1.Cover Sheet

RITARS-12-H-UVM (Supplemental Funding)
Full Proposal: University of Vermont

Proposal Submitted by:		
For Use by DOT	Date Received	Proposal Number

Title of Project Supplemental Funding: Unmanned Aerial Systems for Transportation Decision Support	Project Duration _22_ months	
Name/Address of Submitting Organization, Business Contact, DUNS# and Taxpayer ID# Sylvie Butel University of Vermont 85 South Prospect Street, 340 Waterman Building Burlington, VT 05405 DUNS: 066811191 Tax ID: 030179440	Telephone 802-656-3360	Fax 802-656-8406
	Total Project Cost: $496,660 (includes match)	
Submission Date: September 5, 2014	DOT Budget $ 248,330 Cost Sharing $248,330 Total Project Cost $ 496,660	
Business Type [x] Academic [ ] Profit [ ] Non-Profit	Size (Number of Employees) [ ] <10 [ ] <100 [ ] <200 [x] >200	
Name/Address of Principal Investigator Jarlath O'Neil-Dunne University of Vermont Spatial Analysis Laboratory 81 Carrigan Drive, Aiken Center 205 Burlington, VT 05405	Telephone and Email 802-656-3324 joneildu@uvm.edu	Fax 802-656-8683
Names of other Key Investigators		

Summary

This is a request for supplemental funding for project RITARS-12-H-UVM. This supplemental funding will be used to expand the operational capacity of the Unmanned Aerials Systems (UAS) portion of our project to address the needs of state and local

transportation agencies and to commercialize the technology. This project will seek to apply our proven UAS acquisition and analytical capability in four categorical areas that have been determined to be of high interest by stakeholders: 1) stream geomorphic assessment 2) construction management and phasing, 3) resource allocation during disaster response, and 4) cost decision support during disaster response. We will marry this with a robust outreach and implementation 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, while also establishing an operational capacity for contract work. The activities in all four areas will seek to develop operational solutions that produce quantifiable results that improve decision making, reduce costs, and provide a measurable impact on existing decision processes, models and resource tasking. Finally, we will develop a business model so that UAS services can be offered to state and local transportation agencies beyond the lifespan of this project

2. Public Abstract

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.

3. Technical Approach and Understanding

3.1 Overview and Objectives

Unmanned Aerial Systems (UAS) are a new technology that are revolutionizing the use of commercial remotely sensed data by the transportation sector. They are lightweight, easily deployable, and can provide actionable information within hours after data acquisition. These characteristics allow UAS to overcome limitations associated with traditional commercial remote sensing technologies such as inadequate temporal resolution, poor spatial resolution, and high costs of data acquisition. This project will build on our existing UAS capacity developed in RITARS-12-H-UVM to deploy commercial, operational UAS technology for a broad range of transportation-related activities and to couple these activities with a detailed outreach program that will directly transfer requisite knowledge to transportation personnel. In our current RITA project, we have employed UAS technology for post-disaster response, specifically estimating the fill volume needed to repair damaged roadways. This proposal builds on our current funding and is designed to meet the needs of our state and local transportation agency collaborators, who have expressed great interest in using commercial UAS remote sensing technology for a broader range of applications.

Our project has four main goals:

1) Conduct UAS operations to support stream geomorphic assessments, construction management and phasing, resource allocation during disaster response, and cost decision support during disaster response.

2) Develop tools, techniques, and procedures that integrate UAS into existing transportation decision support activities.

3) Train regional, state, and local transportation personnel, along with private industry transportation contractors, on UAS operations, data integration, and decision-making.

4) Develop a business model and operational framework that ensures UAS technologies can be offered as a commercial remote sensing solution to address the needs of state and local transportation agencies long after the research project is completed.

