HIRL: Hybrid Image Restoration based on Hierarchical Deep Reinforcement Learning via Two-Step Analysis

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Introduction

Previous studies typically utilize multiple recovery tools to restore images. However, each tool adopted inevitably introduces additional noise and will affect the subsequent recovery results. To address this issue, we propose a hierarchical deep reinforcement learning framework (HIRL). **Firstly**, we investigate the correlation of recovery path and degradation process, and reveal the methodological noise brought by tools. **Secondly**, we propose a hierarchical framework to reduce time consumption and complexity. **Thirdly**, we extend blind image quality assessment method in the reward scheme to guide RL agents for iterative recovery in scenarios without reference images. **Finally**, the proposed HIRL is highly scalable and can be easily extended to the other recovery pipelines.

Proposed Framework

The type and degree of the tools are selected sequentially by the TS and DS evaluation networks. The images are then recovered step by step through the selected tools until there is no reward, where the reward is measured by PSNR and PaQ-2-PiQ. PaQ-2-PiQ is introduced to guide recovery in scenes without reference images.
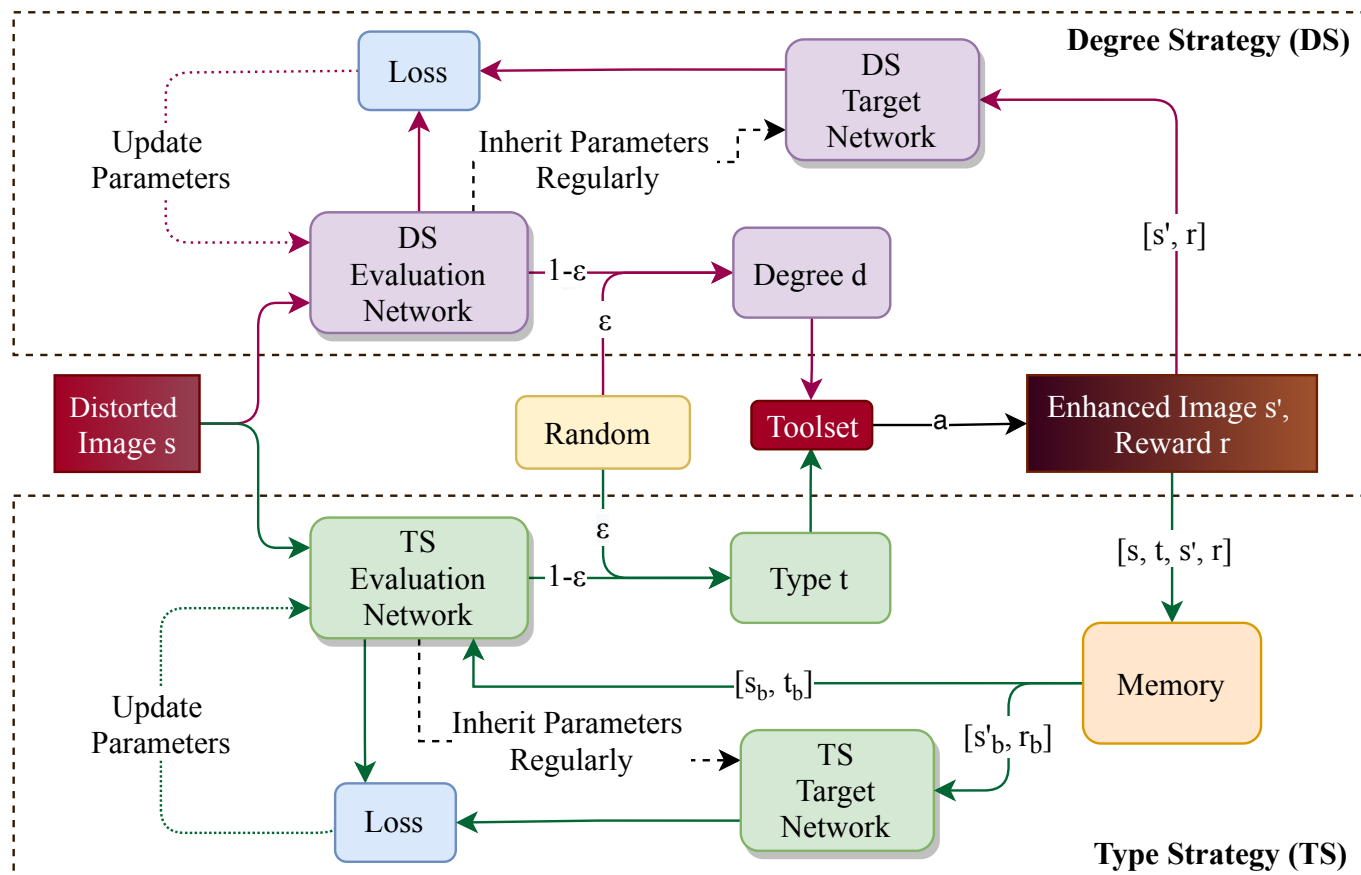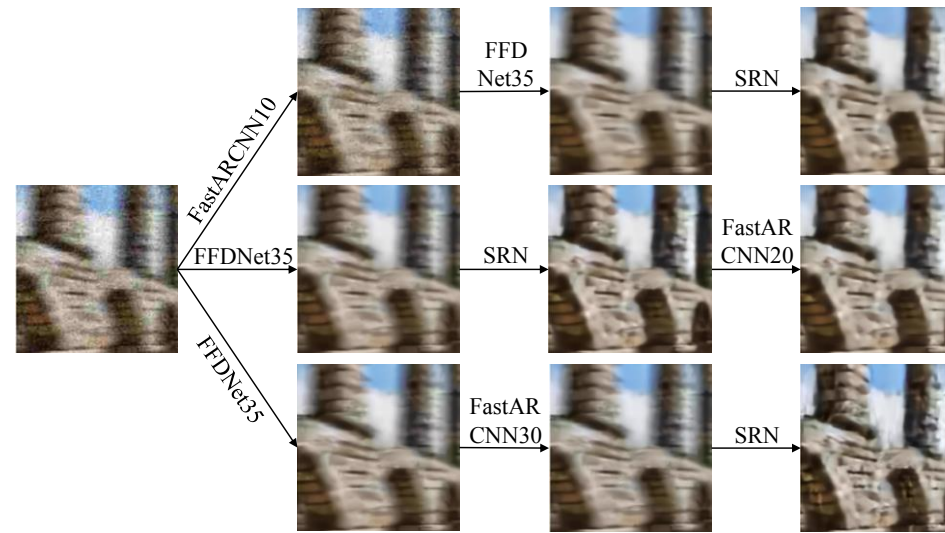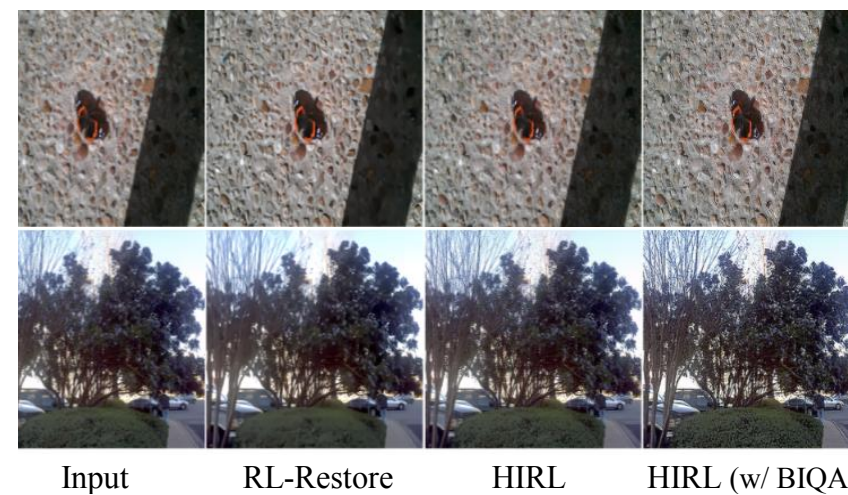

Analysis of Recovery Path

Image restoration pipelines using different strategies. The three branches are the reverse order of the degrading process, greedy strategy, and brute force search, respectively. The PSNR are increased by 1.157 dB, 1.323 dB, and 1.426 dB, respectively.

Experiments

Input   RL-Restore   HIRL   HIRL (w/ BIQA)

Comparison of image recovery performances for different methods on the wild dataset CLIVE, including RL-Restore, and the proposed method without and with blind image quality assessment (BIQA) metric of PaQ-2-PiQ.

Comparison of visual image quality on hybrid distortions of DIV2K datasets. The results are presented from top to bottom for mild, moderate, and severe distortions. The proposed HIRL can effectively suppress noise and blocking effects, and reproduce fine texture details.

FastARCNN   FFDNet   PixelRL   RL-Restore   HIRL