Rapid Exploitation of Commercial Remotely Sensed Imagery for Disaster Response & Recovery

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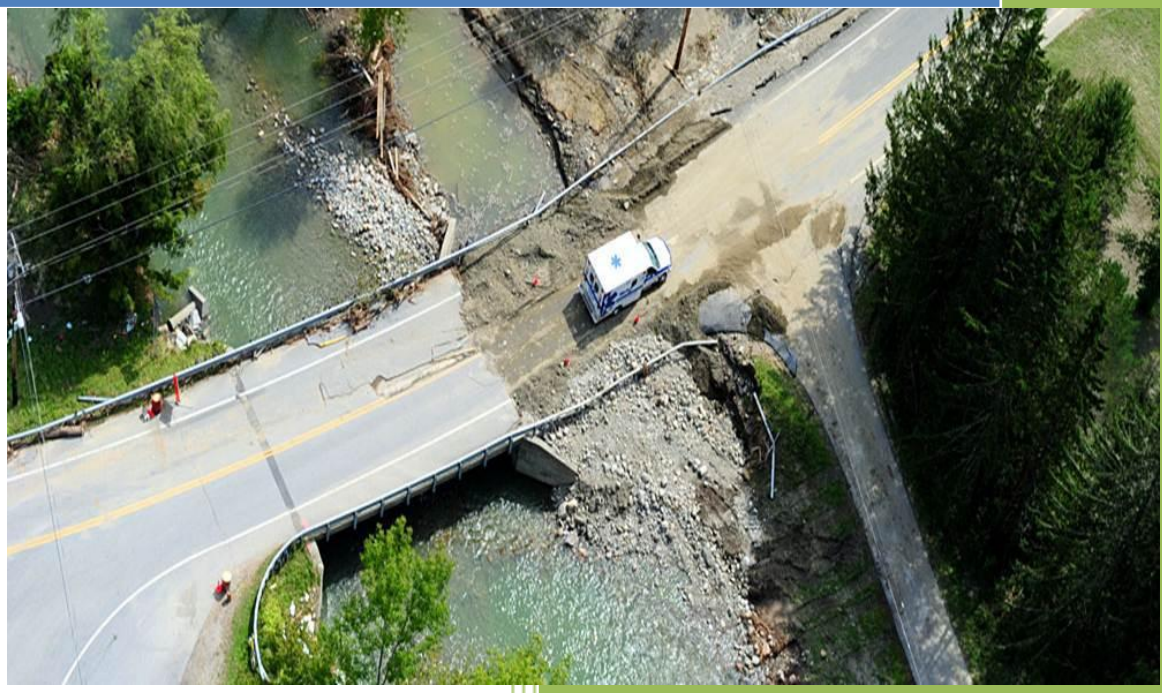
Program Manager: Caesar Singh

COOPERATIVE AGREEMENT
No. RITARS-12-H-UVM

Quarterly Progress Report #4

October 1, 2013 through December 31, 2013



TRC UNIVERSITY OF VERMONT TRANSPORTATION RESEARCH CENTER

University of Vermont Spatial Analysis Lab

United States Department of Transportation

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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
HDDS	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

Natural disasters can severely impact transportation networks. In the hours and days following a major flooding event, knowing the location and extent of the damage is crucial for incident managers for a number of reasons: it allows for emergency vehicle access to affected areas; it facilitates the efficient rerouting of traffic; it raises the quality and reduces the cost of repairs; and it allows repairs to be completed faster, in turn reducing the duration of costly detours. Commercial Remote Sensing (CRS) imagery is increasingly being used in disaster response and recovery, but the ability to acquire CRS data far surpasses the ability to extract actionable information from it. An automated approach to damage assessment is needed, but traditional automated image analysis techniques are inadequate for identifying or characterizing transportation infrastructure damage from high-resolution CRS imagery. Furthermore, new CRS technologies, such as Unmanned Aerial Vehicles (UAV) provide a novel approach to gathering imagery during a crisis in which traditional satellite and aerial systems are either cost prohibitive, ineffective, or unresponsive. We propose a project with two objectives: 1) to develop, calibrate and deploy a decision support system capable of identifying road and bridge damage from high-resolution commercial satellite images and; b) to estimate the amount and type of fill material required for repairs using digital surface models derived from lightweight Unmanned Aerial Vehicles (UAV) programmed to fly over damage road segments. This approach would employ state-of-the-art, object-based image analysis techniques, cost-based image matching, and other advanced computing techniques. We also propose to collaborate with state departments of transportation to develop a web-based interface to share information derived from CRS Imagery.