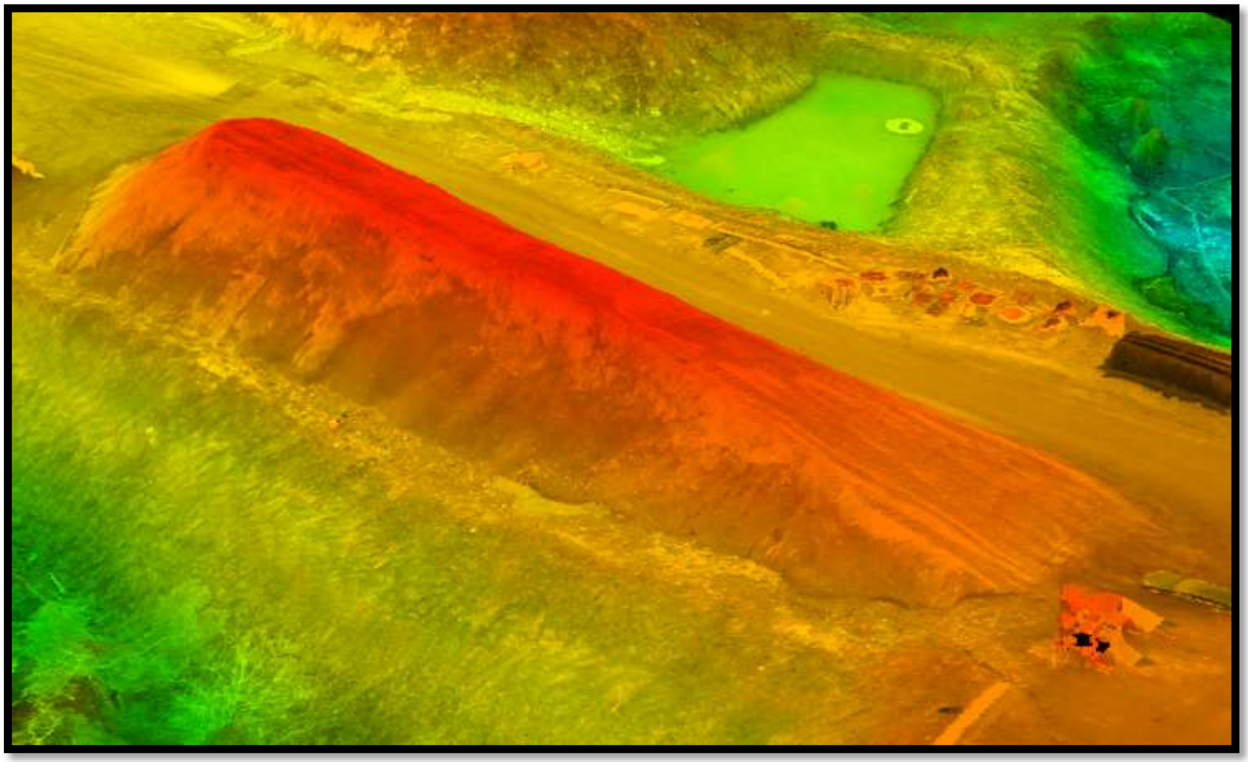

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Figure 1. 3D visualization of spoil pile for a transportation construction site generated from UAS imagery collected during our current RITA-12-H-UVM.

3.2 Development, Validation, and Investigative Approach

Our project will begin by developing the operational capacity for our UAS in four categorical areas. For each of these categories, we will acquire UAS data, generate geospatial products suitable for quantifying and measuring landscape features of interest, integrate the UAS products into existing transportation decision support infrastructure, and gather stakeholder feedback. The four categorical project areas are presented below.

1) <u>Geomorphic assessment of streams.</u> Channel morphology and debris load are stream characteristics that change over time, often rapidly, and such changes may or may not be

associated with a major weather event. These characteristics have important ramifications for adjacent transportation infrastructure, sometimes undermining roads, clogging culverts, and damaging bridges. The condition of hydrologic networks in areas with steep topography can be difficult and dangerous to assess through field-based methods. Traditional remote sensing technologies are expensive and are typically not acquired at sufficient time intervals to update hydrologic models and to conduct transportation infrastructure evaluation and risk assessment. The result is that stream geomorphic assessments are outdated, and the resulting hydrologic transportation models, inaccurate. This lack of up-to-date information hampers planning activities, leading to less informed decisions and potentially missed opportunities to mitigate dangerous vulnerabilities to infrastructure. Without updated stream geomorphic information, improvements executed to downstream transportation components may either be inadequate or excessive. Because UAS data acquisition is cost effective and quick, it can be conducted immediately after an event, such as a spring flood, and the corresponding data products can in turn be used to evaluate the hydrological changes that may impact transportation infrastructure. The low cost of UAS operations also permits more frequent data acquisition, enabling long term monitoring of changes to geomorphology. UAS data thus provide an effective means for mitigating the effects of hydrological events and informing proactive management that avoids more costly repairs. We will collect data for several high priority streams or rivers and generate products that can be used to update stream geomorphic assessments and hydrologic models.

2) <u>Construction management and phasing.</u> Commercial imagery capturing transportation networks can provide valuable information on road conditions, helping to drive maintenance operations, but only if the imagery is acquired at the appropriate spatial resolution and at

regular temporal intervals. Due to the costs of repeated acquisition, satellite and manned aircraft remote sensing technologies rarely play a role in construction management and phasing activities. The result is that managers are reliant on field reports and expensive ground surveys for information. They do not have access to synoptic coverage that allows them to visualize or quantify progress. Moreover, no comprehensive record of the construction phasing exists, complicating resolution of disputes that arise over contractor performance or compliance issues. We will collect UAS data and generate decision support products for transportation construction projects that transportation planners have identified as requiring monitoring and assessment. The UAS products will be integrated into existing inventory and management activities.

3) <u>Resource allocation during disaster response.</u> Resource allocation following a disaster event requires that both the location and extent of damage be known. UAS are an ideal solution for disaster response allocation because they can be deployed rapidly, with low risk to human life, and generate geospatial products in a timely manner, allowing agencies to allocate resources and begin their recovery efforts sooner. Our project team is familiar with disaster operations and is trained to operate within the National Incident Management System. We will develop routines in collaboration with emergency management officials that facilitate integration of UAS data and products into resource allocation models.

4) <u>Cost decision support.</u> Following a disaster, the cost of procuring resources typically increases over time as scarcity drives up cost. In the aftermath of Tropical Storm Irene, it became clear that a lack of information was leading to purchases of resources that were not needed, in a greater quantity than required, or in the wrong place. This information gap thus produced inefficiencies that increased recovery time. Our current UAS volume estimation workflow provides quantifiable information on the amount and location of fill that

is needed to repair a road at a comparable level of accuracy to current terrestrial based techniques. We will integrate this information into a cost decision support model that will improve resource procurement following a disaster, provide high level event cost estimation capabilities, and improve collaborations with natural disaster funding agencies like FEMA.

