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Efficient and Fast Image Dehazing Using Series Mean White Balance and Gamma Correction

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Abstract - The restoration of the information from the images captured in the foggy or hazed scenarios can be beneficial in many cases of surveillance and image forensics to identify the information neatly than the original condition. These requirements are come across due to the effect of outdoor environmental characteristics. The restoration of information in captured images involves several image processing operations like white balancing, colour toning or contrast optimizations. This work proposes a novel series mean white balance approach followed by gamma corrections to dehaze the images. From the experimental results proposed dehazing algorithm is 50-60% faster than the previous algorithm on same input images and system configurations.

Keywords - Dehazing, gamma correction, and series white balance, restoration.

I. INTRODUCTION

Image dehazing is a highly interdisciplinary challenge, involving meteorology, optical physics as well as computer vision and computer graphics. Haze along with fog and clouds are limiting factors for visual range in the atmosphere and heavily reduce contrast in scenes. A main objective in such analysis is improvement of visibility and recovery of colors, as if imaging is done in clear conditions. Computer vision and human vision can then capitalize on such improved images for various applications, such as long range surveillance.

Also, "In general, the haze-free image is more visually pleasuring. Second, most computer vision algorithms, from low-level image analysis to high-level object recognition, usually assume that the input image (after radiometric calibration) is the scene radiance.

The performance of computer vision algorithms (e.g., feature detection, filtering, and photometric analysis) will inevitably suffer from the biased, low-contrast scene radiance.

Last, the haze removal can produce depth information and benefit many vision algorithms and advanced image editing. Haze or fog can be a useful depth clue for scene understanding. The bad haze image can be put to good use."

The need for image enhancement stems from the fact that the atmosphere is never free of particles. With just pure air, the visual range has been found to be between not considering the curvature of the earth's surface. However, real visual ranges are much less than this theoretical value. The international visibility code for meteorological range rates visibilities between under 50m up to over 50km for exceptionally clear air. These codes have been found to reflect a convenient scale for visual ranges in the daily work of meteorologists.

Optical effects in the atmosphere have been subject to studies for many centuries. Early motivations have been to understand the colour shifts of distant objects and all optical effects that can be seen by observing nature through the atmosphere like the blueness of the sky or the red of the dawning sun. Visibility range in various altitudes of the atmosphere, as well as the development of chemical warfare methods that were intended to reduce visibility for hostile airplane pilots were the subjects of meteorological research at that time. Nevertheless, the work from that time is the basis for what one knows about optics of the atmosphere today.

With the help of these theories, one can explain the effects that haze has on the visibility of a scene and eventually of an image taken of that scene. Moreover, with this knowledge one can even improve visibility for the human eye and develop techniques to remove haze. It is possible to improve the visibility in terms of range, colour verisimilitude and feature separation in digital images. Herein the term "dehazing" means to produce an image of a scene that does not contain haze effects although the source of that image originally comprised haze.

II. LIGHT SCATTERING

Light scattering is the most important phenomenon to this subject. It describes the interaction between a (haze) particle and a photon.

A. Rayleigh Scattering

Rayleigh scattering shown in Fig., named after the British physicist Lord Rayleigh, is the dominantly scattering of light or other electromagnetic radiation by particles much smaller than the wavelength of the light.

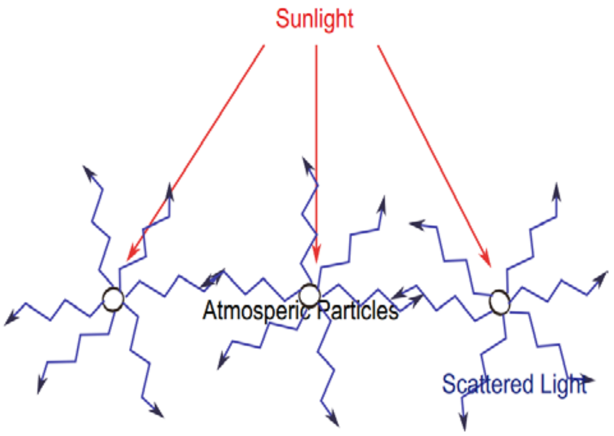

Figure Scattering of light.

B. Mie Scattering

The Rayleigh scattering model breaks down when the particle size becomes larger than around 10% of the wavelength of the incident radiation. In the case of particles with dimensions greater than this, Mie's scattering model can be used to find the intensity of the scattered radiation. The intensity of Mie scattered radiation is given by the summation of an infinite series of terms rather than by a simple mathematical expression.

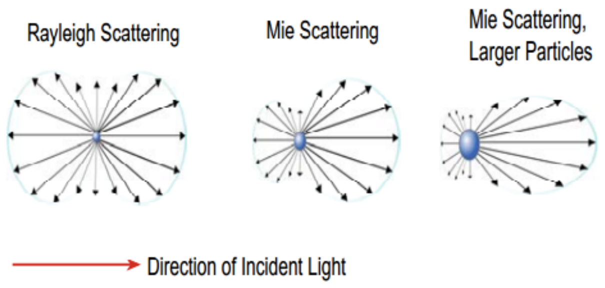

Figure 2.2 Mie Scattering Compare with Rayleigh scattering

III. PROPOSED METHODOLOGY

Despite its remarkable value, determining weather information from a single image has not been thoroughly studied. The main aim of the current study is to develop a set of stable algorithms for the detecting foggy images and labeling the haze degree of images by using a factor with universal applications. Proposed a novel series mean white balance approach followed by gamma corrections to dehaze the images.

