Joint Transportation Research Program

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Investigating Consistency Among Bridge Inspectors Using Simulated Virtual Reality Testbed

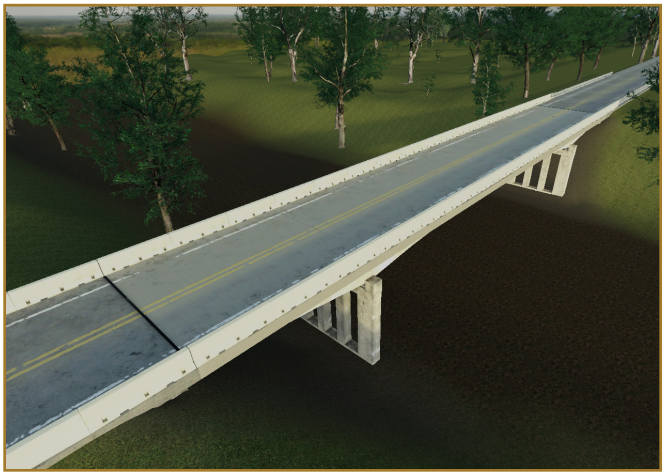
INTRODUCTION

The current condition of US infrastructure requires a data-driven, risk-based approach to asset management. In the case of bridges, inspectors in every state visit these structures and collect data. Based on the information they report, state departments evaluate bridge conditions, predict deterioration, and make repair and retrofit decisions. However, the capacity of inspectors to detect defects might vary due to several factors, such as the inspectors' eyesight or professional experience. In this project, a VR-based application was developed to engage users in immersive, photo-realistic 3D environments and provide a testbed to study the variability among bridge inspectors. The outcome will provide statistical information that will be used to enhance current inspection practices.

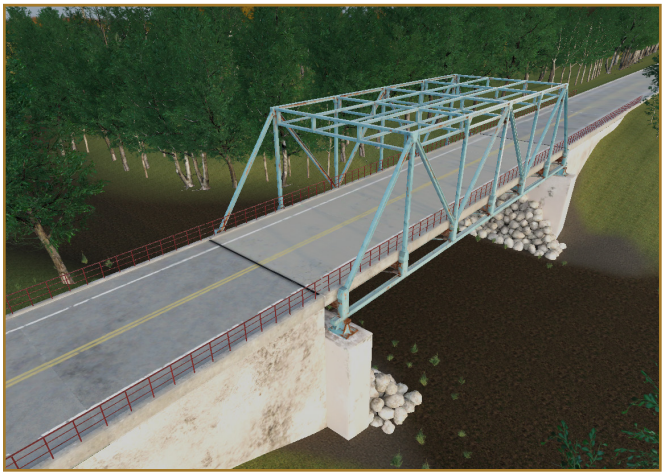
With the use of VR technology, current limitations of inspection evaluation, such as multiple districts and different types of structures, logistics of people and equipment, and weather conditions, are addressed. Besides improving inspection training, time and cost savings, safer conditions, and innovative training tools are also expected results. The final product is a modern VR set-up with testing models of concrete and steel bridges under controlled conditions that is open to assessing future needs. The system runs on a high-resolution tethered headset supported by a gaming laptop to increase portability across Indiana districts.

FINDINGS

The VR-based application is comprised of two bridge modules—one for a steel truss bridge and one for a



Top view of the final version of the concrete bridge modeled within the virtual environment.



Top view of the final version of the steel bridge modeled within the virtual environment.

multi-beam concrete bridge. The 3D bridge models were synthetically recreated using reference images from two case studies. Through constant feedback and multiple demonstration sessions with the Indiana Department of Transportation (INDOT) and Study Advisory Committee (SAC) members, the bridge components, the defects and their severity, and the inspection tools to be modeled were defined. Nine types of defects were modeled, including efflorescence, cracking, corrosion, spalling, and delamination. Eight inspection tools were also recreated in the VR scene, such as chain drag, hammer, scratch or wire brush, flashlight, and tape measure.

IMPLEMENTATION

After completing the inspection in the VR scene, users are required to fill out an online survey for each bridge. Condition rating numbers and comments on the state of the deck, superstructure, and substructure are requested. Additionally, factors such as years of experience and work location are used to identify consistency patterns when compared with the rating numbers. The VR application also offers the possibility of taking screenshots that inspectors can later attach to their surveys to complement their reports. Statistical analysis, including pie charts and histograms, is automatically generated, giving a multi-faceted approach to consistent evaluation among inspectors.

Recommended Citation for Report

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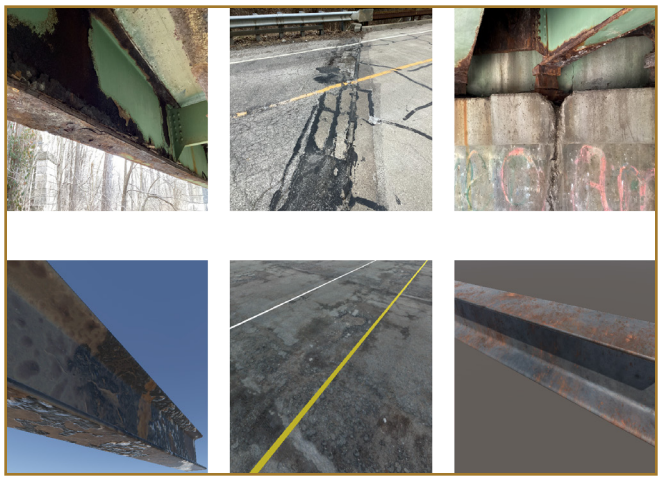
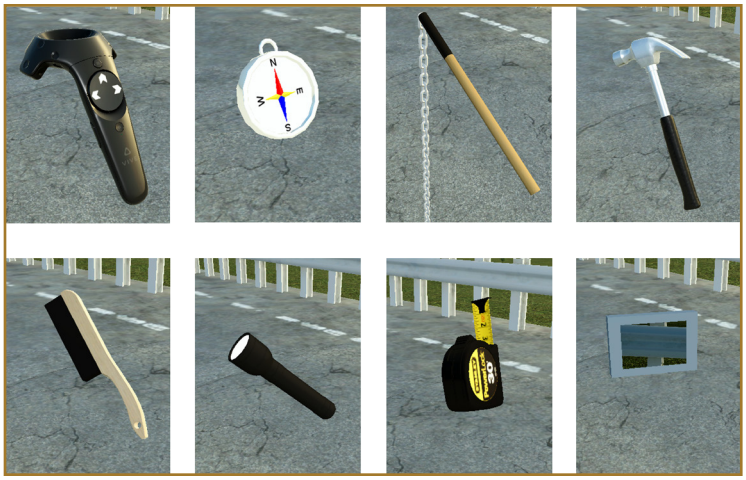


Representation of defects using synthetic modeling: heavy corrosion on steel beams and extensive cracking and spalling in concrete roads. (top) samples of real bridge components taken from Case Study 1 and (bottom) corresponding synthetic modeled recreations.



VR headset controller and inspection tools modeled. From top to bottom and left to right: controller, compass, chain drag, hammer, scratch brush, flashlight, tape measure, and zoom window