PE&RS

September 2024 Volume 90, Number 9

PHOTOGRAMMETRIC ENGINEERING & REMOTE SENSING

The official journal for imaging and geospatial information science and technology

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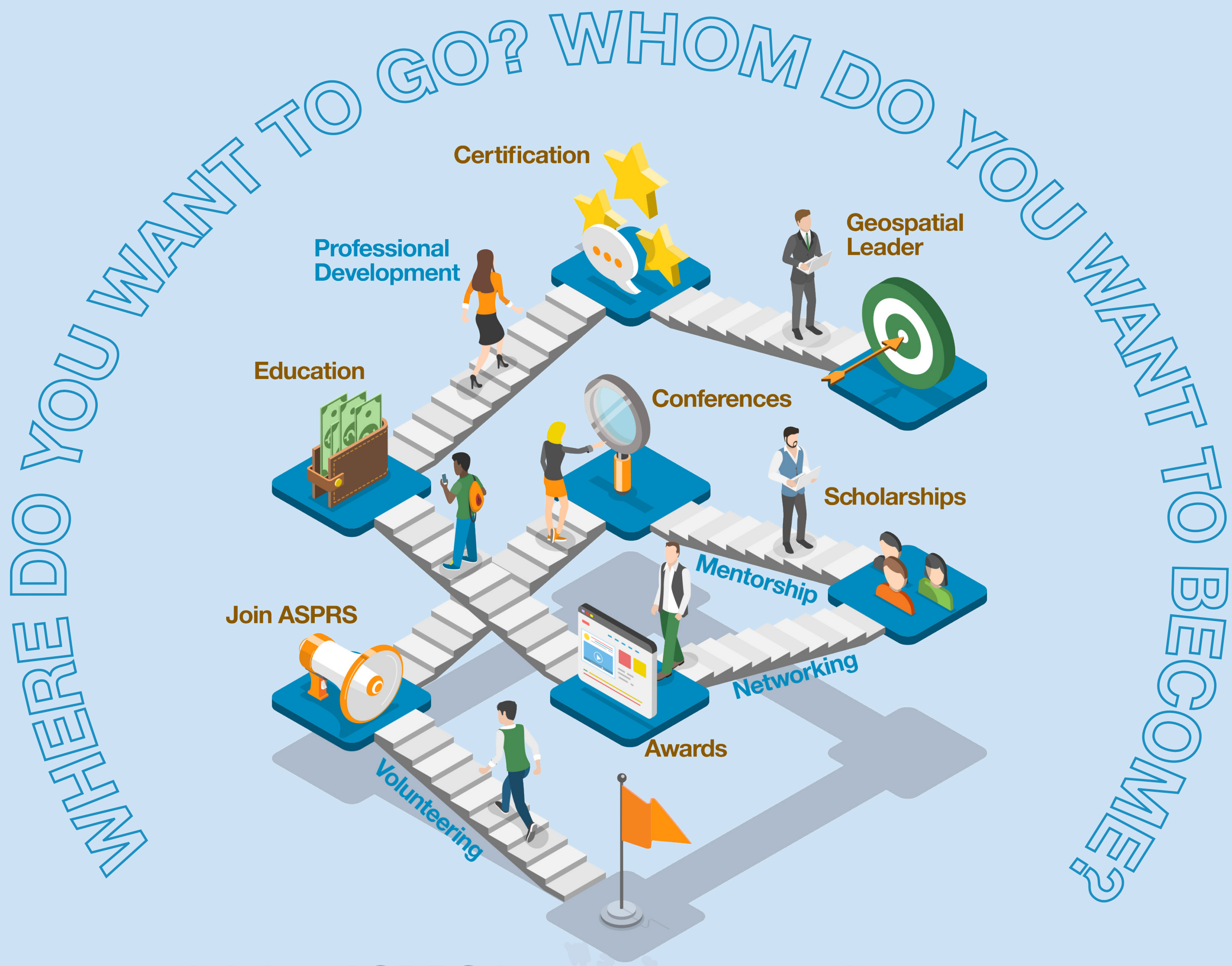

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To have your press release published in *PE&RS*, contact Rae Kelley, rkelley@asprs.org.

ANNOUNCEMENTS

The National Oceanic and Atmospheric Administration has tasked **Woolpert**, https://woolpert.com/, with performing hydrographic survey and collecting bathymetric data in Tangier Sound, Md., under a $6.1 million contract.

The data will update National Ocean Service nautical charting products, which are used for improving the safety of maritime traffic and commerce, and will support commercial fishing, shipping channels, coastal resilience, scientific research, and Seabed 2030.

Seabed 2030 is a collaborative effort between the Nippon Foundation and the General Bathymetric Chart of the Oceans that aims to integrate and share all available bathymetric data to produce a definitive map of the world's ocean floor by 2030. Last year, NOAA tasked Woolpert with collecting data in the Chesapeake Bay Watershed, which included portions of the Potomac, Rappahannock, James, and York Rivers.

Under this contract in Maryland, Woolpert will collect data over 116 square nautical miles in Tangier Sound located in the Chesapeake Bay, the largest estuary in North America. The 64,000-square-mile watershed is heavily trafficked by commercial and recreational vessels used for tourism, fishing, and marine commerce.

"The hydrographic survey data collected under this contract adjoins bathymetric lidar data previously acquired by Woolpert in Tangier Sound," Woolpert Project Manager Ryan Cross said. "This modern, high-resolution bathymetry will help improve the safety of vessel navigation within Tangier Sound, including the Nanticoke and Wicomico Rivers. We are pleased to be providing these surveys for the NOAA Office of Coast Survey throughout this important and interesting survey area."

Cross said the high-resolution multibeam and side-scan sonar data also will be used to detect and map seabed features and archaeologic sites beneficial for fisheries and cultural resource management.

"The data will benefit the USACE Oyster Habitat Preservation and Restoration working group as well as contribute to ongoing underwater archaeological exploration and investigation," Cross said.

The contract is underway and is expected to conclude in November 2024.

SkyFi and **Vexcel**, https://vexceldata.com, Announce Partnership -- Another new partnership is now official, this time between SkyFi and Vexcel. SkyFi works hard to make Earth observation imagery and analytics accessible and more cost-effective with a user-friendly platform. By leveraging partnerships with companies like Vexcel, that has a detailed aerial imagery library in 40+ countries, they are helping increase their customers ability to better understand the world around them.

SkyFi's platform delivers insights across commercial and government sectors, enabling informed decisions and solutions for a wide range of industries. Vexcel's highly accurate data was an ideal fit to add into their mix of solutions so their customers could enhance their visualization opportunities.

Some of the many use cases or industries SkyFi customers can immediately benefit from having access to Vexcel imagery include:

- Insurance
- Disaster Response & Management
- Energy
- Infrastructure Monitoring
- Agricultural Insights
- Finance & Real Estate
- Environmental Monitoring
- Transportation and Mobility

Learn more about this partnership annoucement on SkyFi's company page, https://skyfi.com/.

With wildfires increasing in frequency and severity, a better understanding of what are known as wildland-urban interface (WUI) areas is critical for protecting these ecosystems and their communities. To better inform local fire services and the public about wildfire exposure and fire prone areas, the United States Fire Administration (USFA), a component of Federal Emergency Management Agency (FEMA), has developed two new WUI fire awareness tools. These tools, the WUI Fire Property Awareness Explorer and the WUI Fire Community Awareness Explorer, both leverage data from **Esri**, www.esri.com, the global leader in location intelligence.

Esri's ArcGIS Living Atlas of the World datasets provide the WUI Explorers with spatial insight about where human activity and wildland vegetation intermix. By raising awareness about WUI locations and potential fire susceptibility, these tools support community risk reduction, code adoption and enforcement, mitigation, and planning efforts. Users can identify these particularly vulnerable areas and take proactive measures to reduce their impact.

