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DesnowOracle: Quantifying Mask-Oracle Gap Recovery by a Training-Free Snow Prior in Compact Image Desnowing

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Abstract Snow occludes visual information needed by outdoor perception systems. This study evaluates whether a deterministic, training-free spatial snow-response map improves compact image

desnowing beyond the effect of its conditioning branch. All conditions use a fixed approximately 2-million-parameter backbone and matched controls. Under the original 2,500-image, 100-epoch protocol, estimated-map SSM improves mean PSNR by 1.004 dB over Base and by 0.490 and 0.517 dB over zero-and shuffled-input SSM. A paired analysis averaging predictions across three seeds gives median gains of 0.387 and 0.420 dB, respectively. Under an extended protocol that also changes training-set size and learning-rate scheduling, this ordering reverses: estimated-map SSM trails zero and shuffled controls by 0.109 and 0.160 dB in mean PSNR. Thus, the experiments demonstrate protocol sensitivity, not an isolated convergence effect. A mask oracle remains an architecture-specific, synthesis-privileged diagnostic reference; the estimated map recovers 12.4% of its short-protocol PSNR headroom. Results on 1,329 unpaired real images are mixed and indirect: no-reference indices favor the estimated map, whereas unlabelled detector counts do not distinguish its content from the controls. These findings show why spatial-prior claims require matched controls, correct repeated-measures analysis, and protocol checks.

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