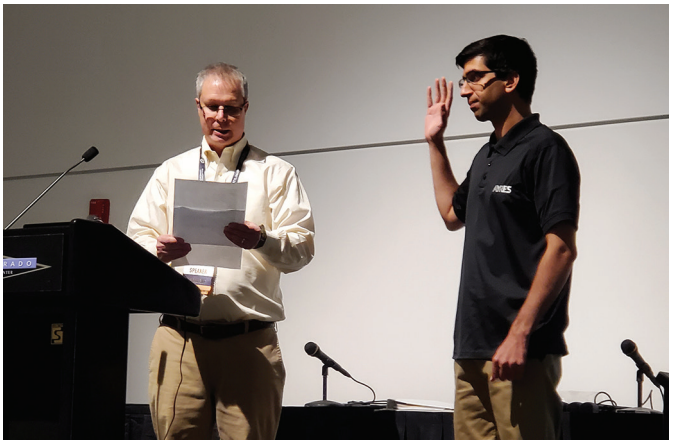
President Amenda presents Immediate Past-President Parrish with the ASPRS Birdseye Medal

Youssef Kaddoura is sworn in as the Early-Career Professional Council Chair




Srini Dharmapuri sworn in as Primary Data Acquisition Division Director


Tao Liu sworn in as Remote Sensing Applications Division Director



Ravi Soneja sworn in as Primary Data Acquisition Division Assistant Director


Indumathi Jeyachandran sworn in as Remote Sensing Applications Division Assistant Director.


Amanda Aragon is sworn in as the Committee Chairs Council Chair.

# **SUSTAINING**MEMBERS

**ACI USA Inc.**
Weston, Florida
https://acicorporation.com/
*Member Since: 2/2018*

**Aerial Services, Inc.**
Cedar Falls, Iowa
www.AerialServicesInc.com
*Member Since: 5/2001*

**Airworks Solutions Inc.**
Boston, Massachusetts
*Member Since: 3/2022*

**Applanix**
Richmond Hill, Ontario, Canada
http://www.applanix.com
*Member Since: 7/1997*

**Ayres Associates**
Madison, Wisconsin
www.AyresAssociates.com
*Member Since: 1/1953*

**Cardinal Systems, LLC**
Flagler Beach, Florida
www.cardinalsystems.net
*Member Since: 1/2001*

**CT Consultants**
Mentor, Ohio
*Member Since: 3/2022*

**Dewberry**
Fairfax, Virginia
www.dewberry.com
*Member Since: 1/1985*

**Esri**
Redlands, California
www.esri.com
*Member Since: 1/1987*

**GeoCue Group**
Madison, Alabama
http://www.geocue.com
*Member Since: 10/2003*

**Geographic Imperatives LLC**
Centennial, Colorado
*Member Since: 12/2020*

**GeoWing Mapping, Inc.**
Richmond, California
www.geowingmapping.com
*Member Since: 12/2016*

**GPI Geospatial Inc.**
Orlando, Florida
www.aca-net.com
*Member Since: 1/1994*

**Halff Associates, Inc.**
Richardson, Texas
www.halff.com
*Member Since: 8/2021*

**Keystone Aerial Surveys, Inc.**
Philadelphia, Pennsylvania
www.kasurveys.com
*Member Since: 1/1985*

**Kucera International**
Willoughby, Ohio
www.kucerainternational.com
*Member Since: 1/1992*

**L3Harris Technologies**
Broomfield, Colorado
www.l3harris.com
*Member Since: 6/2008*

**Merrick & Company**
Greenwood Village, Colorado
www.merrick.com
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# Automatic Satellite Images Orthorectification Using K–Means Based Cascaded Meta-Heuristic Algorithm

