Spectral Super-Resolution of Satellite Imagery with Generative Adversarial Networks

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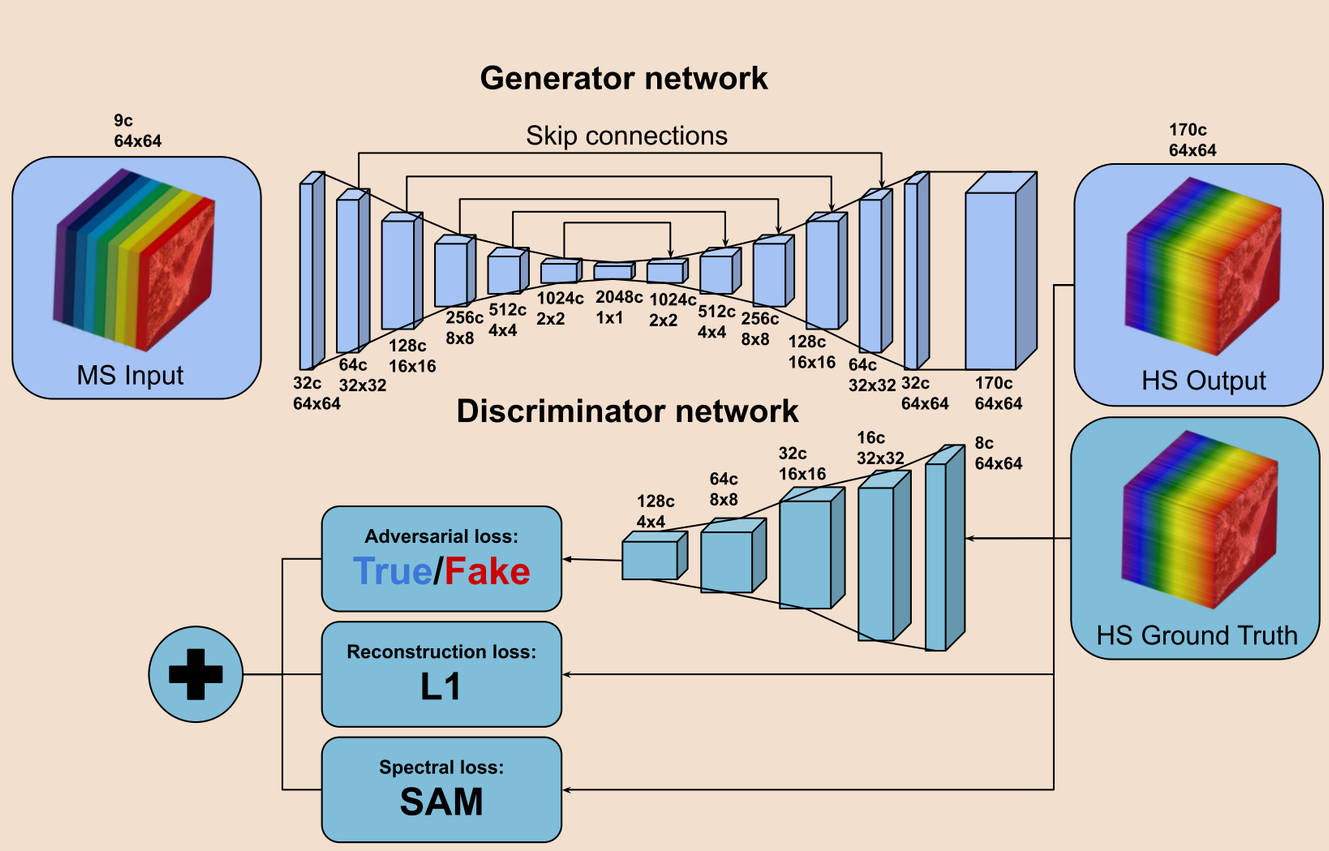
Introduction

Hyperspectral (HS) data is the most accurate interpretation of surface as it provides fine spectral information with hundreds of narrow contiguous bands as compared to multispectral (MS) data whose bands cover bigger wavelength portions of the electromagnetic spectrum. Different methods have been proposed in order to transform MS data to HS data. In this study, we outperform state-of-the-art results by enhancing Generative Neural Networks in order to specifically extract spectral features and generate reliable data without the need of testing on seen land surface.



