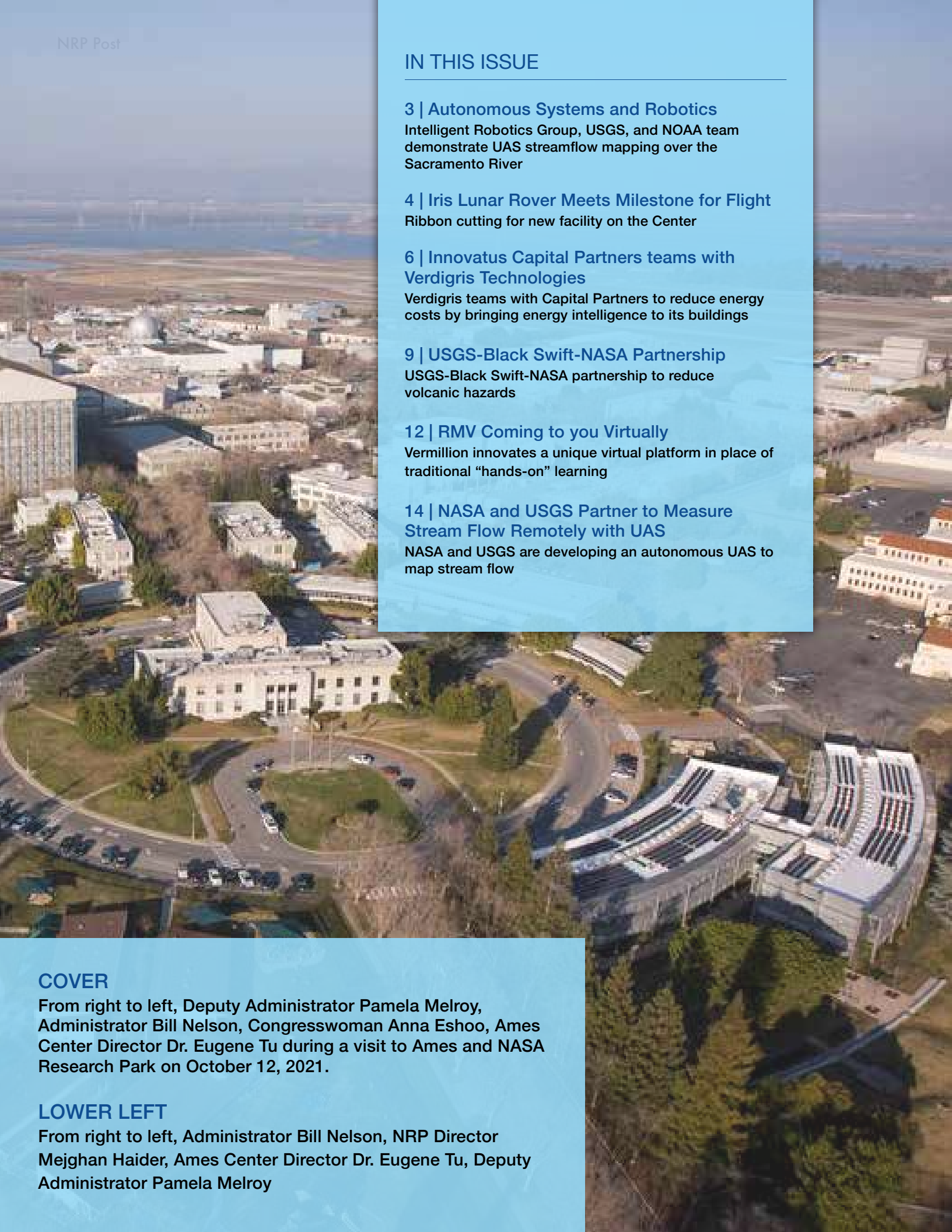
National Aeronautics and Space Administration

THE NRP POST

A Publication of NASA Research Park

2021 Issue 3

IN THIS ISSUE



COVER
From right to left, Deputy Administrator Pamela Melroy, Administrator Bill Nelson, Congresswoman Anna Eshoo, Ames Center Director Dr. Eugene Tu during a visit to Ames and NASA Research Park on October 12, 2021.

