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Advanced deep learning comparisons for non-invasive tunnel lining assessment from ground penetrating radar profiles

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Innovative, automated, and non-invasive techniques have been developed by scientific community to indirectly assess structural conditions and support the decision-making process for a worthwhile maintenance schedule. Nowadays, machine learning tools are in the spotlight because of their outstanding capabilities to deal with data coming from even heterogeneous sources and their ability to extract information from the structural systems, providing highly effective, reliable, and efficient damage classification tools. In the current study, a supervised multi-level damage classification strategy has been developed regarding Ground Penetrating Radar (GPR) profiles for the assessment of tunnel lining conditions. In previous research, the authors firstly considered a convolutional neural network (CNN), adopting the quite popular ResNet-50, initialized through transfer learning. In the present work, further enhancements have been attempted by adopting two configurations of the newest state-of-art advanced neural architectures: the neural transformers. The foremost is the original Vision Transformer (ViT), whose core is an encoder entirely based on the innovative self-attention mechanism and does not rely on convolution at all. The second is an improvement of ViT which merges convolution and self-attention, the Compact Convolution Transformer (CCT). In conclusion, a critical discussion of the different pros and cons of adopting the above-mentioned different architectures is finally provided, highlighting the actual powerfulness of these technologies in the future civil engineering paradigm nevertheless.

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