The generalized workflow for each of the areas is illustrated in Figure 2. Stakeholders will assist in the development of each project, including selection of data acquisition sites. UAS flight operations will occur at individual sites and the acquired imagery will be processed quickly and efficiently. Decision support tools will then convert the raw UAS imagery into practical data and visualization products. The stakeholders will evaluate these products and, if their needs are not met, the decision support tools will be refined as necessary to improve their utility. All products and tools will then be used for both in-person and web-based training activities.

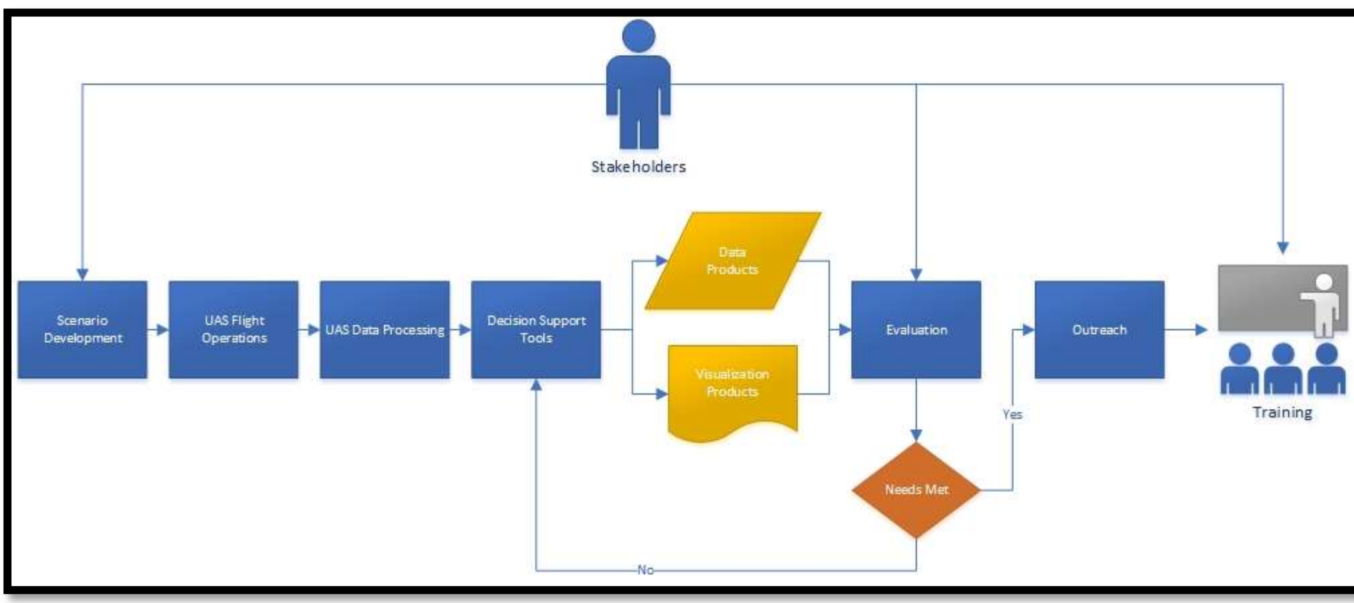

Figure 2. Generalized workflow for UAS operations.

Our criteria for implementing the UAS products will focus on the following questions:

Q1) What operational practices and policies must be considered in each scenario?

Q2) What barriers would prevent successful UAS data acquisition for each scenario?

Q3) How does the cost of UAS data acquisition and processing compare to traditional commercial remote sensing methods?

Q4) How does the cost of UAS data acquisition and processing compare to field-based methods?

Q5) How does the accuracy of the UAS products compare to traditional commercial remote sensing methods?

Q6) How does the accuracy of the UAS products compare to field-based methods?

Q7) Can UAS products be delivered in a sufficiently timely manner to influence the decision-making cycle?

Q8) What modifications to the UAS products are necessary to maximize utility to the end user?

Q9) What type of decision support tools must be developed for end users to maximize the value of the UAS products?

Q10) Do UAS products provide additional or unique insights that cannot be obtained through other means?

Figure 3. Monitoring the flight path of a UAS. The student in the picture, Adam Zylka, developed methods for estimating volume from UAS imagery as part of his undergraduate thesis. He was funded under our current RITA grant and is now employed by a UAS company (senseFly), chiefly due to the skills he gained on this project. Adam will serve on the technical advisory board if RITARS-12-H-UVM receives supplemental funding.

We will also use this funding to establish protocols and procedures for integrated UAS collection operations. Integrated operations use more than one UAS to cover a large area and offer the potential to overcome the range limitations inherent to lightweight UAS. Effective UAS operations require adherence to well-conceived and documented practices and protocols, such as flight and equipment checklists and standard operating procedures, and we will develop and refine necessary guiding documentation for integrated UAS operations over the duration of the project.

