

1. Introduction

Given a latent sharp image $x: \Omega \to \mathbb{R}$, where Ω is a bounded open subset of ${\mathbb R}$. The speckledegraded image $y: \Omega \to \mathbb{R}$ is accordingly given by $y = x \cdot n$.

We simplify this multiplicative noise model to an additive version by implementing a logarithmic transformation on both sides

 $\hat{y} = \hat{x} \cdot \hat{n}$, with $\hat{y} = -\log(y)$, $\hat{x} = -\log(x)$, and $\hat{n} = -\log(n)$.

2. DSPNet: DeSPeckling Network

2.1. Contribution

- > The multiplicative speckle noise is converted into an additive model using a logarithmic transformation. DSPNet performs the accurate estimation of noise level and blind reduction of speckle noise in the logarithmic domain.
- > The feature pyramid network (FPN) is used as the backbone network in DSPNet for feature extraction. The atrous spatial pyramid pooling (ASPP) is further adopted to increase the receptive field of network.
- \succ The multi-scale structural similarity and ℓ_1 -norm are combined as the loss function of Log-DNNet to balance speckle noise reduction and detail preservation.

DSPNet: Deep Learning-Enabled Blind Reduction of Speckle Noise Yuxu Lu, Meifang Yang, and Ryan Wen Liu School of Navigation, Wuhan University of Technology, China



The subnetworks Log-NENet and Log-DNNet are, respectively, proposed to estimate noise level map and reduce random noise in logarithmic domain. To enhance image quality, the estimated noise level and logarithmic original image are combined as the unified input of Log-DNNet. The final restored image can be accordingly generated through an exponential transformation of the output of Log-DNNet.

2.3. Multi-Scale Mixed Loss Function

 $\mathcal{L}^{Log-DNNet} = \alpha \cdot \mathcal{L}^{MS-SSIM} + (1 - \alpha) \cdot \mathcal{L}^{\ell_1}$

$$\mathcal{L}^{Log-NENet} = \frac{1}{\Omega} \sum_{P \in \Omega} |(\hat{x}(p) - \hat{y}(p)) - \bar{n}(p)|^2$$



The DSPNet superior imaging performance was further conformed by realistic despeckling experiments on three different types of imaging conditions including medical ultrasound imaging, synthetic aperture radar (SAR) imaging, and underwater sonar imaging. The quality-enhanced images could be potentially beneficial for practical tasks such as detection, tracking, and recognition of objects of interest.