UTC Project Information	
Project Title	LiDAR, Drones and BrIM for Rapid Bridge Inspection and Management
University	Oregon State University
Principal Investigator	Yelda Turkan
PI Contact Information	Yelda.turkan@oregonstate.edu
Funding Source(s) and Amounts Provided (by each agency or organization)	University of Washington PacTrans $180,000 Oregon State University $90,000 University of Washington $60,000
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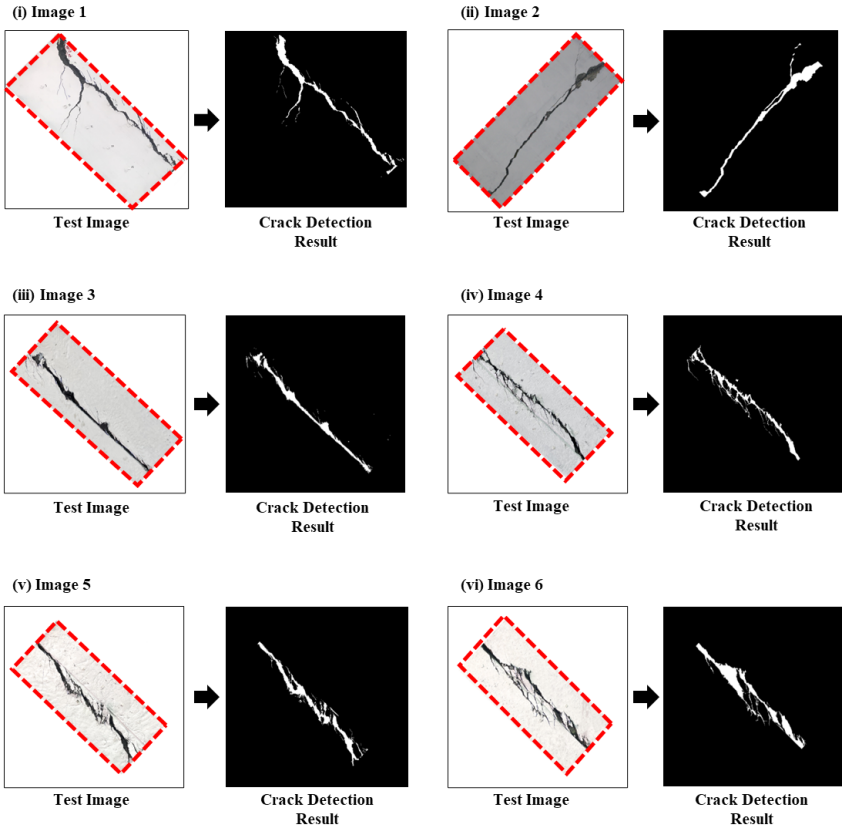
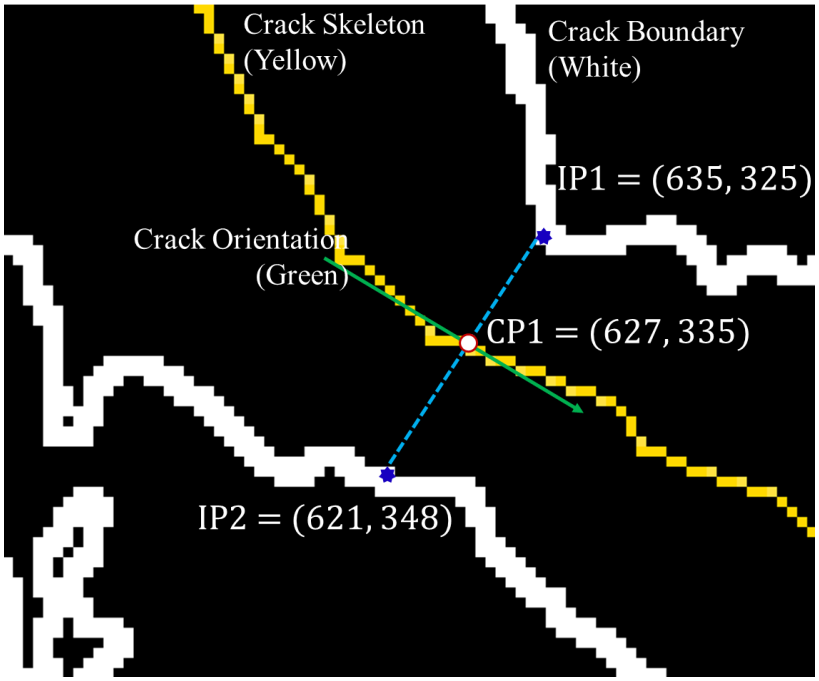
Brief Description of Research Project	The mobility of people and goods is highly dependent on the health of a nation's transportation system. Timely inspection and effective maintenance and management of bridges is crucial to avoid any issues that may have a negative impact on public mobility. However, current bridge inspection practices inhibit the collection and analysis of information regarding the status of bridges in an efficient and timely manner. This problem is exacerbated by the large number of bridges in the U.S. combined with the limited number of inspectors available. For example, in Oregon, there are more than 6,000 bridges and only about 25 inspectors employed by the DOT, thus requiring a substantial number of subcontractors to carry out the work. In this study, we developed a framework that would make bridge inspection and management much more convenient and faster, which can improve the current practice significantly in terms of efficiency and safety, thus helping to improve public mobility.

Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	To establish an improved bridge inspection framework, this study focused specifically on establishing an automated crack assessment method. A methodology was proposed combining Convolutional Neural Network (CNN)-based algorithms and traditional image morphological operations for crack detection and measurements. The proposed approach was tested on data obtained from six images containing ten cracks of various sizes and shapes that were obtained from laboratory experiments in a controlled environment. The proposed methodology achieved an average F1 score of 0.93, with 88.17% and 94.40% accuracy in crack length and width measurements, respectively.  Fig. 1. Test Images (Left) and Crack Detection Results (Right)

	 Fig. 2. Automated Crack Width Measurements
Impacts/Benefits of Implementation (actual, or anticipated)	By combining the two methods (CNN-based methods and image morphological operations), the proposed method can detect cracks in large-sized images, which can be useful for automated detection and measurement of cracks on larger structures such as multi-story buildings or bridges. Also, the expected performance of the proposed method is proven to be accurate. Compared to other similar studies, this study achieved similar and / or better accuracy. This study is an important component of an overall research framework that aims to develop a methodology for rapid structural assessment utilizing UAS images and automatically detecting and measuring surface defects of large structures such as multi-story buildings or bridges. It is envisioned that, in this overall framework, structural assessment results, i.e., surface defects, would be mapped to Building Information Models (BIM), where inspection reports from different dates can be integrated with structural drawings and models in a single database.
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