"One-third of the U.S. population currently lives within the expanding WUI environment, and many do not know the threat they face if there is a fire ignition nearby," said Dr. Lori Moore-Merrell, U.S. Fire Administrator at FEMA. "The USFA awareness tools created using Esri's data and mapping technology will help communities and fire service organizations to understand these unique geographic vulnerabilities so they can better prepare and respond."

The new WUI Fire Awareness tools empower firefighters, emergency managers, and land developers with the information they need to make informed decisions about wildfire mitigation, response, and recovery. Available on a publicly accessible online hub site with maps and analysis users can apply to their own address, the tools provide a comprehensive view of the factors that contribute to WUI exposure and fire prone areas.

The WUI tools use data from FEMA's USA Structures Data and Sentinel-2 Land Cover Data in ArcGIS Living Atlas of the World, giving users access to accurate, up-to date geospatial information. Produced using Esri's Big Data Toolkit, the dataset provides detailed mapping of areas where human activities and wildland vegetation intersect, creating a higher potential for wildfires.

To learn more about how Esri helps agencies like FEMA better inform and prepare communities facing wildfires and other environmental threats, please visit esri.com/en-us/industries/wildland-fire/overview.

Woolpert, https://woolpert.com/, has acquired Murphy Geospatial, a multidisciplinary geospatial solutions company that is headquartered in Kilcullen, Ireland. Murphy Geospatial is a private, family-owned geospatial solutions company that delivers a broad range of services that include survey, mobile and indoor mapping, asset monitoring, subsurface engineering, and 3D digital twin development. The firm has a staff of nearly 400 across six offices in Ireland and the United Kingdom.

Woolpert is a private, U.S.-based architecture, engineering, and geospatial firm that was founded in 1911 and has been providing comprehensive and integrated geospatial services for more than 50 years. Woolpert President Neil Churman said this acquisition is focused on the expansion and elevation of Woolpert's geospatial capabilities in Europe. This union will enable the companies to align best practices, leverage operational efficiencies, and advance services that include survey, reality capture, BIM, asset monitoring, GIS, and all forms of mapping.

"Over the last four decades, Murphy Geospatial has solidified itself as an innovative geospatial partner throughout Ireland, the UK, and the surrounding regions," Churman said. "Together with Murphy Geospatial, Woolpert will expand its geospatial presence in Europe to improve our offering to customers, accelerate next-level solutions, and provide vital support to the infrastructure, manufacturing, construction, property, utility, and natural environment sectors."

Murphy Geospatial CEO Niall Murphy and his team will continue to lead Murphy Geospatial, a Woolpert Company, in strategic alignment with Woolpert. Murphy said the companies share a dedication to client service, geospatial innovation, industry leadership, and employee culture.

"We are thrilled to be joining forces with the Woolpert team," Murphy said. "Their long-standing history in the geospatial sector and commitment to creating a great place to work for employees makes them an ideal match for us. We look forward to taking this next step to better serving our valued clients and advancing the industry together."

CALENDAR

- 26 September, **37th Annual GIS in the Rockies**, Denver, Colorado; http://gisintherockies.org/.
- 7-10 October, **GIS-Pro 2024**, Portland, Maine; https://urisa.org/page/GIS-Pro2024.
- 8-10 October, **Kentucky GIS Conference**, Louisville, Kentucky; https://kamp.wildapricot.org/
- 21-25 October, **ASPRS International Technical Symposium**, virtual; https://my.asprs.org/2024symposium.
- 18-22 November, **URISA GIS Leadership Academy**, Fort Worth, Texas; https://urisa.org/page/URISA_AdvancedGLA.
- 2-6 December, **URISA GIS Leadership Academy**, virtual; https://urisa.org/page/URISA_AdvancedGLA.
- 10-12 February 2025, **Geo-Week**, Denver, Colorado; www.geo-week.com/

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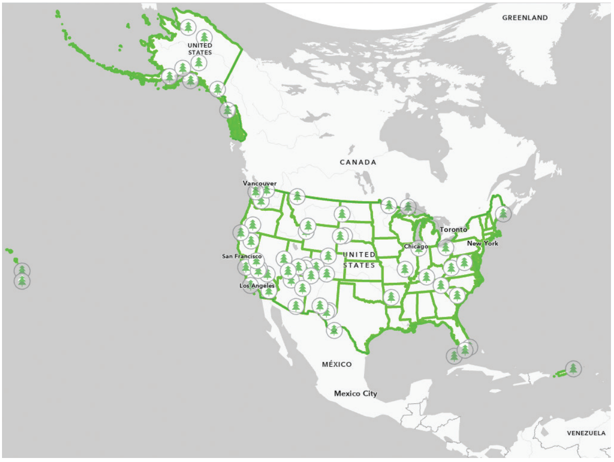

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COVER DESCRIPTION

Roughly 20,000 years ago, the Laurentide Ice Sheet smothered what is now southern New England beneath a thick layer of ice. The leading edge of this hulking mass plowed into the landscape as it advanced, depositing piles of debris called terminal moraines at its southernmost extent. These piles of glacial till became the foundation for the archipelago of islands that now flank southern New England: Long Island, Nantucket, Martha's Vineyard, and Block Island.

Block Island is visible in these images, acquired on July 3, 2024, by the OLI (Operational Land Imager) on Landsat 8. The pear-shaped island, located about 9 miles (14 kilometers) south of mainland Rhode Island, is about 6 miles long and 3.5 miles wide. Roughly 1,400 people live on Block Island, mostly in the town of New Shoreham. A combination of sunglint and a phytoplankton bloom made the wakes trailing behind the many boats near the island especially visible at the time of this image.

Great Salt Pond, once a freshwater pond, became tidal in 1905 when the U.S. Army Corps of Engineers dug a 0.6-mile-long channel to the ocean. The channel helped turn Great Salt Pond (also called New Harbor) into one of the most popular harbors in the Northeast, attracting about 1,500 boats to its three marinas on any given day in the summer. The smaller Old Harbor on the east side of the island is protected by a breakwater and serves as the main entry point for ferries arriving from Rhode Island, Connecticut, Massachusetts, and New York. The harbor also contains slips for commercial and charter fishing boats.

Five wind turbines form a line several miles southeast of Block Island. The turbines, installed in 2016 as part of the first offshore wind farm in the United States, replaced five diesel generators. Now, just 10 percent of the electricity they generate powers all of Block Island. The rest is exported to the mainland.

Conservation areas span about 40 percent of the island, including much of the land north of Great Salt Pond. The Block Island National Wildlife Refuge is one such area and hosts more than 70 species of migratory songbirds, as well as the largest colony of gulls in Rhode Island. The refuge also provides habitat for the American burying beetle, a large black-and-orange beetle that feeds on carrion. When the beetle was listed as endangered in 1989, the community on Block Island was just one of two populations known to remain in the United States. The beetles were recategorized as threatened in 2020.

NASA Earth Observatory images by Lauren Dauphin, using Landsat data from the U.S. Geological Survey. Story by Adam Voiland.

Both images can be viewed online by visiting the Landsat Image Gallery, https://landsat.gsfc.nasa.gov/, image id 153135.

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Photogrammetric Engineering & Remote Sensing is the official journal of the American Society for Photogrammetry and Remote Sensing. It is devoted to the exchange of ideas and information about the applications of photogrammetry, remote sensing, and geographic information systems. The technical activities of the Society are conducted through the following Technical Divisions: Geographic Information Systems, Photogrammetric Applications, Lidar, Primary Data Acquisition, Professional Practice, Remote Sensing Applications, and Unmanned Autonomous Systems. Additional information on the functioning of the Technical Divisions and the Society can be found in the Yearbook issue of *PE&RS*.