**Oussama Mezouar, Fatiha Meskine, and Issam Boukerch**

## Abstract

*Orthorectification of high-resolution satellite images using a terrain-dependent rational function model (RFM) is a difficult task requiring a well-distributed set of ground control points (GCPs), which is often time-consuming and costly operation. Further, RFM is sensitive to over-parameterization due to its many coefficients, which have no physical meaning. Optimization-based meta-heuristic algorithms appear to be an efficient solution to overcome these limitations. This paper presents a complete automated RFM terrain-dependent orthorectification for satellite images. The proposed method has two parts; the first part suggests automating the GCP extraction by combing Scale-Invariant Feature Transform and Speeded Up Robust Features algorithms; and the second part introduces the cascaded meta-heuristic algorithm using genetic algorithms and particle swarm optimization. In this stage, a modified K-means clustering selection technique was used to support the proposed algorithm for finding the best combinations of GCPs and RFM coefficients. The obtained results are promising in terms of accuracy and stability compared to other literature methods.*

## Introduction

Nowadays, accurate spatial information from satellite images is necessary for a wide range of remote sensing applications such as image matching, image registration, and mapping. Taking into consideration the rotation and curvature of the Earth, ground topography, sensor motion, and platform destabilization, the accurate spatial information depicts the Earth's three-dimensional surface (ground space) in a two-dimensional satellite image (image space). As a result, the internal and exterior geometric distortions are shown in raw remote sensing images, which necessitates adopting effective mapping models between image and Earth spaces for geometric correction (Kartal *et al.* 2018). In this regard, careful and accurate orthorectification is usually needed to georeference the satellite images. Orthorectification is a common technique for rectifying geometric distortions and displacement errors caused during the image acquisition process. It comprises geometric transformations between the image coordinate (row, column) and ground coordinate systems (longitude, latitude, and elevation).

There are two categories of transformation models: rigorous (sensor dependent) models, such as Orbital Parameter Models (Toutin 2004), and empirical (non-rigorous or also sensor independent) models, such as Rational Function Models (Tao and Hu 2001; Hu *et al.* 2004; Mezouar *et al.* 2021). The rigorous method is implemented using detailed information about the internal characteristics of the acquisition system, including sensor parameters, Charged Coupled Device (CCD) alignment within the focus plane, and offset angles with respect to the payload cube normal, all of which are well-known to the creator of the satellite (Konugurthi *et al.* 2016). Thereby, the main difficulty with using High-Resolution Satellite Images (HRSI) in rigorous models is that certain providers, like GeoEye, are unwilling to share the physical satellite parameters such as ephemeris data and interior orientation parameters (Yavari *et al.* 2012; Pan *et al.* 2016). Moreover, these models are difficult to perform in real applications because they are complex, and the imaging model might change depending on the sensor type (Boccardo *et al.* 2007). Contrarily, the Rational function model (RFM) is a type of empirical model frequently used in HRSI processing as an alternative to the rigorous model. RFM has been widely used in the remote sensing community owing to its simplicity of implementation and standardization; also, it is independent of image geometry and may be used with a variety of sensors with great results (Pan *et al.* 2016; Chen *et al.* 2006; Fraser and Hanley 2003). RFM is defined as a ratio of two cubic functions used to establish a relationship between object-space coordinates and image-space coordinates (Xiong and Zhang 2010).