LOWER LEFT
From right to left, Administrator Bill Nelson, NRP Director Mejghan Haider, Ames Center Director Dr. Eugene Tu, Deputy Administrator Pamela Melroy

Autonomous Systems & Robotics
Intelligent Robotics Group

Intelligent Robotics Group, USGS, and NOAA team demonstrate UAS streamflow mapping over the Sacramento River.

Members of the Intelligent Systems Division's Intelligent Robotics Group (IRG) and the United States Geological Survey (USGS) are developing an autonomous Unmanned Aerial System (UAS) to map streamflow aerially. This technology will provide measurements for the national stream gage network for areas that lack gages. Over the course of a week in September, the team demonstrated the aerial streamflow mapping capability successfully over the Sacramento River, California, for the first time. IRG and USGS team members integrated a natural color video camera, a thermal camera, a laser range finder, and an embedded Central Processing Unit (CPU) into a platform-independent payload that will enable usage with various UAS. The team also worked with the National Oceanic and Atmospheric Administration (NOAA), who found a suitable field site and took field measurements used for calibration and assessing accuracy of the image-derived estimates.

The team flew a hexacopter equipped with the NASA/USGS payload of visible and thermal imagers, obtaining high-resolution video across a Hartley Island stretch of the Sacramento River. Water depth was estimated with the images using Optimal Band Ratio Analysis (OBRA), and surface flow velocities using Particle Image Velocimetry (PIV). Data was gathered over the course of two days and the three test flights. The streamflow results are close to those taken by an independent NOAA team field-based measurement. The similarity of the results between the aerial mapping and traditional river flow estimates shows that the aerial mapping system can provide hydrographers with a cost-effective, user-friendly means for taking regular and as-needed river and stream flow measurements, as well as measurements under hazardous high-flow conditions that pose a risk to staff and equipment. This platform allows a larger number of USGS streamflow measurements in a larger number of places and in locations that are difficult to access, and additionally provides greater safety for staff in dangerous conditions.

Background: This first aerial streamflow mapping test is the latest collaboration in a long-standing partnership between NASA and the USGS. This UAS streamflow mapping platform and its ability to take a greater number of measurements will enable the USGS to extend its water observation capability across the nation's rivers and streams, leading to better flood resilience and drought monitoring. The Intelligent Robotics Group partners with the USGS and National Geospatial-Intelligence Agency (NGA) to develop Earth-monitoring and analysis capabilities for scientists with both aerial and satellite imagery.

Program Funding: USGS National Innovation Center

Team: Michael Dille, Ted Morse, Antoine Tardy, and Uland Wong; USGS: Isaac Anderson, Cian Dawson, Liz Hyde, Paul Kinzel, and Carl Legleiter; NOAA: Lee Harrison

Point of Contact: Uland Wong, uland.wong@nasa.gov

Iris Lunar Rover Meets Milestone for Flight

By Byron Spice

CMU's student-designed robot will land on the moon in 2021

Carnegie Mellon University students who designed and built a small, boxy robot, named Iris, have achieved a major milestone: their robot passed its critical design review by NASA and is on track to land on the moon in the fall of 2021.

"We are moving forward…we're going to the moon," a triumphant project manager, Raewyn Duvall, told Iris team members during a Zoom meeting following the review.

Officials at NASA and Astrobotic Inc., whose Peregrine lander will deliver the robot to the lunar surface, performed the review. Duvall, a Ph.D. student in the Electrical and Computer Engineering department, said the process resulted in a few small design revisions, which the team is now incorporating.

The team will replace prototype parts with flight components this summer, as they test the robot to prove that it can withstand the trip to the moon without causing problems for Peregrine or for other payloads aboard the lunar lander.

The Moon Ark, an integrative art and design project spanning a decade of student, faculty and partner collaborations, is hitching a ride to the moon along with Iris. The 8-ounce museum is intended to spark wonderment for future humans through poetically entangled visual narratives of the arts, humanities, sciences and technologies.

Carnegie Mellon University

Iris, a small, boxy robot designed by CMU students, has passed its critical design review by NASA and is on track to land on the moon in the fall of 2021.

