Dense Change Detection Using Siamese Neural Networks

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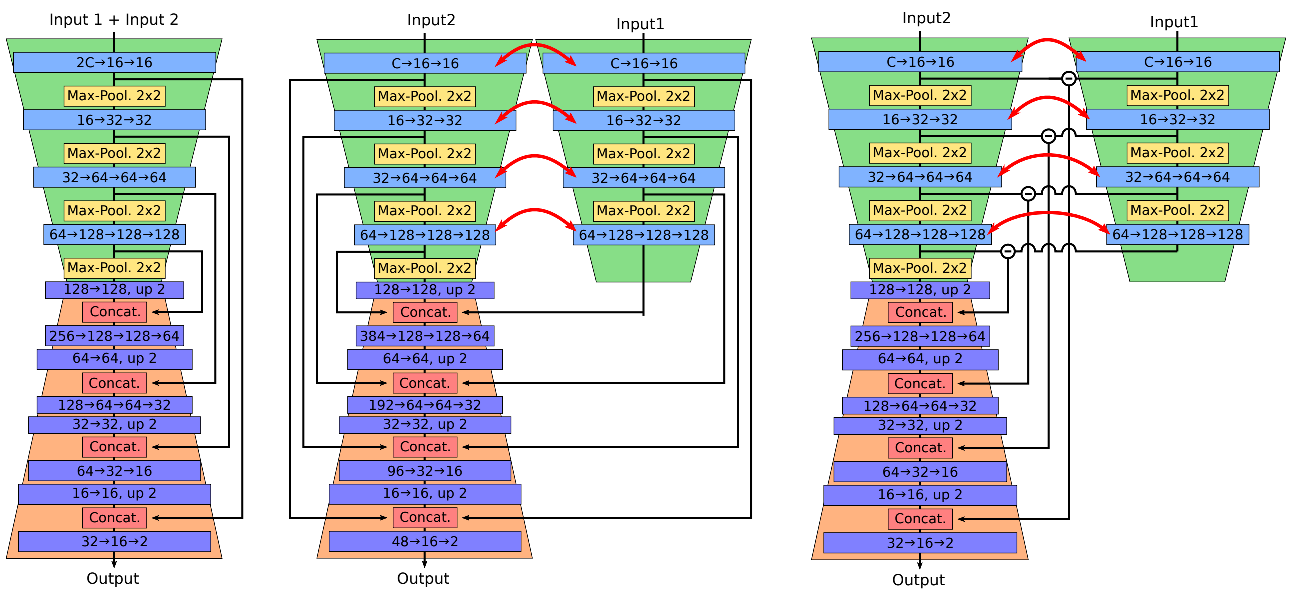
1 Introduction

Change Detection (CD) is one of the main problems in the area of Earth observation image analysis. Its study has a long history, and it has evolved alongside the areas of image processing and computer vision [1, 2]. Change detection systems aim to assign a binary label per pixel based on a pair or sequence of coregistered images of a given region taken at different times. A positive label indicates the area corresponding to that pixel has changed between the acquisitions. While the definition of "change" may vary between applications, CD is a well defined classification problem. Changes may refer, for example, to vegetation changes, urban expansion, polar ice melting, etc. Change detection is a powerful tool in the production of maps depicting the evolution of land use, urban coverage, deforestation, and other multi-temporal types of analysis.