There are two different computational models for RFM, namely terrain-independent and Terrain-dependent (Jannati and Valadan Zoej 2015). The unknown RFM coefficients, known as Rational Function Coefficients (RFCs) or Rational Polynomial Coefficients (RPCs), are estimated in the terrain-independent model using some physical information of the sensor as the attitude and orbital parameters, whereas they are calculated using numerous of well-distributed ground control points (GCPs) in the terrain-dependent model (Mezouar *et al.* 2021). In this case, to simplify the computations with the conventional RFM-based method, the first coefficients of the denominator polynomials are assumed to equal 1. As a result, there are 78 unknown RPCs, meaning that, to apply the traditional RFM-based method, at least 39 GCPs must be available. This concept suffers from an over-parameterization problem that requires a significant number of well-distributed GCPs to be determined, which is an explicit limitation because identifying acceptable GCPs is a time-consuming and expensive process (Gholinejad *et al.* 2019a). Moreover, the characteristics of the study areas and other difficulties in GCP selection, such as cloudy regions, dense forest areas, and certain difficult-to-reach places, the GCPs identification could be limited (Nguyen 2015). Developed automated methods for GCPs selection using image matching algorithms may be the best choice for getting GCPs and overcoming these limitations when the time cost and mistakes associated with manual processing are taken into account, especially where the access to satellite images has been simpler due to the availability of numerous sensors with varying resolutions, numbers, and sizes of images (Kartal *et al.* 2018), which has significantly risen the use of image matching techniques in GCPs selection and remote sensing applications as Harris in (Bentoutou *et al.* 2005; Misra *et al.* 2012), Speeded Up Robust Features (SURF) (Teke and Temizel 2010; Wang *et al.* 2019), and Scale Invariant Feature Transform (SIFT) (Huo *et al.* 2011; Ye *et al.* 2018).

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# UAS-Based Multi-Temporal Rice Plant Height Change Prediction

Yuanyang Lin, Jing He, Gang Liu, Biao Mou, Bing Wang, and Rao Fu

## Abstract

*Analyzing rice growth is essential for examining pests, illnesses, lodging, and yield. To create a Digital Surface Model (DSM) of three important rice breeding stages, an efficient and fast (compared to manual monitoring) Unoccupied Aerial System was used to collect data. Outliers emerge in DSM as a result of the influence of environment and equipment, and the outliers related to rice not only affect the extraction of rice growth changes but are also more challenging to remove. Therefore, after using ground control points uniform geodetic level for filtering, statistical outlier removal (SOR) and quadratic surface filtering (QSF) are used. After that, differential operations are applied to the DSM to create a differential digital surface model that can account for the change in rice plant height. Comparing the prediction accuracy before and after filtering: $R^2$ = 0.72, RMSE = 5.13cm, nRMSE = 10.65% for the initial point cloud; after QSF, $R^2$ = 0.89, RMSE = 2.51cm, nRMSE = 5.21%; after SOR, $R^2$ = 0.92, RMSE = 3.32cm, nRMSE = 6.89%. The findings demonstrate that point cloud filtering, particularly SOR, can increase the accuracy of rice monitoring. The method is effective for monitoring, and after filtering, the accuracy is sufficiently increased to satisfy the needs of growth analysis. This has some potential for application and extension.*

## Introduction

With two-thirds of China's urban and rural residents relying on rice as their food ration, ensuring food security is of importance to people's lives. Even more difficulties for food production are posed by deteriorating quality of arable land, water scarcity, and climate change. In order to preserve our food security and maintain the ecological balance between humans and nature, prompt and accurate access to the size of rice production is necessary (Yu *et al.* 2016). A crucial component of precision agriculture is quick and precise access to information about crop development, which aids in crop management decisions, risk assessment, and also makes up for the manpower shortage (Guo *et al.* 2015; Gil-Docampo *et al.* 2020; Tang *et al.* 2020). Due to the need for crop growth surveys to collect data on rice growth, field monitoring of the crop during the growing season is essential. Traditional manual crop growth monitoring techniques, such as measuring crop height with a steel ruler or gathering data on crop development with various handheld tools, could endanger the crop. Additionally, the workload is heavy and ineffective, and varying measuring requirements among different measurers may have an impact on accuracy and decrease productivity (Li *et al.* 2015; Jimenez-Berni *et al.* 2018). It can greatly raise the cost, particularly when crops are cultivated over large regions or monitored in places that are difficult to access (Chang *et al.* 2011). Rice growth can only be predicted on a large scale at the national, provincial, and county levels due to low resolution and cloud cover occlusion in satellite imaging. This is especially true for hilly areas in southern China where the accuracy of satellite imaging is insufficient for monitoring changes in rice growth height (Matese *et al.* 2015; Cen *et al.* 2019). Although ground-based systems (like lidar) can quickly capture dense point clouds with high accuracy for target features, the cost of three-dimensional (3D) laser scanners restricts precision agricultural research and production. Unoccupied aerial vehicle platforms and sensor prices have dramatically dropped over the past few years, making it possible to obtain remote sensing data with improved spatial and temporal resolution (Candiago *et al.* 2015; Burkart *et al.* 2018). Unoccupied Aerial System (UAS) are more versatile, easier to use, and have higher spatial resolution than satellites for crop monitoring. They can produce high-resolution data products and gather a variety of information about crops, making it simple for farmers to keep an eye on and manage their crops (Rasmussen *et al.* 2016; Zhou *et al.* 2017).