Technical Status

Task 1 - Creation of a Technical Advisory Committee
We will recruit a committee of relevant professional (e.g. state DOT representatives, academics) near the outset of the project to advise on project activities. A full description of the project tasks can be found in Section 2 of the Cooperative Agreement.

Output/Deliverables: The Advisory Board comprised of 6 to 8 members will provide guidance in specific technical and policy recommendations that the team would take into consideration for implementation. Notes will be taken at each meeting and provided to members as a brief summary report.

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

- An Advisory Committee Meetings was held on December 6th 2013. During this meeting, we covered the System Design Review.
- We also held a couple of internal project team meetings to discuss progress and reporting efforts.

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.

- The TAC will meet in person or by video conference twice per year or on an as needed basis. Notes will be taken at each meeting and provided to members as a brief summary report.
- Internal project team meetings to occur on a regular basis.

Schedule:
Highlight any changes to the schedule as previously reported.

- None.

Effort Expended:

Effort expended by task for all staff categories must be reported.

Employee Name/Labor Category	Budgeted Hours	Revised Budgeted Hours	Year 1 (hours)				Cummulative (hours)
			Quarter 1	Quarter 2	Quarter 3	Quarter 4	
Austin Troy	200	93.84	56.5	13.34	24		93.84
Jarlath O'Neil Dunne	50	129.52	30		15	14.38	59.38
Ernest Buford	0	0.00					0
Amanda Hanaway	180	263.96	16	25	20	23.13	84.13
Sean MacFadden	0	0.00					0
James Sullivan	24	24.00	6	4	2	6	18
Technician	0	0.00					0

Note: Austin Troy has left the University of Vermont, and Jarlath O'Neil-Dunne has taken over as PI. Austin's remaining hours for this task (106.16 hours) have been divided up equally between Jarlath and Amanda Hanaway (106.16 hours/2 = 53.08 hours). In an effort to keep the cost of the project the same, the number of hours were factored by the difference in salaries (53.08 hours of Austin's time = 79.52 hours of Jarlath's time = 83.96 hours of Amanda's time = $6,194.44).

Task 2 - Creation of a project website

We will create a project website which will stay in operation throughout the duration of the project and will help to organize, centralize, and disseminate information from the project.

Output/Deliverables: A project web site will be created on the University of Vermont domain (www.uvm.edu) containing a password protected section for internal documents and data products that have access/use restrictions associated with them (e.g. commercial satellite imagery) as well as access to up-to-date documents deemed suitable for the public domain.

Accomplishments:

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

- This Quarterly Report has been added to the website.

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.

- On previous quarterly reports, it was noted that Data, Software, and Equipment purchases had caused a minor delay to the project schedule. At this point, the project is back on schedule due to the team's ability to collect field data more efficiently than expected.

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.

- The contract requires a blog post about various aspects on the project after the first twelve months. We will provide a link from the project website to the "Letter from the SAL" blog post once approved by DOT.
- Update the website by uploading and linking TAC meeting minutes and Quarterly Reports, as well as any other necessary upgrades and updates.

Schedule:

Highlight any changes to the schedule as previously reported.

- None.

Effort Expended:

Effort expended by task for all staff categories must be reported.