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PE&RS. *PE&RS* (ISSN0099-1112) is published monthly by the American Society for Photogrammetry and Remote Sensing, 8550 United Plaza Blvd, Suite 1001, Baton Rouge, Louisiana 70809 . Periodicals postage paid at Bethesda, Maryland and at additional mailing offices.

SUBSCRIPTION. *PE&RS* is available as an e-Subscription (single-site and multi-site licenses) and an e-Subscription with print add-on (single-site license only). PE&RS subscriptions are on a calendar-year, beginning in January and ending in December.

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GIS Tips & Tricks

By Al Karlin, Ph.D., CSM-L, GISP

Multiple Maps in a Single Project — The Easy Way

In ArcGIS Desktop, Esri closely linked the Map window and the Layout window, with a project file (.MXD) limited to containing only one of each. One of the most desired features in ArcGIS Pro was the ability of a project file (now an .APRX) to contain multiple maps, scenes, and layouts, in much the same way as older ArcView products could. Of course, now, Esri provided several workflows to add multiple maps, scenes, and layouts to an ArcGIS Pro project.

For the examples below, I'll start with a new ArcGIS Pro 3.3 project file with two feature classes; polygon outlines of the United States, and a point feature class of the U.S. National Parks in a map frame that I called "CONUS – National Parks" (Figure 1). Then I'll demonstrate a few tips on adding additional map frames to this project and adding each into a single Layout frame. In order to achieve a cleaner looking background without the topography I updated the default basemap (remember to never accept the defaults) from World Reference to Human Geography Base.

The scale on this map is very small (1:38,000,000) and many of the parks appear to overlap but decreasing the scale will cut out Alaska and Hawaii. A solution is to zoom into the lower-48 (Continental U.S.; CONUS) and make new map frames for Alaska and Hawaii.

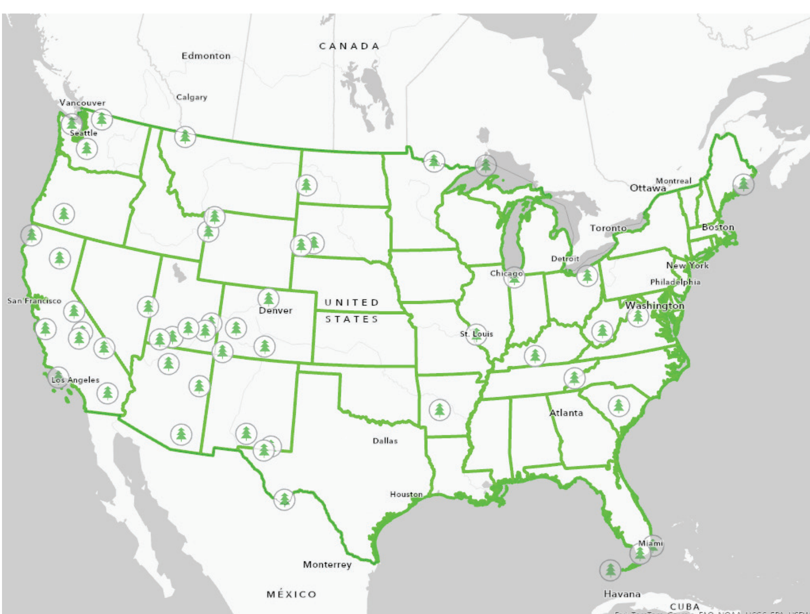


Figure 1. ArcGIS Pro map frame showing two feature classes; U.S. State outlines and U.S. National Parks.

TIP #1: The "Obvious" Way – Inserting a New Map (or Layout) from the Ribbon

Perhaps the most obvious and simplest way to add another map, scene (the topic of future columns) or layout to your project file is to INSERT it from the ribbon. On the INSERT Tab on the ribbon are icons to insert maps and layouts, note that both the New Map and New Layout Icons include down arrows which provide additional options (Figure 2).

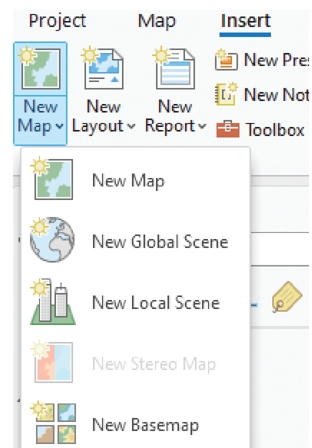


Figure 2. The New Map and New Layout icons on the INSERT tab on the ribbon showing the New Map options.

Inserting a new Map into the project adds a blank map (Figure 3) with a default (remember never to accept the defaults) basemap and coordinate system (WGS 1984 Web Mercator). Notice this is a blank map titled "Map". Now you need to, (1) update the base map to your preference, (2) change the name of the map, (3) provide a user-defined coordinate system and (4) add feature classes. A lot of steps when all you really wanted to do is copy the map and zoom to a different portion.

When adding maps to your project using this workflow, your new maps will not share any feature classes or properties with your original map; in this case, my coordinate system; NAD1983/2011 Continental Albers, my selected basemap, and the two feature classes. However, I frequently need a series of related maps that I want to all share a common base map, coordinate system and some, if not all, feature classes.

For this case, I want to make a layout that has the U.S. National Parks showing all CONUS 50 states, plus Alaska and Hawaii. If I had a com-

Photogrammetric Engineering & Remote Sensing
Vol. 90, No. 9, September 2024, pp. 529-531.
0099-1112/22/529-531

doi: 10.14358/PERS.90.9.529

plex map with multiple feature classes, it would be tiresome to use the "simple" workflow and then either copy | paste those feature classes into the new maps or navigate through a file structure to add them.

TIP 2: The Catalog Workflow – Using the Catalog to Manage Frames

The Catalog pane has multiple uses, one of which is to manage (create, copy and/or delete) frames in the project. In this case, I am going to first DELETE the new Map that I just created, by opening the Catalog, expanding the **MAP** tab (clicking on the down arrow), then selecting (left-clicking on) the "Map", right-clicking on "Map" to open the options and selecting "Delete" to remove the map from the project (Figure 4). Esri will ask you to confirm that you want to delete the map, answer "YES" and the map will be deleted. Of course, you can select the map in the Catalog pane, and just press the <DEL> key, as a shortcut.

TIP 2A: Adding a Blank Map

As an alternative to TIP #1, adding a blank map to your project from Catalog is much like adding a blank map from the Ribbon. From the Catalog pane, select the **MAP** tab (NOTE: you do not need to expand the **MAP** tab), left-click to open the options and select New Map (or use the keyboard shortcut Ctrl-M), to insert a new map frame (Figure 5).

TIP 2B: Copying an Existing Map

In this example, I have a feature class containing outlines of all of the states and all of the U.S. National Parks, but to fit the total extent onto a single map frame would require an extremely small scale, so I am going to make three map frames and then place them on a single layout.

The fastest workflow is to:

1. Copy the CONUS-National Parks map frame into two new map frames, one for Alaska, the other for Hawaii
2. Zoom to Alaska and Hawaii on their respective map frames (controlling the map scale),
3. Insert a Layout frame
4. Insert each map frame into the layout

To copy the CONUS-National Parks map frame, expand the **MAPS** tab in the Catalog, Select the CONUS-National Parks map, right-click and select Copy (or use the keyboard shortcut Ctrl-C) (Figure 6).

Then select the **MAPS** tab in the Catalog pane, right-click to activate the options and choose Paste (or use the keyboard shortcut Ctrl-V) (Figure 7). The new map frame will be added to the Catalog with a # appended to the title. In this case, it was titled CONUS-National Parks1, so I changed it to ALASKA-National Parks. Notice that this new Map frame inherited the feature classes, basemap, and coordinate system from the CONUS-National Parks map.