"This is going to be an exciting summer," said William "Red" Whittaker, professor in the Robotics Institute and director of the Field Robotics Center. Once the robot passes the payload acceptance review this fall, the team will deliver the fully flight-ready Iris to the company by the end of the year so it can be integrated with Peregrine.

"The vision, design and implementation for this robot are driven by amazing student power — unprecedented for a space venture of this ambition and technical challenge," Whittaker said. "It requires the highest standards of commitment, collaboration and cross-disciplinary skill, as well as incredible resourcefulness."

The four-wheeled Iris, which weighs about four pounds, will be America's first robotic rover to explore the moon's surface. Although NASA landed the first humans on the moon and has explored Mars with rovers, it has yet to launch a lunar rover. Russia and China have both operated unmanned rovers on the moon.

Last year, NASA awarded a contract to Pittsburgh's Astrobotic to deliver 14 scientific payloads to the vicinity of Lacus Mortis, or Lake of Death, a large pit the size of Pittsburgh's Heinz Field. In a separate agreement with CMU, Astrobotic has agreed to deliver Iris and a CMU arts package called MoonArk on that mission.

Whittaker and his students began developing the robot in 2017, with support from NASA. They envision it as the prototype for a new family of affordable robots that might be used by small research groups without the resources of a space agency. Astrobotic plans to offer these "CubeRovers" as a product line.

CMU's robot has recently been named Iris, in part to honor Siri Maley, a former master's student in mechanical engineering who was a leader and an early champion of the robot's development (Iris is Siri spelled backwards). Also, the robot's main sensors are two video cameras and, in cameras, an iris is a diaphragm that controls the amount of light that enters the lens. Finally, Duvall noted, an iris is a flower known for withstanding extreme environments, just as the robot will on the moon.

Duvall said usually about 40 students — primarily undergraduates — were involved each semester, though the ranks swelled to more than 70 this semester.

"The fact that it's going into space has been a strong pull for student involvement," she explained.

As a student project, the robot went through many design changes, in part because each succeeding group was eager to put their own twist on it, Duvall said. But building a light robot also required some difficult design choices.

One major change was the number of wheels. Iris began as a two-wheeled robot supported in the rear by a tail that dragged along the surface. The idea was that the lightweight tail replaced heavier wheels. But the tail caused so much drag that the team decided to add two wheels, foregoing the weight advantage in favor of saving energy, Duvall said.

Nick Acuna, a sophomore mechanical engineering major, joined the project as a first-year student, though he doubted he could contribute much that was useful. Assigned to the wheel design group, he discovered a way to make carbon composite wheels that "worked really, really well." It enabled the wheels, which resemble bottle caps, to be both lighter and stiffer. By the end of last summer, he had been elevated to mechanical lead.

"This project is pretty important to me,""Acuna said, explaining that he enjoys going "all in," focusing his drive on a single thing. In high school, wrestling was his focus. Now, with Iris, "I've slowly gotten to that same mindset." Working on CMU's first space program is nothing short of inspiring, but also humbling, he added.

"It lets you dream about what you can accomplish in the future, if you're already doing this as a student," he explained. "I know a lot of great people have come through this project. We have the privilege of being the team in the semester when we bring it all to fruition.

"All these giants have touched it and we're the ones who get to see it through to the end."

More than 70 students, primarily undergraduates, have worked to develop the Iris robot over several years. Pictured, prior to social distancing precautions, is the spring 2020 team.

VERDIGRIS

Innovatus Capital Partners teams with Verdigris Technologies to reduce energy costs by bringing energy intelligence to its buildings

New York based Innovatus Capital Partners ("Innovatus") a boutique specialty finance firm with over $1.5 billion in assets under management, is deploying Verdigris' artificial intelligence (AI) technology across its national commercial building portfolio. With a diversified portfolio of U.S. commercial office properties located in emergent top-tier markets, Innovatus is focused on creating value in special situations, emergent asset classes and asset-based investments.

Verdigris, a global leader in real-time responsive energy intelligence, combines its IoT energy sensors and adaptive and autonomous building solutions to cost-effectively manage energy consumption and optimize operations in smart buildings.

