

Novel Data Collection Method For Hard-To-Reach Ground Sensors

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Data Mule unmanned aircraft system (UAS) autonomously flies to ground-based sensors located in hard-to-reach areas and wirelessly uploads data.

Data Mule UAS was successfully demonstrated at the Barry M. Goldwater Range (BMGR) East in 2019 and Naval Base Ventura County (NBVC) in 2020.

PROJECT DESCRIPTION

- Ground sensors collect important environmental data to help inform natural resource management decisions on military installations and provide data for Integrated Natural Resource Management Plans.
- Sensors for natural resources are frequently located in hard-to-reach areas that require field personnel to drive/hike to retrieve data, which is time-consuming, exposes personnel to safety risks (e.g., steep terrain, extreme temperatures), and is costly.
- This project demonstrated the use of the Data Mule UAS to upload and manage data from remote ground-based camera traps in a desert and coastal environment. We used a vertical take-off and landing, fixed-wing UAS to fly to the ground station, wirelessly collect the camera trap imagery, and fly back to deliver the data.
- This technology was validated for its efficiency and effectiveness in comparison with the standard method of manually collecting data from ground sensors.
- We flew 100+ flights and demonstrated the feasibility and effectiveness of the technology in DoD context.

TECHNOLOGY EVALUATED

- Data Mule UAS wirelessly uploads data to its onboard payload from a solar powered communication station integrated into a ground sensor. The UAS payload and ground station are equipped with wireless communication hardware and software.
- Data are wirelessly transferred from a ground-based camera trap to the payload onboard storage device.
- Amount of data uploaded depends on upload speeds which varies by location and environment. Requires direct line of sight between payload and ground station.

TECHNOLOGY ADVANTAGES

- Enables data retrieval over difficult terrain, when access is restricted (e.g., breeding season), more frequently, and more cost effectively.
- Resistant against data loss with a novel Two-Pass Data Management software. Data is only deleted during the next flight after it has been successfully uploaded.
- Works with a variety of commercial-off-the-shelf (COTS) UAS and ground-based sensors.

APPLICATIONS OF THE TECHNOLOGY

- Data Mule UAS can remotely retrieve data from cameras traps and other sensors.
- Data Mule UAS technology is best suited for areas that have limited or restricted access from the ground, rugged or sensitive terrain, and when sensors are far from existing roads making physical retrieval of data more difficult and time consuming.

Demonstration Sites: BMGR East, AZ and NBVC, CA

Data Mule UAS technology was demonstrated at:

- BMGR East (southeastern AZ) in June-Nov 2019: large remote military base with extremely hot and dry desert conditions; camera traps placed at remote, supplemental water sources for wildlife.
- NBVC Point Mugu and San Nicolas Island (southern CA) in May-Jan 2020/2021: coastal environment with humidity, fog, and windy conditions; camera traps placed in bird nesting areas that are not accessed during the nesting season.

Project success based on:

- Data Mule UAS ability to autonomously conduct flights from a pre-programmed mission plan, connect consistently with communication stations, and upload camera trap sensor data from ground station to storage payload.

Cost effectiveness of the technology depends on:

- How many successive camera traps are visited in a single flight; while it takes more time to visit a single camera trap with the UAS than by ground access, it was faster to visit multiple (5) camera traps successively with the UAS than by ground access.



DEMONSTRATION RESULTS

Missions Flown:

- Flew 100+ successful flight
- Over 25,000 images remotely retrieved
- Autonomous navigation and data collection
- Multi-waypoint long distance (up to 10 km)
- Multiple missions per single flight
- Multiple missions beyond telemetry range
- Multiple missions beyond visual line of sight

Cost Effectiveness of Data Mule UAS Improves when:

- Multiple flights flown from a single landing zone
- Multiple data stations are in close proximity
- Data collection is needed more frequently
- There are long hiking distances to access ground sites

Advantages of Data Mule UAS:

- Flights accessed data more quickly and over shorter distances than standard ground access
- Can access sites with no ground accessibility (e.g., restricted access during nesting season)
- Works with a variety of COTS UAS and types of ground sensors
- Reduced ground disturbance
- Reduced risk to field personnel

Disadvantages of Data Mule UAS:

- Need training to fly UAS
- DoD has multiple restrictions and required approvals for UAS operations
- UAS operations limited by UAS flight envelope (e.g., temperature range, winds, rain)
- Greater upfront costs

Additional Resources

ESTCP PROJECT

Use of the "Data Mule" Unmanned Aircraft System to Remotely Download Ground Based Sensor Data on Military Lands

Project Overview Video Link: <https://youtu.be/34mJcgrfgM>

CONTACT INFORMATION

David Delaney, David.Delaney@usace.army.mil
Mission Mule: <https://www.missionmule.com>
Zane Mountcastle, zane@missionmule.com

About ESTCP

The Environmental Security Technology Certification Program (ESTCP) is the U.S. Department of Defense's environmental technology demonstration and validation program. The program's goal is to identify and assess innovative technologies that address DoD's high-priority environmental requirements efficiently and cost-effectively.

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