Figure 3. The blank map as it is inserted into the ArcGIS Pro Project file.

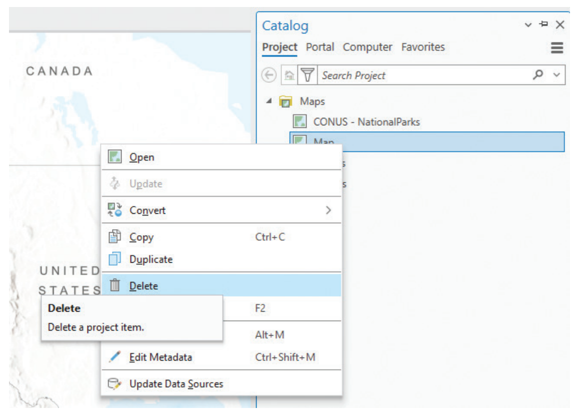


Figure 4. Deleting a map frame from an ArcGIS Pro project using Catalog.

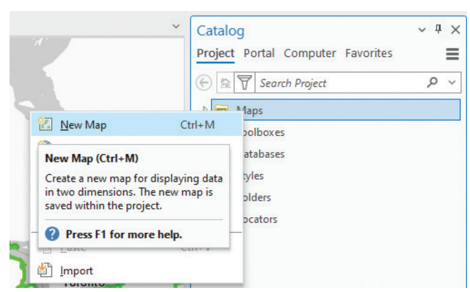


Figure 5. Inserting a blank map frame using the Catalog pane.

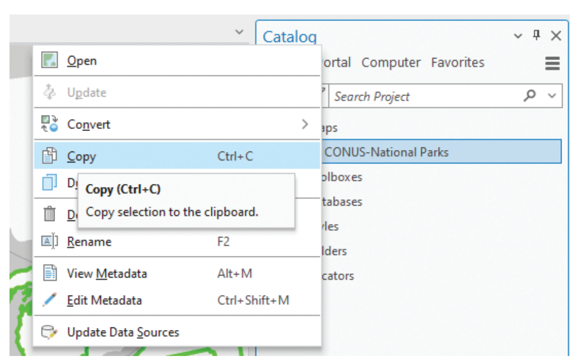


Figure 6. Copying a map in the Catalog pane.

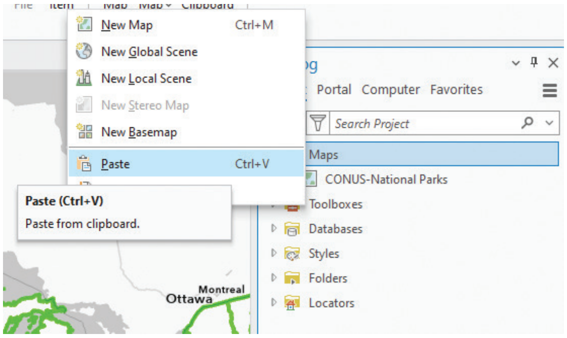


Figure 7. Pasting a new map frame into the Catalog.

Of course, Esri provides an even easier method for copying a map. You can select a map frame in Catalog, right-click on it, and use the "Duplicate" option. The results will be the same as the copy | paste workflow. I repeated this workflow and renamed the third map to HAWAII-National Parks.

Now that I have three copies of my original CONUS-National Parks map, I renamed the map frames (ALASKA-National Parks and HAWAII-National Parks), zoomed to those states in their respective map frames, inserted a Layout Frame from the Insert Tab on the ribbon, and build my map of the U.S. National Parks (Figure 8) showing the three Map frames.

As with most GIS workflows, this is one of several ways to simplify repetitive mapping tasks.

TIP 3: For QGIS Users

Adding a Map (or Layout) to a project is also very simple; however, the new map is a cloned view of the existing. Clicking on the "New Map View" icon on the main toolbar (Figure 9) opens a new map view window that clones your existing map.

To add one or more "Print Layouts" to a project, use the Project | New Print Layout option (in blue) from the Menu Bar, or use the keyboard shortcut <Ctrl-P> (Figure 10). You will need to supply a new Layout name to open the Layout Template. If you have multiple layouts, use the Layout Manager… (in red outline) to select (show), duplicate, rename and/or delete (remove) a layout.

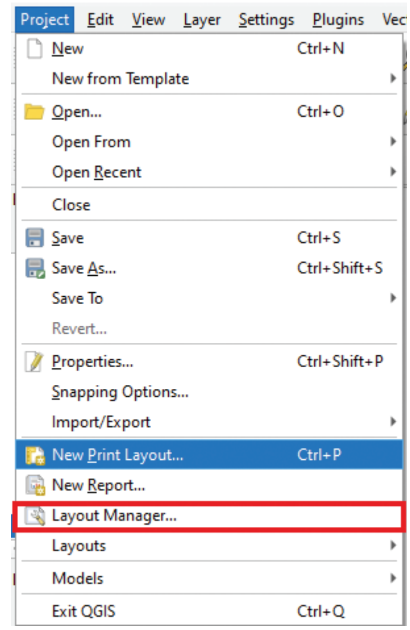


Figure 10. Adding (in blue) and Managing (in red outline) Layouts in QGIS.

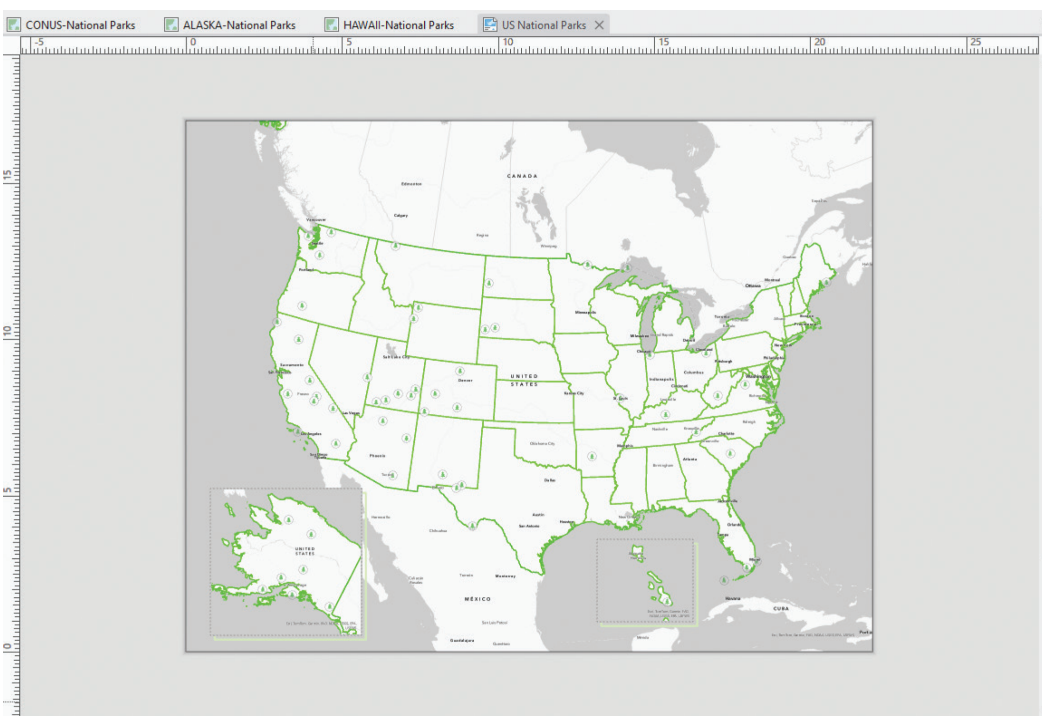


Figure 8. Layout frame showing the three map frames constructed using Catalog.

