Transfer Learning or Design a Custom CNN for Tactile Object Recognition

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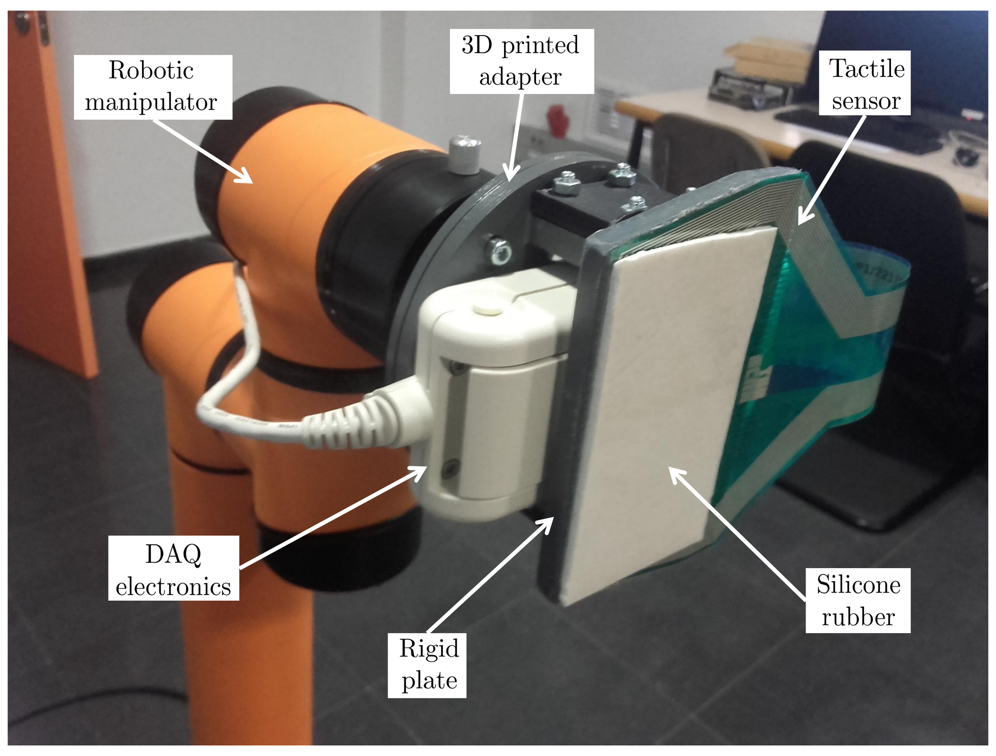
Abstract

In this paper tactile information is processed with different CNN-based methods. A high-resolution tactile sensor has been attached to a robotic end-effector to identify objects in contact. Transfer learning approach is compared with a custom-made CNN in terms of accuracy and classification time. The customized CNN (TactNet) include 3 configurations with 4, 5 and 6 layers, which are tested in this work and trained from scratch using tactile information only. A comparative study of performance between these methods has been carried out.



Transfer Learning

Transfer learning consists on using a trained neural network for a different purpose for which it was created. The structure of a CNN can be separated based on the function of each part:

- **First Convolutional Layers:** Features extraction.
- **Last Layers:** Classification of the input data.

