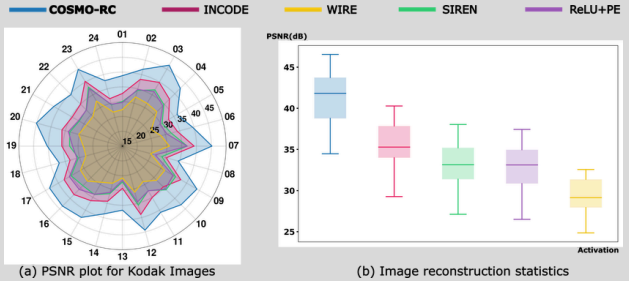
# COSMO-INR: Complex Sinusoidal Modulation for Implicit Neural Representations

## Image Reconstruction




(a) PSNR plot for Kodak Images

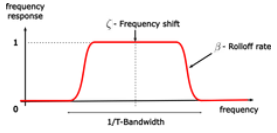
(b) Image reconstruction statistics

## Image Inpainting


## Proposed Raised Cosine activation

$$\phi_{(x)} = \frac{1}{T} sinc\left(\frac{x}{T}\right) \frac{\cos\left(\frac{\pi\beta x}{T}\right)}{1-\left(\frac{2\beta x}{T}\right)^2} \cdot \exp\left(2\pi\zeta x j\right)$$

Time domain representation




Frequency domain representation

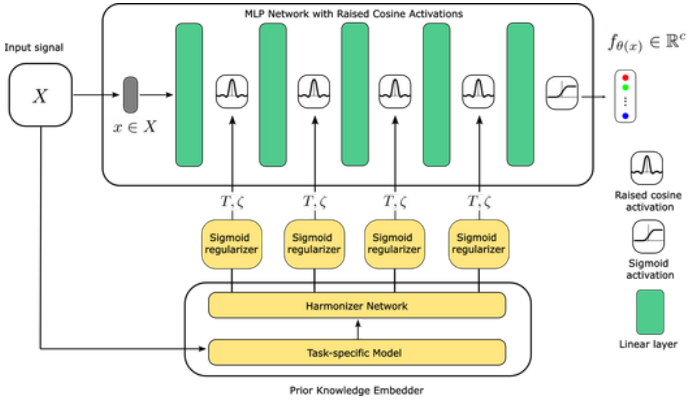
## Abstract

**Problem:** Implicit Neural Representations (INRs) are powerful continuous models, but their performance depends strongly on the activation function. Key issues remain: limited theory for why activations work, spectral bias (weak high-frequency modeling), noise sensitivity, and training instability.

**Solution:** We analyze INRs using harmonic analysis and Chebyshev polynomials, and prove that complex sinusoidal modulation of activations yields more complete spectral support across the network. We then design a new activation and add a regularized deep prior to adapt activation parameters and stabilize training.

**Results:** We observe consistent gains across tasks, including +5.67 dB PSNR in image reconstruction (avg., Kodak dataset), +0.46 dB in denoising, and +0.64 dB over nearest SOTA for 6× super-resolution, with additional improvements on inpainting and 3D shape reconstruction.

## COSMO-INR Model architecture




## Team

**Students:** Pandula Thennakoon, Avishka Ranasinghe, Mario De Silva, Buwaneka Epakanda

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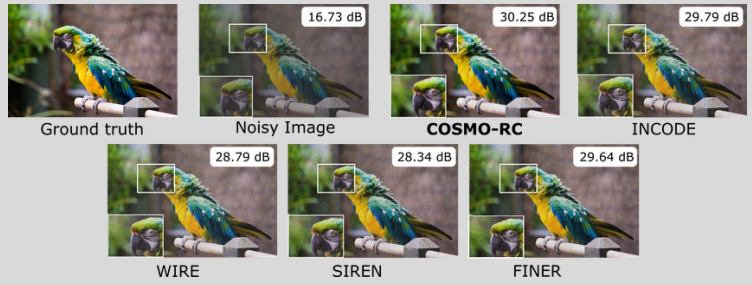
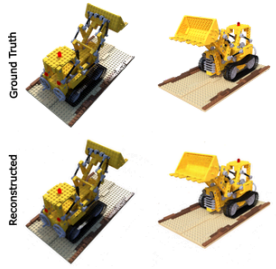
## Image Denoisiong




## 3D Object Representation


## NeRF: Neural Radiance Fields




| Method | PSNR |
|---|---|
| Gauss | 24.42 |
| ReLU + P.E. | 24.71 |
| WIRE | 25.26 |
| SIREN | 25.89 |
| INCODE | 26.05 |
| **COSMO-RC (Ours)** | **29.50** |