Source Code:

BMVC 2025

# WTNet: A Weather Transfer Network for Domain-Adaptive All-In-One Adverse Weather Image Restoration

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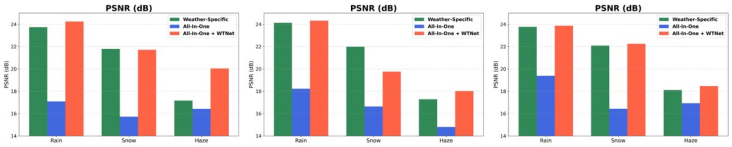
## Introduction

### Contributions

- **Weather Transfer Network (WTNet)**
  - Predicting and transferring degradation patterns
  - Generating fine-tuning sets for test-time adaptation
  - Enabling dynamic adaptation of all-in-one models to specific or mixed weather conditions during testing
- **Improvement of SOTA Restoration Models**
  - Three restoration models: PromptIR (NeurIPS 2023), AST (CVPR 2024), and AdaIR (ICLR 2025)
  - One real-world mix-weather dataset: WeatherStream

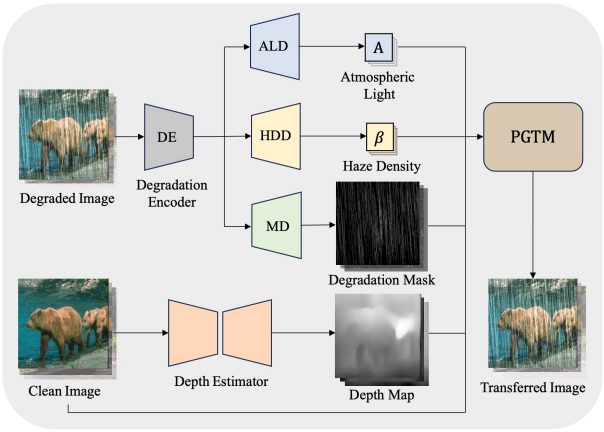
### Motivation & Observation

- Domain gap between synthetic and real-world data distributions
- Balanced performance
- Predicting degradation patterns is easier than content restoration

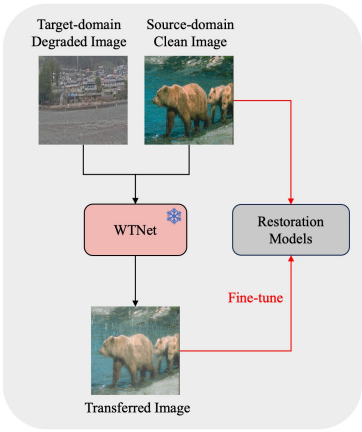



## Method

- **Training:** Using synthetic paired data to learn and disentangle degradation-related parameters
- **Testing:** Using real-world degraded images to generate fine-tuning sets for adapting all-in-one restoration models




Training




Testing

### Parametric Decoders

- **ALD:** Atmospheric Light Decoder ($A$)
- **HDD:** Haze Density Decoder ($\beta$)
- **MD:** Mask Decoder

### PGTM

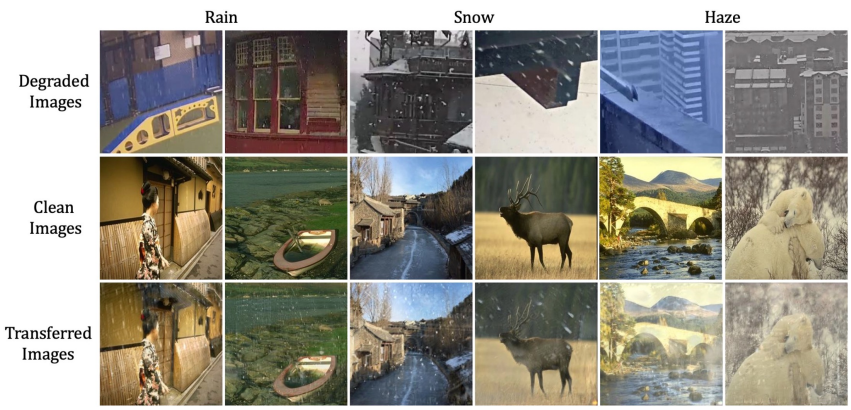
- Physics-Guided Transfer Module
- Transfers parameters to clean images using atmospheric scattering model

## Results

### Quantitative Results

| Method | | Rain PSNR ↑ | Rain SSIM ↑ | Snow PSNR ↑ | Snow SSIM ↑ | Haze PSNR ↑ | Haze SSIM ↑ | Average PSNR ↑ | Average SSIM ↑ |
|---|---|---|---|---|---|---|---|---|---|
| **PromptIR** [30] | Baseline | 17.09 | 0.524 | 15.73 | 0.465 | 16.42 | 0.383 | 16.41 | 0.457 |
| | +WTNet | **24.12 (+7.03)** | **0.766 (+0.242)** | **22.10 (+6.37)** | **0.730 (+0.265)** | **19.81 (+3.39)** | **0.635 (+0.252)** | **22.01 (+5.60)** | **0.710 (+0.253)** |
| **AST** [51] | Baseline | 18.23 | 0.592 | 16.64 | 0.542 | 14.80 | 0.405 | 16.56 | 0.513 |
| | +WTNet | **24.27 (+6.04)** | **0.762 (+0.170)** | **21.29 (+4.65)** | **0.698 (+0.156)** | **17.68 (+2.88)** | **0.575 (+0.170)** | **21.08 (+4.52)** | **0.678 (+0.165)** |
| **AdaIR** [7] | Baseline | 19.39 | 0.614 | 16.43 | 0.546 | 16.93 | 0.398 | 17.58 | 0.519 |
| | +WTNet | **23.21 (+3.82)** | **0.752 (+0.138)** | **22.11 (+5.68)** | **0.724 (+0.178)** | **19.49 (+2.56)** | **0.650 (+0.252)** | **21.60 (+4.02)** | **0.709 (+0.190)** |
| Average Gain | | **+5.63** | **+0.183** | **+5.57** | **+0.200** | **+2.94** | **+0.225** | **+4.71** | **+0.203** |

### Weather Transferred Results




### Qualitative Results