"Innovatus has seen tangible reductions in our energy costs, along with other unexpected benefits such as identifying equipment scheduling issues at several of our buildings. The Verdigris deployment model, analytics and automation are extremely valuable to our investment strategy for identifying disruptive growth opportunities," said Bradley Seiden, Managing Director at Innovatus Capital Partners. "Verdigris is a tested and proven energy management solution, delivering real-time insights and automatic optimization that are ahead of other solutions in the marketplace and are adaptive to the needs of our buildings in each market."

In the first phase of energy-saving automation, Innovatus has deployed Verdigris' Adaptive AutomationTM at the Westwood Corporate Center, a premier five-story, 120,000 square foot, Class A office building on Forum Drive in south Orlando. During this phase, Verdigris AI has already identified measurable annual savings in both baseload and peak demand optimization. These savings are achieved automatically, with no additional effort or attention by the facility engineering team, freeing them up to focus on other projects. To expand on the success of this first phase, savings can be further enhanced by automating additional HVAC equipment. Innovatus and Verdigris look forward to creating a truly "self-driving" building. Westwood Corporate Center is managed by Lincoln Property Company.

"Lincoln Property Company is very excited to be working with Innovatus Capital Partners and Ver-

digris on these very unique AI enhanced energy initiatives that we truly believe sets on a unique path to maximizing energy conservation while effectively maintaining tenant comfort within our office building," said Edward J. Price, Senior Vice President for Lincoln Property Company Southeast.

By applying AI and machine learning in real-time to the precision data that Verdigris sensors capture, Verdigris delivers insights on granular energy issues that other systems miss. Facility and property managers can act at optimal times or implement automated responses to improve energy efficiency, address potentially critical issues, and reduce downtime.

Commercial real estate owners increase net operating income by cutting energy costs. Meanwhile, occupants enjoy an optimized environment enabled by AI-enhanced building controls. Verdigris' non-intrusive IoT sensors work alone or in synergy with building management systems. Customers have achieved fast ROI, often within months, by decreasing energy costs 20 percent or more.

"We're helping companies survive and thrive in a dynamic period of digital transformation while navigating Covid, economic turbulence, the increasing impact of climate change, and sustainability legislation. To do that, buildings and industry need cost-effective and scalable data and AI solutions that enable intelligent environments to align the interests of building owners, operators and occupants," said Thomas Chung, Head of Growth at Verdigris.

Verdigris' patented technology monitors granular energy consumption and power quality details for individual devices at thousands of times per second, detecting hidden issues that most other systems miss and automating responses for optimized "driverless" buildings.

About Innovatus - Innovatus Capital Partners, LLC is a boutique specialty finance firm focused on creating value for investors in emergent asset classes, private credit and asset-based investments, based in New York. Innovatus has assets under management in excess of $1.5 billion. Innovatus has a dedicated team of real estate investment professionals with deep experience in commercial real estate acquisitions, recapitalizations and asset management across core-plus and opportunistic real estate investments amongst all property types including office, retail, hotel, medical, industrial and warehouse. Innovatus and its principals have significant real estate experience with ventures that range from the creation of a CMBS lending group and servicing platform to making equity investments in developments and single asset purchases. Further information can be found at www.innovatuscp.com

About Verdigris - Verdigris Technologies is a leading AI company that empowers the world's smartest buildings with data, insights and automation. Through artificial intelligence and IoT-enabled sensors, Verdigris 'learns' and distinguishes the equipment components of commercial buildings, providing rich data streams about critical equipment. Powerful analytics constantly scan this data to find hidden inefficiencies, produce actionable reports and empower building managers to optimize facilities management. Among other honors, Verdigris was named one of the top ten Most Innovative Companies in Energy by Fast Company and

selected as the Frost and Sullivan Technology Innovation Leader in the North American AI-based Energy Management and Automation Industry. Verdigris is headquartered at the NASA Ames Research Park in Silicon Valley, California with offices in the US and Taiwan. See verdigris.co for recent press and testimonials. For more information, please contact Media Relations at press@verdigris.co.