Employee Name/Labor Category	Budgeted Hours	Revised Budgeted Hours	Year 1 (hours)				Cummulative (hours)
			Quarter 1	Quarter 2	Quarter 3	Quarter 4	
Austin Troy	42	38.88	15	13.75	10.13		38.88
Jarlath O'Neil Dunne	16	18.34	9	0			9
Ernest Buford	6	6.00		6			6
Amanda Hanaway	76	78.47	32.75	12.75	4	5	54.5
Sean MacFadden	0	0.00					0
James Sullivan	36	36.00	18.38	10.38	2	10	40.76
Technician	0	0.00					0

Note: Austin Troy has left the University of Vermont, and Jarlath O'Neil-Dunne has taken over as PI. Austin's remaining hours for this task (3.12 hours) have been divided up equally between Jarlath and Amanda Hanaway (3.12 hours/2 = 1.56 hours). In an effort to keep the cost of the project the same, the number of hours were factored by the difference in salaries (1.56 hours of Austin's time = 2.34 hours of Jarlath's time = 2.47 hours of Amanda's time = $182.05).

Task 3 - Damage detection system methods development
Design, develop, deploy, and validate a decision support system that automates the detection of post-event damage to roads from CRS satellite imagery and provides actionable information to incident commanders.

Output/Deliverables: We will develop, validate, and accurately assess a methodology for automating the identification of large road damage. This methodology will result in the development of a "knowledge base" of expert classification rules that remote sensing technicians can then reuse in other location. This knowledge base will be made available on our website along with documentation and tutorials on using it (see Task 6). We will also create and post an ESRI geoprocessing utility or standalone utility that extracts the geographic coordinates of the center of each damage polygon and then sends that coordinate to a web server (see Task 5).

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

- Ruleset Set Development in progress
    - Deployed damage detection rule set for Colorado flooding.
    - Deployed damage detection rule set for New York City Superstorm Sandy.
- Damage Detection Routine Testing completed

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.

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.

- A knowledge base of feature extraction and classification rules for identifying road damage from high resolution imagery, for re-use in commercially available object-based image analysis software.
- Validate damage detection routines.
- Ruleset Set Development to continue under differing conditions.

Schedule:

Highlight any changes to the schedule as previously reported.

- We do not anticipate any schedule changes.

Effort Expended:

Effort expended by task for all staff categories must be reported.

Employee Name/Labor Category	Budgeted Hours	Revised Budgeted Hours	Year 1 (hours)				Cummulative (hours)
			Quarter 1	Quarter 2	Quarter 3	Quarter 4	
Austin Troy	42	28.66		8.66	20		28.66
Jarlath O'Neil Dunne	30	49.98		13	6	6	25
Ernest Buford	0	0.00					0
Amanda Hanaway	170	170.00		11	37.13	35	83.13
Sean MacFadden	1191	1191.00	325	406.25	287.5		1018.75
James Sullivan	30	30.00		10	5	15	30
Technician	0	0.00					0

Note: Austin Troy has left the University of Vermont, and Jarlath O'Neil-Dunne has taken over as PI. Austin's remaining hours for this task (13.34 hours) have been shifted to Jarlath. In an effort to keep the cost of the project the same, the number of hours were factored by the difference in salaries (13.34 hours of Austin's time = 19.98 hours of Jarlath's time = $1,556.78).

Task 4 - Fill calculation system methods development
Design, develop, deploy, and validate a decision support system that uses CRS Unmanned Aerial Vehicles (UAV) to estimating the amount and type of fill material needed to fill damaged areas.

Output/Deliverables: We will develop, validate, accurately assess and document a methodology for automating the calculation of the quantity of fill by type for road damage voids caused by flooding. We will produce a technical document and tutorial that outlines this methodology (see Task 6). We will also produce and make available an ESRI geoprocessing tool capable of performing the fill calculations.

