ABSTRACT

This research is driven by the rising demand for accurate, streamlined, and time-efficient bridge engineering inspections while considering state agencies' tight schedules and budget limitations. Bridge inspection practices mainly rely on onsite visual assessment procedures, which are complex from technical and logistical perspectives and require significant time and resources. Performing inspection tasks using viewing digital models that are reliable and complete represents one strategy to streamline the inspection process. The 3D model represents the material and geometric aspects of the bridge. Constructing a reliable and detailed 3D textured bridge model necessitates carefully selecting the correct image texture for each surface element to accurately represent the true state of the surfaces. The critical challenge in leveraging image-based rendering techniques (IBR) for texture mapping and rendering 3D polygonal models is selecting the optimal reference image to maintain consistency across the textured model. The selection of the source image may impact the overall rendering appearance and may lead to visible seams in the final output. Usually, follow-up procedures are performed to veil the visible seams and enhance the visual quality of the 3D textured model. For the purpose of engineering inspection, it is crucial that the 3D textured model accurately represents and preserves the true state of the surfaces, which could be compromised by post-processing techniques. Therefore, this important issue in the field of image-based rendering (IBR) must be addressed, which is the focus of this dissertation.

The dissertation improves and automates the existing process of selecting reference images for textures by integrating image geometry and scene information to select the best reference view for each polygon. This selection process must be embedded into a global process that maximizes overall scene continuity and coherence. A Rendering Quality Metric (RQM) is proposed to numerically measure the quality of the 3D textured model through a comprehensive evaluation of the model. This RQM can be viewed as penalizing image discontinuities or rewarding image continuity in the entire model. The significance of RQM lies not solely in evaluating the quality of the 3D textured product but also in providing users with insights into potential improvements to the current product, based on needs or requirements not yet considered. Furthermore, automating and optimizing the process of selecting reference images can minimize rendering artifacts, enable full automation of the rendering process, and improve virtual bridge inspection. This novel optimization approach aims to automate the selection of optimal image texture to

maximize surface information while minimizing visual inconsistencies for engineering inspection. The approach can be considered as an extension of prior steps, including photogrammetric analysis, bundle block adjustment (BBA), and 3D surface model generation. This extension can facilitate the end-to-end photogrammetric modeling and rendering workflow. This research directly addresses the task of rendering the surface model.