About Lincoln Property Company - Lincoln Property Company is one of the largest and most diversified real estate services firm in the United States and is the only national real estate company to rank concurrently in the top 10 of Management/Ownership of Office, Industrial, Multi-family, and Retail. With an international footprint that includes offices in 45 cities across the United States and 6 cities in Europe and South America, LPC remains a privately and closely held company. As a matter of corporate intention and philosophy, the company has operated virtually debt-free since the early 1990's, uniquely positioning itself to provide focus and performance as well as consistency and stability to its clients and employees in the economically challenging times of today. This corporate philosophy combined with over 50 years of global real estate is what differentiates LPC from other service providers and real estate companies.

VERDIGRIS

For more information, media contacts:

Bradley Seiden, Managing Director, Innovatus Capital Partners, LLC; 917-873-0332 or bseiden@innovatuscp.com

Edward J. Price, Senior Vice President, Lincoln Property Company Southeast, 407-872-3500 or eprice@lpc.com

Media Relations, Verdigris Technologies, press@verdigris.co and www.verdigris.co

Beth Payan, Larry Vershel Communications Inc. 407-461-3781 or beth@LarryVershel.com

USGS-Black Swift, NASA partnership to reduce volcanic hazards

October 19, 2021

Last week, a team of Federal scientists and industry engineers pushed back the frontiers of monitoring hazardous volcanoes, flying a small unoccupied aircraft system (UAS) over an active Alaskan volcano. This public-private partnership between USGS, NASA and Black Swift Technologies LLC showed that cost-effective UAS equipped with state-of-the-art gas sensors and imaging systems can fly safely beyond visual line-of-sight (BVLOS), opening the door to routine autonomous missions over hazardous volcanoes around the world. With this new tool, scientists can alert local and aviation communities to oncoming signs of danger. The team flew four missions, acquiring high-resolution imagery to map possible changes from recent volcanic activity, and demonstrated the capacity of gas sensors to detect hallmark volcanic gases that may signal onset of activity. The experience collected on these safe flights pave the way for future BVLOS UAS operations for monitoring potentially hazardous volcanoes from a safe distance. This partnership represents a Federal-Industry effort that could provide USGS and NASA with routine use of BVLOS UAS for a diverse suite of hazards, including volcanoes, drought, floods and many others.

[ROLES & RESPONSIBILITIES] This effort is the culmination of three years of collaboration between Black Swift Technologies LLC, USGS and NASA, funded by the USGS Volcano Hazards Program, the USGS National Land Imaging Program, NASA SBIR and NASA Earth Sciences, and coordinated by USGS National Innovation Center. USGS volcanologists Christoph Kern and Angie Diefenbach proposed the opportunity, and developed the imaging and gas payload. Supported by colleagues at both the Alaska and Cascades Volcano Observatories and Matt Fladeland at NASA Airborne Sciences, they worked with Black Swift Technologies LLC to integrate these sensors on Black Swift's S2. The Black Swift team worked with NASA on airworthiness and flight readiness, an exhaustive process that validates safety and readiness for the team's flight. With the assistance of partners in Alaska (Dan Morgan, USGS Alaska Regional Safety Officer, Andy Dietrick, Aleutian Aerial) and the USGS National UAS Projects Office, the team received final per-

Photo Credits: Black Swift Technologies
Photo Caption: Aerial photograph of the crater lake and degassing fumaroles at the summit of Makushin Volcano, Unalaska Island, AK

missions for these path-finding flights from FAA and NASA a few days before they launched.

During the 2nd week of September 2021, a team of scientists and UAS engineers deployed to Dutch Harbor in the Aleutian Islands of Alaska, to fly the first USGS beyond visual line-of-sight (BVLOS) UAS missions. This capacity provides scientists with potentially routine, semi-autonomous UAS flights that can fly dull, dirty or dangerous missions, like systematically collecting volcanic gas emissions to detect changes that signal volcanic unrest. This capacity alleviates some need for sending personnel by helicopter, fixed wing, or on the ground, into dangerous or difficult to access areas.