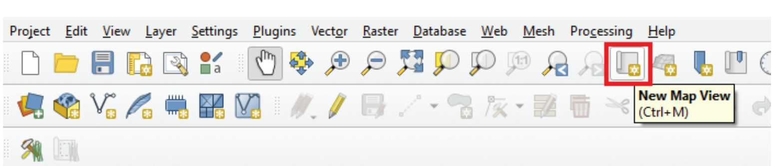
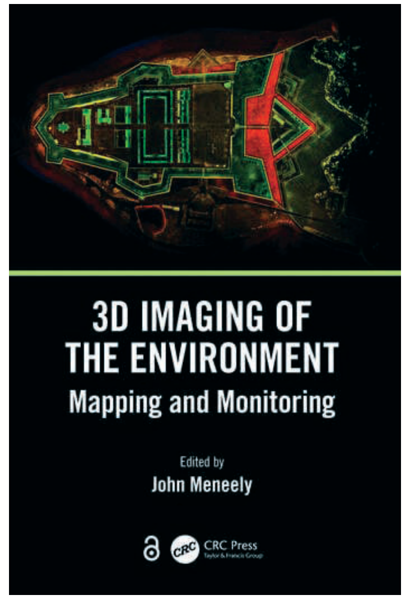


Figure 9. Adding a Map frame to a QGIS project using the "New Map View" icon.

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

Al Karlin, Ph.D., CMS-L, GISP is with Dewberry's Geospatial and Technology Services group in Tampa, FL. As a senior geospatial scientist, Al works with all aspects of lidar, remote sensing, photogrammetry, and GIS-related projects.



3D Imaging of the Environment: Mapping and Monitoring

John Meneely, Editor. CRC Press: Boca Raton, FL. 2024. xiv and 232 pp., diagrams, maps, photos, images, index. Hardcover. $120.00. ISBN 978-0-367-33793-3.

Reviewed by Matthew E. Ramspott, Ph.D., Professor, Department of Geography, Frostburg State University, Frostburg, Maryland.

In *3D Imaging of the Environment: Mapping and Monitoring*, editor John Meneely has assembled 14 chapters from various expert authors, each focused on a particular example. Meneely, founder of 3D Laser Scanning Ltd, previously worked with 3D imaging techniques in his academic research career. The book, intended for an interdisciplinary audience interested in recent advances in imaging technology and applications, offers competent presentation of recent technical advances with strong potential for pushing new discoveries and future operational remote sensing possibilities. Each chapter stands alone, formatted similarly to a scientific paper. Despite some minor thematic and stylistic inconsistencies (see descriptions of Chapters 5 and 11, below), this is an important new book offering timely examples, guidance, and expert knowledge.

Chapter 1, details digital asset documentation of Historic Environment Scotland, explores the role of spatial scale in determining data capture technique, with attention to technical commonalities that operate across diverse scales. Chapter 2 explores flood hazard mitigation in densely built urban environments, utilizing handheld mobile data capture technology. Multi-platform and multiscale data collection efforts are integrated for detailed urban hydrological modeling. Chapter 3 documents repeat mapping of glaciated and recently deglaciated landscapes, containing useful guidance for unmanned aircraft system (UAS) field campaign operations in remote or otherwise difficult locations. The problems associated with the establishment and maintenance of appropriate ground control needed for repeat surveys and change assessments are particularly challenging in these dynamic landscapes.

Chapter 4, documenting recent work mapping the interior of a cave complex in Slovakia, comparatively discusses mobile laser scanning (MLS) and stationary terrestrial laser scanning (TLS) methods. This chapter also gives a useful summary of the history and development of laser scanning technology for cave mapping applications, noting a significant uptick in utilization since 2008. Chapter 5, concerned with data capture and reproduction by 3D printing of paleontological specimens (dinosaur bones) seems perhaps rushed to publication, lacking the context and background that is a mainstay of most if not all the other chapters. Chapter 6 presents results using repeat laser scans to monitor fine-scale detail of architectural surfaces subject to degradation from weather and pollution impacts. The benefit of this newly available data (and associated visualizations) to aid in understanding the processes of limestone surface decay is remarkable.

Chapter 7 reports on UAS-based Lidar for forest characterization in a rugged mountainous area. Results are compared with contemporaneously collected UAS photogrammetry and TLS surveys. In addition, this chapter contains a listing of lightweight laser scanning devices along with their comparative specifications. Chapter 8, with particularly outstanding quality of illustrative graphics, documents a successful effort to produce detailed maps and visualizations of a small Irish island (Inishtrahull) and its historic structures. This chapter begins with a wonderful geographical/historical description of this unique place. It continues with description of UAS survey methodology and practical advice on addressing the potential challenges associated with sharing the results of complex, detailed, data-rich surveys (including 3D point clouds and derived models) to a wider audience via online platforms.

Chapter 9, also with notably strong maps and graphics, reports on CHERISH, a multidisciplinary effort aimed at developing 3D maps & models to aid in educating the public about coastal conservation projects in Wales & Ireland. (This chapter is also offered in an open access version online from the publisher). The background section offers perspective on the appropriate appli-

Photogrammetric Engineering & Remote Sensing
Vol. 90, No. 9, September 2024, pp. 533-534.
0099-1112/22/533-534

doi: 10.14358/PERS.90.9.533

cation of various data capture technologies, governed in part by the balancing of "scale, accuracy, resolution, and efficiency" (p. 140). In addition to material about TLS and UAS-based Lidar, remote sensing systems suitable for capturing bathymetry are also covered here. Chapter 10 concerns a fine-scale application of 3D imaging and surface analysis: data capture for replica model generation of the components of a 1200-year-old stone monument (St. Patrick's Cross, Down Cathedral). There is an interesting discussion about the use of relative radiance (hillshade) modeling, spatial filtering, and other digital image processing methods to reveal previously undocumented surface details.

Chapter 11 seems a little out of alignment with the theme of the book as it has no mention of 3D imaging at all and is concerned with thermal imaging, used here to detect leaks in local water distribution systems. The chapter nonetheless contains excellent theoretical background on the development and the operational limitations of thermal imaging, with practical advice for effective applications of thermography in a variety of situations. In Chapter 12, an archaeological site is replicated (3D printed at reduced scale) using data captured by an MLS. This chapter devotes attention to technical discussion of operation of the scanner as well as the 3D printing process. Chapter 13 details logistical challenges associated with TLS setups over large geomorphologically active areas (sand spit/coastal dune complexes in Western Ireland). Couched in the discussion of data processing, this chapter presents results from CANUPO, an advanced classification method that takes advantage of the multi-scale dimensionality of point cloud features to separate vegetation from terrain and enable extraction of accurate terrain models. Chapter 14 documents the development of an immersive multimedia virtual reality (VR) experience designed to "transport" museum visitors to Fingal's Cave in Scotland, a remote location unique in its physical geography as well as its cultural and historical significance. Complete with an overview of recent advances in VR hardware, this chapter also references Amara's Law and the Gartner Hype Cycle as they pertain to the progression of adoption and impact of novel technologies over time.

Overall, *3D Imaging of the Environment: Mapping and Monitoring* is authoritative, professionally edited and indexed, creatively illustrated, and well-suited to its target audience. Each chapter offers unique examples, insights, and context. Altogether the collection offers a valuable, timely, and practical contribution to the knowledge base on the state of the art in 3D imaging and visualization.

ASPRS AND THE ASPRS FOUNDATION ANNOUNCE NEW LYMAN LADNER MEMORIAL SCHOLARSHIP

The Awards Committee of the American Society for Photogrammetry and Remote Sensing (ASPRS) and the ASPRS Foundation announce the new ASPRS Lyman Ladner Memorial Scholarship for the 2025 application cycle. The scholarship is fully endowed at the initial amount of $2,000, with potential for the award amount to grow in future years.

