Semi-supervised Deep Learning Techniques for Spectrum Reconstruction

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Adriano Simonetto, Pietro Zanuttigh

University of Padova, Dept. of Information Engineering

adriano.simonetto@phd.unipd.it, zanuttigh@dei.unipd.it

Vincent Parret, Piergiorgio Sartor, Alexander Gatto

Stuttgart Lab 1 of R&D Center, **Sony Europe B.V.**

{Vincent.Parret, Piergiorgio.Sartor, Alexander.Gatto}@sony.com

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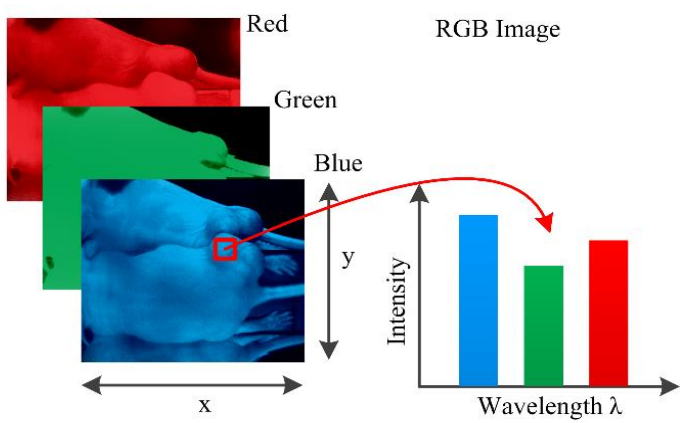
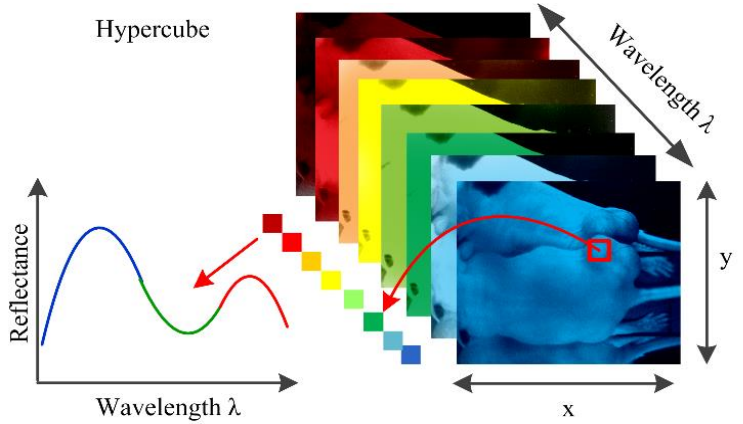
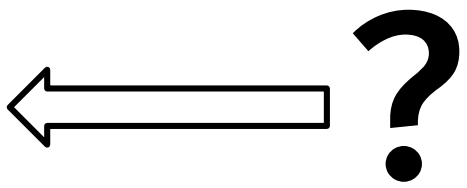
Stuttgart Lab1

Hyperspectral imaging and its applications

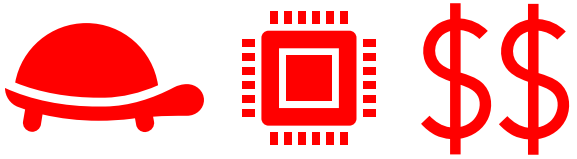
- Hyperspectral (HS) images provide much more info than RGB images







