Deep Learning for Automated Image Classification of Seismic Damage to Civil Infrastructure

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Research Motivation

Facilitate image data processing efforts of virtual/ground reconnaissance teams by adding detailed metadata.
Research Motivation

Improve ability to conduct specific queries of image repositories (i.e. EERI LFE Reconnaissance Archives)
Research Motivation

Enable robust analysis of damage images to support modifications to codes/guides of practice
Research Objective & Tasks

Develop and train a deep learning network for automated image tagging

Gather Images for Damage-Structure Pair

Expert Tags Damage in Images

Train Neural Network (NN)

Deploy NN to Automate Tagging of New Images
Rapid Manual Tagging Tool: Interface
Rapid Manual Tagging Tool: Output
Neural Network: Workflow

**TRAIN**

- **Input Training Images**
  - Update Weights to Minimize Errors
  - Damage Classification
    - Damage ✓
    - Damage ✓
    - Damage ✗

- **Layer 1**
- **Layer 2**
- **Layer 3**
- **Layer 4**

**DEPLOY**

- **Input Image to Classify**
  - Multiply Learned Weight by Input Values (Pixels in Images)
  - Damage Tagged
Neural Network: Phase I - Binning

• Binary Classification: Damage/No Damage
• Training/Validation Image Set: 200 images
• Total Images Classified: 1283

Accuracy: 88.3%
Neural Network: Phase II - Bounded Region

- Focus on specific damage-structure pair: shear damage to short RC columns
- Training/Validation Set: ~200 images
- Total Images Classified: 1500

Accuracy: 77%
Results of Training: Examples

Original Image

Output Image from Algorithm after Training (20,000 epochs)

No Match in Image to Damage-Structure Pair
Neural Network: Phase II – Other Damages

Roadway cracking identified with 92% accuracy
Neural Network: Phase II – Other Damages

Horizontal offset of rail track identified with 80% accuracy
Current & Future Work

- Examination of expert consensus when tagging post-earthquake structural damage
- Development of training/validation images sets for unreinforced masonry structures
- Creation of damage maps from neural network output
Outreach : Engaging Other Engineers

• Use open source tagging tool to add location specific damage-structure tags to images: https://github.com/mpantoja314/ImageTagVER/

• Volunteer as expert tagger for *existing* image set to refine neural network training

• Contribute expertly tagged image set to train *new* damage-structure pair for neural network
Acknowledgements

Undergraduate Student Researchers:
Caleb Azevedo, Jack Bergquist, Rachel Chandler, Charles Facciolo, and Anugrah Gupta

Internal Funding from Cal Poly – SLO:
• Research, Scholarly, and Creative Activities (RCSA) Grant
• CPConnect Interdisciplinary Grant
Feedback & Questions

Thank you for your attention.
We welcome your comments and questions.

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