We will initiate an aggressive outreach and training program that ensures a rapid and effective transfer of information and technology to state and local transportation agency personnel and private sector contractors. Our outreach and implementation activities will focus on educating these groups on the value of UAS technology and use of its imagery and derivative products. This phase will also include development of cost-benefit scenarios for UAS services that will encourage transportation agencies to use these services in future planning, management, and disaster-response applications. These groups will be invited to participate in UAS flight operations and attend a remote sensing workshop. We will take a “train the trainer” approach in which attendees are provided with the tools and tutorials to integrate UAS data into decision making activities, fuse UAS data with other commercial remotely sensed data, and to conduct advanced 3D analysis using commercial software tools. Given that geographical and budgetary constraints may prevent in-person attendance by some interested parties, an emphasis will be put on the development and deployment of virtual training materials. The materials will include UAS checklists and operating procedures, a series of videos on UAS operations and decision support tools, sample UAS imagery, and step-by-step tutorials for working with UAS data products. Our team includes a dedicated outreach professional, and other members have helped develop online geospatial coursework for the Penn State World Campus and University of Vermont Continuing Education.

This project will afford the opportunity to conduct UAS operations under a variety of operational and environmental conditions. We will conduct detailed cost accounting at all times and will use this information to design and implement the cost recovery model for on-demand UAS services. The cost model will ensure that UAS services remain available to transportation agencies after the conclusion of US DOT project funding. All UAS services will be coordinated by the University of Vermont Spatial Analysis Laboratory (SAL), of which PI Jarlath O’Neil-Dunne is the Director. The SAL is a designated income/expense activity within the university system, allowing it to engage in direct contract projects of limited scope. In fiscal year 2013, the SAL engaged in more than $280,000 worth of income/expense activities on projects for Federal, state, and local government agencies. We will also partner with private sector transportation consulting firms who are developing UAS capabilities as part of their commercial portfolio or who will integrate UAS products into their consulting operations (e.g. hydrologic models).

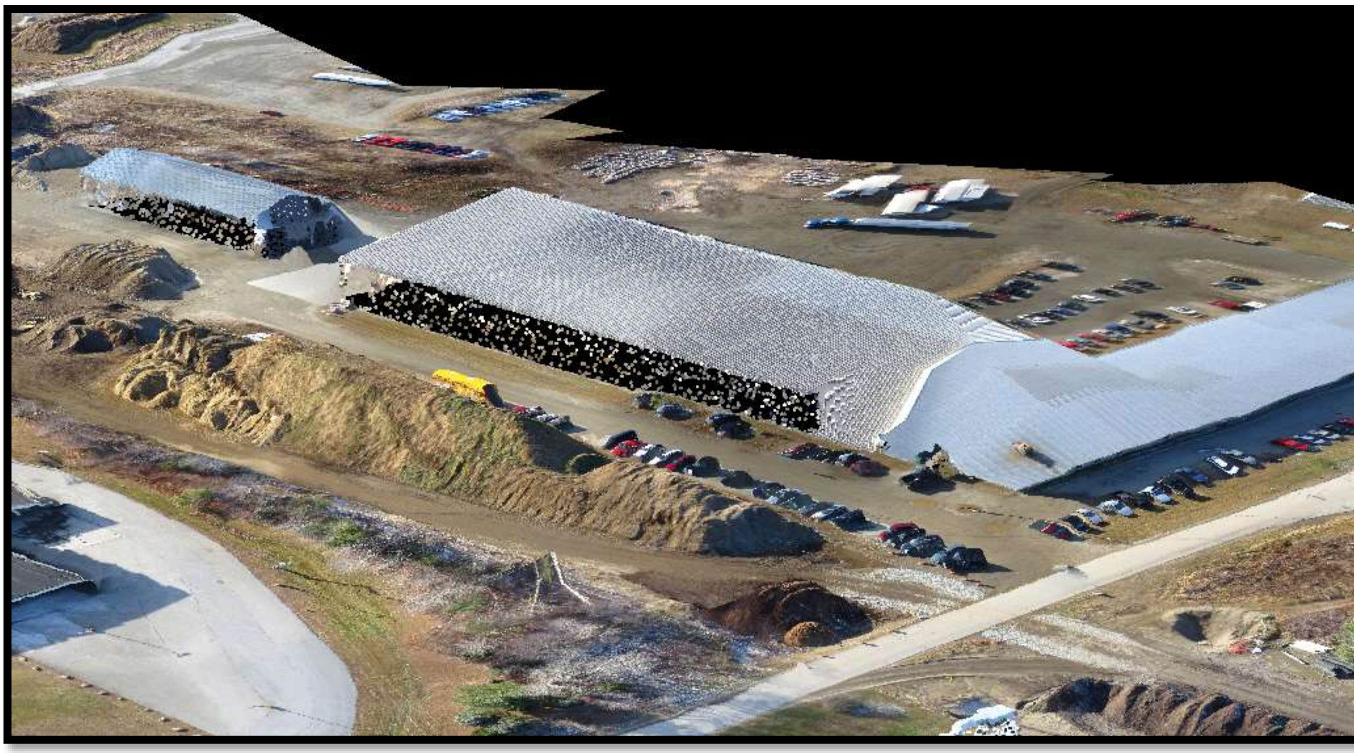

Figure 4. 3D colorized perspective of an active transportation construction site developed from UAS imagery during our first round of RITA funding.