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

- UAV flight operations ongoing
- Fill calculations have been developed
- Fill calculation tool has been developed
- Cost-based image matching workflow has been completed
- Ground validation data acquired

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.

- UAV shipment took longer than expected due to international customs issues thereby delaying training and initial flight operations. However, flight operations have been more efficient than originally anticipated, allowing the team to get back on schedule with the project. We have flown 18 missions and collected over 300GB of data.

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.

- UAV flight operations to continue
- Fill calculations validation to be completed

Schedule:

Highlight any changes to the schedule as previously reported.

- None.

Effort Expended:

Effort expended by task for all staff categories must be reported.

Employee Name/Labor Category	Budgeted Hours	Revised Budgeted Hours	Year 1 (hours)				Cummulative (hours)
			Quarter 1	Quarter 2	Quarter 3	Quarter 4	
Austin Troy	20	10.00			10		10
Jarlath O'Neil Dunne	295	309.98		71.38	68.38	4	143.76
Ernest Buford	226	226.00		34.63	167.21		201.84
Amanda Hanaway	49	49.00					0
Sean MacFadden	366.9	366.90			200		200
James Sullivan	40	40.00			10	8	18
Technician	50	50.00				20	20

Note: Austin Troy has left the University of Vermont, and Jarlath O'Neil-Dunne has taken over as PI. Austin's remaining hours for this task (10 hours) have been shifted to Jarlath. In an effort to keep the cost of the project the same, the number of hours were factored by the difference in salaries (10 hours of Austin's time = 14.98 hours of Jarlath's time = $1,167).

Task 5 - Development of web portal decision support tool
Develop web-based decision support tools and GIS data layers, and disseminates information on road damage via social media.

Output/Deliverables: Outputs will include development of a front-end website prototype on our own servers which will pull data from Google Fusion Tables, which is a cloud-based platform. We will then work with our VTrans partners to make these data sets and web resources available to them so that they can freely integrate them into their online information systems. We will document the process of developing the portal and will write up manuals for both users and for website administrators.

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

- Web-site Front End/Back End Work was started
- Post Damage Geoprocessing Tools was started

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.

- Web-site Front End/Back End Work to continue
- Post Damage Geoprocessing Tools to be completed

Schedule:
Highlight any changes to the schedule as previously reported.

- None

Effort Expended:

Effort expended by task for all staff categories must be reported.

Employee Name/Labor Category	Budgeted Hours	Revised Budgeted Hours	Year 1 (hours)				Cummulative (hours)
			Quarter 1	Quarter 2	Quarter 3	Quarter 4	
Austin Troy	24.5	0.00					0
Jarlath O'Neil Dunne	157	193.70					0
Ernest Buford	158.02	158.02					0
Amanda Hanaway	40	40.00					0
Sean MacFadden	197.08	197.08					0
James Sullivan	16	16.00					0
Technician	880	880.00				79.5	79.5

Note: Austin Troy has left the University of Vermont, and Jarlath O'Neil-Dunne has taken over as PI. Austin's remaining hours for this task (24.5 hours) have been shifted to Jarlath. In an effort to keep the cost of the project the same, the number of hours were factored by the difference in salaries (24.5 hours of Austin's time = 36.70 hours of Jarlath's time = $2,859.15).

Task 6 - Project outreach and communication

Make the methods and technologies developed in this project to be easily transferable to other state DOTs.

Output/Deliverables: We will complete, make available and disseminate all outreach materials. For the damage-detection methodology, this will include our knowledge base of classification/detection rules, which can then be ported and reused in object-based image-classification software using different imagery, as well as a detailed methodological document and video tutorial that will assist technicians in replicating this system. For the fill calculation task, it will include the ArcGIS geoprocessing tool files and user manual, a methodological document, and a set of video tutorials. For the decision support portal development, we will include a methodological document about setting up the interface and serving the data from Google Fusion Tables, as well as guides for users and administrators. We will hold a focus group meeting with select partners to get feedback on our outputs and determine what additional information or clarification may be needed for subsequent adopters to make use of the project's methods. We will also follow up with VTrans and, if applicable, other New England DOTs, to determine if and how the methods we developed were actually employed and what improvements could potentially be made. Finally, we will write a final report (draft and revised versions), give presentations on the project at professional meetings and prepare manuscripts on the project for publication.