SAM-GAN: Proposed method

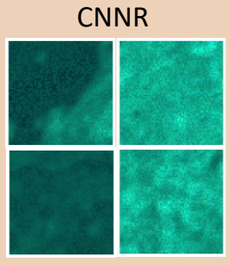
The architecture SAM-GAN is a spectral-oriented and general-purpose solution to spectral super-resolution of satellite imagery. The proposed architecture learns mapping from MS to HS data, generating nearly 20x more bands than the given input.
SAM-GAN is our approach based on Pix2Pix's Pair-Identical Image-to-Image Translation, which is distinguished by a novel loss function that adds the Spectral Angle Mapper equation in order to minimize the errors of spectral features and achieve learning from high-level features from both the spatial dimension and the long spectral dimension. We compared our approach with basic Pix2Pix and the latest deep learning specialized solution (CNNR) that solved the same task.

Compared with State-of-the-art

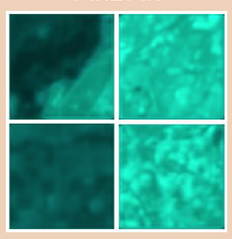
Earlier results

The results shown below are from the models trained with 12 epochs.
SAM-GAN already achieves nearly-perfect results while its competitors still lack level of definition.

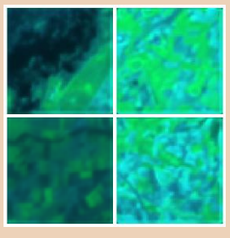
CNNR



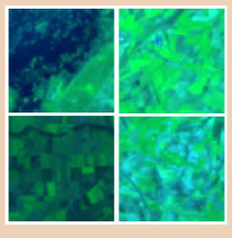
Pix2Pix



SAM-GAN



Ground Truth



Better end-results

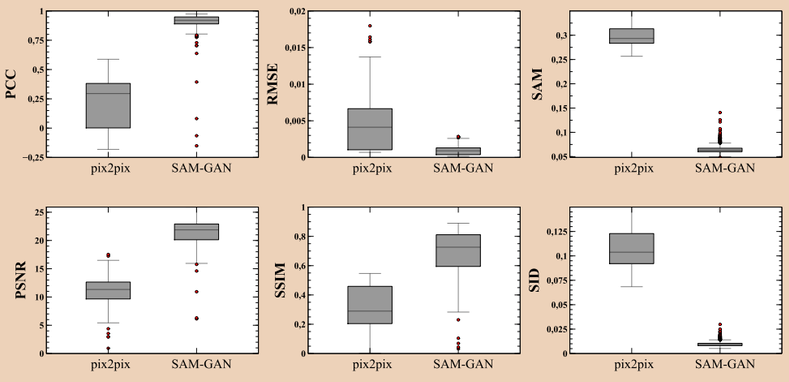
SAM-GAN, when fully-trained, still outperforms other methods in most of the considered metrics.
Especially, our architecture performs better in spectral-based metrics as our specialization is in the spectral domain, while Pix2Pix sometimes performs slightly better in the spatial domain.

Architecture	PCC	RMSE	PSNR	SSIM
CNNR	0.767	0.00274	18.69	0.528
Pix2Pix	0.867	**0.00215**	**20.37**	0.741
SAM-GAN	**0.886**	0.00245	19.34	**0.753**

Architecture	SAM	SID
CNNR	0.0789	0.01391
Pix2Pix	0.0649	0.00991
SAM-GAN	**0.0601**	**0.00944**

Performs on unseen land

Other methods require either training on multiple overlapping scenes or augmenting data in order for the training to see all land surface.
Our model is the only non-linear proposed solution to solve spectral super-resolution without the need of testing on already seen land because it learns the spectral features in order to construct the HS data.



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