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Review on Haze Removal Techniques using Image Processing and Deep Learning

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Abstract: *Haze removal, or dehazing, is a crucial process in image processing aimed at restoring clarity to images obscured by atmospheric conditions. This review explores recent advancements in haze removal techniques, emphasizing image processing and deep learning methodologies. Traditional dehazing methods, such as dark channel prior and color attenuation prior, effectively enhance image quality but often fall short in scenarios with complex lighting or dense haze. With the rise of deep learning, techniques using convolutional neural networks (CNNs), generative adversarial networks (GANs), and attention mechanisms have emerged, offering robust dehazing solutions across diverse atmospheric conditions. For instance, models like DehazeNet and AOD-Net streamline the haze removal process, while multi-scale and pyramid-based networks capture haze effects across varying depths. Attention-guided GANs and feature fusion networks further improve haze detection and detail retention. Despite these advancements, challenges persist, particularly in handling non-uniform haze, optimizing real-time performance, and achieving consistency across variable haze intensities. The integration of domain adaptation and transfer learning presents potential solutions, enhancing generalizability in cross-domain applications. This review identifies significant research gaps, including the need for lightweight architectures, adaptive techniques for different lighting environments, and efficient methods suitable for real-time application. By examining 25 recent studies, this review highlights the latest methodologies, their strengths and limitations, and outlines future directions to advance haze removal technologies. The insights gathered aim to guide further development in image restoration for applications in environmental monitoring, autonomous vehicles, and remote sensing..*

Keywords: Haze removal, dehazing, image processing, deep learning, dark channel prior, convolutional neural networks (CNNs), generative adversarial networks (GANs), attention mechanisms, multi-scale networks, pyramid-based networks, feature fusion, real-time performance, non-uniform haze, domain adaptation, transfer learning, environmental monitoring, autonomous vehicles, remote sensing, image restoration