Hyperspectral imagers



- Many applications benefit from the additional information

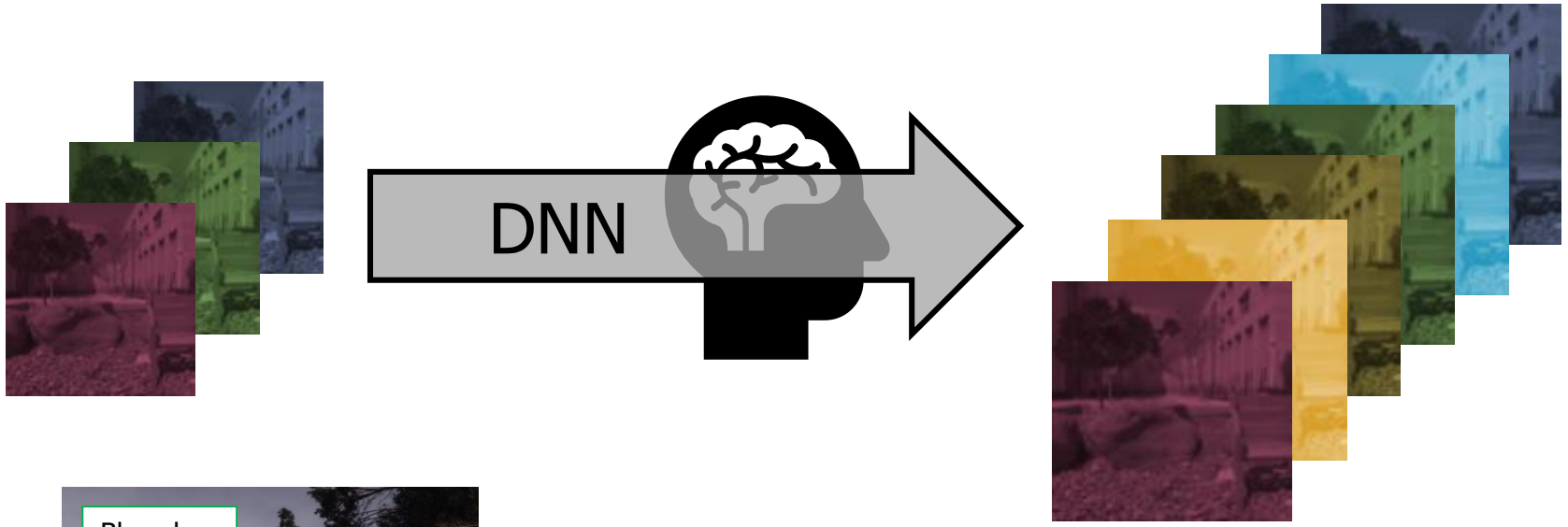
Food inspection

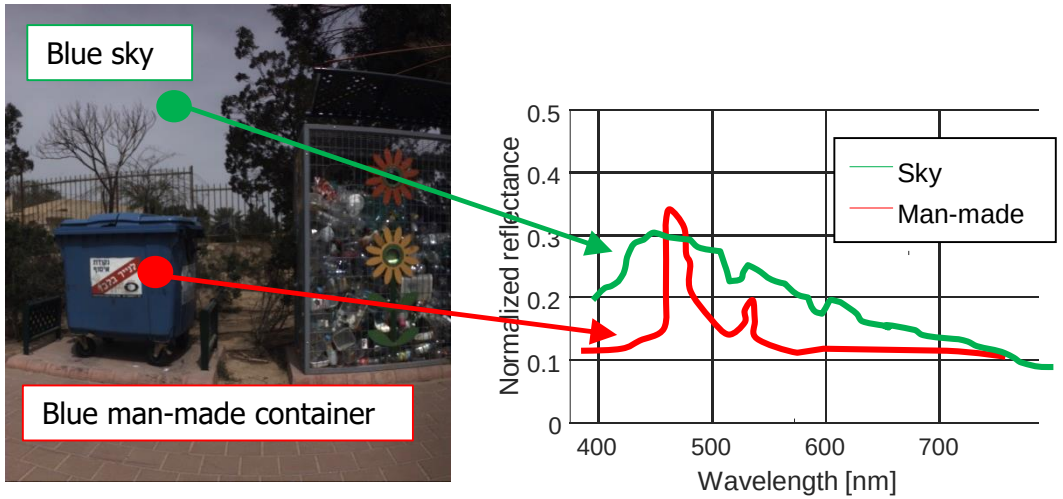
Health care

Recycling

Illustration: HSI

Spectrum reconstruction from single RGB image



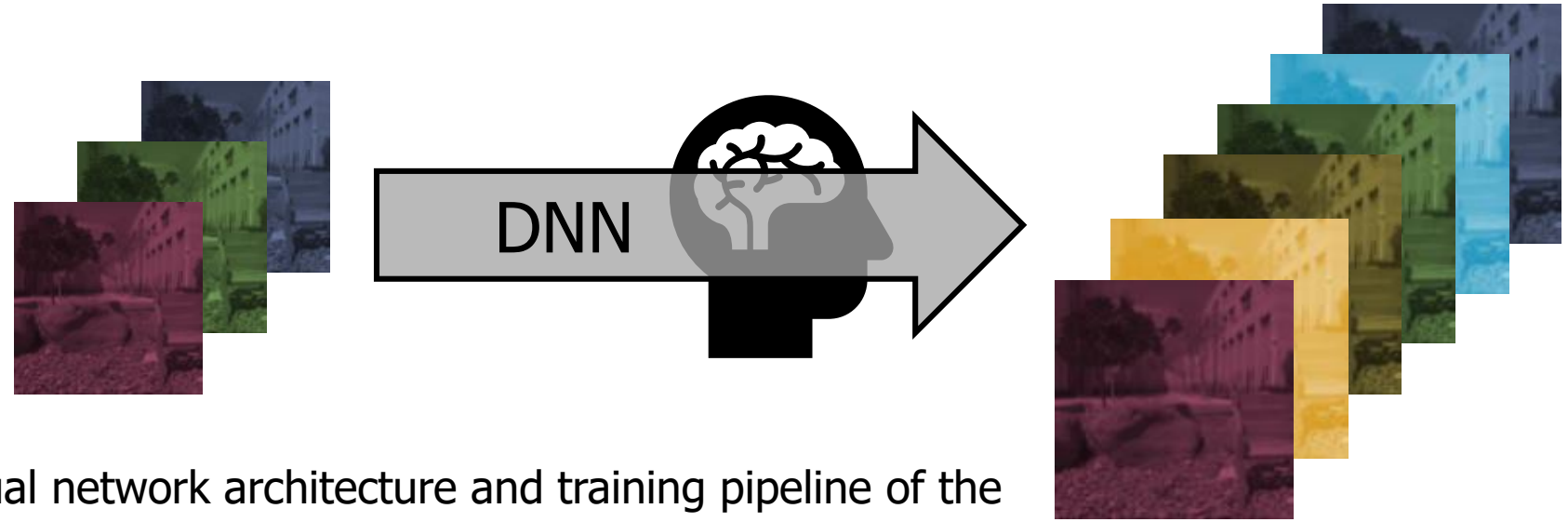


The network implicitly make use of the semantic of the scene.

