| **UTC Project Information** | |
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| Project Title | Bridge Structural Inspections using Bridge Information Models (BrIM) and Unmanned Aerial Vehicles (UAVs) |
| University | Oregon State University |
| Principal Investigator | Yelda Turkan |
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| Funding Source(s) and Amounts Provided (by each agency or organization) | University of Washington PacTrans $35,000<br>Oregon State University $35,000 |
| Total Project Cost | $70,000 |
| Agency ID or Contract Number | 69A3551747110 |
| Start and End Dates | August 16, 2017 – August 15, 2019 |
| Brief Description of Research Project | This study developed a novel bridge inspection framework to mitigate the problems that were identified in current bridge inspection and management practices. The framework implements camera-based Unmanned Aerial Systems (UAVs) along with computer vision algorithms to collect and process inspection data, and Bridge Information Modeling (BrIM) to store and manage all related inspection information. In addition, an illustrative case study was conducted on an existing bridge in Eugene, Oregon using the proposed framework to test its feasibility and efficiency.<br><br>The proposed framework provides bridge data in the form of digital images and 3D models in a central database that is simultaneously accessible to all stakeholders via cloud computing. |

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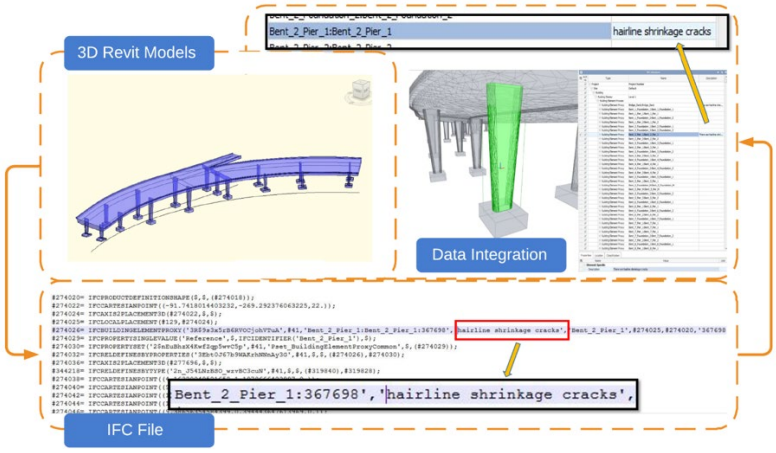
| Describe Implementation of Research Outcomes (or why not implemented)<br><br>Place Any Photos Here | To demonstrate the feasibility and efficiency of the proposed framework, an illustrative case study has been conducted on an existing bridge located in Eugene, Oregon. The UAS was operated on December 1 and 7, 2017 due to the good weather conditions, without strong winds for the flight. High-resolution images of bridge elements from different angles were captured using the rotating gimballed camera. The collected images and videos were stored in the memory card in JPEG and MP4 formats, respectively. In the next step, these images were processed using a variety of digital image processing algorithms in Matlab environment to detect any cracks or other defects such as spalling. Figure 1 shows an example image where seven hairline flexure cracks identified as cracks at the end of the image processing step.<br>In the meantime, researchers developed 3D BrIM for the bridge using Autodesk Revit and mass concept software, which was ultimately converted into Industry Foundation Classes (IFC) format, a neutral file format for BIM data exchange. The procedure for integrating bridge inspection data in the IFC model is shown in Figure 2.<br><br>  <br>Figure 1 Crack detection results: (a) Original UAS image; (b) Detected and labeled cracks on the UAS image<br><br>  <br>Figure 2 Procedure for integrating bridge inspection data |

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| Impacts/Benefits of Implementation (actual, or anticipated) | The case study results verified the following: (1) high-resolution images collected using an UAV enable to visually identify different types of defects, and detect cracks automatically using computer vision algorithms, (2) the use of BrIM enable assigning defect information on individual model elements, manage all bridge data in a single model across the bridge life cycle. The proposed framework is expected to help to: (1) collect and document accurate bridge inspection data; (2) reduce the time and number of site visits and eliminate potential errors resulting from data transcription; and (3) enable a more efficient, cost-effective, and safer bridge inspection process. |
| Web Links<br>• Reports<br>• Project Website | https://doi.org/10.1108/ECAM-12-2018-0556<br>https://depts.washington.edu/pactrans/research/projects/bridge-structural-inspections-using-bridge-information-models-brim-and-unmanned-aerial-vehicles-uavs/ |