Figure 5. As part of our current RITA project, we have developed decision support tools using commercial software, such as Applied Imagery's Quick Terrain Modeler. This example shows how volumetric information can be extracted from 3D data acquired by a UAS. Applied Imagery is a project partner for this proposed supplemental grant.

Figure 6. PI Jarlath O'Neil-Dunne demonstrating UAS capabilities to a Vermont Agency of Transportation (VTrans) employee as part of our current RITA project. Behind Jarlath is the pile shown in Figure 4, for which the volume was calculated.

3.3 Technical Barriers

UAS deployment presents particular challenges. Personnel must be trained on the operational aspects of the UAS, and obtaining authorization for flight operations can take days or weeks. Fortunately, however, we have been able to work through these potential barriers during our RITARS-12-H-UVM. Our entire team has been trained on UAS operations, and we have an established protocol that allows us to conduct flight operations once appropriate notice has been given to pertinent officials. Our team has received appropriate National Incident Management System training and is prepared for integration with other data-gathering assets in disaster- or emergency-response operations. We have conducted UAS operations during all four seasons and in diverse temperature, wind, and cloud conditions. Our flight planning, image acquisition, data processing, and decision support tools are fully functional and have been presented to DOT project managers. Selection of Vermont as the study area also offsets some of the challenges unique to UAS; the state's rural nature and low population densities alleviate the privacy concerns regarding UAS, and there are also comparatively few airspace restrictions. Other potential barriers include the necessity of conducting UAS operations under a broad range of weather conditions, which risks damage to our current UAS. To maintain project scheduling and efficiency even in the event of occasional UAS mechanical damage, we have budgeted a second UAS and replacement parts. The final technical barriers pertain to the outreach portion of the project. Our team has extensive experience in online, print, and video material development. Our team has several members whose relationships with relevant government agencies and organizations are strong in Vermont and New England.

3.4 Equipment and Facilities

This project will leverage existing resources at the University of Vermont Transportation Research Center (TRC) and Spatial Analysis Laboratory (SAL). The SAL maintains cutting-edge hardware and software to support a broad range of remote sensing and GIS processing and analysis capabilities. This project will also leverage equipment purchased as part of our existing RITA grant, including a UAS (senseFly eBee) and computer hardware and software. An additional UAS will be purchased to facilitate integrated flight operations and to serve as a secondary option to the primary aircraft, which will ensure we are always in service for our clients. The training workshop will be held in the Geospatial Teaching Lab located in the University of Vermont's Aiken Center, which is a LEED Platinum certified building. The Geospatial Teaching Lab has 22 high-end geospatial workstations. Applied Imagery will be providing software to ensure that all participants are able to participate in hands-on activities.

3.7 Tasks and division of labor

This proposed project will consist of seven main tasks:

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

2. **Reporting**. Activities related to reporting progress and results to the funding agency.

3. **Stakeholder/partnership meetings**. Meetings with external groups and collaborators, including state transportation departments, industry partners, and the advisory committee. These meetings will drive scenario/site selection.

4. **UAS operations.** Flight planning, flight operations, data acquisition, and data processing.

5. **Decision support tools**. Data dissemination, data products, visualization products, and systems integration.

6. **Training and outreach.** Hosted workshop and online “virtual campus” tutorials and data.

7. **Publications/presentations**. Documentation of the project and its results in conference/journal publications and conference presentations. Development of training and operational materials for dissemination to stakeholders.

8. **Business plan development.** Cost accounting to support the development of a business plan to enable UAS services to be offered to state and local transportation agencies once the RITA project has come to a conclusion.

The level-of-effort budget for the major project tasks, along with the division of labor by general category, are presented in Table 1**Error! Reference source not found.**.

Table 1. Hours by category.

Task	Description	Management	Engineering	Technical	Clerical
1	Project coordination	75	0	0	12
2	Reporting	40	0	0	152
3	Stakeholder/partnership meetings	78	34	411	191
4	UAS operations	46	501	1508	33
5	Decision support tools	29	115	526	5
6	Training and outreach	12	5	290	103
7	Publications/presentations	37	4	20	86
8	Business development	20	57	71	30
Totals		**337**	**716**	**2826**	**612**

4. Proposed Work Plan and Budget

4.1 Activities

1. Internal meeting following project award. Modifications to the plan as necessary.
2. Reporting
    a. Quarterly reports
    b. Final report
3. Stakeholder/partnership meetings.
    a. Project kick-off
    b. Establish advisory committee
    c. Advisory committee updates
    d. Meetings with state/local transportation agencies

    e. Select test sites
    f. Meetings with industry partners
    g. Stakeholder decision support tools feedback

4. UAS operations
    a. Flight planning
    b. Flight approval
    c. Equipment and flight checklists
    d. Operating procedures
    e. Flight operations
        i. Geomorphic assessment
        ii. Construction management and phasing
        iii. Resource allocation
        iv. Cost decision support
    f. After action reports
5. Decision support tools
    a. Post-processing tools
    b. 2D data products
    c. 3D data products
    d. Online data portal
    e. Integration with current tools used by Vermont Agency of Transportation
    f. Validation
6. Training and outreach
    a. Training data
    b. Training videos

   c. Training manual
   d. Training workshop
   e. Workshop feedback
   f. Online materials
7. Presentations/publications
   a. Conference presentations
   b. Journal/conference publication
8. Implementation
   a. Cost accounting
   b. Rate calculations
   c. Business plan

4.2 Major activities, deliverables and milestones

A listing of the major activities, deliverables, milestones, and associated costs are presented in the "Technical Deliverables and Milestones" spreadsheet (separate document). The chief deliverables for this project are as follows:

- A web page for the project that provides a centralized location for information on the project, project updates, checklists and operating procedures, and links to training products and data.
- White papers summarizing each of the four case studies.
- UAS equipment checklist.
- UAS flight checklist.
- UAS operating procedures manual.
- A two-day workshop on UAS products for transportation decision support.