The Schematic block representation of proposed work has given in figure 3.1. The figure has following blocks which are described with their functionality and operation.

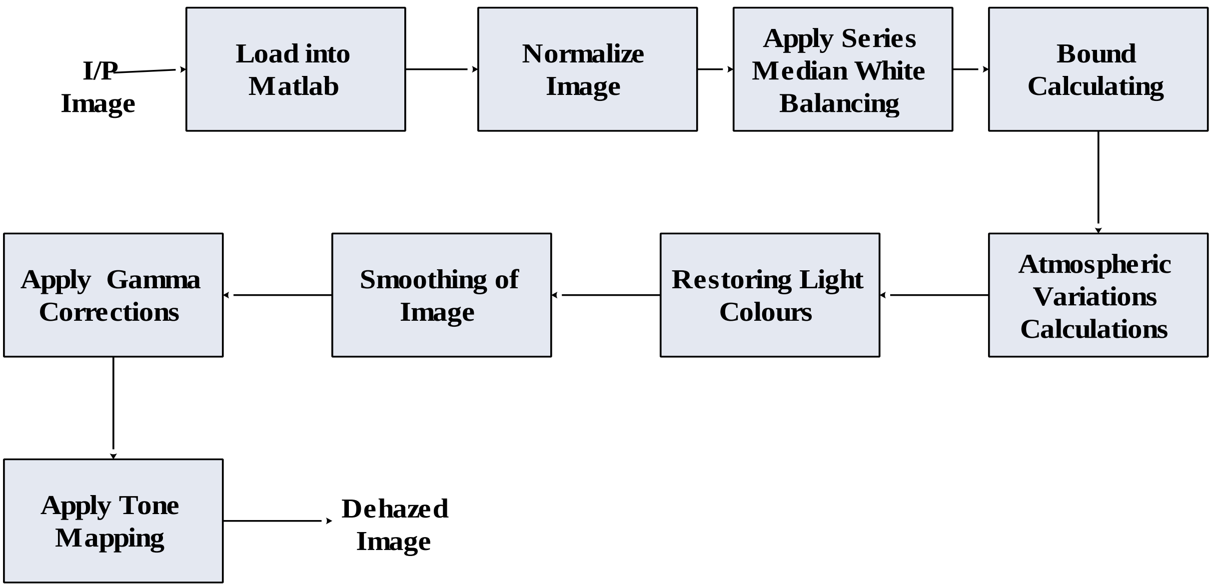

Figure 3.1 Architecture of Proposed work.

Image Normalization : The main stages of this algorithm include normalization, the normalization of the Hazy image so that it has a pre-specified mean and variance. Due to imperfections in the Hazy image capture process such as non-uniform intensity of light due to atmospheric effects, a Hazy image may exhibit distorted levels of variation in grey-level values along the ridges and valleys. Thus, normalization is used to reduce the effect of these variations atmospheric variations like fog, smoke, etc. which facilitates the subsequent image Dehazing steps.

Median White Balancing: White balance (WB) is the process of removing unrealistic color casts, so that objects which appear white in person are rendered white in your photo. Proper camera white balance has to take into account the "color temperature" of a light source, which refers to the relative warmth or coolness of white light. Our eyes are very good at judging what is white under different light sources, but digital cameras often have great difficulty with auto white balance (AWB) — and can create unsightly blue, orange, or even green color casts. Understanding digital white balance can help you avoid these color casts, thereby improving your photos under a wider range of lighting conditions.

Bound Calculating: The computing of bounds for nodes considers the best filtering. The upper and lower bound of the length and the width are determined by finding the smallest bounding box for the inner and outer boundary of the side wall.

Atmospheric variations Calculations: clear-day images have higher contrast than images plagued by bad weather; in most of the local regions even the sky, hazed images have larger minimum values of most color channel (RGB) pixels closing to airlight value.

Restoring Light Colours: Light colours are restored according to the atmospheric variation detected in image.

Smoothing of Image: Conservative smoothing is a noise reduction technique that derives its name from the fact that it employs a simple, fast filtering algorithm that sacrifices noise suppression power in order to preserve the high spatial frequency detail (e.g. sharp edges) in an image. It is explicitly designed to remove noise spikes --- i.e. isolated pixels of exceptionally low or high pixel intensity (e.g. salt and pepper noise) and is, therefore, less effective at removing additive noise (e.g. Gaussian noise) from an image.

Gamma Correction: Gamma is an important but seldom understood characteristic of virtually all digital imaging systems. It defines the relationship between a pixel's numerical value and its actual luminance. Without gamma, shades captured by digital cameras wouldn't appear as they did to our eyes (on a standard monitor). It's also referred to as gamma correction, gamma encoding or gamma compression, but these all refer to a similar concept. Understanding how gamma works can improve one's exposure technique, in addition to helping one make the most of image editing.

