

# Image Restoration Problem Report

## Problem Statement

The paper addresses the problem of restoring degraded images, such as old or damaged photos, using a *zero-shot* restoration approach. Traditional methods often require task-specific training for each type of degradation. However, this paper introduces a model that does not rely on prior task-specific learning, making it more flexible across various restoration challenges without pre-training on the specific types of degradation.

## Title

**Zero-Shot Image Restoration Using Denoising Diffusion Null-Space Model (DDNM)**

## Venue and Publication Year

NTIRE Workshop, CVPR 2022

## Cost Function and Explanation of Variables

The Denoising Diffusion Null-Space Model (DDNM) optimizes the following cost function to reconstruct the degraded images:

$$L(\theta) = E_{t, x_t, x_0} [\|\epsilon - \epsilon_\theta(x_t, t)\|^2]$$

In this function:

- $\epsilon$ : The true noise added to the image at each step of the diffusion process.
- $\epsilon_\theta$ : The noise predicted by the model at each time step  $t$ , where  $\theta$  represents the model parameters.
- $x_t$ : The noisy image generated at a specific time step  $t$  in the diffusion process.
- $x_0$ : The original, clean version of the image.

This cost function minimizes the difference between the actual noise added and the predicted noise, allowing DDNM to iteratively refine and restore the missing or corrupted parts of the image. By optimizing this function, DDNM effectively reconstructs high-quality images from various degraded inputs without requiring prior knowledge about the type of degradation, demonstrating a robust approach to historical image restoration.

This zero-shot restoration method was part of a broader discussion in the NTIRE Workshop at CVPR 2022, which focused on recent advances and challenges in image restoration and enhancement [1].

## References

- [1] NTIRE2022: New Trends in Image Restoration and Enhancement workshop and challenges on image and video restoration and enhancement. *CVPR Workshops*, 2022. <https://cvpr2022.thecvf.com/author-guidelines>