However, this problem is very ill-posed.

Illustration: ICVL

Spectrum reconstruction from single RGB image



Residual network architecture and training pipeline of the *HSCNN-R* [1], leading the NTIRE 2018 challenge [2].

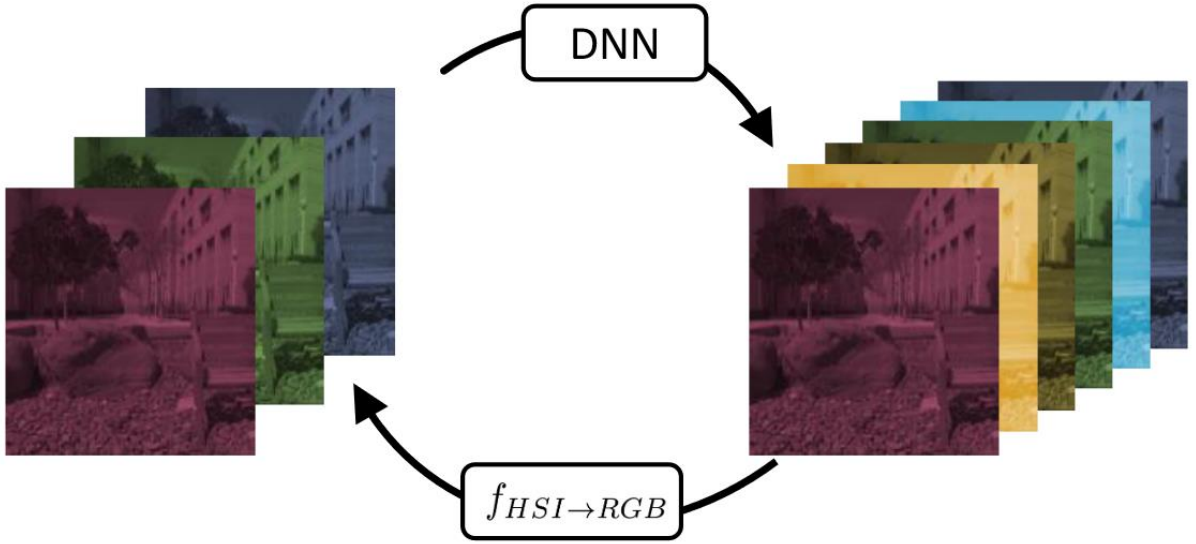
Fully supervised ➡ HS images required. Not usable in practice.

