SEMI-SUPERVISED DEEP LEARNING TECHNIQUES FOR SPECTRUM RECONSTRUCTION

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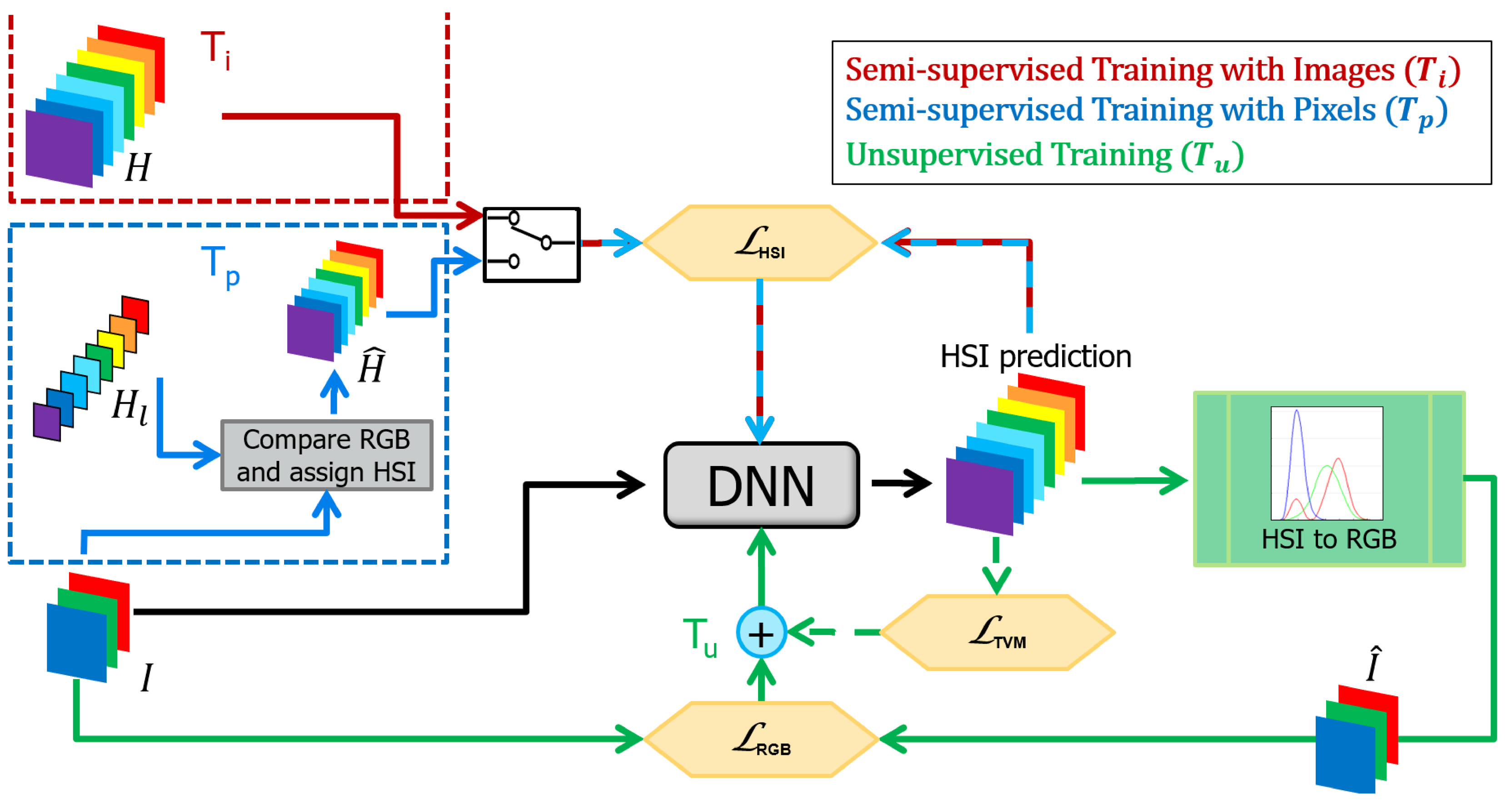
Abstract

