COMPUTER VISION-BASED STRUCTURAL ASSESSMENT EXPLOITING LARGE VOLUMES OF IMAGES

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Abstract
Visual assessment is a process to understand the state of a structure based on evaluations originating from visual information. Recent advances in computer vision to explore new sensors, sensing platforms and high-performance computing have shed light on the potential for vision-based visual assessment in civil engineering structures. The use of low-cost, high-resolution visual sensors in conjunction with mobile and aerial platforms can overcome spatial and temporal limitations typically associated with other forms of sensing in civil structures. Also, GPU-accelerated and parallel computing offer unprecedented speed and performance, accelerating processing the collected visual data. However, despite the enormous endeavor in past research to implement such technologies, there are still many practical challenges to overcome to successfully apply these techniques in real world situations. A major challenge lies in dealing with a large volume of unordered and complex visual data, collected under uncontrolled circumstance (e.g. lighting, cluttered region, and variations in environmental conditions), while just a tiny fraction of them are useful for conducting actual assessment. Such difficulty induces an undesirable high rate of false-positive and false-negative errors, reducing the trustworthiness and efficiency of their implementation. To overcome the inherent challenges in using such images for visual assessment, high-level computer vision algorithms must be integrated with relevant prior knowledge and guidance, thus aiming to have similar performance with those of humans conducting visual assessment. Moreover, the techniques must be developed and validated in the realistic context of a large volume of real-world images, which is likely contain numerous practical challenges. In this dissertation, the novel use of computer vision algorithms is explored to address two promising applications of vision-based visual assessment in civil engineering: visual inspection, and visual data analysis for post-disaster evaluation. For both applications, powerful techniques are developed here to enable reliable and efficient visual assessment for civil structures and demonstrate them using a large volume of real-world images collected from actual structures. State-of-art computer vision techniques, such as structure-from-motion and convolutional neural network techniques, facilitate these tasks. The core techniques derived from this study are scalable and expandable to many other applications in vision-based visual assessment, and will serve to close the existing gaps between past research efforts and real-world implementations.

Keywords
Visual assessment, Computer vision, Structure-from-motion, Multi-view geometry, Convolutional neural network