[1] Z. Shi, C. Chen, Z. Xiong, D. Liu, and F. Wu, "Hscnn+: Advancedcnn-based hyperspectral recovery from rgb images" in Conference on Computer Vision and Pattern Recognition Workshops, 2018

[2] Arad, O. Ben-Shahar, and R. Timofte, "Ntire 2018 challenge onspectral reconstruction from rgb images" in Conference on Computer Vision and Pattern Recognition Workshops, 2018

Illustration: ICVL

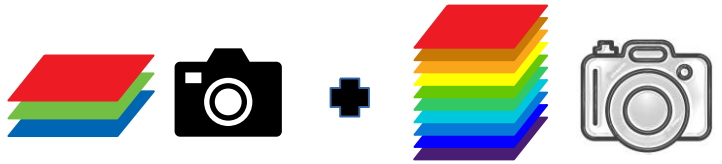
Proposed semi-supervised approaches



Physical model for the inverse transformation ➡ Semi-supervised

Unsupervised Training (T_u)

Semi-supervised Training with Images (T_i)



Semi-supervised Training with Pixels (T_p)

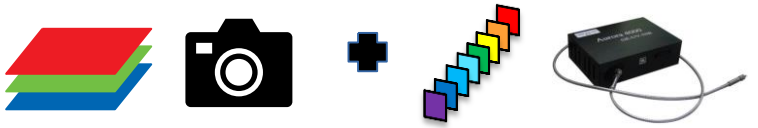
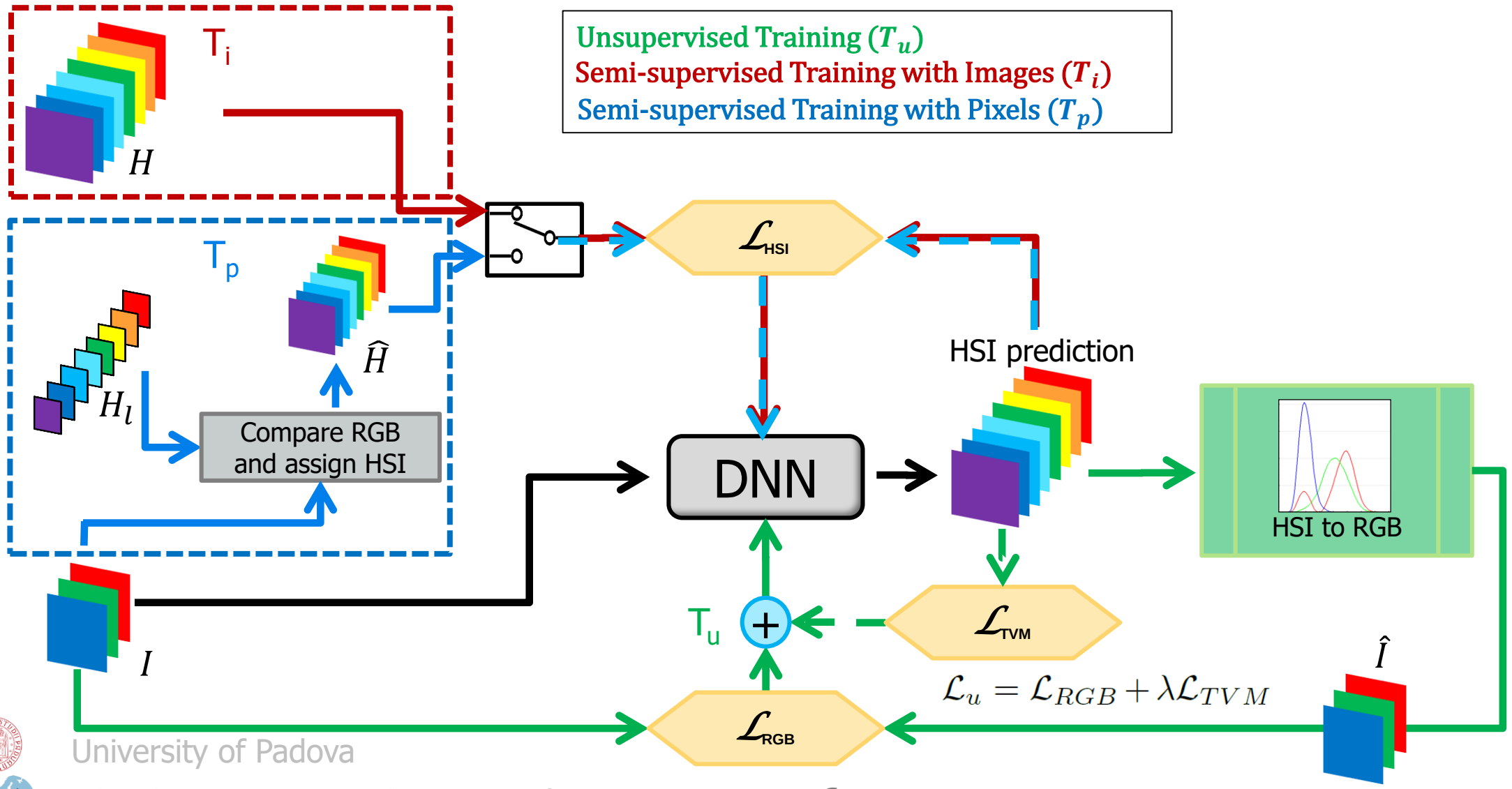


