Using Convolutional Neural Networks for Crack Detection

­Manual inspection of cracks or defects in concrete civilian buildings, bridges or dams is costly and time consuming. That is why there is interest in fully unmanned inspection of various kinds, such as detection of cracks or other defects in concrete walls/other structures. An unmanned drone or other vehicle can be used to scan the structure, and resulting images can be processed by an algorithm that would decide whether a crack or a defect exists.

Convolutional neural networks, or CNNs, are a class of deep neural networks that are most commonly used for analyzing images. The difference of CNNs from other neural networks comes from a different approach to regularization: a CNN tries to assemble difficult patterns using smaller and simpler patterns. This is done by introducing convolution and pooling layers to the NN, which reduce the spatial size of the input array (image). As any neural network, CNN uses an activation layer for defining the output. Typically NN use sigimoidal functions, but V. Nair and G.E. Hinton in 2010[[1]](#footnote-1) introduced a more efficient activation function called – ReLU (Rectified Linear Unit).

Such CNNs with the purpose of detecting cracks in images were already created successfully. In present, multiple deep learning frameworks exist for simplifying the process of creating a CNN, such as PyTorch, which I plan to use for this project.  
  
Here are relevant articles and research on crack detection:

1. Cha, Young‐Jin, Wooram Choi, and Oral Büyüköztürk. "Deep learning‐based crack damage detection using convolutional neural networks." *Computer‐Aided Civil and Infrastructure Engineering* 32.5 (2017): 361-378.[[2]](#footnote-2)
2. Oullette, R., Matthew Browne, and Kotaro Hirasawa. "Genetic algorithm optimization of a convolutional neural network for autonomous crack detection." *Proceedings of the 2004 congress on evolutionary computation (IEEE Cat. No. 04TH8753)*. Vol. 1. IEEE, 2004.[[3]](#footnote-3)
3. Fan, Zhun, et al. "Automatic pavement crack detection based on structured prediction with the convolutional neural network." *arXiv preprint arXiv:1802.02208* (2018).[[4]](#footnote-4)
4. Zhao, Xuefeng, and Shengyuan Li. "A method of crack detection based on convolutional neural networks." *Proceedings of the structural health monitoring* (2017).[[5]](#footnote-5)
5. Li, Shengyuan, and Xuefeng Zhao. "Convolutional neural networks-based crack detection for real concrete surface." *Sensors and Smart Structures Technologies for Civil, Mechanical, and Aerospace Systems 2018*. Vol. 10598. International Society for Optics and Photonics, 2018.[[6]](#footnote-6)

1. Nair, Vinod, and Geoffrey E. Hinton. "Rectified linear units improve restricted boltzmann machines." Proceedings of the 27th international conference on machine learning. 2010. <https://www.cs.toronto.edu/~fritz/absps/reluICML.pdf> [↑](#footnote-ref-1)
2. <https://www.researchgate.net/profile/Young-Jin_Cha/publication/315613676_Deep_Learning-Based_Crack_Damage_Detection_Using_Convolutional_Neural_Networks/links/59c94bf90f7e9bbfdc32ea61/Deep-Learning-Based-Crack-Damage-Detection-Using-Convolutional-Neural-Networks.pdf> [↑](#footnote-ref-2)
3. <https://www.researchgate.net/profile/Matthew_Browne/publication/4089988_Genetic_algorithm_optimization_of_a_convolutional_neural_network_for_autonomous_crack_detection/links/53f7f1a50cf24ddba7db2907/Genetic-algorithm-optimization-of-a-convolutional-neural-network-for-autonomous-crack-detection.pdf> [↑](#footnote-ref-3)
4. <https://arxiv.org/pdf/1802.02208.pdf> [↑](#footnote-ref-4)
5. <https://www.researchgate.net/profile/Shengyuan_Li2/publication/322840468_A_Method_of_Crack_Detection_Based_on_Convolutional_Neural_Networks/links/5c6a216b299bf1e3a5af0ad0/A-Method-of-Crack-Detection-Based-on-Convolutional-Neural-Networks.pdf> [↑](#footnote-ref-5)
6. <https://www.researchgate.net/profile/Shengyuan_Li2/publication/324046926_Convolutional_neural_networks-based_crack_detection_for_real_concrete_surface/links/5b4e9b1445851507a7a9a28c/Convolutional-neural-networks-based-crack-detection-for-real-concrete-surface.pdf> [↑](#footnote-ref-6)