The team first launched Black Swift's S2 UAS from the Dutch Harbor airport Friday September 10, 2021, proving safe BVLOS flights over the active Alaskan volcano Makushin. The Black Swift S2 is a fixed-wing, electric UAS with 3-m wingspan, propelled into the air by means of a pneumatic launcher. From the apron of Dutch Harbor airport, the S2 launched and travelled 2 miles westward at 400 ft above ground level, with the team deconflicting airspace via visual line-of-sight observations. After the initial 2-mile traverse, the aircraft entered an area in which other aircraft are prohibited from flying by a temporary flight restriction (TFR) filed with the Federal Aviation Administration (FAA). At this point, the aircraft began climbing to the 6,000 ft summit of Makushin Volcano, located approximately 15 miles to the west. Traveling BVLOS now, the team kept track of the aircraft via visualizations of the flight track and profile provided on monitors at the base station.

Credit: USGS (Christoph Kern)
Caption: Jack Elston (Black Swift Technologies) and Andy Dietrick (Aleutian Aerial) retrieving the S2 from the Dutch Harbor airport apron after a successful landing.

Improved weather conditions the week of September 13 allowed them to launch multiple successive flights with science payloads, including visible and IR photogrammetry cameras. Despite headwinds of approximately 30 kts, the aircraft was able to map the summit area with the nadir-facing high-resolution visible and thermal cameras. The imagery shows the summit crater lake and vigorous degassing from fumaroles on either side, as well as several other snow-free areas with fumarolic activity.

The aircraft then safely returned, passing over and successfully mapping the active hydrothermal area at Upper Makushin Valley before landing at Dutch Harbor airport. A second mission was flown with the gas sensing payload. While approaching the volcano, the UAS encountered strong headwinds and downdrafts (2000 ft per minute) and the aircraft autonomously turned back and landed safely at the base station.

While in Dutch Harbor, the team conducted outreach events in the adjacent community of Unalaska, including a radio interview and interaction with approximately 200 local elementary, middle, and high school students.

Photo Credits: Black Swift Technologies
Photo Caption: Aerial photograph of the crater lake and degassing fumaroles at the summit of Makushin Volcano, Unalaska Island, AK

Coming to You "Live" Virtually From RMV Technology Group

By Renee Mitchell, Moffett Field, California

Vermillion Innovates a Unique Virtual Platform In Place of Traditional "Hands-On" Learning

Since 2014, the NASA ESD Program Manager training developed by Bob Vermillion, CEO/Founder of RMV Technology Group LLC, a NASA Industry partner, has held the 5-day "Hands-On" Instrument driven program at NASA Ames Research Center. Participants come from almost all NASA centers from LaRC to AFRC, plus support contractors.

Held once every two years in early Spring, the 2020 training was cancelled repeatedly during the pandemic. One delay after another and the decision was finally made among the NASA Interagency Working Group on ESD (IAWG) to go "Virtual" over a year later. Because the "Hands-On" program has been so successful, the group did not feel that Virtual could replace previous RMV training. Other organizations claim to teach "Virtual", however, these presentations are merely PowerPoints embedded into a webinar platform.

The challenge for RMV was real. We had to overhaul and modify the training to "focus in" on the most critical elements to ensure effective remote learning. RMV had only a 3-month window to redevelop and get the job done. During that time, we produced over 50 videos reinforcing NASA-STD-8739.6B and conducted several "shakedown" training sessions. In addition, RMV developed a list of "Live" demos to encourage deeper engagement during the remote training in the RMV lab throughout the course. With implementation of a

NASA ESD Interagency Working Group for ESD (IAWG) Awards Certificate of Excellence to Bob Vermillion, NASA ESD Technical Authority.

During the monthly TEAMS Virtual Meeting, Gene Monroe, NASA IAWG Chair, made a special announcement to award Bob Vermillion with a Certificate of Excellence for the RMV development of the NASA ESD Program Manager program, presented on 18 August 2021.

In attendance were a few invited guests that included Glenn Delgado, Associate Administraitor for the NASA Office of Small Business (OSBP), Greg Josselyn, NASA Ames Research Center (ARC) Associate Director of Engineering and Coreena Conley, Executive Director, Veteran Business Outreach Center (VBOC) SBA Region IX, Sacramento, California.