Among the many phenotypic traits derived from UAS, crop height is a key predictor of crop evapotranspiration, yield, biomass, and health as well as its resilience to pests and overturning (Olson and Anderson 2021). Crop height can be extracted using products made from high-resolution photos captured by UAS. Matese *et al.* (2017) collected vineyard photos with a UAS equipped with a high-resolution digital camera and created digital terrain model (DTM) to determine the height of the grape plants. Ziliani *et al.* (2018) used a fixed-wing UAS to capture Red-Green-Blue photos of crops and create a Digital Surface Model (DSM) to determine crop canopy height, while Bendig *et al.* (2014) used multi-temporal Crop Surface Models (CSMs) to extract barley plant height. However, due to weather conditions and system equipment errors, computer-generated point clouds can have non-geomorphic anomalous point clouds, also called outlier point clouds. Outlier point clouds are classified into three categories: isolated outliers, isolated and clustered outliers, and randomly distributed outliers close to the objects and/or ground (Zeybek 2021b). Outlier point clouds, particularly the third one, can influence crop height extraction accuracy, but manual extraction and removal of outlier clouds based on experience are time-consuming and expensive, so automatic identification and removal of outlier points can extract plant height more quickly and accurately. The point clouds were filtered by Zeybek and Şanlıoğlu (2019) using four filtering algorithms, and the results demonstrate that these semi-automatic filtering procedures achieved a desirable accuracy in comparison to the operator accessibility of complex area filtering and time reduction with automation.

This study used a consumer-grade UAS to gather remote sensing data on rice in Qingbaijiang, Sichuan, China, during crucial developmental stages in order to construct high-precision digital orthophoto maps (DOM) and DSM (Lear 1997). Fewer studies have examined the removal of outlier point clouds from feature surfaces, despite the fact that numerous studies have concentrated on crop height extraction. In this study, the ground control points (GCP) is used to geographically align the images of each phase to ensure that all data are on the same geoid. Statistical outlier removal (SOR) and quadratic surface filtering (QSF) filtering were used to remove the outlier point clouds, and finally the extraction accuracy of rice plant height change values before and after

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# Spherical Hough Transform for Robust Line Detection Toward a 2D–3D Integrated Mobile Mapping System

**Daiwei Zhang, Bo Xu, Han Hu, Qing Zhu, Qiang Wang, Xuming Ge, Min Chen, and Yan Zhou**

## Abstract

*Line features are of great importance for the registration of the Vehicle-Borne Mobile Mapping System that contains both lidar and multiple-lens panoramic cameras. In this work, a spherical straight-line model is proposed to detect the unified line features in the panoramic imaging surface based on the Spherical Hough Transform. The local topological constraints and gradient image voting are also combined to register the line features between panoramic images and lidar point clouds within the Hough parameter space. Experimental results show that the proposed method can accurately extract the long strip targets on the panoramic images and avoid spurious or broken line-segments. Meanwhile, the line matching precision between point clouds and panoramic images are also improved.*