Lyman Ladner retired from the USGS Western Mapping Center (WMC) in 1995 after 32 years of service. Early in his career, Lyman became very interested in photogrammetry and took a leave of absence to study photogrammetry at ITC in The Netherlands. Upon his return to USGS, Lyman received his BS in mathematics from San Jose State University and studied analytical photogrammetry under Professor James M. Anderson at UC Berkley. Lyman later served as Chief of the WMC Technology Office, where he and his team were responsible for development of the Digital Orthophoto (DOQ) production software.

This development led to WMC becoming the DOQ Center for the USGS and eventually to the multi-agency National Digital Orthophoto Program. He was awarded the US Department of the Interior's Meritorious Service Award for his efforts and, in 2020, he and his development team were recognized nationally by ASPRS with the Outstanding Technical Achievement Award. Lyman retired as the Assistant Chief of the WMC Research and Development Office.

This scholarship, to be awarded annually, is designed to recognize Lyman's contribution to the photogrammetry profession and his devotion to ASPRS as an emeritus member. The purpose is to encourage undergraduate and graduate level college students to pursue a course of study in surveying and photogrammetry leading to a career in the geospatial mapping profession.

An eligible candidate who wishes to be considered for the scholarship must submit an on-line application that includes the following items:

- A listing of courses taken or planned in photogrammetry and related geospatial information technologies, recognizing that instruction in remote sensing is often embedded in courses taught in many different disciplines.
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- A listing of internships, special projects, or work experience; technical papers, research reports or other documents; courses taught as a lecturer or teaching assistant; and presentations made that demonstrate the applicant's capabilities in this field.
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- A statement, not to exceed 2 pages, detailing the applicant's educa-

tional and research goals that relate to the advancement of photogrammetry and related geospatial information technologies and the applications of these technologies.

Further information and application details will be available on the ASPRS web site in the early Fall and the initial scholarship will be awarded at the 2025 ASPRS Annual Conference at Geo Week in February 10-12, 2025 at the Denver Convention Center.

Established in 1979, the ASPRS Foundation is a tax-exempt organization with the primary purpose to advance the understanding and use of spatial data for the betterment of humankind and the effective operation of public and private organizations. The Foundation's mission is to establish an extensive and broadly-based program that provides grants, scholarships, loans and other forms of aid to individuals or organizations pursuing knowledge of imaging and geospatial information science and technology, and their applications across the scientific, governmental, and commercial sectors. A key goal of the Foundation is to fully endow all existing ASPRS awards and scholarships in a manner that, at a minimum, keeps up with inflation.

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Development of an Automatic Feature Point Classification Method for Three-Dimensional Mapping Around Slewing and Derricking Cranes

Hisakazu Shigemori, Junichi Susaki, Mizuki Yoneda, and Marek Ososinski

Abstract
Crane automation requires a three-dimensional (3D) map around cranes that should be reconstructed and updated quickly. In this study, a high-precision classification method was developed to distinguish stationary objects from moving objects in moving images captured by a monocular camera to stabilize 3D reconstruction. To develop the method, a moving image was captured while the crane was slewed with a monocular camera mounted vertically downward at the tip of the crane. The boom length and angle data were output from a control device, a controller area network. For efficient development, a simulator that imitated the environment of an actual machine was developed and used. The proposed method uses optical flow to track feature points. The classification was performed successfully, independent of derricking motion. Consequently, the proposed method contributes to stable 3D mapping around cranes in construction sites.

Introduction
In recent years, labor shortages have become a problem at construction sites (Kakimi *et al.*, 2019), and improving labor productivity has become an urgent issue. One solution is to simplify or automate crane operation. Ramli *et al.* (2017) presented a review of crane control strategies. Various crane types and control issues were explained, and single- and double-pendulum crane systems as well as anti-sway control systems for industrial cranes were introduced. Guo *et al.* (2021) provided a review of automated lift planning for mobile cranes; crane selection, localization, and automated lift path planning was particularly focused on. Zhang *et al.* (2016) developed an adaptive tracking controller for double-pendulum overhead cranes subject to parametric uncertainties and external disturbances. To drive the trolley to the target position smoothly, an S-shaped trajectory was selected as the desired trajectory of the trolley. The proposed adaptive tracking-control method guarantees that the trolley-tracking error rapidly converges to zero. Tak *et al.* (2021) noted several practice issues in construction sites and proposed a four-dimensional crane simulation and on-site operation management framework for multiple mobile cranes in the building information modeling environment.

The automation of crane operation requires the creation of a three-dimensional (3D) map of the crane environment to determine the crane load route. Light detection and ranging (lidar) and optical cameras are typically used to create 3D maps. One 2023 method of large-scale 3D mapping for cranes used slowly rotating lidar and an inertial measurement unit attached to the crane boom (Hassan *et al.* 2023). A complementary filter was employed in series with moving average filtering and the structural information of the crane was combined with these to estimate the sensor pose at each scan (Hassan *et al.* 2023). The estimated sensor poses were used to convert a set of two-dimensional scans into a 3D point cloud map. Lidar is expensive, however, and owing to the limited implementation cost, 3D maps must be created at low cost. Therefore, from the perspectives of manufacturing cost and implementation, the method of using a moving image obtained from a monocular camera attached vertically downward at the tip of the crane boom is most desirable.

Wang *et al.* (2022) estimated the working area limit line, indicating safety-related information in a top-view image. The approach conducts real-time scene reconstruction by performing visual simultaneous location and mapping (SLAM) with visual odometry and monocular depth estimation. According to our preliminary examination, visual SLAM does not generate stable and reasonable 3D maps from moving images at the tip of a crane boom.

These unstable results may be caused by two factors. First, the slewing motion of the crane makes the outcome unstable with respect to photogrammetry. In general, aerial photogrammetry—a camera mounted vertically downward on an aircraft—is used to estimate the 3D position of a geographic feature from moving images captured by an aircraft flying in a straight line (Mikhail *et al.* 2001). The moving images acquired from the aforementioned crane were obtained by slewing the crane (i.e., rotation occurred between the images); therefore, the rotation between images must be estimated during 3D reconstruction, and errors are consequently expected to accumulate. Second, moving objects (e.g., hooks) and stationary objects are mixed in the moving image. For 3D reconstruction, image rectification must be performed by calculating the projective transformation matrix between the images by using the corresponding points of the two images (Hartley 1999); however, calculation of the projective transformation matrix requires the use of stationary objects in the image, and the rectification accuracy is significantly affected if moving objects are used.

A robust method for outliers in this process was developed using random sample consensus to calculate projective return matrices, but, depending on the number of outlier feature points, random sample consensus may not be able to exclude them (Raguram *et al.* 2013). Therefore, stationary and moving objects must be classified before creating a 3D map. Furthermore, if the hook and cab can be distinguished, the position of the hook can be estimated; therefore, stationary objects, hooks, and cabs must be distinguished in moving images.

In recent years, semiconductor technology has led to the development of image classification methods based on machine learning. Regional convolutional neural networks , which are the pioneers of

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Contributed by Rongjun Qin, January 22, 2024, (sent for review March 7, 2024; reviewed by Jianli Wei, Linfu Xie).

