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14. Supplementary Notes

15. Abstract

Objective

The objective of this research was to collect nondestructive evaluation data from five bridge decks in the county of Grand forks, ND, and to perform initial analysis for their evaluation of use and outline parameters for their future use.

Scope

Bridge decks experience faster deterioration than other bridge components and they cannot be fully evaluated through visual inspections. Non-destructive evaluation (NDE) methods can provide vital information about bridge deck condition. North Dakota Department of Transportation has scheduled five bridges in Grand Forks District for deck repair. The principal investigator proposes collecting NDE data in contact and non-contact (unamend aerial systems) manners from these bridge before, during, and after repair. The NDE data will be analyzed to evaluate the decks and then compared with ground truth to identify their shortcomings and potentials in the fields. In addition, accurate annotated NDE datasets will be formed for the first time that can effectively be used to develop robust artificial intelligent models, capable of NDE data analysis for bridge deck evaluation without relying on experts' opinion.

Summary

The research team reviewed recent advanced NDE methodologies including, but not limited to, resolution, environmental, sensor, and platform requirements for equipment, and specifications. The research team also performed a thorough literature review. All NDE data were collected before the bridges were repaired. Impact Echo is commonly used to detect shallow delamination while GPR can detect the location of bars and their level of corrosion. IRT images were collected using Unmanned Aerial Systems (UAS) to detect delamination. The bridge decks in this study were prepared for ground truth data collection by scarifying delaminated portions of the deck identified by chain-dragging and other visual investigation methods. A delamination survey map locating the areas of delamination and their classes/level of deck removal, produced by NDDOT, served as the ground truth for annotating IRT, IE and GPR field tests data in this study. The maps were aligned with the ground truth maps using image registration, affine transformation, image binarization, morphological operations, connected components and region props techniques to execute a semi-automatic pixel – wise annotation. The research team created the annotated dataset that can be used for training Artificial Intelligence models for defect detection, validating NDE for bridge evaluation, data fusion for improved defect detection, development of new data quality assessment methods based on probability of defect detection etc.

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