Comparison of Methodologies: Earthquake and Corrosion Damage Detection vs. Autonomous Concrete Crack Detection

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Introduction

Both papers leverage deep learning techniques for detecting structural damage, yet they approach the problem from different angles and with distinct methodologies. Here is a comparative analysis of their methodologies and differences.

Paper 1: Detection of Damages Caused by Earthquake and Reinforcement Corrosion in RC Buildings with Deep Transfer Learning

Methodology

- **Objective**: To distinguish between earthquake-induced damages and reinforcement corrosion in RC buildings.
- **Data Collection**:
  - Images of damaged RC elements collected from field surveys post-earthquakes (İstanbul-Silivri and Elazığ-Sivrice earthquakes).
  - Validation with data from the Samos Earthquake.
- **Model**: Deep transfer learning.
  - Uses a pre-trained CNN model.
  - Fine-tunes the model with a dataset of damaged RC elements.
- **Training and Validation**:
  - 1040 images used for training.
  - Validation with a different data pool to ensure robustness.

- **Performance**:
  - Achieved a success rate of 90.62% in distinguishing between corrosion and earthquake-induced damages.

Paper 2: Autonomous Concrete Crack Detection Using Deep Fully Convolutional Neural Network

Methodology

- **Objective**: To detect cracks in concrete using a deep fully convolutional network (FCN).
- **Data Collection**:
  - Public dataset from Middle East Technical University.
  - 40,000 images for crack and non-crack classification.
  - 600 annotated images for segmentation tasks.
- **Model**:
  - Initial classification using pre-trained CNNs (VGG16, InceptionV3, ResNet).
  - Semantic segmentation using an FCN with an encoder-decoder structure inspired by KittiSeg.
- **Training and Validation**:
  - Classification performance evaluated with pre-trained models.
  - FCN trained end-to-end for pixel-level segmentation.
- **Performance**:
  - VGG16 and InceptionV3 outperformed ResNet in classification.
  - FCN achieved around 90% average precision in crack detection.
  - Validated with images from a cyclic loading test video.

Key Differences

1. **Objective and Focus**:
   - **Paper 1**: Focuses on differentiating between types of structural damage (earthquake vs. corrosion) in RC buildings.
   - **Paper 2**: Focuses on detecting and segmenting cracks in concrete surfaces.

2. **Type of Damage**:
   - **Paper 1**: Deals with earthquake-induced and corrosion-induced damages.
   - **Paper 2**: Specifically targets crack detection.
3. **Data and Validation**:
   - **Paper 1**: Utilizes field-collected images of damaged RC elements. Validates with different earthquake data.
   - **Paper 2**: Uses a large public dataset for initial training and a smaller annotated dataset for segmentation. Validates with both static images and dynamic video frames.
4. **Model Architecture**:
   - **Paper 1**: Employs a transfer learning approach using a pre-trained CNN fine-tuned for the specific task.
   - **Paper 2**: Uses a fully convolutional network (FCN) for pixel-level segmentation with an encoder-decoder structure.
5. **Implementation and Output**:
   - **Paper 1**: Aims to assist in post-earthquake damage assessment, providing a classification of damage types.
   - **Paper 2**: Aims to provide detailed crack detection and path/density information, useful for ongoing structural health monitoring.
6. **Performance Metrics**:
   - **Paper 1**: Reports a success rate of 90.62% for damage type classification.
   - **Paper 2**: Reports around 90% average precision for crack detection and segmentation.

Conclusion

Both papers contribute to the field of structural health monitoring using deep learning but address different problems with distinct methodologies. Paper 1 focuses on classifying types of damage in RC buildings using a transfer learning approach, while Paper 2 focuses on detecting and segmenting concrete cracks using a fully convolutional network. Each method demonstrates high accuracy and provides valuable tools for improving the assessment and maintenance of civil engineering structures.

References

1. Paper 1: Dogan, G., Hakan Arslan, M., Ilki, A. (2023a). Detection of damages caused by earthquake and reinforcement corrosion in RC buildings with Deep Transfer Learning. Engineering Structures, 279, 115629. https://doi.org/10.1016/j.engstruct.2023.115629

2. Paper 2: Dung, C. V., Anh, L. D. (2019a). Autonomous concrete crack detection using deep fully convolutional neural network. Automation in Construction, 99, 52–58. https://doi.org/10.1016/j.autcon.2018.11.028