

Fast Computer-Based Evaluation Tool for Post-Earthquake Reconnaissance Training

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Abstract

In the immediate aftermath of a significant earthquake, thousands of structural damage images are uploaded to online data repositories by civil/structural engineering reconnaissance teams and formal/social media platforms by citizens, amateur photographers, and journalists. While these image sets provide valuable information, it is difficult and time-intensive for experts to assign detailed damage tags to each of the images in order to conduct rigorous statistical analyses of seismic response of structures necessary to inform existing national/international codes for structural design practice.

However, it is not necessary that the individuals tagging damage be seasoned structural engineers with experience specifically in post-earthquake reconnaissance. Training engineers to tag for damage and structure is difficult and is not carried consistently. This paper presents a consistent approach developed by the authors that facilitates the training of young engineering students/professionals or even novice citizen volunteers (“trainees”) by standardizing the way they identify and tag specific damage-structure pairs. Implementation of this software tool involves selecting around 200 photographs tagged by an expert and with proven accuracy (“ground truth”) which is compared to files tagged by the trainees. The trainees are then provided with instantaneous feedback on the accuracy of their damage assessment. Based on Formative Assessment pedagogical theory, is very important to give students prompt and accurate feedback

The output of the project is an open-source software package consists of an easy-to-navigate graphical user interface that displays untagged photographs from the ground truth set in a slide show sequence. The trainee is prompted to draw a bounding box around the damage(s) shown in each image and select an associated damage-structure pair from a set of radio buttons. Upon completion of tagging all photographs in the slide show, the software provides a formative assessment both by indicating the trainee’s percent accuracy compared to the expert and specific feedback about the most common errors to indicate their readiness to tag other images or perform reconnaissance tasks.

The aforementioned problem of evaluating trainee results against the expert is not as simple as comparing and finding differences between two sets of image files. The research team anticipates challenges in that each trainee will select a slightly different sized area for the same occurrence of damage, and some damage-structure pairs are more difficult to recognize and tag. Additionally, the authors intend for this tool be used in conjunction with free earthquake reconnaissance webinars that train responders, similar to the one recently hosted by the Applied Technology Council (ATC) in the aftermath of Hurricane Harvey. Historically, these webinars have a heavy attendance and it will be necessary to compare the ground truth set to files from hundreds of trainees; therefore, the research team has selected to implement the algorithm on the graphics processing unit (GPU) using CUDA.

To assess the efficacy of the training tool, the authors plan to gather results and feedback from a group of volunteer citizen/engineers. The plan is to evaluate trainees’ ability to identify specific post-earthquake damage-structure pairs before and after several iterations of formative assessment from the software tool.