## Introduction

The Vehicle-Borne Mobile Mapping System, equipped with panoramic cameras, laser scanners, access to the Global Positioning System, and an Inertial Measurement Unit, has been widely used for highway inventory (Cui *et al.* 2016; Hussnain *et al.* 2021; Puente *et al.* 2013). The data acquired from these systems integrate rich geometry and spectral information, thus enabling new solutions to the understanding and modeling of roads and their ancillary facilities (Ren *et al.* 2022; Yuan *et al.* 2022). However, considerable misalignment often exists between the panoramic images and the lidar point clouds because of inaccurate pre-calibrated parameters. The main reasons for this misalignment are the unforeseen movement of the independent sensors during relocation and the projection deformation of images (Bao *et al.* 2022). Therefore, the relevant extrinsic parameters must be calibrated manually and frequently, which is laborious. Many studies have explored the use of panoramic cameras and laser scanners (Akca 2010; Alba *et al.* 2011; Cui *et al.* 2016; Zhang and Cui 2022), which can be separated into three categories (Li *et al.* 2018): area-based, multi–view-based and feature-based.

Area-based methods iteratively project the point clouds to the image surface and calculate the statistical correlation between the projected results and the two-dimensional (2D) images, i.e., using mutual information (Miled *et al.* 2016) or grayscale similarity. The relevant extrinsic parameters are then decided by maximizing the statistical correlation. The main problem with such methods is that the correlation between depth information and color information is not significant in many scenes (Wang *et al.* 2012). Because of the difficulties of 2D–three-dimensional (3D) registering between different data models, multi–view-based approaches first generate 3D point clouds from multiple view images and then convert the issue into 3D–3D registration. The main difficulty with such approaches is that the image point clouds are influenced by drift, leading to a non-rigid transformation between the two point clouds (Li *et al.* 2018).

Compared with the above methods, feature-based methods are more efficient and adaptive (Miled *et al.* 2016) and are thus widely used in current applications. In feature-based methods, the key factor is to find the correct matching feature pairs between images and point clouds regardless of the point (i.e., SIFT (Lowe 2004), ASIFT (Morel and Yu 2009)), line (i.e., the Line Segment Detector (LSD) (Von Gioi *et al.* 2008)) or plane features. Because images and point clouds have different modes and dimensions, point-based features may have low consistency or repetition rates, leading to misalignment (Yang and Chen 2015). Plane-based features require regular shaped human-made objects for planar surfaces, such as buildings, which may not be available in scenes such as highways. As a result, line-based methods with high repetition rates and ease of expressing the scene structure have drawn increasing attention (Zhang *et al.* 2008). The problem with feature-based methods is the distortion of panoramic images. For example, a straight line in space appears as a curve on a panoramic image because of image deformation. Current studies mainly deal with this issue via the distortion correction of panoramic images, which limits the corrected image to a specific perspective but decreases matching precision and efficiency.

Figure 1. Distortion of straight lines on a panoramic image of a highway scene.

To address this issue, this work proposes the spherical straight line model, which directly constructs the connection between the 3D straight lines within the Hough space. This work makes two main contributions:

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# Blind and Robust Watermarking Algorithm for Remote Sensing Images Resistant to Geometric Attacks

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## Abstract

*To address the problem of weak robustness against geometric attacks of remote sensing images' digital watermarking, a robust watermarking algorithm based on template watermarking is proposed in this paper, which improves the robustness of digital watermarking against geometric attacks by constructing stable geometric attack invariant features. In this paper, the Discrete Fourier Transform domain template watermark is used as the invariant feature against geometric attacks, and the embedding of the cyclic watermark is used to improve the watermark robustness for recovering the watermark synchronization relationship. To achieve blind extraction of the watermark, a parameter extraction method based on noise extraction is designed. The experimental results demonstrate that the proposed method can effectively improve the robustness of digital watermarking of remote sensing images against geometric attacks. Meanwhile, it can also resist common image processing attacks and compound attacks.*

