

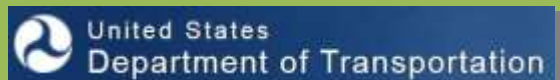
# Unmanned Aerial Systems for Transportation Decision Support

Principal Investigator: Jarlath O'Neil-Dunne  
Program Manager: Caesar Singh

COOPERATIVE AGREEMENT  
No. OASRTRS-14-H-UVM

## Quarterly Progress Report #1

October 1, 2014 through December 31, 2014



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## Glossary

3D	Three Dimensional
AASHTO	American Association of State Highway Transportation Officials
CAD	Computer-Aided Design
CNL	Cognition Network Language
COA	Certificate of Authorization
CRS	Commercial Remote Sensing
DOT	Department of Transportation
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
GIS	Geographic Information Systems
HDSS	Hazard Data Distribution System
ICS	Incident Command System
LiDAR	Light Detection and Ranging
NAIP	National Agricultural Imagery Program
NIMS	National Incident Management System
NOAA	National Oceanic and Atmospheric Administration
OBIA	Object-Based Image Analysis
OGC	Open Geospatial Consortium
PI	Principal Investigator
PM	Program Manager
RiP	Research in Progress database
RITA	Research and Innovative Technology Administration
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SAL	Spatial Analysis Laboratory (University of Vermont)
SI	Spatial Information
TAC	Technical Advisory Committee
TRC	Transportation Research Center
UAV	Unmanned Aerial Vehicles
USDOT	United States Department of Transportation
USGS	United States Geological Survey
UVM	University of Vermont
VAOT	Vermont Agency of Transportation (also known as Vtrans)
VTrans	Vermont Agency of Transportation (also known as VAOT)
XML	eXtensible Markup Language

## Executive Summary

Commercial remotely sensed datasets have tremendous value for a broad range of transportation-related activities, but their full potential is often constrained by inadequate temporal resolution, poor spatial resolution, and high acquisition costs. Unmanned Aerial Systems (UAS) have the potential to overcome these limitations, radically changing the way remote sensing data are used for transportation planning, operations, maintenance, and program development. Contemporary off the shelf UAS are inexpensive to purchase, easy to operate with proper training, rapidly deployable, and provide data with spatial resolutions that cannot be matched by traditional airborne and spaceborne platforms. This supplemental funding will be used to expand the operational capacity of the UAS portion of our project, addressing the needs of state transportation agencies. This project will apply proven UAS acquisition and analytical capabilities in four categorical areas that have been determined to be of high interest by stakeholders: 1) geomorphic assessment, 2) construction management and phasing, 3) resource allocation during disaster response, and 4) cost decision support. We will marry this with a robust outreach and training program that will improve the abilities of state and local transportation planners to integrate UAS data and products into their decision-making and management operations. The activities in all four areas will develop operational solutions with quantifiable results that improve decision making, reduce costs, increase life safety, and provide a measurable impact on existing decision processes, models and resource tasking.



The above figure provides a sample of data the project team collected at the Morrisville Alternative Truck Route Project in Vermont. This data was used to calibrate fill calculation models, but will also serve to demonstrate construction phasing and progress.

## Technical Status

### Task 1: Project coordination

*The supervision, scheduling, and phasing of personnel and resources associated with the project.*

Output/Deliverables: Finalized project timeline, acquisition of equipment and needed supplies and relay of project team effort to team members.

#### Accomplishments:

*Provide a clear and complete account of work performed on each task and its relationship to task objectives and milestones.*

- A project website was created: <http://www.uvm.edu/trc/rapid-exploitation-of-commercial-remotely-sensed-imagery-for-disaster-response-recovery/unmanned-aerial-systems-for-transportation-decision-support/>

#### Problems Encountered:

*Describe any problems encountered or anticipated that will affect the completion of the agreement within the time and fiscal constraints as set forth in the agreement, together with recommended solutions to such problems, or a statement that no problems were encountered.*

- None

#### Future Plans:

*Discuss work planned for the next period and its relationship to the present period. Provide an outline of the work to be accomplished during the next report.*

- Purchase additional UAS equipment
- Update website with new information as it becomes available

#### Schedule:

*Highlight any changes to the schedule as previously reported.*

- None





**Task 3: Stakeholder/partnership meetings**

*Establish the advisory committee and carry out meetings with external groups and collaborators, including state transportation departments, industry partners, and the advisory committee. Meetings include: project kick-off, advisory committee updates, meetings with local/state transportation agency personnel, selection of UAS flight sites, industry/commercial integration partner meetings, and stakeholder decision support feedback. The committee will review project progress and provide guidance throughout the life of the project.*

Output/Deliverables: Create an advisory board of transportation agencies members and subject matter experts; Meeting notes.