- Online training materials including videos, sample data, and step-by-step manuals.
- Paper submitted to a conference or peer-reviewed journal.
- Presentation at a transportation conference (e.g., Transportation Research Board).
- Business plan and cost model for implementation.

4.3 Technical Advisory Council

The following individuals have been identified as members of the advisory council, subject to approval by DOT:

- Johnathan Croft, Vermont Agency of Transportation
- Michael Umansky, Applied Imagery
- Baptiste Tripard, senseFly
- Adam Zylka, senseFly
- Michelle Boomhower, Chittenden County Regional Planning Commission
- Evan Fitzgerald, Fitzgerald Environmental
- Guy Rouelle, Vermont Agency of Transportation
- Charles Hebson, Maine Department of Transportation
- Jason Moghaddas, Spatial Informatics Group

4.4 Travel

Total travel for this proposed project is estimated at $3960. Travel will consist of vehicle mileage, lodging, meals, and parking for a combination of fieldwork and regional DOT visits. An itemized list of these costs is presented in Table 2.

Table 2. Summary of estimated travel expenses.

Year 1

Fieldwork: 10x short distance day trips (avg. 100 miles round trip)			
	Mileage	$.56/mi	$ 560
Regional State DOT visits: 2x medium distance overnight trips (avg. 400 miles)			
	mileage	$.56/mi	$ 448
	meals (2 people)	$55/person/day	$ 220
	lodging (2 people)	$175/person/day	$ 700
	parking		$ 80
Year 2			
Fieldwork: 9x short distance day trips (avg. 100 miles round trip)			
	mileage	$.56/mi	$ 504
Regional State DOT visits: 2x medium distance overnight trips (avg. 400 miles)			
	mileage	$.56/mi	$ 448
	meals (2 people)	$55/person/day	$ 220
	lodging (2 people)	$175/person/day	$ 700
	parking		$ 80

5. Merit of the Technology

The commercial remotely sensed data used in the transportation sector has traditionally consisted of passive (e.g., visible imagery) and active (e.g., LiDAR) data acquired from aerial and satellite platforms. The last decade has seen major advances in commercial remote sensing acquisition and processing such that it is now possible to obtain sub-meter resolution imagery in the immediate aftermath of a disaster or other episodic events, usually from a satellite orbiting hundreds of miles above the earth's surface. It is also possible to construct highly detailed 3D models of planned construction sites and other landscape features using airborne LiDAR data. Despite these advances, commercial remote sensing technologies have not been employed in transportation-related activities as often and as fully as possible. This underutilization is at least partly attributable to the complexity of commercial remotely sensed data, whose effective use often requires specialized software and training. More important, however, are the inherent limitations of relying on a system of spaceborne satellites and manned airborne systems. Such systems are costly to operate, in turn making data collection an expensive undertaking for transportation agencies. This cost barrier severely curtails the ability of decision makers to access high temporal-resolution data. Furthermore, the spatial resolution of many commercial systems, even ones with sub-meter capabilities, is inadequate for transportation operations that require recognition of fine-scaled features.

Consider this example: a transportation manager for a major construction project requires regular, updated maps for monitoring progress and identifying potential design or implementation issues. Theoretically, this need should be easily met through the application of commercial remote sensing technologies. However, the cost of acquiring imagery from aerial and satellite platforms would not only be high but the timeliness of the data would suffer from slow procurement procedures and post-processing activities. Figure 7 below shows an example of such a scenario from our currently funded RITA project, “Rapid Exploitation of Commercial Remotely Sensed Imagery for Disaster Response & Recovery.”

Figure 7. Imagery from a new road construction project. The pre-construction imagery (left) was acquired by a manned aerial system as part of a statewide mapping project. The imagery acquired during construction (right) was done by a lightweight UAS during RITARS-12-H-UVM.

The base imagery (left) was acquired prior to construction as part of a statewide mapping project at a cost well into the hundreds of thousands of dollars. The UAS imagery (right) was acquired as part of a test flight. The UAS succeeded in acquiring imagery for the entire construction site (~3 linear miles) in less than two hours and produced 4-cm imagery and 3D models ready for use by the state transportation agency within 18 hours. The UAS employed in this case was a commercial off-the-shelf system with a team of five individuals to conduct the mission. Such commercial remote sensing data collection capabilities represent a game changer for state and local transportation agencies, along with the many private sector contractors that support their work. UAS capability gives these groups access to commercial remote sensing technology that is affordable, easily deployable, and capable of generating the data required for the most demanding transportation projects. This is not to say that UAS will entirely replace other commercial remote sensing technologies; like all imagery systems, UAS have limitations that constrain their use, including payload size, weather, and flight time. What they do very well is fill an important data gap, providing near real-time imagery to planners and managers who have immediate information needs.