Photogrammetric Engineering & Remote Sensing
Vol. 90, No. 9, September 2024, pp. 537–551.
0099-1112/22/537–551

doi: 10.14358/PERS.24-00008R2

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Semantic Segmentation of Point Cloud Scene via Multi-Scale Feature Aggregation and Adaptive Fusion

Baoyun Guo, Xiaokai Sun, Cailin Li, Na Sun, Yue Wang, and Yukai Yao

Abstract

Point cloud semantic segmentation is a key step in 3D scene understanding and analysis. In recent years, deep learning–based point cloud semantic segmentation methods have received extensive attention from researchers. Multi-scale neighborhood feature learning methods are suitable for inhomogeneous density point clouds, but different scale branching feature learning increases the computational complexity and makes it difficult to accurately fuse different scale features to express local information. In this study, a point cloud semantic segmentation network based on RandLA-Net with multi-scale local feature aggregation and adaptive fusion is proposed. The designed structure can reduce computational complexity and accurately express local features. The mean intersection-over-union is improved by 1.1% on the SemanticKITTI data set with an inference speed of nine frames per second, while the mean intersection-over-union is improved by 0.9% on the S3DIS data set, compared with RandLA-Net. We also conduct ablation studies to validate the effectiveness of the proposed key structure.

Introduction

Light detection and ranging (lidar) sensors (Jaboyedoff *et al.* 2012), as major 3D-sensing sensors, are capable of acquiring highly accurate 3D point cloud information. Compared with other sensors such as cameras, lidar is relatively less affected by factors such as lighting and weather, so lidar point cloud data is more used for tasks such as scene perception and target detection in complex and uncertain real-world scenes. Scene perception based on laser point clouds has been widely used in augmented reality (AR)/ virtual reality (VR), autonomous driving, and smart cities, and has become one of the current popular research areas (Tchapmi *et al.* 2017).

However, semantic segmentation of point clouds is a challenging task (Han *et al.* 2021) because point cloud data is unstructured and cannot be directly applied to traditional 2D convolution. In addition, the differences in spatial distance, density, and number of points between density-inconsistent point clouds make it difficult to generalize features learned from dense regions to sparsely sampled regions, thus affecting the ability of deep learning networks to generalize to density-varying point clouds.

Some methods (Qi, Su, *et al.* 2017; Qi, Yi, *et al.* 2017; Jiang *et al.* 2018; Hu *et al.* 2020) can directly deal with unstructured point sets. PointNet (Qi, Su, *et al.* 2017) is the pioneering work on point-based networks. In order to lift the limitation of fixed-size receptive fields on the expressiveness of local features, some works (Guan *et al.* 2022; Mao *et al.* 2022; Xu *et al.* 2022) use multi-scale receptive fields to extract multi-scale features; e.g., PointNet++ (Qi, Yi, *et al.* 2017) designed a basic structure called set abstraction (SA) layers, where each layer captures the local features of each point through the process of sampling, grouping, and feature extraction, and further designed the SA module with multi-scale grouping local feature learning method, which compensates for the lack of local feature characterization capability of a single neighborhood by considering multiple scales of neighborhood information in the grouping stage. However, there are still some limitations and shortcomings of this local feature learning method for multi-scale neighborhoods. The main shortcomings include the following.

High Computational Cost of Feature Aggregation in Multi-Scale Neighborhoods

Multi-scale local feature aggregation (MSLFA) usually requires capturing local features and geometric information in large-scale, medium-scale, and small-scale neighborhoods, resulting in increased computational cost, especially when aggregating contextual information in large-scale neighborhoods, which requires more computational resources and time. In addition, since the same neighboring points exist in the point groups of neighboring point queries at different scales, the MSLFA process will repeatedly process these neighboring points, which leads to the problem of computational redundancy.

Multi-Scale Feature Fusion Problem

Features at different scales at each location have different importance in accurate representation, and simply splicing or additive fusion of features will be detrimental to the accurate representation of local features.

Therefore, in this paper, local feature learning of large-scale branching is achieved through extended local feature aggregation (LFA) instead of directly capturing local information within the large-scale neighborhood to reduce computational overhead, while medium- and small-scale branching can reduce the redundant computation in MSLFA by reducing the repeated feature aggregation operations on the same neighboring points in point groups of different scales. Meanwhile, multi-scale feature fusion fuses features by comprehensively considering the neighborhood size and the importance of features, so as to accurately express local features.

The main contributions of this paper are as follows:

- We design the MSLFA module to improve the efficiency of multi-scale feature aggregation by progressively increasing the perceptual field size of each point and reducing the repetitive LFA operations for the same neighboring points in different-scale neighborhoods.
- We design a multi-scale feature adaptive fusion module to effectively fuse features according to their importance at different scales.
- We use the proposed module to design a semantic segmentation network and test it on several point cloud benchmarks of large-scale real scenes. The experimental results clearly demonstrate the effectiveness of our approach.

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Contributed by Ruisheng Wang, October 17, 2023 (sent for review March 8, 2024; reviewed by Fanar M. Abed, Alper Yilmaz).

Photogrammetric Engineering & Remote Sensing
Vol. 90, No. 9, September 2024, pp. 553–563.
0099-1112/22/553–563

doi: 10.14358/PERS.24-00008R2

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A Robust Star Identification Algorithm for Resident Space Object Surveillance

Liang Wu, Pengyu Hao, Kaixuan Zhang, Qian Zhang, Ru Han, and Dekun Cao

Abstract

Star identification algorithms can be applied to resident space object (RSO) surveillance, which includes a large number of stars and false stars. This paper proposes an efficient, robust star identification algorithm for RSO surveillance based on a neural network. First, a feature called equal-frequency binning radial feature (EFB-RF) is proposed for guide stars, and a superficial neural network is constructed for feature classification. Then the training set is generated based on EFB-RF. Finally, the remaining stars are identified using a residual star matching method. The simulation experiment and results show that the identification rate of our algorithm can reach 99.82% under 1 pixel position noise, and it can reach 99.54% under 5% false stars. When the percentage of missing stars is 15%, it can reach 99.40%. The algorithm is verified by RSO surveillance.

Introduction

Because of the recent deterioration of the space environment, the need for resident space object (RSO) surveillance has greatly increased (Segal *et al.* 2014). Space-based space surveillance systems have emerged as the mainstream research direction in space object monitoring owing to their advantages of being unaffected by weather conditions, environmental factors, and geographical limitations (Abdelkhalik *et al.* 2006; Ettouati *et al.* 2006; Ye and Zhou 2015; Dave *et al.* 2020; Spiller *et al.* 2020; Liu *et al.* 2022). The star identification algorithm can be used in space-based space surveillance systems to determine the orientation of RSOs relative to the monitoring camera. Furthermore, it can generate star masks and extract RSOs from the star map (Ye and Zhou 2015; Gong *et al.* 2009).

The surveillance camera must possess higher sensitivity to detect more space objects. Increased sensitivity enables the camera to have a greater capability for detecting stars with higher magnitudes, thereby allowing for the detection of more space objects and facilitating the observation of weaker RSOs. However, RSOs are often situated at considerable distance from the surveillance system, and their imaging characteristics can be similar to those of regular stars. Consequently, during the star identification phase, RSOs may be mistakenly identified as false stars, which poses a significant challenge to the star identification algorithm. Hence, there is a pressing need to develop a star identification algorithm that can effectively address the requirements of space object surveillance while adequately handling the presence of a substantial number of RSOs.

There are two primary algorithms for star identification algorithm in star pattern recognition: star tracking mode and full-sky star identification mode. The full-sky star identification mode, which is more intricate than the star tracking mode, can function properly even when attitude information is lost. The classic star identification algorithm can be roughly divided into two categories according to the matched features: subgraph isomorphism and pattern recognition algorithms. The triangle algorithm, which uses angular distances between stars to construct the triangle features, is representative of subgraph isomorphism algorithms. It has the advantages of simple principles and high stability but disadvantages such as an extensive database and long search time (Liebe 1992, 2002). Starting from the triangle algorithm, researchers began to improve the subgraph isomorphism algorithm by reducing the database capacity to enhance efficiency (Quine and Durrant-Whyte 1996) and by introducing more stars to improve robustness (Mortari *et al.* 2004). Building a hash map for all triangle features can reduce the computational complexity to O(8), and setting rules to remove redundant triangle features can improve the efficiency of identification (Wang *et al.* 2017). Some algorithms use different matching ideas to avoid false matches caused by angular distance measurement errors and false stars. Schiattarella *et al.* (2017) proposed a multipole algorithm, which is specially designed for a large number of false stars.