Tone Mapping: To solve the problem of displaying wide dynamic range content on low dynamic range displays, computational algorithms known as tone mapping operators have been proposed. Tone mapping is a technique that aims to match the dynamic range of WDR content with the display device dynamic range. Tone mapping compresses or expands the luminance to fit WDR content on LDR (Low Dynamic Range) display. The goal of tone mapping can be different and depends on the particular application.

Process flow of the proposed work has given in figure 3.2

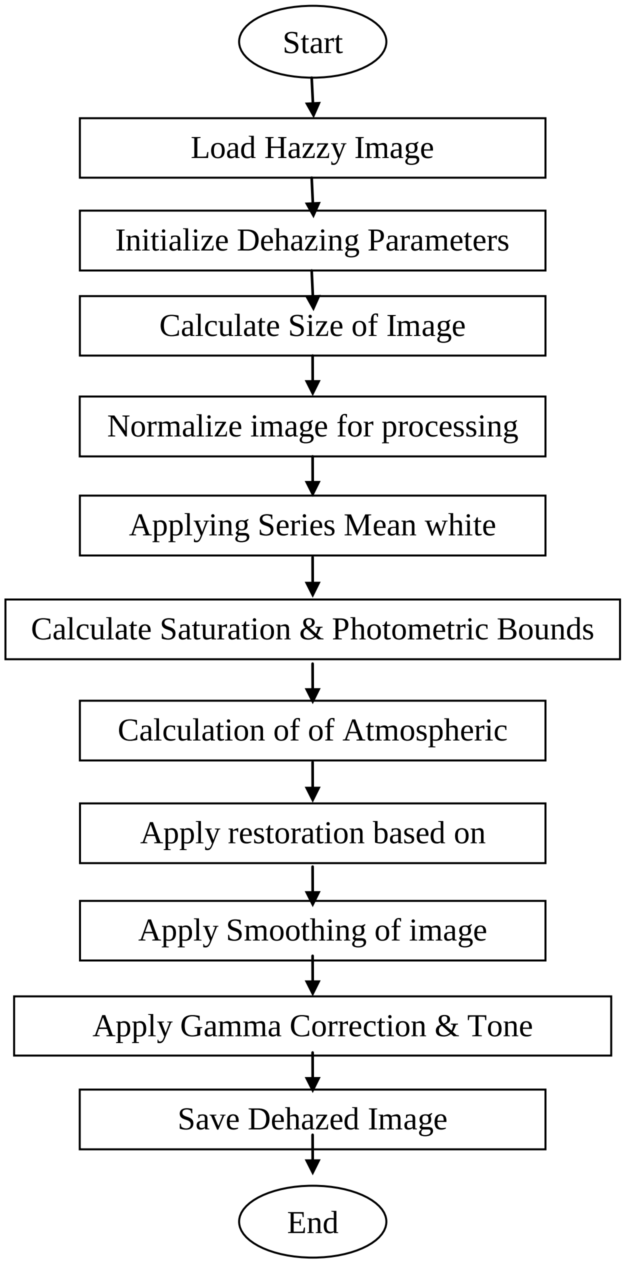

Figure 3.2 Flow Chart Of Proposed Work

IV. EXPERIMENTAL RESULTS

The above mentioned system with proposed methodology is explained with flow chart and block diagram.

The simulation is performed in Matlab 11a. The Outcome of Proposed work has given in Figure 4.1 to figure 4.6 for different test sample images. Input Image (400x600) with Dehazed Image. Fig. 4.2 Input Images (1) with Dehazed Image. Fig. 4.3 Input Image (2) with Dehazed Image Fig. 4.4 Input Images (3) with Dehazed Image. Fig. 4.5 Input

Image (4) with Dehazed Image. Fig.4.6 Input Image (5) with Dehazed Image. With respective Dehazing time 5.7906 seconds, 1.6798, 0.38826 seconds, 1.8502 seconds, 0.70303 seconds, 104924 seconds.

Table 1: Time Performance Comparison

Image	Previous Algorithm	Proposed Algorithm
400x600	120 sec.	5.7906 sec.

Fig. 4.1. Input Image (400x600) with Dehazed Image .

Fig. 4.2 Input Image (1) with Dehazed Image.

Fig. 4.3 Input Image (2) with Dehazed Image

Fig. 4.4 Input Images (3) with Dehazed Image

Fig. 4.5 Input Image (4) with Dehazed Image

Fig.4.6 Input Image (5) with Dehazed Image

V. CONCLUSION AND FUTURE SCOPE

In this work, the physical basis for dehazing algorithms has been exhibited and existing methods been described. Today's methods are physically sound and produce qualitatively good results, however for real-time applications they may not always be fast enough. A novel series mean white balance approach followed by gamma corrections to dehaze the images is proposed in this work. Experimental results show the validity and effectiveness of this method with the help of the implemented test environment. It is shown that the Dehazing method is capable of performing the task in a real-time fashion on modern standard computer hardware. The performance of the proposed work has been compared with existing base work [1] with respect to processing time in seconds.

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