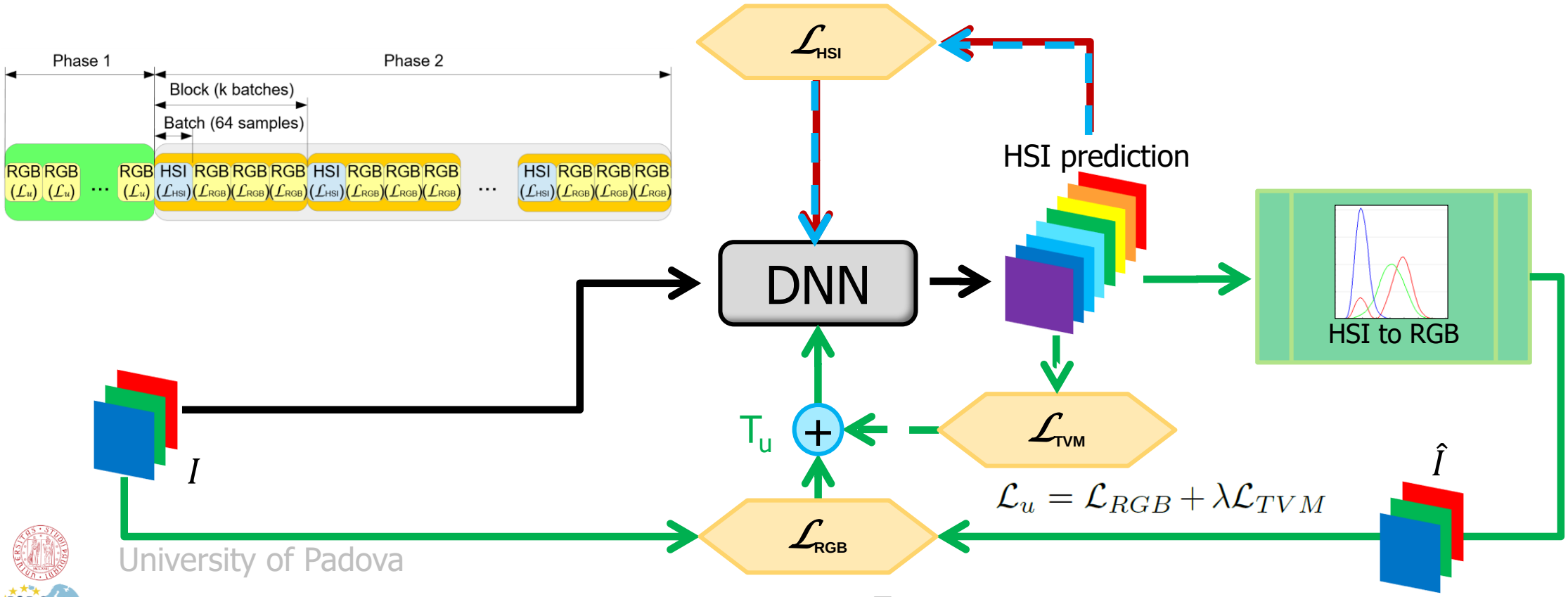
Illustration: ICVL

Training pipeline



Training pipeline

Unsupervised Training (T_u)
Semi-supervised Training with Images (T_i)
Semi-supervised Training with Pixels (T_p)

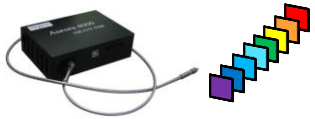


Results and benchmark with the literature

The approaches were tested on the ICVL database [3].