Accomplishments:

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

- HDDS Tutorial Video has been uploaded to the project website
- Submitted a Quarterly Progress Report
- Held a meeting with the Vermont Division of Emergency Management and Homeland Security to provide an overview of the project and discuss the role of UAVs in assessing transportation infrastructure during a natural disaster.
- Participated in a teleconference with Vermont State Police to provide an overview of the project and discuss how UAVs could be integrated into state police responses to natural disasters.
- Conducted an in-field training session for the VTrans mapping unit on UAV flight operations. VTrans personnel were able to participate in flight planning, launch and recovery.
- Provided orthorectified imagery and 3D point clouds to VTrans for the Morrissville Truck Alternative Route construction project. The data were used to update the VTrans GIS database.

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.

- The contract requires a minimum of two presentations on the project or aspects of the project at regional or national transportation/geospatial conferences, the first to occur within the 12 months. The Project PI, Jarlath O'Neil-Dunne is slated to present at the Annual TRB Conference in January 2014.
- The next Quarterly Progress Report.

Schedule:

Highlight any changes to the schedule as previously reported.

- None

Effort Expended:

Effort expended by task for all staff categories must be reported.

Employee Name/Labor Category	Budgeted Hours	Revised Budgeted Hours	Year 1 (hours)				Cummulative (hours)
			Quarter 1	Quarter 2	Quarter 3	Quarter 4	
Austin Troy	100.5	10.62			10.62		10.62
Jarlath O'Neil Dunne	78.18	123.12		5			5
Ernest Buford	0	0.00					0
Amanda Hanaway	69.99	114.93			12	10	22
Sean MacFadden	0	0.00					0
James Sullivan	165.98	165.98			5.38		5.38
Technician	70	70.00					0

Note: Austin Troy has left the University of Vermont, and Jarlath O'Neil-Dunne has taken over as PI. Austin's remaining hours for this task (89.88 hours) have been divided up equally between Jarlath and Amanda Hanaway (89.88 hours/2 = 44.94 hours). In an effort to keep the cost of the project the same, the number of hours were factored by the difference in salaries (44.94 hours of Austin's time = 67.32 hours of Jarlath's time = 71.08 hours of Amanda's time = $5,244.50).

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	Revised Total Budgeted Hours	Year 1 (hours)				Cummulative (hours)
			Quarter 1	Quarter 2	Quarter 3	Quarter 4	
Austin Troy	429.00	182.00	71.5	35.75	74.75	0	182
Jarlath O'Neil Dunne	626.18	824.64	39	89.38	89.38	24.38	242.14
Ernest Buford	390.02	390.02	0	40.63	167.21	0	207.84
Amanda Hanaway	584.99	716.36	48.75	48.75	73.13	73.13	243.76
Sean MacFadden	1,754.98	1,754.98	325	406.25	487.5	0	1218.75
James Sullivan	311.98	311.98	24.38	24.38	24.38	39	112.14
Technician	1,000.00	1,000.00	0	0	0	99.5	99.5

Funds Expended for the Program

Provide a chart showing current and cumulative expenditures versus planned expenditures

