UTC Project Information	
Project Title	Cost-effective bridge safety inspections using unmanned aerial vehicles (UAVs)
University	Oregon State University
Principal Investigator	Dan Gillins
PI Contact Information	dan.gillins@oregonstate.edu
Funding Source(s) and Amounts Provided (by each agency or organization)	University of Washington PacTrans $39,785 Oregon State University $39,785
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Agency ID or Contract Number	DTRT13-G-UTC40
Start and End Dates	January 15, 2015– September 16, 2016
Brief Description of Research Project	The objective of this research is to evaluate how useful UAV technology could be in performing visual bridge inspections. The FHWA requires biennial bridge inspections, evaluating this exciting and emerging technology will provide helpful information to every region in the United States. To accomplish this objective, the project goals are to investigate existing UAV technology, including available platforms, sensors, flight controllers, and mission planning tools. Review FHWA requirements for performing bridge inspections per 23 CFR Part 650. Acquire UAV-based imagery and video for 1-3 representative bridges; develop recommendations for how to properly plan flights for bridge inspections; analyze resulting images and video to determine which FHWA bridge requirements are satisfied (and which ones are not satisfied); and transfer to the DOTs recommendations on how to properly implement UAVs for performing bridge inspections.

Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	In the study, a small quadcopter was flown to collect ultra-high-definition video of a large bridge in Independence, Oregon. A number of minor bridge defects were noted in the imagery, including rust, missing nuts, efflorescence, cracks, and spalling. The videos could be used to satisfy many of the routine and initial bridge inspection requirements of the AASHTO Bridge Inspection Manual (AASHTO, 2011). The imagery may also be useful for in-depth inspections; however, in-depth inspections sometimes require probing and scraping that cannot be accomplished with UAS. In addition, in-depth inspections require the inspector to be at arm's length of the bridge. Obviously, a UAS does not satisfy this requirement. The greatest challenge involves capturing imagery with a UAS with sufficient resolution for an inspection. At arm's length, the human eye has a spatial resolution approximately equal to 0.1 mm. Even within 3 meters of the bridge, the approximate spatial resolution of the high-definition camera onboard the quadcopter in this experiment was 0.7 mm. Flying even closer to the bridge is difficult because of complicated wind eddies that can potentially push the aircraft into the structure. This issue could, potentially be alleviated by flying a heavier aircraft equipped with a camera with a larger sensor size and an optical zoom. Future research remains to investigate other UAS platforms for bridge inspection.
	Example of imagery of a bridge acquired from an Aerialtronics octocopter (left). The image shown here was acquired at a relatively large stand-off distance and flying height to capture the entire deck. For high-resolution inspection work, the UAV can be operated at a shorter, fixed stand-off distance and/or a larger focal length camera can be utilized. 

Impacts/Benefits of Implementation (actual, or anticipated)	UAS has great potential for reducing some of the dangers and costs associated with a bridge inspection. Further, UAS can be beneficial for a number of additional transportation engineering-related problems, such as for monitoring traffic, inspecting construction sites, surveying and mapping, performing roadside condition inventorying, etc. It is worth noting that the authors received a two-year grant from the Oregon Department of Transportation (ODOT) to conduct additional field tests. Under the grant, the team will fly additional bridges using other sizes of multi-copters and cameras. In addition, the team will acquire imagery during official bridge inspection(s) conducted by ODOT. The costs and benefits of the tests will be documented in a future ODOT research report.
Web Links • Reports • Project Website	http://hdl.handle.net/1773/43506