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Deep Joint Source-Channel Coding for Wireless Image Transmission

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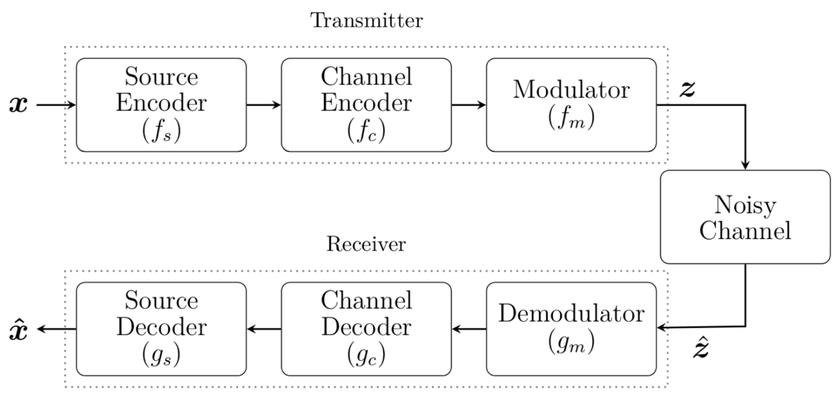
Image transmission under challenge

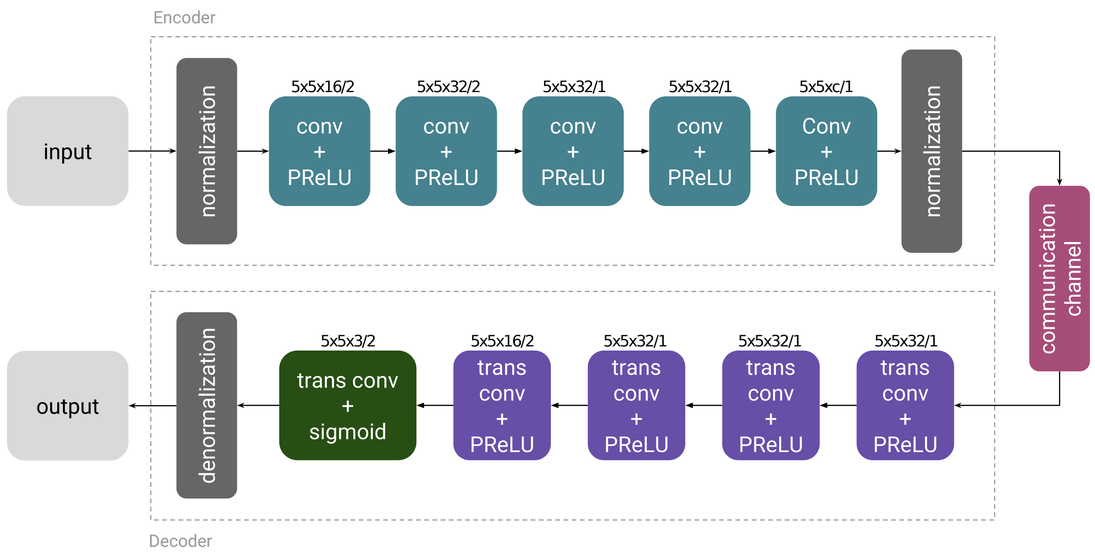
*How to transmit images under **extremely low latency**, **bandwidth** and **energy constraints**?*

- Traditional approach - Shannon Separation Theorem:



- Optimality holds only for **infinite blocklength** and complexity
- Design assumes a specific channel quality, being vulnerable to variations and **non-ergodic channels**
- No separation theorem for **multi-user networks**

Can we learn to do better?



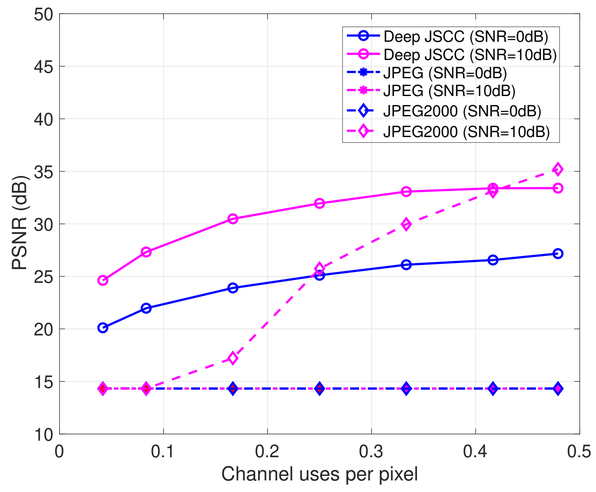
- **Autoencoder:** unsupervised deep neural network for code design
- **Direct mapping** from pixel values to channel inputs
- **Low-delay:** bandwidth compression; **Low-energy:** power constraint

Sample results

Channel SNR	Original	Deep JSCC	JPEG	JPEG2000
1dB		 SSIM: 0.81 PSNR: 25.07dB	 SSIM: 0.61 PSNR: 20.63dB	 SSIM: 0.70 PSNR: 24.11dB
4dB		 SSIM: 0.86 PSNR: 26.86dB	 SSIM: 0.79 PSNR: 24.78dB	 SSIM: 0.83 PSNR: 27.5dB
7dB		 SSIM: 0.90 PSNR: 28.45dB	 SSIM: 0.86 PSNR: 27.14dB	 SSIM: 0.89 PSNR: 30.15dB
13dB		 SSIM: 0.94 PSNR: 31.46dB	 SSIM: 0.91 PSNR: 29.81dB	 SSIM: 0.93 PSNR: 33.03dB