## Introduction

Remote sensing images are basic strategic resources, which play an important role in land use, environmental protection, military operations, and other fields (Amhar *et al.* 2022). While the development of network technology makes the transmission of remote sensing image data more convenient, it makes the security protection problems such as piracy, leakage, and illegal dissemination of remote sensing image data become increasingly serious (Zhou *et al.* 2015; Singh *et al.* 2021; Yu *et al.* 2019). The emergence of digital watermarking technology provides a powerful solution for remote sensing image data security protection (Zhu 2017; Zhou *et al.* 2020).

Robustness is an important indicator of the capability of digital watermarking algorithms, which means the ability of watermarking algorithms to detect the correct watermark information after being attacked. Currently, scholars have conducted extensive research on how to improve the robustness of digital watermarking algorithms, which has significantly improved the robustness of remote sensing images in terms of filtering, noise, compression, and other attacks (Fu *et al.* 2016; Wang *et al.* 2017). However, for geometric attacks, such as rotating and scaling the remote sensing image to change the image size and position, etc., the watermark information cannot be extracted because it is very easy to destroy the watermark synchronization relationship, i.e., the consistent relationship between the embedding and extracting position in the image. And most of the current remote sensing image data watermarking algorithms are unable to resist geometric attacks. Therefore, how to improve the robustness against geometric attacks has become a key issue in digital watermarking algorithms to security for protect remote sensing image.

Existing watermarking algorithms aiming to resist geometric attacks for remote sensing image data are mainly divided into two categories. The first category is non-blind watermarking algorithms, which require the original data or other relevant information to correct the watermarked image after being attacked. It can recover the watermark synchronization relationship for watermark information detection. For example, Tarhouni *et al.* (2020) store the speeded up robust features (SURF) feature point information of the original image, and during the watermark extraction process, the SURF feature points in the attacked image are extracted, and then matched with the origin points to correct the watermark synchronization relationship. This type of method can accurately recover the relative position relationship between image watermark embedding and extraction by matching the set of image feature points. However, the original information such as image (Lee *et al.* 2020; Mohammed *et al.* 2020), feature points (Li and Zhang 2020), and transform domain coefficients (Dappuri *et al.* 2020) needs to be saved in advance and will be matched from the database with the information to be detected. Therefore, the non-blind watermarking algorithm increases the cost of storage and retrieval, which is not conducive to practical applications.

The second type of algorithm is blind watermarking algorithm, which does not require the original data or other relevant information for watermark detection. It usually maintains the watermark synchronization relationship by mining the invariant features, and uses the relative position relationship, which between the invariant features and the watermark embedding position, to achieve watermark embedding and detection. For example, Hsu and Chen (2016) constructed circular local invariant regions near the filtered feature points and embedded the watermark in the local invariant regions. Due to the invariant property of the feature points, the local invariant feature regions can be recovered by finding the requirement feature points in the attacked images, thus recovering the watermark synchronization relationship. This type of algorithm does not require the original data in the watermark detection process, and the watermark synchronization relationship is recovered based on the invariant information, such as feature points (Wang *et al.* 2011; Keskinarkaus *et al.* 2012), template watermark (Fang *et al.* 2021; Sun *et al.* 2021), and other invariant information, to resist geometric attacks. However, remote sensing images are feature-rich and watermark embedding is based on filtered features which are vulnerable to geometric attack and cannot resist arbitrary geometric attacks.

