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Synthetic data for civil infrastructure assessments

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Abstract: Manual visual inspection of civil infrastructure is high-risk, subjective, and time-consuming. The success of deep learning and the proliferation of low-cost consumer robots has spurred rapid growth in research and application of autonomous inspections. The major components of autonomous inspection include data acquisition, data processing, and decision making, which are usually studied independently. However, for robust real-world applicability, these three aspects of the overall process need to be addressed concurrently with end-to-end testing, incorporating scenarios such as variations in structure type, color, damage level, camera distance, view angle, lighting, etc. Developing real-world datasets that span all these scenarios is nearly impossible. In this seminar, I will discuss two approaches to generating synthetic data of damaged structures to that can enable end-to-end testing of autonomous inspection strategies and provide additional training data for deep neural networks. The first approach I discuss will cover Computer Generated Imagery (CGI) where we use non-linear finite element models to inform the realistic and automated visual rendering of different damage types, the damage state, and the material textures. Finally, I discuss deep learning-based data generation methods, namely the use of Unpaired image-to-image translation achieved using Cycle Consistent Adversarial Network (CCAN) architectures for the production of images of damaged structures.

Spekaer bio: Dr. Vedhus Hoskere is an Assistant Professor in the Department of Civil and Environmental Engineering at the University of Houston (UH) and holds a joint appointment in Electrical and Computer Engineering. Dr. Hoskere received his Ph.D. in Civil Engineering in 2020, after an MS in Computer Science in 2020, and an MS in Structural Engineering in 2016, all from the University of Illinois at Ubana-Champaign. At UH, Dr. Hoskere is the Director of the Structures and Artificial Intelligence Lab. (https://sail.cive.uh.edu/) Dr. Hoskere's research interests are interdisciplinary, at the intersection of structural engineering, machine learning, computer vision, and robotics. His doctoral work focused on developing artificial intelligence, machine learning and computer vision solutions for rapid and automated civil infrastructure inspection and monitoring. His research at UH looks at building on his prior experience to develop systems for autonomous infrastructure management including incorporation of physics-based modelling, autonomous robotic data acquisition, deep learning-based data to decision frameworks, and autonomous robotic manipulation systems for infrastructure repair. Dr. Hoskere has published 14 journal papers and 29 conference papers. Dr. Hoskere has received awards for his research at prestigious avenues including "best poster" at SHMII-9 and "best paper" at the ASCE EMI Conference.