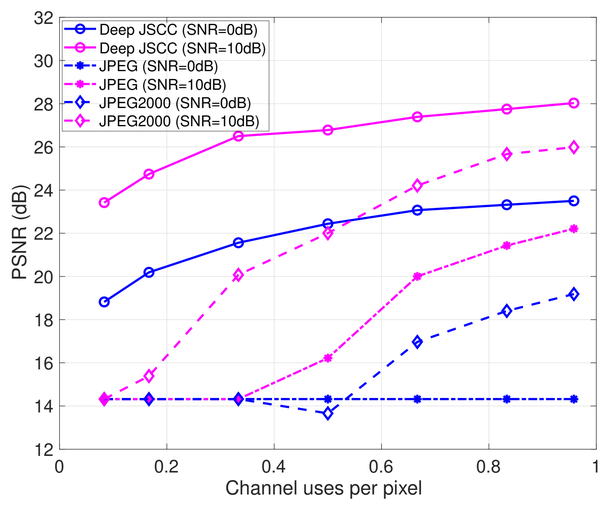
✔ Competitive Performance

AWGN Channel



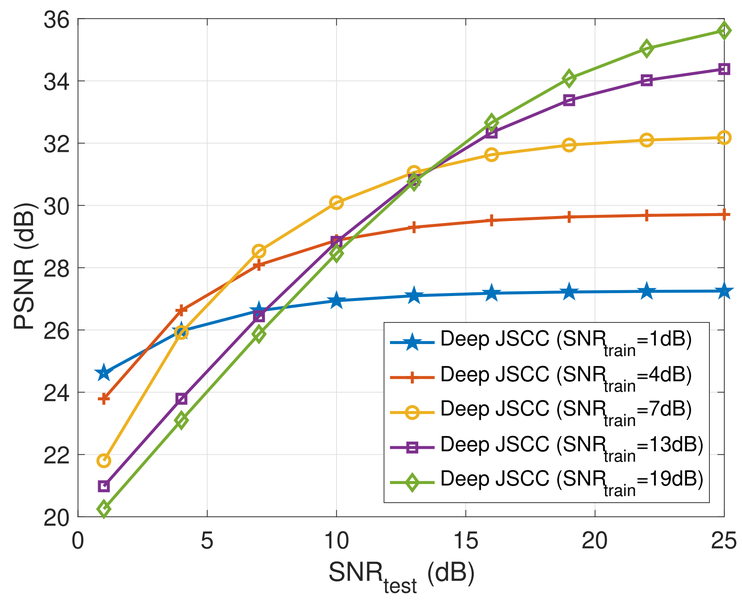
Excel at low SNR and high compression rates!

Fading Channel



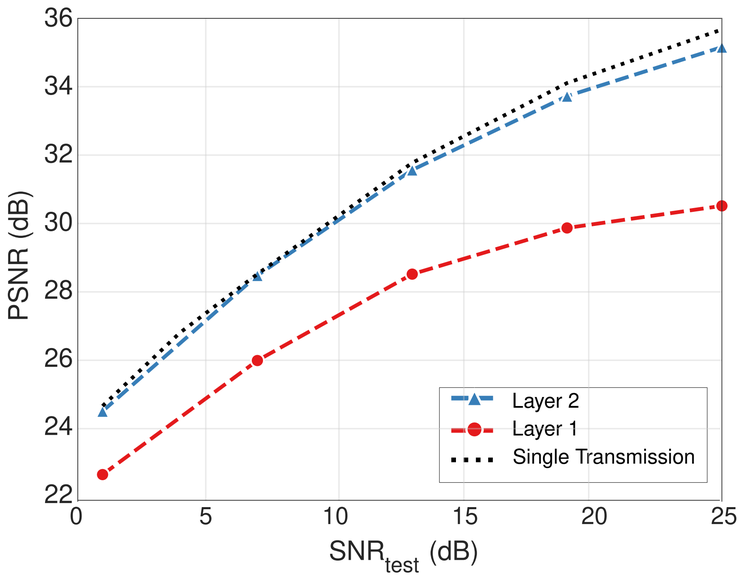
No need for pilots or explicit channel estimation!

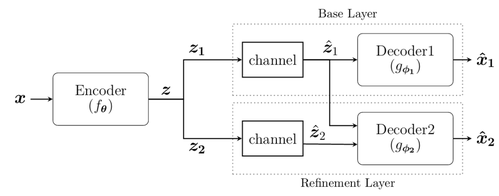
✔ Analogic behaviour



Graceful degradation and no cliff effect!

✔ Successive refinement





Negligible performance loss due to layering!

References

- E. Bourtsoulatze, D. Burth Kurka and D. Gunduz, **Deep joint source-channel coding for wireless image transmission**, *IEEE Trans. on Cognitive Comm. and Networking*, 2018.
- D. Burth Kurka and D. Gunduz, **Successive refinement of images with deep joint source-channel coding**, *IEEE International Workshop on Signal Processing Advances in Wireless Communications (SPAWC)*, Cannes, France, Jul. 2019.