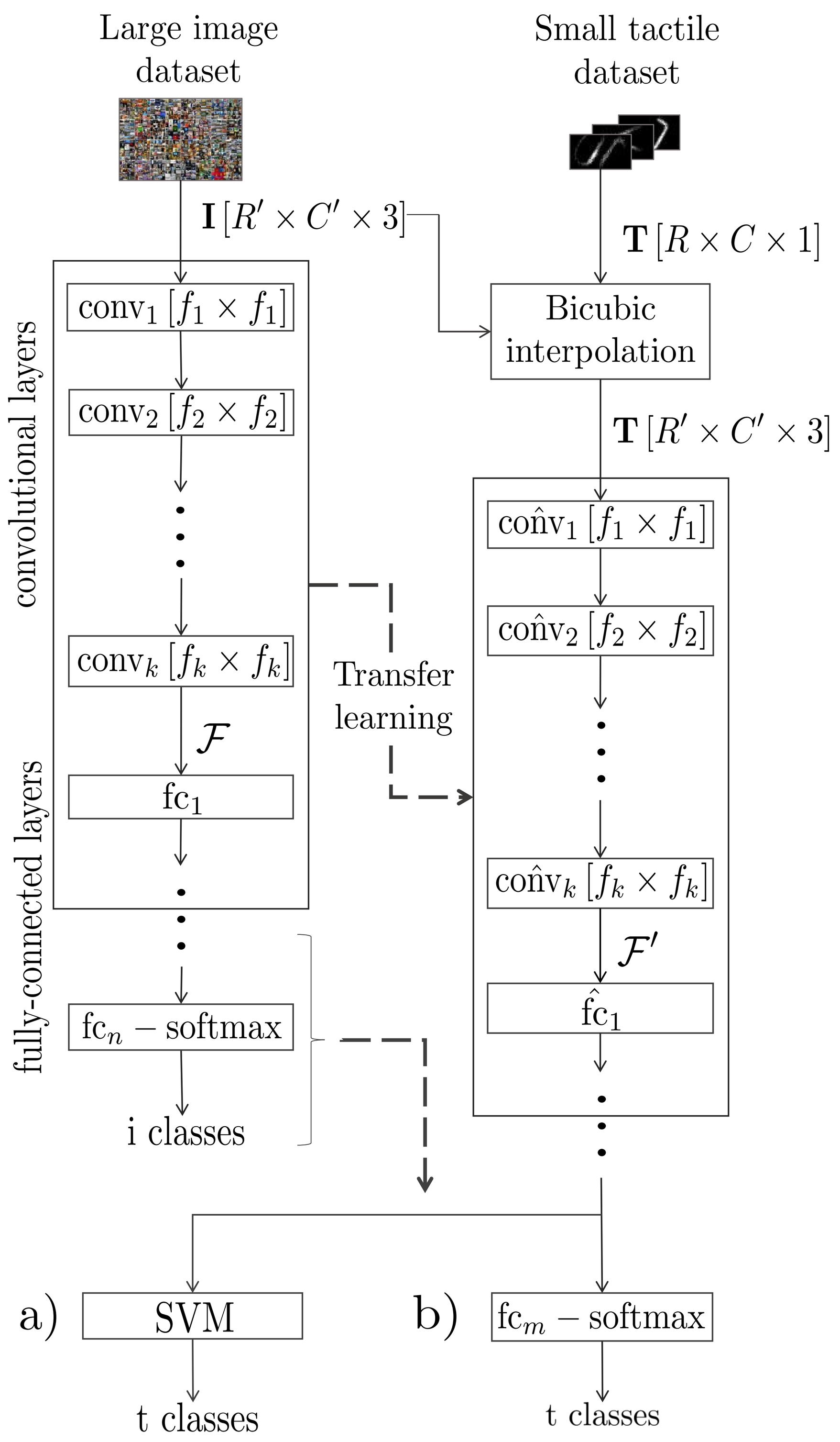
This approach consists on using the features extraction layers of a pre-trained CNN and replacing the classification layers with a custom classifier.

The features extraction layers can be exploited to extract $\mathcal{F}'$. A resize of the pressure images is done using the bicubic interpolation method.

The classification layers of the network can be replaced by two classifiers:

a) SVM.