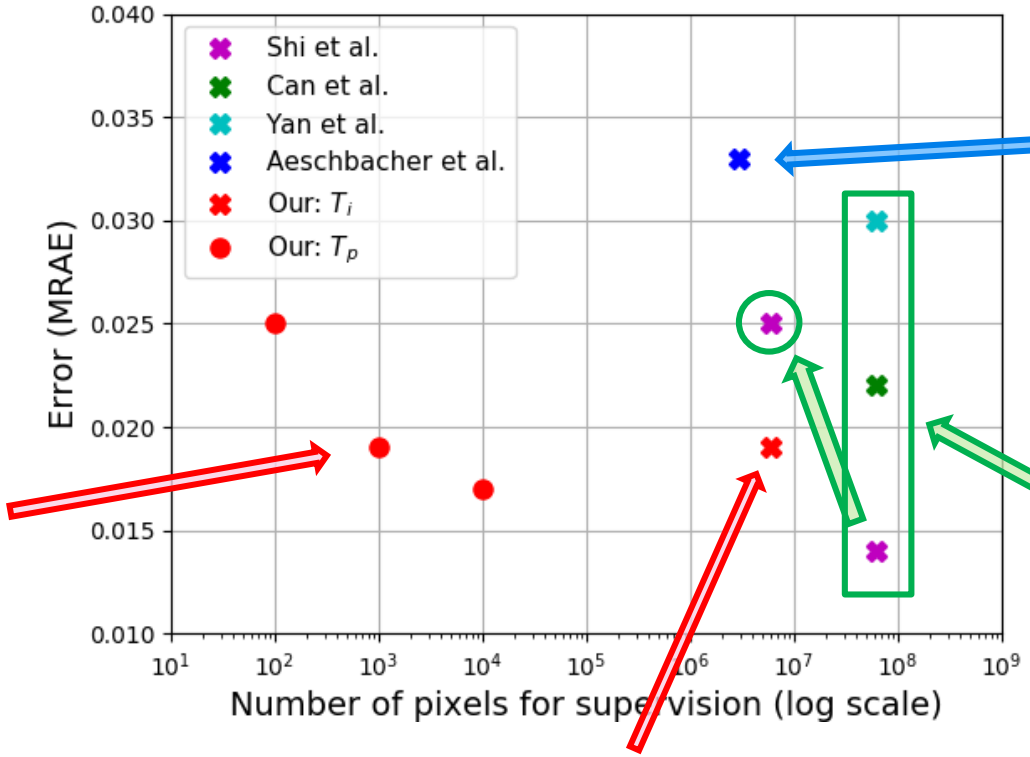
Our: semi-supervised (T_p)

Spectrometer (100-10k points)



+

RGB camera (100 images)



Literature: fully supervised

Pixels from HS camera ($3 \cdot 10^6$ pixels)

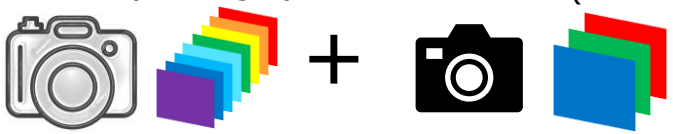
Literature: fully supervised

HS camera (100 images)

Our: semi-supervised (T_i)

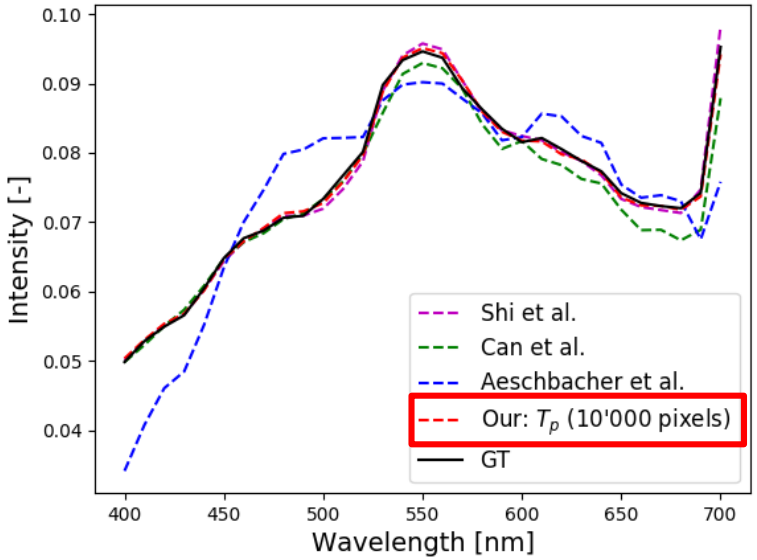
HS camera (10 images)