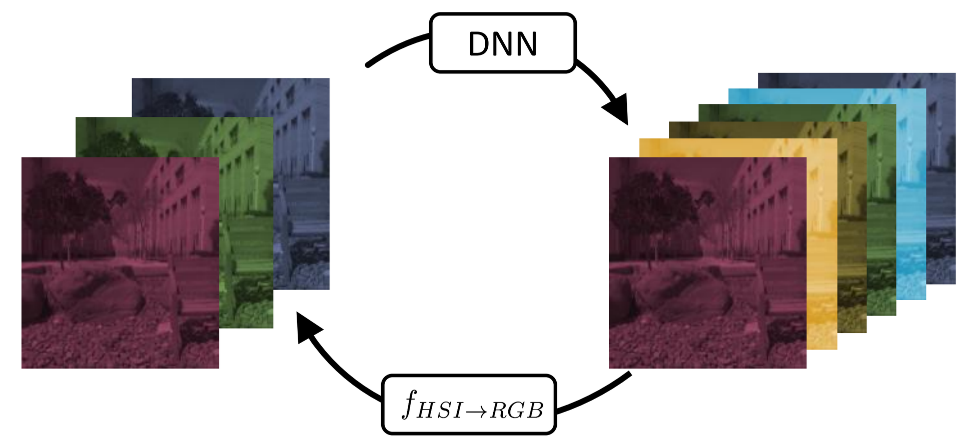
State-of-the-art approaches for the estimation of hyperspectral images (HSI) from RGB data are mostly based on deep learning techniques but due to the lack of training data their performances are limited to uncommon scenarios where a large hyperspectral database is available. In this work we present a family of novel deep learning schemes for hyperspectral data estimation able to work when the hyperspectral information at our disposal is limited. Firstly, we introduce a learning scheme exploiting a physical model based on the backward mapping to the RGB space and total variation regularization that can be trained with a limited amount of HSI images. Then, we propose a novel semi-supervised learning scheme able to work even with just a few pixels labeled with hyperspectral information. Finally, we show that the approach can be extended to a transfer learning scenario. The proposed techniques allow to reach impressive performances while requiring only some HSI images or just a few pixels for the training.

Structure of the Training Pipeline



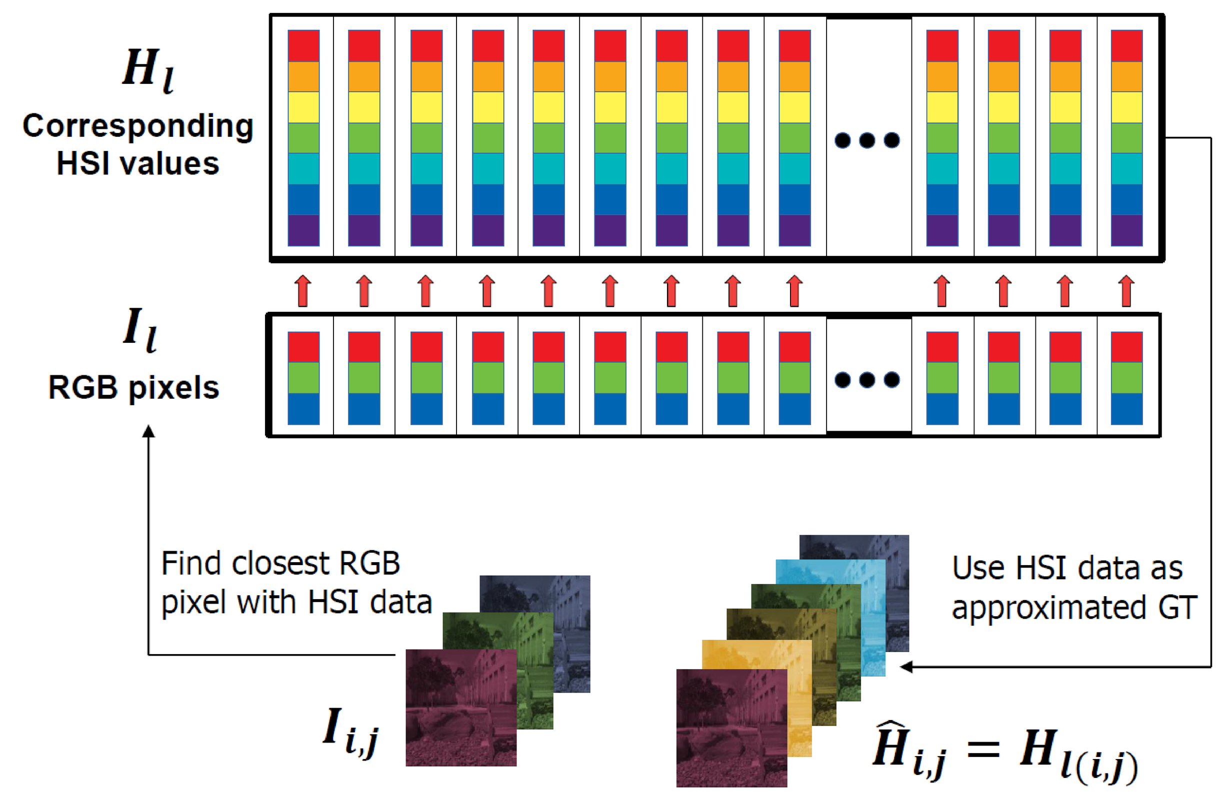
Physical Model

The physical model ensures our output to be consistent with the input RGB. While not a sufficient constraint by itself, it provides a better training.