Unlike subgraph isomorphism algorithms, pattern recognition algorithms construct a pattern for each guide star, which is usually built from companion stars of the guide star. One representative of pattern recognition algorithms is the grid algorithm (Padgett and Kreutz-Delgado 1997), which is robust to position noise but easily affected by false stars and missing stars. Some scholars have improved the grid algorithm (Lee and Bang 2007; Na *et al.* 2009). However, the improved grid algorithm still requires the nearest companion star as the directional reference star; a wrong selection of the directional reference star can yield very different features. Therefore, a feature with rotation invariance is needed. The radial feature has rotation invariance, and it is a reliable feature. Zhang *et al.* (2008) use radial and circular features for matching while introducing Field of view FOV constraint removal to ensure accurate matching. Gong *et al.* (2009) proposed an autonomous star identification algorithm for RSO surveillance, created a flower code as the feature of the guide star, and analyzed the influence of the reflecting RSOs as the false stars. The results show that this algorithm is robust.

Because of the complex and changeable space environment and the increasing number of RSOs, the robustness to position noise and false stars need to improve. Moreover, the traditional algorithms have high computational complexity and long running time, which will affect the generation of the star mask and thus affect the efficiency of RSO surveillance. During the reasoning process, the weights and biases of the network are fixed, so all input data are reasoned according to the same calculation process. Therefore, when the size of the input data is unchanged, the time complexity of inference is stable and independent of the size of the input data, and can be regarded as constant time. This is why its time complexity is O(1). As early as 1989, neural networks have been applied to star identification (Alvelda and San Martin 1988). Because of the property of implicit storage of the neural network, the database matching process is eliminated, and the identification complexity is significantly reduced (Lindsey *et al.* 1997; Li *et al.* 2003). Some scholars use convolutional neural networks (CNNs) to identify the star

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Contributed by Prasad S. Thenkabail, December 25, 2023 (sent for review January 10, 2024; reviewed by Minmin Huang, Md Enamul Huq).

Photogrammetric Engineering & Remote Sensing
Vol. 90, No. 9, September 2024, pp. 565–574.
0099-1112/22/565–574

doi: 10.14358/PERS.23-00086R2

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Wavelets for Self-Calibration of Aerial Metric Camera Systems

Jun-Fu Ye, Jaan-Rong Tsay, and Dieter Fritsch

Abstract

In this paper, wavelets are applied to develop new models for the self-calibration of aerial metric camera systems. It is well known and mathematically proven that additional parameters (APs) can compensate image distortions and remaining error sources by a rigorous photogrammetric bundle-block adjustment. Thus, kernel functions based on orthogonal wavelets (e.g., asymmetric Daubechies wavelets, least asymmetric Daubechies wavelets, Battle-Lemarié wavelets, Meyer wavelets) are used to build the wavelets-based family of APs for self-calibrating digital frame cameras. These new APs are called wavelet APs. Its applications in rigorous tests are accomplished by using aerial images taken by an airborne digital mapping camera in situ and practical calibrations. The test results demonstrate that these orthogonal wavelet APs are applicable and largely avoid the risk of over-parameterization. Their external accuracy is evaluated using reliable and high precision check points in the calibration field.

Introduction

Geometric camera calibration aims to determine the camera's internal parameters and the corresponding image distortion function. The topic came to the forefront when aerial surveying was used for mapping and reconnaissance in World War I. To achieve higher accuracy measurements of object coordinates in stereo-photogrammetry, early studies adopted different methods or types of equipment to calibrate aerial cameras, such as visual calibrations in Canada and visual optical benches and camera collimators in the United States. The rapid increase in the demand for aerial photography for reconnaissance and mapping during World War II prompted camera manufacturers, calibration authorities, and academic photogrammetrists in North American and European countries to commence discussions on standardization of camera calibration techniques (Clarke and Fryer 1998). Since the late 1950s, many camera calibration methods have been proposed, especially for metric cameras.

These calibration methods can be roughly divided into four categories (Slama *et al.* 1980; Clarke and Fryer 1998; Luhmann *et al.* 2011; Fritsch 2015). (a) Laboratory calibration uses high-precision and expensive calibrators (e.g., collimators, goniometers) to determine the interior orientation (IO) parameters; because of heavy workload, this calibration method is generally used only for metric cameras. (b) Stellar calibration is conducted by observing several uniformly distributed stars in the sky with known precise positions to calibrate the internal geometric parameters of cameras. (c) Test field calibration is based on measuring a series of target object points with known coordinates, distances, or angles from multiple viewpoints, such as uniformly distributed high-precision ground points on a flat terrain area, a designed calibration plate, or several plumb lines. (d) Analytical self-calibration can be perceived as an extension to test field calibration; it substitutes for the actual object target point measurements in the test field.

All the unknowns, including but not limited to the IO parameters of cameras and the object coordinates of all object points, can be solved simultaneously by using bundle-block adjustment of analytical photogrammetry to provide a very robust solution. Self-calibration parameters, also called additional parameters (APs) can automatically be selected by statistical tests.

Analytical self-calibration with APs in the bundle-block adjustment has been widely accepted as an efficient technique to fully or partially compensate for systematic image errors since the 1970s (Ackermann 1981). At the same time, many studies in the 1970s proposed various self-calibration models for calibrating analog single-head cameras. These self-calibration models are formulated based on physical or mathematical principles.

The most classic physical self-calibration model is derived from Duane C. Brown's early research on lens distortion in photogrammetric cameras (Brown 1956, 1964, 1966); the model was introduced in the analytical plumb-line method to calibrate close-range cameras (Brown 1971). Further, this physical self-calibration model was extended and used in an experimental aerial photogrammetric application (Brown 1976). The mathematical self-calibration models do not depend on observable physical phenomena but are based on rigorous mathematical geometric principles to approximate the systematic distortion of the images. Some examples of early mathematical self-calibration models are provided by Ebner (1976) and Grün (1978); both adopted second- and fourth-order orthogonal bivariate algebraic polynomials, respectively, as mathematical basis functions for the self-calibration models.

El-Hakim and Faig (1977) used spherical harmonic functions to build the mathematical self-calibration model. These mathematical models are described by algebraic or trigonometric polynomials whose terms are functions of the image coordinates. It took another 40 years, however, to explain and proof the mathematical concept of photogrammetric self-calibration by Fritsch (2015, 2017). This is based on the Weierstrass theorem of the 1880s and nothing else than a function approximation problem .

Many early studies noted that physical and mathematical self-calibration models can effectively reduce systematic image errors and provide similar results (Ackermann 1981). However, some of the studies also indicated clear flaws or hidden risks (Ackermann 1981; Fraser 1982; Ziemann 1986; Clarke and Fryer 1998). Physical self-calibration models rely on prior knowledge of physical distortions and have high correlations between certain parameters and the exterior orientation (EO) parameters of images. Mathematical self-calibration models, which are not physically interpretable, typically use more APs than physical self-calibration models. From a mathematical point of view, algebraic polynomials are not suitable for modeling the lens distortion

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Contributed by Rongjun Qin, January 7, 2024 (sent for review March 7, 2024; reviewed by Xun Geng, Hongbo Pan).

Photogrammetric Engineering & Remote Sensing
Vol. 90, No. 9, September 2024, pp. 575–587.
0099-1112/22/575–587

doi: 10.14358/PERS.24-00002R2