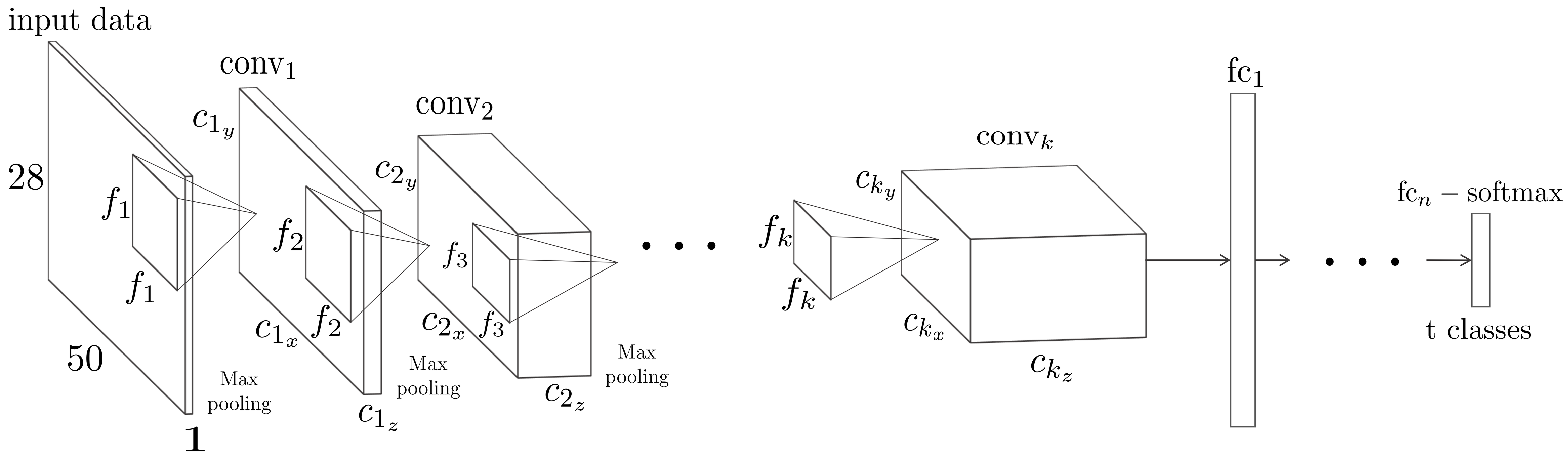
b) Fine-tunning the classification layers in a dataset of tactile images.



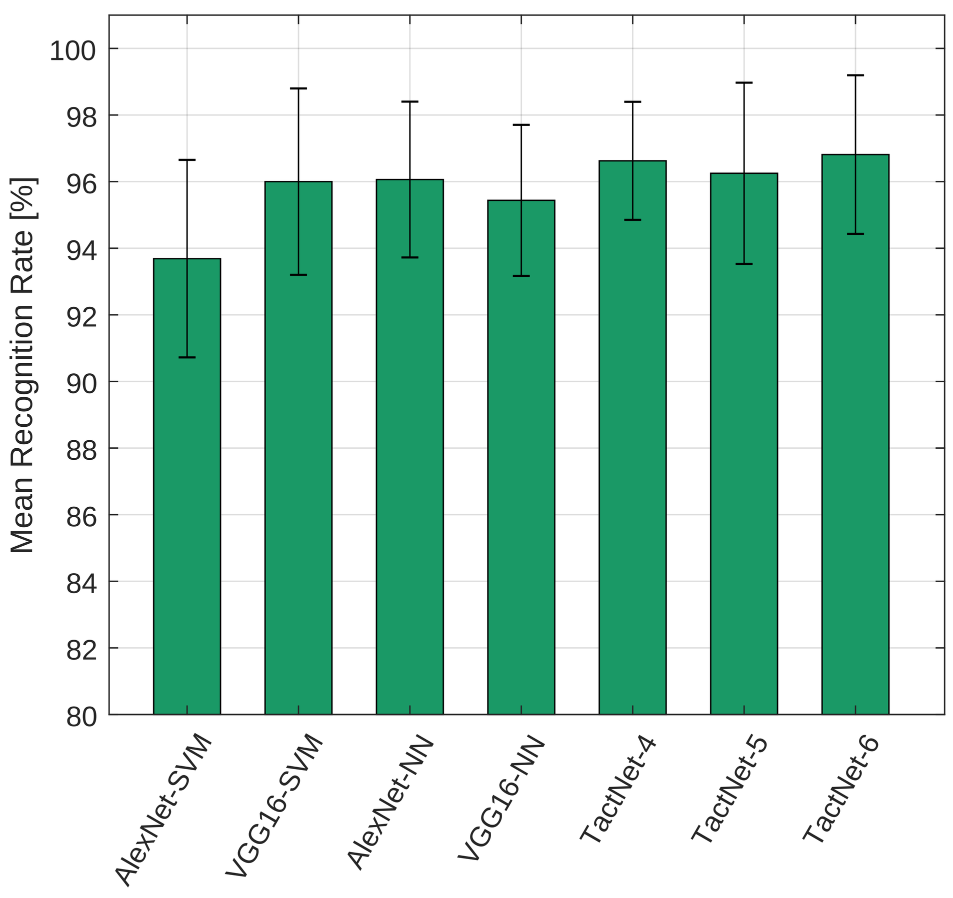
TactNet

A custom-made CNN has been trained from scratch on a pressure images dataset. This network is configured with 4, 5 and 6 layers, and follows the architecture of the AlexNet.