Employee Name/ Labor Category	Total Invoiced for Salary	Revised Total Invoiced for Salary	Year 1 (Invoiced Salary)				Cummulative (Invoiced Salary)
			Quarter 1	Quarter 2	Quarter 3	Quarter 4	
Austin Troy - Regular	$50,816.24	$21,558.40			$8,723.04		$8,723.04
Austin Troy - Cost Share			$8,343.78	$4,171.89			$12,515.67
Jarlath O'Neil Dunne - Regular	$50,013.61	$65,865.02	$3,038.10	$6,962.71	$6,962.71	$1,995.30	$18,958.83
Jarlath O'Neil Dunne - Cost Share							$0.00
Ernest Buford	$22,470.35	$22,470.35	$0.00	$2,306.16	$9,490.84	$0.00	$11,797.00
Amanda Hanaway	$43,808.73	$53,646.46	$3,596.78	$3,596.78	$5,395.53	$5,557.59	$18,146.67
Sean MacFadden	$98,881.57	$98,881.47	$19,891.95	$24,864.94	$29,837.93	$0.00	$74,594.81
James Sullivan	$23,559.89	$23,559.89	$1,813.91	$1,813.91	$1,813.91	$2,988.70	$8,430.41
Technician	$19,891.05	$19,891.05	$0.00	$0.00	$0.00	$1,979.26	$1,979.26
Non-Salary Expenditures				$25,987.91		$4,542.76	$30,530.67
Non-Salary Cost Share							$0.00
Total	**$309,441.45**	$305,872.65	**$36,684.51**	**$69,704.29**	**$62,223.95**	**$17,063.61**	**$185,676.37**
Cost Share:	$382,630.00	$382,630.00	$8,343.78	$4,171.89	$0.00	$0.00	$12,515.67
Invoiced:	$371,750.00	$371,750.00	$28,340.74	$65,532.40	$62,223.95	$17,063.61	$173,160.70
Total:	**$754,380.00**	$754,380.00	**$36,684.51**	**$69,704.29**	**$62,223.95**	**$17,063.61**	**$185,676.37**

Note: Due to an accounting error, Jarlath O'Neil Dunne's time was reported incorrectly as cost share for the first quarter. This has been revised in the table above, as well as in our accounting system. The expenditures shown in the table above are approximate, and are subject to variations from what is shown on the project invoices due to University Wide Salary and Cost of Living Adjustments. Also, hours reported for each task are estimated for the current quarterly report and then revised in the next quarterly report to reflect what is presented on invoices.

Breakdown of Non-Salary Expenditures

Airfare Domestic	$234.80
Computing Supplies	$163.48
Conference Regstr Fee Domestic	$375.00
Consult/Prof Svcs Org Fees	$1,820.00
Express Mail & Delivery Svcs	$90.22
IC - Micro Comp Srvcs/Accsr	$72.00
Laboratory & Research Supplies	$338.62
Mileage Domestic	$220.92
Non-Cap Cmptr Hardware <$5000	$3,047.72
Non-Cap Moveable Equip >$5000	$24,167.91
Grand Total	$30,530.67

Meetings

List of Advisory Committee Meetings to Date:

- 3/19/2013 Meeting. Meeting minutes and webinar recording are provided on the project website.
- 12/6/13 Meeting. Meeting minutes and webinar recording will be provided on the project website within the next two weeks.

List of Meetings with the USDOT Project Management Team:

- 1/15/14 Meeting. A technical and financial update was provided to Caesar Singh and Vasanth Ganesan. The meeting minutes will not be posted to the website due to the detailed level of information exchanged in the meeting.

Presentations

- Sensing Technologies for Transportation Applications. Sunday, January 12, 2014, 9:00 am to 12:00 pm (noon), Hilton, Columbia Hall 11, Washington D.C. More information provided in the appendix.
- Emerging Remote-Sensing Technologies for Studying the Vermont Landscape. Thursday, December 12, 2013, University of Vermont, Aiken Center.