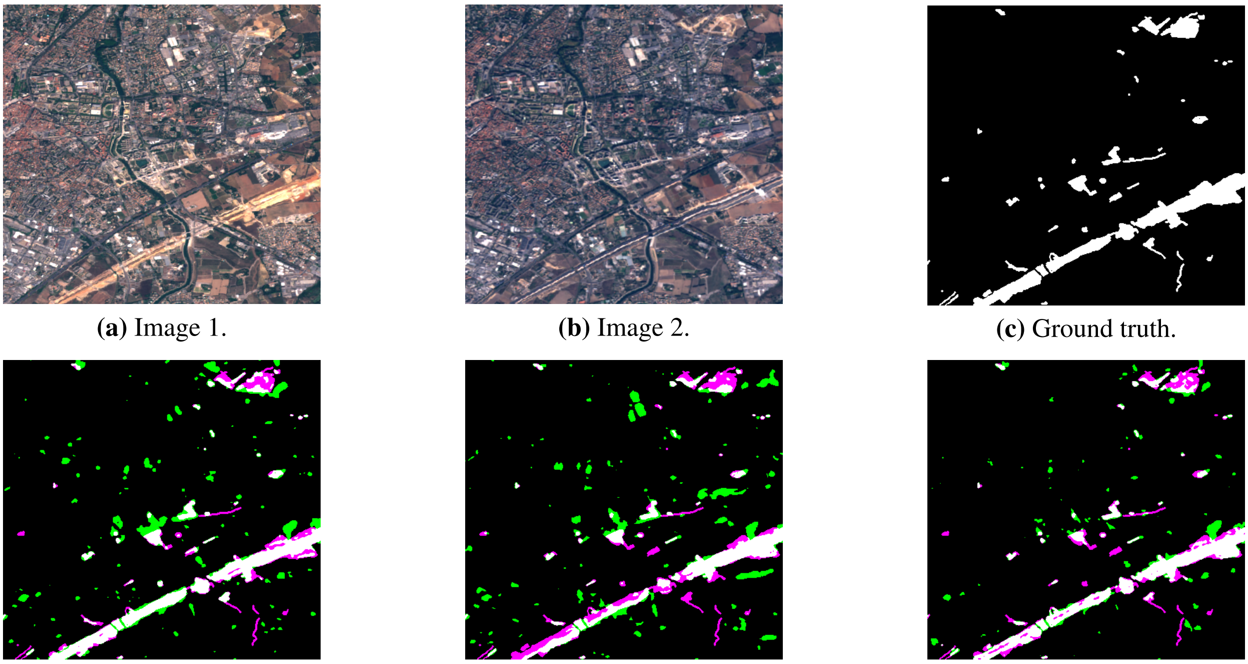
2 Method

We present three Fully Convolutional Neural Network (FCNN) architectures that perform change detection on multi-temporal pairs of images Earth observation images. These architectures are trained end-to-end from scratch using only the available change detection datasets. The networks are tested in both the RGB and multispectral cases when possible. They are extensions of the ones presented in [3], which was the first CD method to be trained end-to-end, to a fully convolutional paradigm. This improves both the accuracy and the inference speed of the networks without increasing the training times. We present fully convolutional encoder-decoder networks that use the skip connections concept introduced in [4]. We also propose for the first time two fully convolutional Siamese architectures using skip connections.



(a) FC-EF. (b)FC-Siam-conc. (c) FC-Siam-diff.

Figure 1: Diagrams of the three proposed FCNN architectures for change detection. Blue blocks are convolutions, yellow is max pooling, red is concatenation, purple is transpose convolution. The red arrows show shared weights between the Siamese parts of the networks.



(a) Image 1. **(b)** Image 2. **(c)** Ground truth.

(d) FC-EF. **(e)** FC-Siam-conc. **(f)** FC-Siam-diff.

Figure 2: Results for the *montpellier* image pair. In images (d), (e), and (f) white is true positive, black is true negative, green is false positives and magenta is false negative.

3 Conclusion

The presented fully convolutional networks surpassed the state-of-the-art in change detection, both in accuracy and in inference speed without the use of post-processing. Most notably, the fully convolutional encoder-decoder paradigm was modified into a Siamese architecture, using skip connections to improve the spatial accuracy of the results.

A natural extension of the work presented on this paper would be to evaluate how these networks perform at detecting semantic changes. It would also be interesting to test them with other image modalities (e.g. SAR), and to attempt to detect changes in image sequences. It is also likely that these networks would profit from training on larger datasets.

References

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