"whitelisted" software licensed by RMV, the training materials were made available in a secure format. Finally, and equally important, the Hands-On Training Session gave each student the opportunity to demonstrate their proficiency utilizing equipment in the comfort of their office, home or laboratory. The excellent reviews attest to the innovation and hard work by RMV in developing a unique and effective ESD "Hands-On" Training Program. Remote Training specific to Agency need that is done right can be very effective for future NASA training in a "Live" Virtual platform.

Above all, the most important "take away" is that ESD Integrity for Space & Defense must be compliant and traceable to NASA-STD-8739.6B which the contracting community uses as an ESD roadmap for compliance. ESD integrity requires following NASA guidelines down to the board level to manage, handle, assemble, store and transport devices for safety, security and, ultimately, Mission Success.

The Latest News from RMV Technology Group

Learn more about the NEW and Upcoming iNARTE® ESD International Certification courses exclusively developed and conducted by the Subject Matter Experts of RMV Technology Group. Please contact Renee Mitchell, President, RMV Technology Group LLC at 650-964-4792 or email Renee at renee@esdrmv.com.

www.esdaerospacetraining.org www.esdrmv.com

NASA and USGS Partner to Measure Stream Flow Remotely with UAS

By Chad Wagner, Groundwater and Streamflow Information Program & Tim Newman, National Land Imaging Program - October 19, 2021

NASA and USGS are developing an autonomous UAS to map stream flow from the air and demonstrated it successfully for the first time over the Sacramento River, California.

Last month, USGS engineers and scientists conducted the first operational flight of a new intelligent system for measuring stream discharge from a UAS (Uncrewed Aircraft System). This capability complements our current national stream gage network, extending measurements to reaches where we lack gages. The team flew a UAS equipped with thermal infrared and visible imagers and collected high-resolution video across a test section of the Sacramento River in California. They estimated water depth by applying a technique called optimal band ratio analysis (OBRA) to images and inferred surface flow velocities via particle image velocimetry (PIV). The resulting estimate of stream discharge is close to an independent field-based measurement from a NOAA team. This initial test represents the latest step in a long-standing partnership between NASA Ames Intelligent System Division and USGS elements, including scientists from the Water Mission Area, engineers from the UAS Research Center, and coordination and funding from National Land Imaging and National Innovation Center. Accurate, remote measurements of stream discharge from UAS could play a role in extending our water observations across the Nation's many ungaged streams, improving flood resilience and drought awareness.

USGS hydrologists Carl Legleiter and Paul Kinzel have been exploring the use of different methods to estimate surface flow velocities remotely, including PIV, a technique that infers velocities by measuring the displacement of distinctive pixel structures in sequential images. They proposed mounting a thermal imager on a UAS, and then taking images over a stream until the error budget for the velocity field meets a threshold value. Combined with the OBRA method of mapping bathymetry and, the resulting surface velocity fields can be used to calculate the volume of water flowing through a stream cross-section per unit time. They partnered with Uland Wong, Michael Dille, Antoine Tardy, and Ted Morse of the NASA Ames Research Center's Intelligent Systems Division to integrate a thermal camera, a natural color video camera, a laser range finder, and an embedded CPU into a platform-independent payload. USGS National Innovation Center UAS Research Center engineers Elizabeth Hyde and Isaac Anderson developed the custom payload enclosure, mounting hardware, and ground station for in-flight communication. USGS hydrogeophysicist Cian Dawson coordinated and piloted the test flights. The team collaborated with hydrologist Lee Harrison of NOAA, who identified the field site, secured permissions, and collected field measurements of depth and velocity for calibration and accuracy assessment of the image-derived estimates. These in-situ observations were obtained within two days of the USGS-NASA test flight.