Accomplishments:

*Provide a clear and complete account of work performed on each task and its relationship to task objectives and milestones.*

- The project team has identified and contacted the following people to confirm their participation in the Technical Advisory Committee (TAC) for this project:
  - Guy Rouelle, Aviation Program Administrator, Vermont Agency of Transportation (VTrans)
  - Johnathan Croft, GIS Database Administrator, VTrans
  - Michele Boomhower, Director of Policy, Planning and Intermodal Development, VTrans
  - Michael Umansky, Applied Imagery
  - Charles Hebson, Manager of Surface Water Resources, Maine Department of Transportation (DOT)
  - Adam Zylka, senseFly
  - Jason Moghaddas, Spatial Informatics Group
  - Bryan McBride, Spatial Networks

Problems Encountered:

*Describe any problems encountered or anticipated that will affect the completion of the agreement within the time and fiscal constraints as set forth in the agreement, together with recommended solutions to such problems, or a statement that no problems were encountered.*

- No problems were encountered.





#### **Task 4: UAS Operations**

*Planning, data acquisition, and data processing associated with UAS operations.*

Output/Deliverables: Flight plans; UAS operating guidelines to include a UAS equipment checklist, UAS flight checklist, UAS operating procedures and manual.

#### Accomplishments:

*Provide a clear and complete account of work performed on each task and its relationship to task objectives and milestones.*

- The project team collected data on the following dates:
  - November 17<sup>th</sup> at the University of Vermont. This flight served multiple purposes. Representatives from senseFly traveled to UVM to provide additional training and introduce their new thermal camera system. Additionally, representatives from VTrans and ANR were present for a flight demonstration.
  - December 4<sup>th</sup> and December 16<sup>th</sup> in Plainfield, VT. Data was collected with respect to a geomorphic assessment model for the river system in Plainfield.

#### Problems Encountered:

*Describe any problems encountered or anticipated that will affect the completion of the agreement within the time and fiscal constraints as set forth in the agreement, together with recommended solutions to such problems, or a statement that no problems were encountered.*

- None

#### Future Plans:

*Discuss work planned for the next period and its relationship to the present period. Provide an outline of the work to be accomplished during the next report.*

- Plan many more flights.
- Start working on a UAS Checklist
- Start working on UAS data processing procedures

#### Schedule:

*Highlight any changes to the schedule as previously reported.*

- None.



### **Task 5: Decision Support Tools**

*Decision support tools to support the four categorical areas: Geomorphic assessment, Construction management and phasing, Resource allocation, and Cost decision support.*

#### Output/Deliverables:

Geomorphic assessment: 2D orthophoto mosaics, 3D point clouds, Updated hydrologic network in GIS format, Stream cross sections and morphological change, Geomorphic assessment report, Comparison of UAS-based geomorphic assessment to field-based ones. Construction management and phasing: 2D orthophoto mosaics, 3D point clouds, GeoPDF visualization products, Web-based multi-temporal mapping portal, Mobile construction phasing assessment tool. Resource allocation: KML image chip files, 2D compressed orthophoto mosaics, Best practices/NIMS integration white paper. Cost decision support: Updated fill estimation/cost estimation tool, Web-based mapping portal.

#### Accomplishments:

*Provide a clear and complete account of work performed on each task and its relationship to task objectives and milestones.*

- 2D orthophoto mosaics and 3D point clouds were provided for the Plainfield, VT geomorphic assessment.

#### Problems Encountered:

*Describe any problems encountered or anticipated that will affect the completion of the agreement within the time and fiscal constraints as set forth in the agreement, together with recommended solutions to such problems, or a statement that no problems were encountered.*

- None

#### Future Plans:

*Discuss work planned for the next period and its relationship to the present period. Provide an outline of the work to be accomplished during the next report.*

- Develop decision support tools for the Plainfield, VT geomorphic assessment.
- Collect more data for all four categorical areas.

#### Schedule:

*Highlight any changes to the schedule as previously reported.*

- None.



**Task 6: Training and Outreach**

*Host workshop and online “virtual campus” tutorials and data. Training data will be assembled from the missions conducted in task 4. Three videos will be produced to UAS decision support tools. A training manual will be compiled for the workshop. A workshop on UAS decision support tools will be given in UVM’s geospatial teaching facility and feedback from attendees will be gathered. All materials will be posted online for universal access.*

Output/Deliverables: Workshop on UAS products for transportation decision support; online training materials including videos, sample data, and step-by-step manuals.

Accomplishments:

*Provide a clear and complete account of work performed on each task and its relationship to task objectives and milestones.*

- None.

Problems Encountered:

*Describe any problems encountered or anticipated that will affect the completion of the agreement within the time and fiscal constraints as set forth in the agreement, together with recommended solutions to such problems, or a statement that no problems were encountered.*

- None.

Future Plans:

*Discuss work planned for the next period and its relationship to the present period. Provide an outline of the work to be accomplished during the next report.*

- None.