A comprehensive literature review of UAS technology for transportation applications was conducted by Peng (2011). A significant portion of the mentioned studies analyzed traffic conditions using video recorded with Unmanned Arial Vehicles (UAVs). Most of the other studies utilized high-resolution aerial photography taken with UAVs to monitor transportation infrastructure such as roads, bridges and rail lines, in order to identify instances of rutting, potholes, and road surface roughness. Prior work has generally focused on specific technical challenges and applications, but not on operationalizing the technology for use by state and local transportation agencies.

At present, the largest obstacle to effective use of UAS is that they have not been integrated into Federal airspace. Government agencies and private industry have thus been hesitant to seek, or unable to obtain, permission to conduct UAS operations. The FAA has been directed to integrate UAS into Federal airspace by 2015, but the lack of experience with UAS technology in the transportation sector means that it could take years for state agencies and private contractors to effectively integrate UAS into their current operations. This lag can be substantially reduced by effective transfer of the knowledge and skills developed from academic research to practitioners in the transportation field.

Outreach and training activities underpin much of our proposal. Given the relatively short lifespan of the project (2 years), we understand the need for direct and meaningful technology transfer. First, we have included an outreach professional on our team with experience developing print, online, and video materials. Second, our proposed project will train transportation sector personnel on the use of UAS technology and products at a two-day, hands-on workshop. Third, we will provide a robust set of data products, tutorial videos, and manuals available on the web so that any person can complete the training on their own time.

Finally, we will preserve the knowledge gained as part of this project by distributing UAS checklists and standard operating guidelines.

Figure 8. A UAS during takeoff. This particular UAS, the senseFly eBee, was purchased as part of our current RITA grant and will be leveraged for use in supplemental work.

6. Key Personnel and Facilities

6.1. Organizations

Transportation Research Center

The UVM Transportation Research Center (TRC) is a hub for innovative and interdisciplinary research, education, and outreach on sustainable transportation system solutions. Since its founding in 2006, the TRC has attracted more than $6.5 million to UVM in new external grants, funded 67 graduate students with $28,000 stipends, hosted over 3,200 people at its events, and created 12 new courses. The TRC also serves as the host of the National University Transportation Center (UTC), funded by the U.S. Department of Transportation, the Vermont Clean Cities Coalition, funded by the U.S. Department of Energy and the Vermont Department of Public Service, and the New England Transportation Consortium (NETC), pool-funded by the six New England state DOTs.

Spatial Analysis Laboratory

The Spatial Analysis Laboratory (SAL) is an applied research facility located in the Rubenstein School of Environment & Natural Resources at the University of Vermont (UVM). The SAL specializes in ecosystem assessment, biodiversity analysis, ecosystem services, land-cover mapping, transportation modeling, planning for conservation lands, scenario modeling of land use change, high-resolution remotely sensed data analysis, defense applications, web-based mapping, and the development of new applications for natural resource management. The SAL has been internationally recognized for its expertise developing object-based approaches to extracting information from multi-billion pixel data sets. The SAL maintains a robust suite of hardware and software dedicated to the processing and analysis of geospatial data.

6.2 Personnel

Jarlath O'Neil-Dunne

Mr. O'Neil-Dunne will serve as Principal Investigator (PI). He is the Director of the UVM SAL and a faculty member in the Rubenstein School of the Environment and Natural Resources. He and his team have been internationally recognized for their expertise in developing and deploying object-based systems capable of extracting information from massive amounts of high-resolution remotely sensed data for urban planning, defense, and natural resource applications. He is the PI on UVM's current RITA grant. Mr. O'Neil-Dunne is a former intelligence officer whose last assignment was the geospatial team lead for a group specializing in infrastructure analysis for select Middle Eastern countries. He is also the director of VermontView, a state affiliate of the AmericaView program. During Tropical Storm Irene, he coordinated all image acquisition, processing, and exploitation activities for Vermont.

Amanda Hanaway-Corrente

Amanda Hanaway-Corrente is a licensed Professional Engineer employed at the UVM TRC as the New England Transportation Consortium (NETC) Coordinator, which enables the collaboration between the Research Sections at the Vermont Agency of Transportation (VAOT) and the Departments of Transportation in Massachusetts, Connecticut, Rhode Island, New Hampshire, and Maine. She also represents the UVM TRC as the VAOT Research Advisory Committee (RAC) Liaison, and as such has served on the RAC Region 1 Planning Committee for the 2012 AASHTO Research Advisory Committee and TRB State Representatives Annual Meeting with members from the Research Section of the Departments of Transportation in Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. Amanda was also named Vermont's 2011 Young Engineer of the Year. Her professional engineering license is in the field of transportation engineering as she has designed many roads, roundabouts, and parking lots.