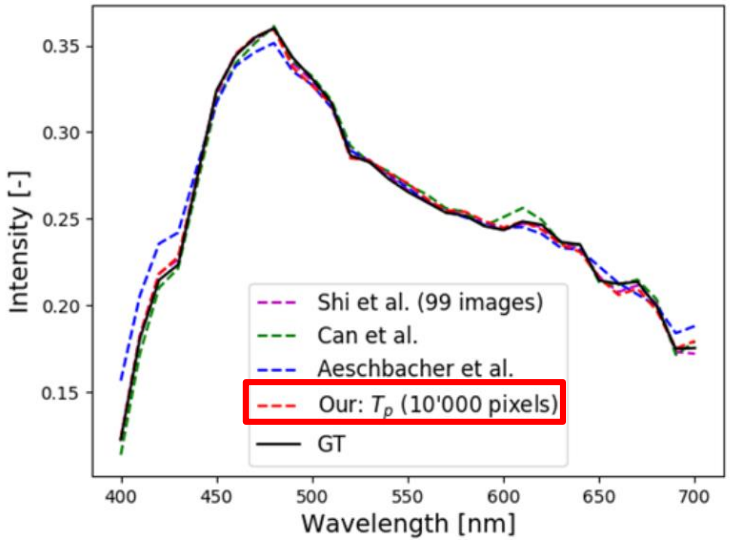
RGB camera (100 images)

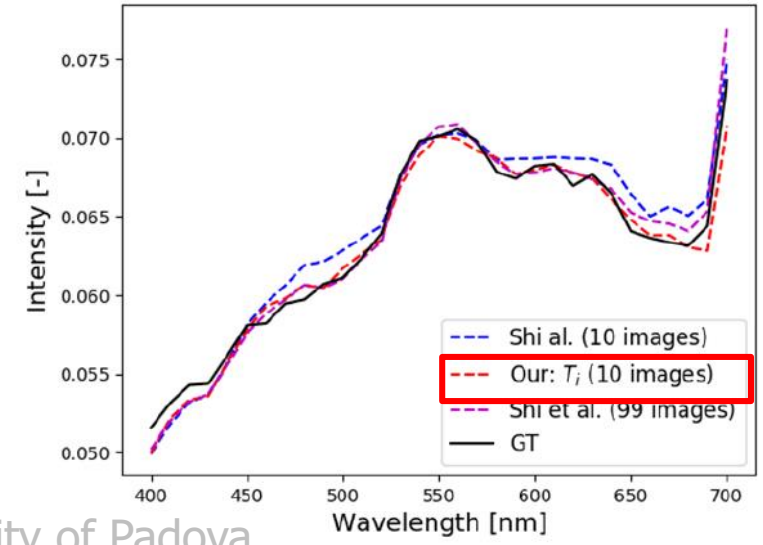


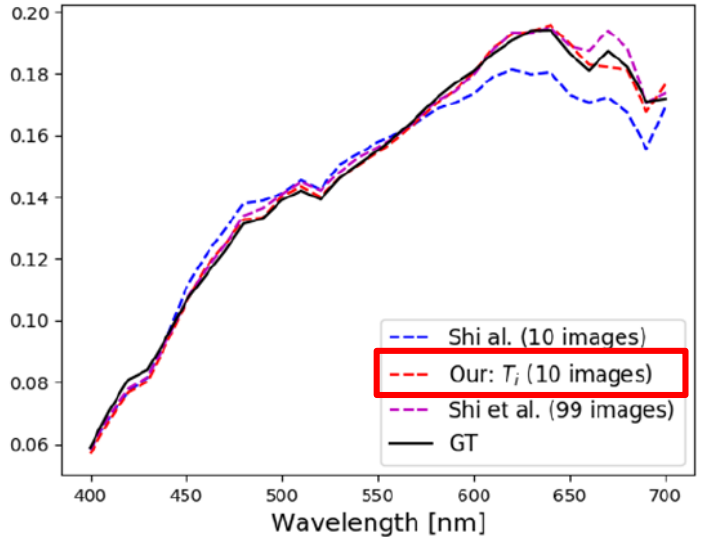
[3] Arad and O. Ben-Shahar, "Sparse recovery of hyperspectral signal from natural rgb images" in European Conference on Computer Vision, 2016.