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 Arial Vehicles to monitor sections of rivers and streams that are difficult to access on the ground. After Tropical Storm Irene, it was determined that debris which had accumulated upstream was forced downstream and caused severe blockages.
- 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. The Vermont Research Advisory Council (RAC) Program recently chose the following project for funding: "Using Remote Data Collection to Identify Bridges and Culverts Susceptible to Blockage During Flooding Events.
- Department of Emergency Management and Homeland Security. The project team has been working with DEMHS on their critical infrastructure program. The discussions have been focused on how UAVs and GIS data can be used to determine what should be considered critical infrastructure, and how to maintain and protect it better in the future.

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

Appendix

Appendix A – Purchasing and Flying UAVs in Vermont: Lessons Learned (so far)
Appendix B – Sensing Technologies for Transportation Applications presentation details

Appendix A
Purchasing and Flying UAVs in Vermont: Lessons Learned (so far)

Flying UAVs in Vermont: Lessons Learned

The University of Vermont (UVM) is currently undergoing a research project funded by USDOT entitled "Rapid Exploitation of Commercial Remotely Sensed Imagery for Disaster Response & Recovery". This is the first university research project in the State of Vermont which will use Unmanned Aerial Vehicles (UAVs). To assist in future UAV projects, we have compiled a list of lessons learned about purchasing and flying UAVs in Vermont. This list will be updated as the project progresses.

- **Certificate of Authorization (COA).** Some UAV vendors (e.g. Gatewing) will only sell to organizations that can obtain a COA. The COAs can only be issued to public agencies. Some public colleges and universities within the United States are considered public agencies, but for various legal reasons UVM is not considered a public agency. Opinions on whether or not COAs are required for university research differed among the other universities we spoke with who operate UAVs. Some have obtained COAs, some believe that no COA is required as they are operating under 400ft, and others work with their state transportation agency to secure cleared airspace. We decided to purchase a UAV that did not require a COA.

- **Purchasing.**
  - Research-grade UAVs can take weeks to months to be delivered from the time of purchase.
  - UAVs purchased from international vendors may be held up at customs due to certain components. For our Sensefly EBEE to be released by customs we had to complete both the FCC-740 and the 5106 form.

- **Authorization for Flights.** All UAV flights will need to be scheduled and approved by Guy Rouelle at the Vermont Agency of Transportation.

  - Step One: Guy Rouelle at the Vermont Agency of Transportation should be contacted at the onset of the project. He should be provided with a project summary and scope of work. Flight will require a Mission Profile and during this initial conversation Mr. Rouelle will tell you exactly what information to include in the Mission Profile and how far in advance to submit it. Also, depending on where you want to fly and at what altitude, you may need a Certificate of Authorization (COA) for the flight. If your organization is not an Agency of the State, we recommend that you choose flight paths that are outside of restricted airspace and below 400ft AGL to avoid the COA requirement. Confirm with Mr. Rouelle as to whether or not your project will require a COA.

  - Step Two: Send a Mission Profile to Guy Rouelle at least 1-2 weeks ahead of the scheduled flight. The more information you can provide ahead of time, the better. The Mission Statement should include:
    - UAV departure point,
    - route of flight,
    - altitude,
    - duration of flight,
    - preprogrammed profile or remotely controlled

  - Step Three: Guy Rouelle will contact FAA and Portland FSDO, if necessary. Also, Mr. Rouelle will obtain a Special Airworthiness Certificate (SAC), if necessary.

- **Restricted Airspace.** The general rule of thumb is that UAVs should be flown 5 or more miles away from designated airports and Camp Johnson. However, different airports have different requirements, and some additional restricted airspace exists within Vermont. Work with Guy Rouelle when selecting a flight location.

- **Flight Altitude.** The UAV should be operated below 400ft AGL to avoid the need for FAA clearance.

- **Incident Command System (ICS) Training.** FEMA may require the UAV user to obtain ICS Training prior to any field work associated with a natural disaster. We recommend courses IS-100.b Introduction to Incident Command System, IS-700.a National Incident Management System (NIMS): An Introduction, and IS-800.b National Response Framework: An Introduction, at a minimum.