Results

During the third week of September 2021, the team of scientists and UAS engineers deployed to the Hartley Island reach of the Sacramento River and launched the USGS-NASA payload. This site provided an opportunity to test the system's performance over an important California waterway. The reach had a

mean channel width of 97 m, a mean depth of 1.7 m, a mean depth-averaged flow velocity of 0.99 m/s, and a water surface slope of 0.00018. The instrumentation was deployed from a hexacopter UAS, but the payload design is platform-independent, providing

During three test flights, sensors acquired video while the UAS hovered above the channel at locations coinciding with the NOAA field surveys. The natural color video data was collected high enough above the center of the channel to include both banks within each video frame, with a 6.1 cm pixel size. Due to differences in resolution and field of view between the two cameras, separate flights at lower altitudes were performed to ensure that at least one bank was visible in the thermal infrared images. Altitudes during data collection ranged from approximately 430 ft (~121 m) to 775 ft (~236 m) above the water surface. The natural color video frames were geo-referenced to an orthophoto acquired earlier in the week by NOAA colleagues using a Quantum-Systems Trinity F90+ fixed-wing vertical takeoff and landing (VTOL) UAS.

The team used Wi-Fi to control the sensors during the flight and position the UAS to optimize acquisition over the river. Live-streamed images helped the flight team guide the UAS pilot to the desired sample location where both stream banks were visible. Both optical and thermal cameras recorded video and an on-board laser measured flying height to calculate image scale. Due to a preexisting condition with the cooling mechanism for the thermal camera, this sensor did not provide usable data, but the natural color video encompassed the full 97-m width of the Sacramento River at the sample location, capturing both variations in color related to water depth and features at the water surface being advected by the flow.

The team processed the optical video using image stabilization and PIV algorithms and then geo-referenced the remotely sensed data. There is very strong agreement between image-derived estimates of surface flow velocity and in-situ observations of depth-averaged flow velocity collected with an acoustic Doppler current profiler (ADCP) deployed from a NOAA boat.

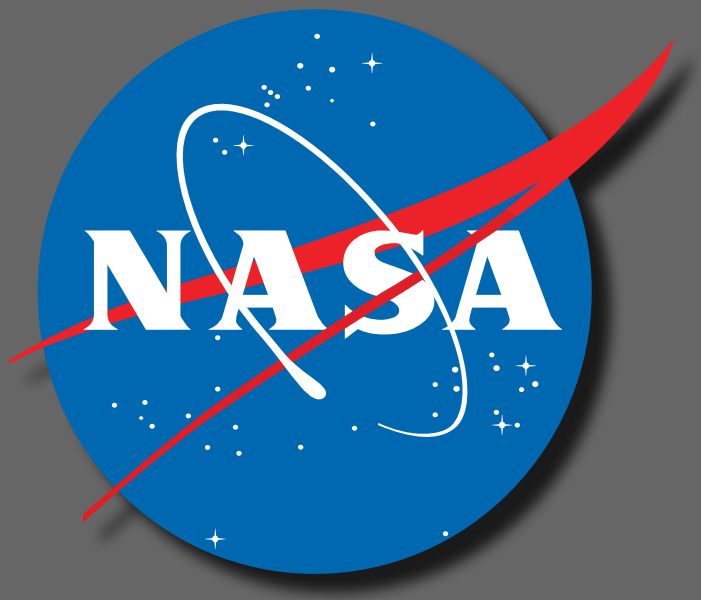
The close correspondence between traditional and UAS-derived river discharge estimates demonstrates that this system could provide hydrographers with an efficient, cost-effective means of performing both routine and as-needed discharge measurements, including under hazardous high-flow conditions which pose a safety risk to both personnel and instrumentation. Such a capacity could enable the USGS to collect a greater number of streamflow measurements at a greater number of monitoring locations, with reduced demands on staff, particularly in dangerous or difficult to access locations.

For more information on stream gaging, contact PIs Carl Legleiter or Paul Kinzel. For more information on the partnership with NASA, please contact Jonathan Stock or Bruce Quirk.

Chad Wagner
Program Coordinator, Groundwater and Streamflow Information Program
Water Mission Area

Tim Newman
Program Coordinator, National Land Imaging
Core Science Systems Mission Area

USGS
science for a changing world



National Aeronautics and Space Administration

NRP POST

A Publication of NASA Research Park

NASA Research Park
Editor, Layout and Design: TED TRIANO
Phone: (650) 604-2NRP
Email: arc-dl-nrp-post@mail.nasa.gov
Website: www.nasa.gov/researchpark

NP-2021-12-01-ARC