**Image Restoration – Reviving Visual Information**

**-Team 1**

**Introduction**

Image restoration is a crucial area in digital image processing that focuses on reviving degraded visual information. This process has applications in historical preservation, medical imaging, forensic analysis, and consumer photography. Traditional methods often fail to restore fine details, necessitating advanced AI-driven solutions.

**Problem Statement**

Images are often degraded due to noise, blur, low resolution, and environmental factors. The primary challenge is to develop an AI-based image restoration model capable of:

- Removing noise, blur, and artifacts

- Restoring details in damaged or low-resolution images

- Enhancing and colorizing black-and-white historical images

- Improving real-time image and video quality for various fields

- Generating high-resolution images while maintaining authenticity

**Existing Techniques & Literature Review**

Modern image restoration combines Convolutional Neural Networks (CNNs) and Transformers to extract and reconstruct high-quality images. Key methodologies include:

- Transformers: Enhance feature representation for better restoration

- GANs (Generative Adversarial Networks): Generate high-quality images

- Autoencoders: Compress and restore degraded images

**Proposed Restoration Framework**

The proposed model follows a structured approach:

1. Feature Extraction: The input degraded image is analyzed to extract essential details.

2. Encoding & Decoding: Attention-based residual blocks refine the extracted features.

3. Upsampling & Downsampling: The image is processed to reduce noise and enhance clarity.

4. Sparse Transformer: Efficient Transform extracts fine features from image and enhances it.

**Technologies Used**

- Deep Learning Frameworks: PyTorch and Torchvision for building and training models

- Image Processing Libraries: OpenCV for image transformations

- Optimization Techniques: Learning rate scheduling for efficient model training

- Datasets: GoPro, LOL dataset for training and evaluation

**Model Performance & Evaluation**

- Peak Signal-to-Noise Ratio (PSNR): 27.69 dB (GOPRO),19.46 (LOL), indicating effective denoising

- Structural Similarity Index (SSIM): 0.9089 (GOPRO),0.82 (LOL) demonstrating high visual fidelity

**Future Scope**

- Real-time restoration in AR/VR applications

- AI-based reconstruction of historical artwork

- Noise reduction in space and astronomy imaging

- Enhancing smartphone photography using AI

- Preventing deepfake misuse through advanced restoration techniques

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