The above analysis shows that the non-blind watermarking algorithm increases the storage and retrieval costs, because it requires the participation of raw data or other relevant information for watermark detection. The blind watermarking algorithm achieves blind detection by finding the invariant feature to recover the synchronization after the geometric attacks. During the attacks, however, these filtered features

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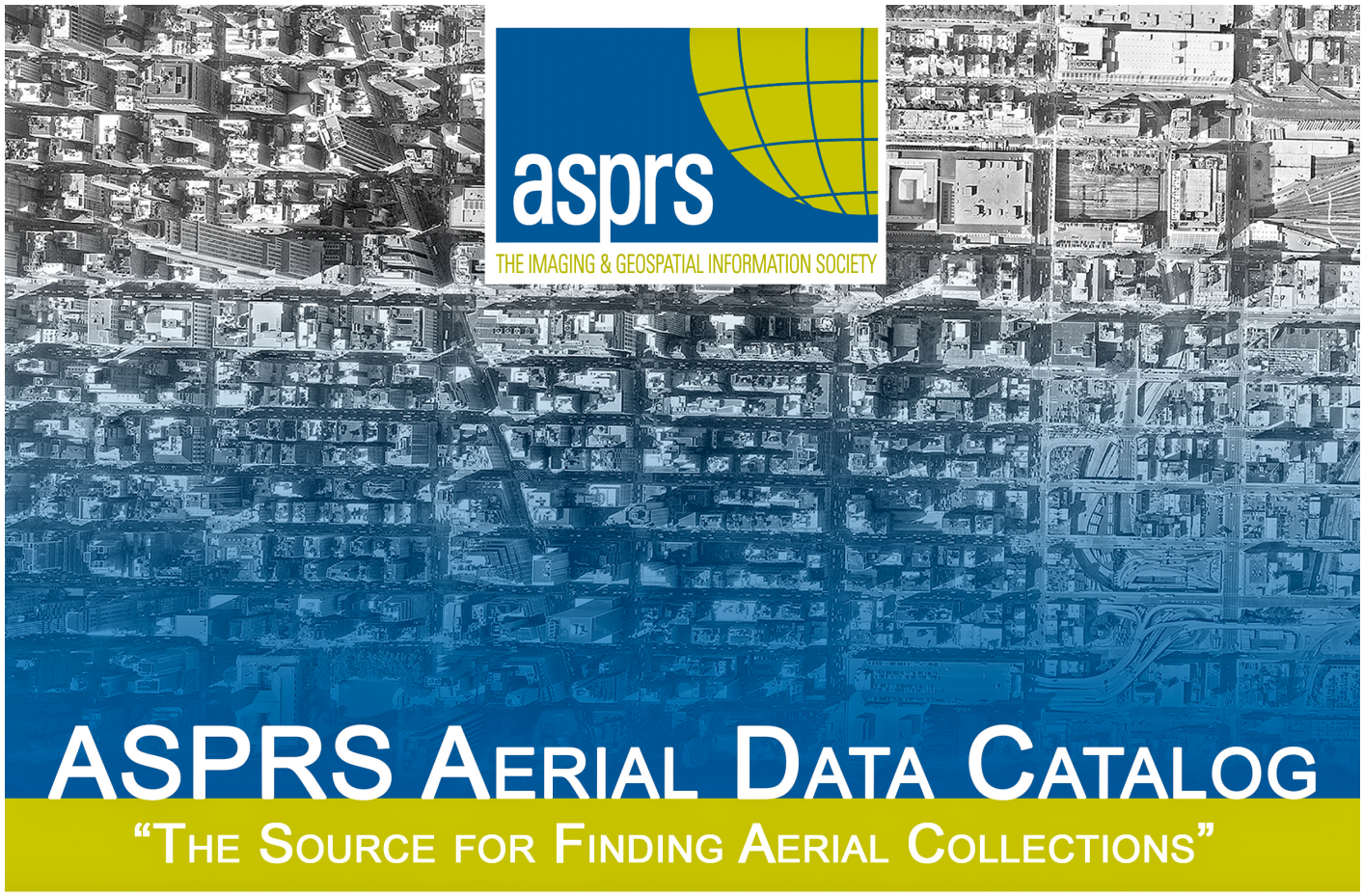

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## For More Details or To Get Involved Contact:

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