Examples of spectra

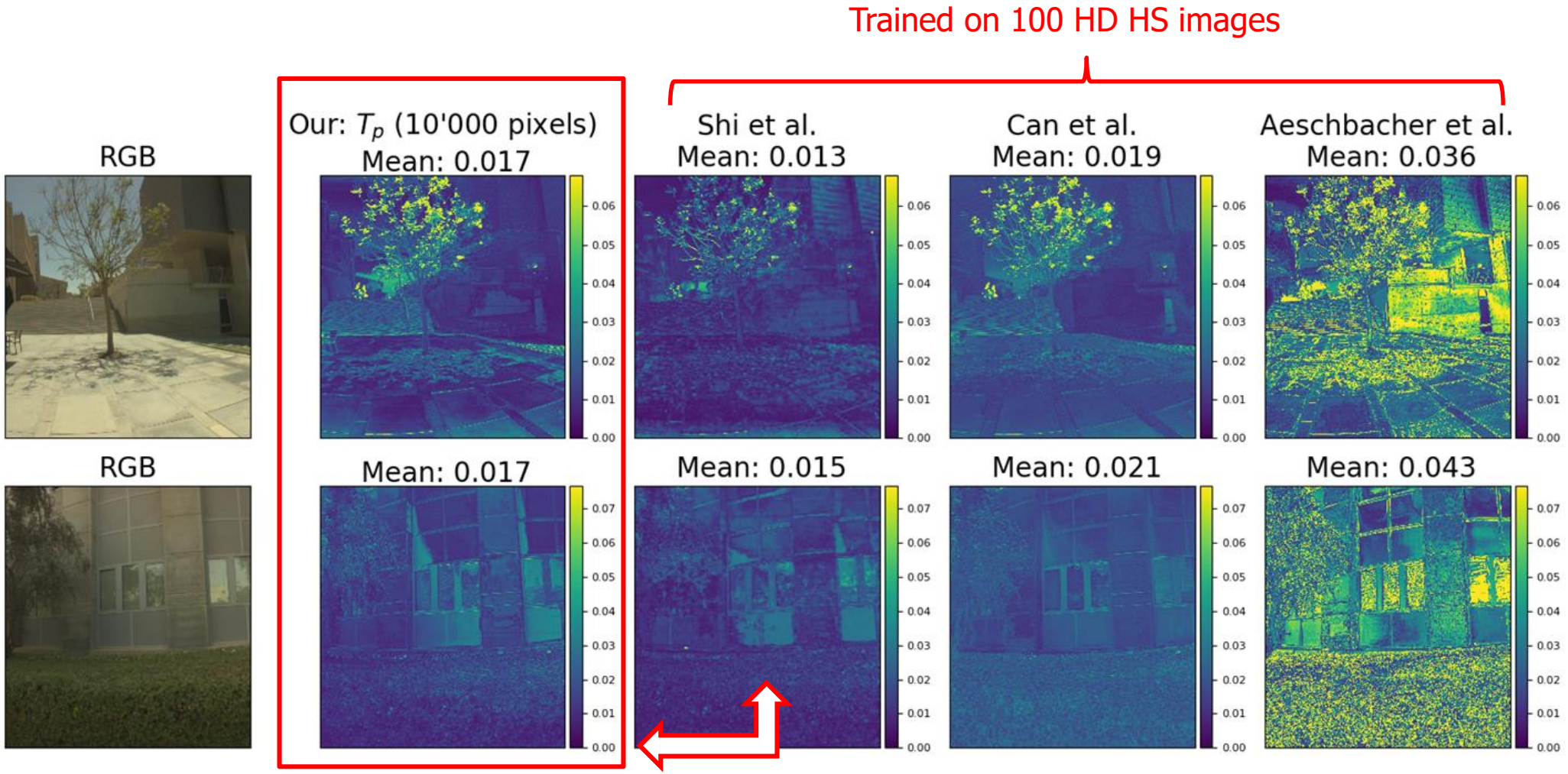








Examples of images



Conclusion

- More results and investigations in the paper and the supplementary material
  - Approaches selected from literature
  - More visual examples
  - Fine-tuning
  - DNN vs non-DL

- Our approaches allow to train with very limited supervision, making it usable in practice

- They outperform or reach comparable accuracy to the fully supervised approaches

- Our physical model is the key component; it allows to use information from the RGB domain

- Potential future work
  - Include adversarial training
  - Test in real environment

Thank you for watching !

We are available for questions or suggestions throughout the conference, or per email.

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