Sean MacFaden

Sean MacFaden is a geospatial analyst with the UVM SAL. He has 20 years of experience in geospatial technologies, including GIS and remote sensing applications for wildlife habitat mapping, biodiversity assessment, conservation lands, forest characterization, and watershed-scale analyses of pollutant loading. Most recently, he has used object-based image analysis (OBIA) techniques in conjunction with high-resolution imagery and LiDAR to map land cover in a variety of urban and suburban settings, including multiple tree canopy assessments (UTC) for cities and counties in the United States

Zack Borst

Zack Borst’s responsibilities at the Transportation Research Center (TRC) include coordinating and implementing Technology Transfer and related communications initiatives of the TRC. This includes the implementation of an overall Tech Transfer communications strategy, planning and overseeing events and conference logistics, maintenance and development of key communications tools, reviewing research report submissions, managing the outreach efforts of specific programs including budget elements, and providing overall support for TRC outreach efforts. Zack comes to the TRC from the Vermont Division of Emergency Management and Homeland Security where he responded to several federally declared disasters that included significant flooding and road damage. Outside of work, Zack is a volunteer and 1st Lieutenant with the Vermont Wing of the Civil Air Patrol, US Air Force Auxiliary where he serves as the squadron communications officer and as an aircrew member responding to search and rescue, disaster relief, and other missions.

6.3 Prior Experience Managing Similar Projects

Mr. O'Neil-Dunne brings years of experience managing large and complex projects in academia, the private sector, and the military. He has served as PI on large Federal grants in the past for a number of agencies, including PI on a current RITA grant. Ms. Hanaway-Corrente brings extensive engineering experience in both the private and academic sectors and leverages very strong relationships within a wide network of state DOTs. The Transportation Research Center and the Spatial Analysis Laboratory have strong track records of performance working on transportation-related and commercial remote sensing projects.

6.4 Collaborations and Partnerships

Vermont Agency of Transportation

VTrans' mission is to provide for the movement of people and commerce in a safe, reliable, cost-effective and environmentally responsible manner. VTrans will serve as a partner on the project, providing guidance and feedback.

Chittenden County Regional Planning Commission

The mission of the Chittenden County Regional Planning Commission is to act as the principal forum for planning, policy, and community development in the region. It fulfills this role by providing planning and technical assistance that meets the needs of member municipalities and the public, while remaining consistent with Federal and state requirements. Its work results in the development and implementation of plans that support sustainable development and improve the region's quality of life and environment.

Vermont Department of Environmental Conservation

The Vermont Department of Environmental Conservation's (DEC) mission is to preserve, enhance, restore and conserve Vermont's natural resources and protect human health for the benefit of this and future generations. Through its programs, the DEC manages water and air quality; regulates solid and hazardous wastes; and administers a number of voluntary pollution and waste reduction programs. While the DEC issues most of the state's environmental permits, the department does more than just set forth regulations and assure compliance. Among other responsibilities, department staff members collect data, conduct research, run volunteer programs, develop educational and outreach materials and programs, administer grants, and work with conservation organizations and state and Federal agencies to examine critical environmental issues.

Applied Imagery

Applied Imagery was founded in 2004 in Silver Spring, MD, a suburb of Washington, D.C., to commercialize software developed at Johns Hopkins University's Applied Physics Lab (APL). Its commercial, off-the-shelf (COTS) software, the Quick Terrain Modeler, is the world's premier 3D point cloud and terrain visualization software package. Quick Terrain Modeler is focused on U.S. Department of Defense and civilian applications and continues to evolve based on customer feedback.

senseFly

senseFly was founded at the end of 2009 as a spin-off of the EPFL*-based Laboratory of Intelligence Systems, a leading research organization in robotics and artificial intelligence

(*Ecole Polytechnique Fédérale de Lausanne: EPFL is Europe's most cosmopolitan technical university). In the summer of 2012, senseFly became a member of the Parrot group. It develops, assembles, and markets autonomous mini-drones and related software solutions for civil professional applications, including accurate mapping of mining sites, quarries, forests, construction sites, crops, etc. senseFly is always on the edge of technology innovation, as it holds several patents in the field of aerial robotics and is pursuing multiple research projects to expand its range of products.

iCubed

I-Cubed offers enterprise geospatial data and information management solutions for commercial and government clients, including defense and C4ISR implementations (C4ISR: the concept of Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance). Its services and applications leverage Earth imagery, map data, and rich geospatial media from ground and low altitude, large-area data collection missions.

Fitzgerald Environmental Associates

Fitzgerald Environmental Associates, LLC. is a Vermont-based company offering consulting services in the applied water and geospatial sciences to a diverse clientele of governmental, non-profit, and private sector entities. Its specialized services include applied fluvial geomorphology, stormwater runoff permitting, urban watershed assessment and planning, river channel and floodplain modeling, wetland delineation and permitting, and surveying and mapping using GPS and GIS. The company was founded in 2006 to provide a multidisciplinary approach to environmental assessment and problem solving; drawing on knowledge from the fields of ecology, geology, hydrology, botany and ecological economics.

6.5 Equipment, materials, and facilities

Together, the SAL and TRC have much of the requisite equipment, materials, and facilities for this project. The exceptions are: 1) an additional UAS that will be purchased for the project; 2) software for the training workshop that will be provided by Applied Imagery; and 3) a web-based data portal that will be developed in collaboration with i-Cubed.

7. Other Related Proposals

We are currently funded under RITARS-12-H-UVM. A separate proposal (RITA-RS-14-01) was not funded.

8. Review Panel Recommendations

Not applicable; there was no review panel for this proposal.

Literature Cited

Peng, Z.R. 2011. Feasibility study of the application of unmanned aerial vehicles transportation applications. University of Florida, Department of Urban and Regional Planning, Gainesville, FL.