PREFACE

I am delighted to present this Ph.D. dissertation on the topic of image dehazing. The purpose of this research is to develop efficient and effective algorithms for haze removal from images, with the ultimate aim of improving visibility and enhancing image quality in various applications. Haze is a common phenomenon that occurs when light scatters and interacts with atmospheric particles, resulting in a reduction of contrast and color fidelity in images. The presence of haze can significantly degrade the aesthetics and visibility of images, making it challenging for computer vision systems to accurately interpret and analyze visual information.

Over the years, various methods have been proposed to tackle the problem of image dehazing. These methods can be broadly categorized into two approaches: single-image-based and multi-image-based. Single-image-based methods aim to estimate the transmission map, which represents the amount of light attenuated by the haze, from a single hazy image. On the other hand, multi-image-based methods leverage multiple images of the same scene taken under different atmospheric conditions to estimate the transmission and atmospheric light. The research begins with an in-depth review of existing dehazing techniques, highlighting their limitations in handling complex scenes, such as those with intricate textures, sharp edges, and varying atmospheric conditions. It becomes evident that traditional dehazing methods tend to over-smooth edges, leading to a loss of vital information and deteriorating the overall visual quality.

Motivated by these challenges, we propose a novel edge-preserving filters for single image dehazing. The proposed approach leverages state-of-the-art edge-preserving filters, such as guided image filter (GIF), weighted guided image filter (WGIF), gradient guided image filter (GGIF) to preserve edge information in smooth and sharp regions. This dissertation focuses on exploring and improving only single-image-based methods for dehazing. The key contributions of this research include the development of novel edge-preserving filtering-based algorithms and techniques to enhance the accuracy and efficiency of haze removal. They remove halos, over-smoothing effect and preserves edge-details precisely in both flat and sharp regions.

These algorithms tackle various challenges, such as handling color distortion, preserving edge-details, and adapting to different types of haze. The research also includes a comprehensive evaluation of the proposed algorithms using various benchmark datasets. The evaluation involves quantitative metrics to assess the performance of the algorithms in terms of image quality improvement and visibility enhancement. Moreover, qualitative evaluations are performed to analyze the visual results and compare them with state-of-the-art methods

Chapter 1 presents haze effect, atmospheric scattering models (ATSM) in image dehazing, haze imaging models, the motivation behind this research work performed, challenges and contributions made in the dissertation.

Chapter 2, presents state-of-the-art works, background and related preliminaries to image dehazing.

In Chapter 3, a novel effective scale-aware edge-smoothing weighting constraint-based weighted guided image filter is proposed for single image dehazing. In this filter, effective scale-aware edge-smoothing weighting constraint is incorporated into the cost function of guided image filter (GIF). The objective of this filter is to refine the transmission map more accurately and preserves edge-details in both flat and sharp regions.

Chapter 4 introduces a new robust scale-aware weighting based effective edge-preserving gradient domain guided image filter (RSAW-EEPGDGIF) is proposed for single image dehazing. In this filter, RSAW is incorporated into the cost function of gradient guided image filter (GGIF). The GGIF introduces a gradient-based regularization term, enabling the preservation of image edges and fine details while achieving better dehazing and denoising results compared to GIF and WGIF. The proposed filter refines the transmission map by decomposing into effective weighted base layer (EWBL) and effective weighted detail layer (EWDL), respectively. Additionally, a sigmoid function-based non-linear mapping function (NLM) is employed in this method to supress the various artifacts as well as enhances the gradient information in EWDL.

In Chapter 5, a non-local haze line averaging (NL-HLA) based robust multi-scale weighting edge-smoothing filter (RMWEF) is proposed for single image dehazing. The objective of this method is to remove morphological artifacts, over-smoothing effect strongly and preserves edge-details precisely in sharp regions.

Chapter 6 presents a new structural patch decomposition-based multi-exposure image fusion (SPD-MEF) with an effective edge-aware weighting filter is proposed for single image dehazing. It is a fusion-based effective algorithm for image dehzing. It extracts under-exposed outcomes from the single input hazy image and then applied SPD-MEF algorithm to integrate these under-exposed sequences for effective haze removal.

Chapter 7 presents the summary and conclusions of this dissertation.

I hope that this dissertation contributes to the field of image dehazing and provides valuable insights for researchers and practitioners interested in this area. It is my sincere hope that the algorithms and techniques presented in this dissertation will find practical applications in various domains, such as image processing, computer vision, and remote sensing.