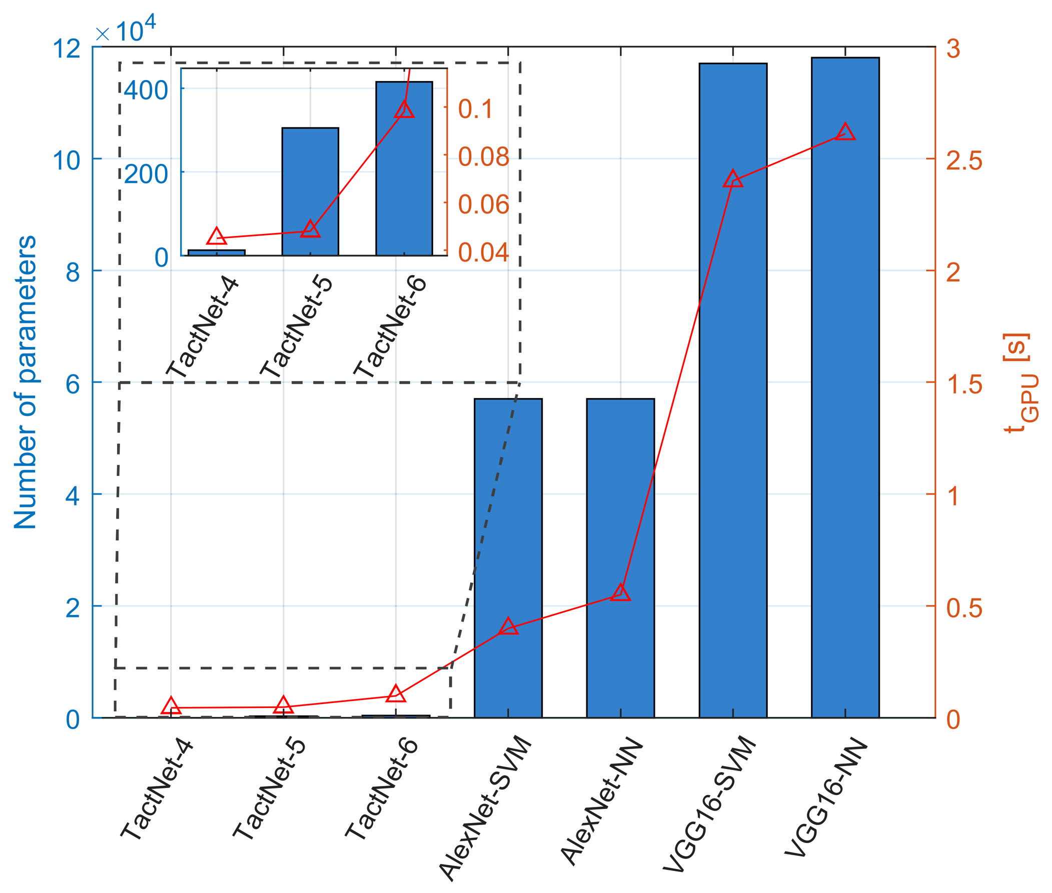
- **TactNet 4:** 3 convolutional layers + 1 fully-connected layer.
- **TactNet 5:** 3 convolutional layers + 2 fully-connected layers
- **TactNet 6:** 4 convolutional layers + 2 fully-connected layers



Results



Comparison of the recognition rate achieved by each method. The error bars represent the one standard deviation.



Number of parameters (left) and computation time (right) of each method needed for classifying the test set.

Conclusions

- Two CNN-based approaches for tactile object recognition: Transfer Learning and TactNet.
- Seven methods: 4 transfer learning-based and 3 TactNet-based.
- Both transfer learning and TactNet can obtain high accuracy rates in object recognition.
- In terms of recognition rate, TacNet-based methods performance better.
- The classification time of the TactNets are much smaller than the transfer learning due to the smaller number of parameters.

Acknowledgements

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