Appendix B
Sensing Technologies for Transportation Applications presentation details

TPW14-005

Sunday, January 12, 2014, 9:00 am to 12:00 pm (noon), Hilton, Columbia Hall 11, Washington D.C.

Sensing Technologies for Transportation Applications

Colin Brooks, Michigan Tech Research Institute (MTRI), presiding

Co-Sponsored by the Committee on Information Systems and Technology (ABJ50) and the Committee on Geographic Information Science and Applications (ABJ60)

This workshop continues a series of workshops on practical uses of sensing technologies for transportation planning, management, and operations. Included technologies are both remote sensing and in situ sensors. Technologies to be covered include both remote sensing and in-situ sensors. The workshop brings together researchers and practitioners to share the results of their efforts with a broader community and discuss future research needs and applications. Presentations will demonstrate the broader application of these developing tools.

Speakers, affiliations, talk titles, and co-authors:

1. Nigel Waters, George Mason University, nwaters@gmu.edu - "Assessing road infrastructure during emergencies through remote sensing and social media." Co-Authors: Guido Cervone, Emily Schnebele, Jeff Harrison. (P14-6187)
2. R. Andrew Swartz, Michigan Technological University, raswartz@mtu.edu - "Autonomous Scour Sensing for Bio-Inspired Magnetostrictive Flow Sensors." Co-Authors: Alison Flatau, Colin Brooks, Brian Barkdoll, Suok-Min Na, K. Arthur Endsley. (P14-6189)
3. Aditi Chattopadhyay, Arizona State University, aditi@asu.edu - "Multilevel Adaptive Remote Sensing Package for Bridge Scour Health Management." (P14-6191)
4. Colin Brooks, Michigan Tech Research Institute (MTRI), cnbrooks@mtu.edu - "Implementing Assessment of Unpaved Road Condition with High-Resolution Aerial Remote Sensing". Co-Authors: Richard Dobson, Chris Roussi, Tim Colling, David Dean, Melanie Kuiber. (P14-6192)
5. Jarlath O-Neil-Dunne, University of Vermont, Jarlath.ONeil-Dunne@uvm.edu - "Rapid Exploitation of Commercial Remotely Sensed Imagery for Disaster Response & Recovery". Co-Authors: Austin Troy, Jim Sullivan, Amanda Hanaway-Corrente, Sean MacFaden. (P14-6193)
6. Ashwin Yerasi, University of Colorado, ashwin.yerasi@colorado.edu - "Sensing Poor Highway Surface Conditions with High-Resolution Satellite Imagery". Co-Author: William Emery. (P14-6196)
7. Yuanchang Xie, University of Massachusetts Lowell, Yuanchang_Xie@uml.edu - "Automatic Track Inspection Using 3D Laser Profilers to Improve Rail Transit Asset Condition Assessment and State of Good Repair – A Preliminary Study." Co-Authors: Samy Metari, Mario Talbot, Kaiguang Zhao, John Laurent. (P14-6198)

8. Brian Bruckno, Virginia Department of Transportation, brian.bruckno@vdot.virginia.gov - "Application of Interferometric Synthetic Aperture Radar to sinkhole detection and rock slope monitoring." Co-Author: Edward Hoppe. (14-2178)
9. Sean Barbeau, University of South Florida, sjbarbeau@gmail.com - "Automatic Identification of Points of Interest in Global Navigation Satellite System Data: A Spatial Temporal Approach." Co-Authors: Khoa Tran, Miguel Labrador. (P14-6199)
10. Srinivas Pulugurtha, The University of North Carolina at Charlotte, sspulugurtha@uncc.edu – "Travel time data collection and spatial information technologies for reliable transportation systems planning." Co-Author: Venkata Duddu. (P14-6326)

Session Type: Workshop (W)

Subject Areas: Data and Information Technology

Note: Each talk is 15 minutes in length.

Subcommittee webpage is located at: http://www.abj50.org/subcommittees/sensing-technologies/