Schedule:

*Highlight any changes to the schedule as previously reported.*

- None.









## Business Status

### Labor-Hours Expended for the Program

Provide a tabulation of the planned, actual and cumulative labor-hours expended for the program.

Employee Name/ Labor Category	Total Budgeted Hours	Year 1 (hours)				Year 2 (hours)				Cummulative (hours)
		Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 5	Quarter 6	Quarter 7	Quarter 8	
Jarlath O'Neil Dunne	324.94	0								0
Amanda Hanaway	536.30	8								8
Sean MacFadden	715.00	0								0
Zachary Borst	715.00	56								56
Technician	3,138.10	0								0

### Funds Expended for the Program

Provide a chart showing current and cumulative expenditures versus planned expenditures

Employee Name/ Labor Category	Total Invoiced for Salary	Year 1 (Invoiced Salary)				Year 2 (Invoiced Salary)				Cummulative (Invoiced Salary)
		Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 5	Quarter 6	Quarter 7	Quarter 8	
Jarlath O'Neil Dunn	\$27,266.46	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Amanda Hanaway	\$28,336.38	\$622.48	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$622.48
Amanda Hanaway (Cost Share)	\$14,168.60	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Sean MacFadden	\$45,703.84	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Zachary Borst	\$36,132.08	\$2,778.28	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$2,778.28
Technician	\$80,828.98	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Non-Salary Expenditures	\$15,795.55									\$0.00
Non Salary Cost Share	\$219,894.40									\$0.00
<b>Total</b>	<b>\$232,436.34</b>	<b>\$3,400.75</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$3,400.75</b>
Cost Share:	\$234,063.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Invoiced:	\$234,063.30	\$3,400.75	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$3,400.75
<b>Total:</b>	<b>\$468,126.30</b>	<b>\$3,400.75</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$3,400.75</b>

### Cost Share:

- \$3,200 in Facility Rental Fee, Custodial Services and Catering Work Orders are requested for a GIS and Remote Sensing Tools workshop to be held at the University of Vermont.

- \$5,000 in Personnel Time, \$10,000 in Technical Support, \$9,000 in web-based software training, and \$1,000 in Sensor leasing all as cost-share from senseFly.
- \$123,090 of cost-share for Quick Terrain licenses for workshops, and \$2500 for a 2 day training session for Quick Terrain modeler.
- \$6,750 for UAS Business Development, \$1200 in Travel Costs, \$1500 for Data Storage and \$3750 for data processing all as cost share from Spatial Informatics Group
- \$17,976 for Fulcrum Team License, \$7560 for the Premium Support Package, \$4000 for On-Site Training and \$5000 for Image Processing and Conversion, all as cost share from Spatial Networks.
- \*Unmanned aerial systems will be purchased on this project in year 1 for the purpose of assessing the volume of fill needed to repair damaged roads. One UAS will be purchased for \$24,000; \$23,000 as cost share.
- NOTE: The total cost share listed above is \$224,526. However, we only need \$219,894.40, so that's all we committed to in the financial reporting.

**Budget for Non-Salary Expenditures:**

Equipment (*see note above)	\$1,000.00
Facility Fees, Custodial Work Orders, UVM Services	\$4,880.00
Travel (**see note below)	\$9,915.55
<b>Grand Total</b>	<b>\$15,795.55</b>

\*\*Note: This request includes an estimated cost for regional travel to meet with agencies and collaborators, conduct ground-truthing, and launch unmanned aerial vehicles.

## Meetings

### List of Advisory Committee Meetings to Date:

- None yet, but a kick-off meeting will be planned for the next quarter.

### List of Meetings with the USDOT Project Management Team:

- None yet.

## Presentations

- None yet.

## Partnerships

The Project Team has been collaborating not only with the project's Technical Committee, but the following organizations as well:

- Vermont Agency of Natural Resources. The project team has been working with ANR on their stream monitoring program. The discussions have been focused around using Unmanned Aerial Vehicles to monitor sections of rivers and streams that are difficult to access on the ground for geomorphic assessments.
- Vermont Agency of Transportation. The project team has been working with the Maintenance and Operations Department at VAOT on their culvert maintenance program. The discussions have been focused on what is happening upstream which may be causing culverts downstream to become blocked.
- Windham Regional Planning Commission. The project team assisted the commission by acquiring UAV data of an area damaged by flooding.

## Quarterly Report Submission Timeline

*If the submission due date is a holiday/weekend please ensure that the submission is made by the subsequent business day. Deliverables covering partial periods of performance up to one month will be rolled over into the subsequent quarterly progress report.*

- Quarterly Report for Period covering January 01 to March 31 is due by April 15
- Quarterly Report for Period covering April 01 to June 30 is due by July 15
- Quarterly Report for Period covering July 01 to Sept. 30 is due by October 15
- Quarterly Report for Period covering October 01 to December 31 is due by January 15