ABSTRACT

Ghosh Mondal, Tarutal Ph.D., Purdue University, July 2021. Vision-based Autonomous Inspection and Condition Assessment of Civil Infrastructures. Major Professor: Mohammad R. Jahanshahi.

This dissertation broadly focuses on autonomous condition assessment of civil infrastructures using vision-based methods, which present a plausible alternative to existing manual techniques. A computer vision-based approach is presented to track the evolution of a damage over time by analysing historical visual inspection data. Once a defect is detected in a recent inspection data set, its spatial correspondences in the data collected during previous rounds of inspection are identified leveraging popular computer vision-based techniques. A single reconstructed view is then generated for each inspection round by synthesizing the candidate corresponding images. The chronology of damage thus established facilitates time-based quantification and lucid visual interpretation. This study is likely to enhance the efficiency structural inspection by introducing the time dimension into the autonomous condition assessment pipeline.

Apart from that, this dissertation exploits a region-based convolutional neural network (Faster R-CNN) for detection of various earthquake-induced damages in reinforced concrete buildings. Four different damage categories are considered such as surface crack, spalling, spalling with exposed rebars, and severely buckled rebars. The performance of the model is evaluated on image data collected from buildings damaged under several past earthquakes taking place in different parts of the world. The proposed algorithm can be integrated with inspection drones or mobile robotic platforms for quick assessment of damaged buildings leading to expeditious planning

of retrofit operations, minimization of damage cost, and timely restoration of essential services.

Additionally, this dissertation incorporates depth fusion into a CNN-based semantic segmentation model. A 3D animation and visual effect software is exploited to generate a synthetic database of spatially aligned RGB and depth images representing various damage categories which are commonly observed in reinforced concrete buildings. A number of encoding techniques are explored for representing the depth data. Besides, various schemes for fusion of RGB and depth data are investigated to identify the best fusion strategy. It was observed that depth fusion enhances the performance of deep learning-based damage segmentation algorithms significantly.

Overall, the scientific research presented in this dissertation will be a stepping stone towards realizing a fully autonomous structural condition assessment pipeline.