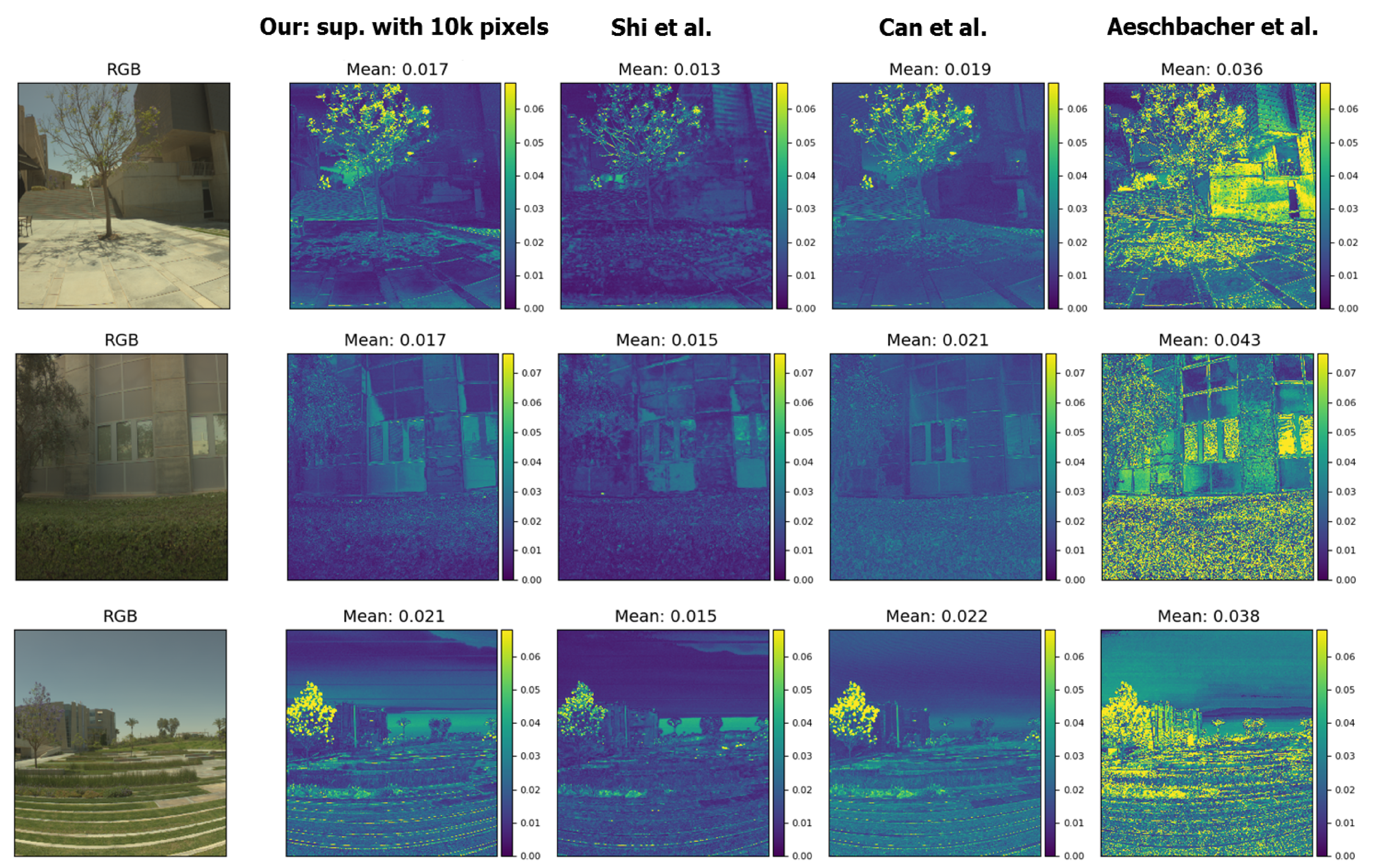


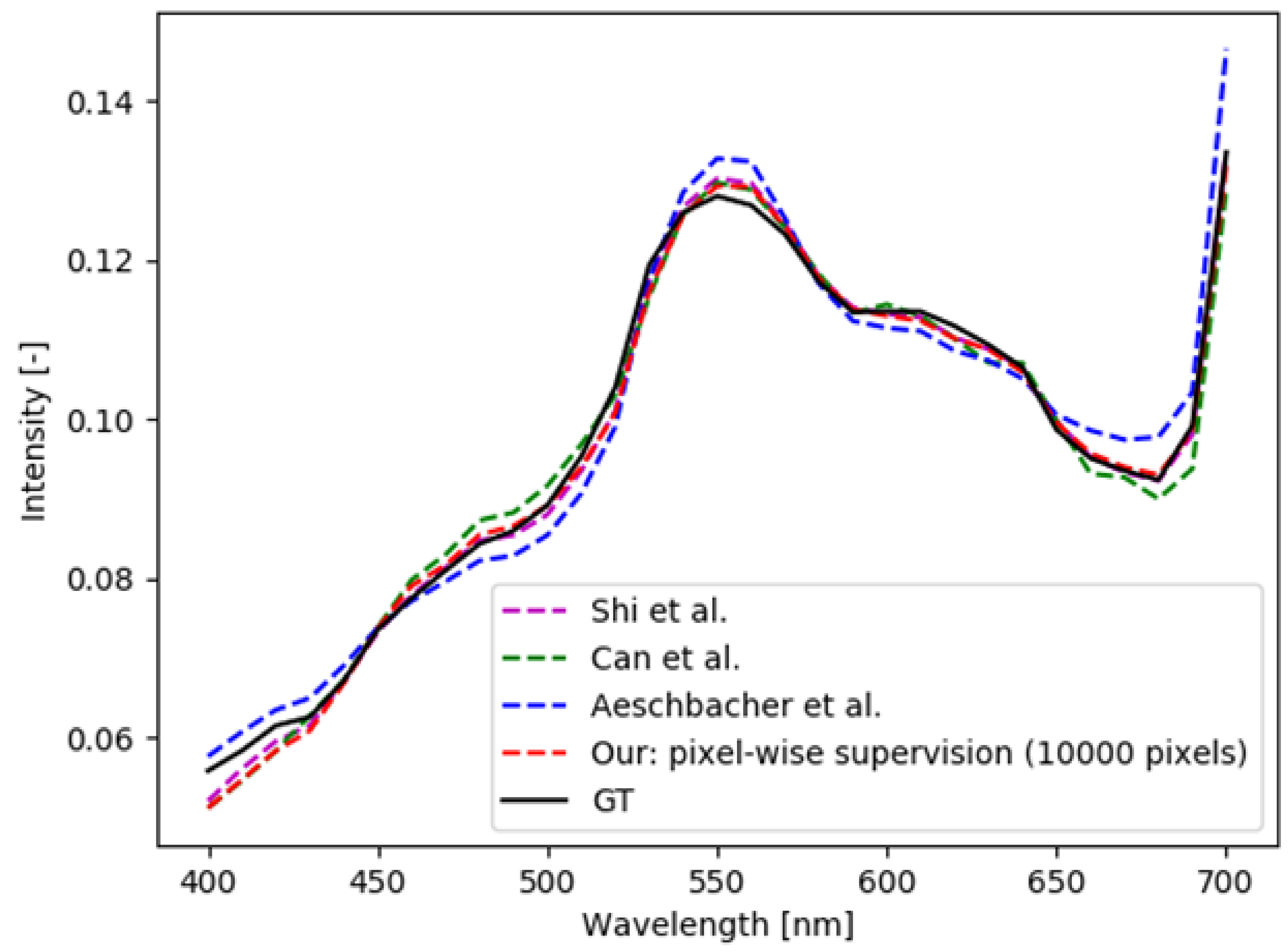
Semi-supervised Training

- The training techniques combine HSI information and the physical model
- The training is performed alternating the two losses
- The HSI information can be provided in the form of:
  1. A small set of HSI images (T_i)
  2. Only some sparse pixels with HSI information (T_p), as shown below



Qualitative Results





Quantitative Results

Our approaches outperform or reach comparable performance with other fully supervised methods from the literature, which heavily rely on HSI ground truth

Method	HSI GT	MRAE $*10^2$	RMSE $*10^2$
Aesch. et al.	$3*10^6$ pixels	3.3	0.74
Yan et al.	99 images	3.0	0.69
Can et al.	99 images	2.2	0.59
Shi et al.	99 images	**1.4**	**0.48**
	10 images	2.5	0.75
Ours (T_i)	10 images	1.9	0.61
Ours (T_p)	100 pixels	2.5	0.72
	1'000 pixels	1.9	0.66
	10'000 pixels	**1.7**	**0.55**