ISSN:0975-9646

Improved Method of Single Image Dehazing based on Multi-Scale Fusion

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Abstract: The immunities in the ambience such as fog and haze can significantly put down the visibility of the captured images. Primarily, this is owing to the substantial bearing of immunities in the atmosphere which take up and scatter the light traveling to the observer from the scene point. Proposed scheme presents a new single image strategy for the betterment of the visibleness of degraded images through dehazing the affected images. The method is based on a fusion-based approach. Through the use of a white-balance along with a contrast enhancing procedure it derives two images from original hazy input image that is blurred. To blend expeditiously the knowledge of the inputs that are produced, their significant features are filtered by calculating three weight maps: luminance, chromaticity, and saliency, to maintain the areas with great visibility. The strategy is designed in a multiscale manner. In order to denigrate the artifacts acquainted by the weight maps, it utilizes a pyramidal representation. The strategic scheme performs a per-pixel manipulation. The experimental results show that the approach gives outcomes comparative to and even a lot better than more complex state of the art techniques, getting the reward of being beneficial for real-time applications where the data processing is fast adequate so as to sustain with an outside processing. As an extension to this strategy unsharp masking method for image dehazing is being used. The resulting image will be cleared and enhanced from the prior.

Keywords: Single image strategy, degraded image, fusion based, weight maps, multi-scale, per-pixel**.**

I. Introduction

The outdoor scene images are frequently degraded by poor atmospheric conditions. In these instances, atmospheric singularities like fog and haze weaken substantially the visibility of the captured image. Considering the aerosol is misted by additional particles and consequently, portions and distant objects of the image are more invisible, the reflected light is spread which washed-out colors and is differentiated by reduced contrast [1]. Within the last years increasing attention has caught by restoration of images taken in these specific conditions. In exceedingly range of outdoor applications, this task is very important including Surveillance, Intelligent Vehicles, Remote Sensing, Object Recognition and. In Remote Sensing techniques, reflected light's recorded bands are processed so as to revive the outputs. This image dehazing issue is fixed by Multi-image techniques [2] through processing several input images, captured in heterogeneous environmental conditions. Some other option would be to suppose that an estimated 3D geometric style of the image is supplied [3]. Treibitz and Schechner showed how different angles of polarized filters are utilized to calculate the haze effects. A tougher issue is when only a single degraded image is available. So an effective and efficient strategy is needed to figure out the problem of Single Image Dehazing.

Contrary to existing methods, proposed approach is developed based on a fusion strategy. This strategy shows the effectiveness and the power of a fusion-based way for dehazing the single degraded image. Image fusion is a well-studied procedure that plans to blend easily a few input images by maintaining just the particular features of the composite output image. This work, aims to develop a rapid and simple method and for that reason, as may be demonstrated, all the fusion processing steps are designed in order to support these important features. The key theory behind the fusion based technique is that two input images are derived from the original input with the goal of regaining the visibility for every single area of the image in at least one of them. Furthermore, the fusion enhancement technique approximations for every single pixel the desired perceptual established attributes (called weight maps) that commands the contribution of every input to the final outcome. In order to derive the images that fulfill the visibility assumptions (good visibility for each region in at least one of the inputs) required for the fusion process.

The proposed approach of Single Image Dehazing using Multi-Scale Fusion protects the images consisting of sensitive contents and can give dehazed output images efficiently utilizing just a solitary hazy image. The proposed approach is based on the selection of appropriate weight maps and inputs, a multi-scale fusion strategy can be used to effectively dehaze images. The main goal of investigated method is to develop a simple and fast technique and hence it was worked during the practical studies, all the fusion processing steps are designed in order to support these important features. The main concept behind our this fusion based technique is that we derive two input images from the original input with the aim of recovering the visibility for each region of the scene in at least one of them. Additionally, the fusion enhancement technique estimates for each pixel the desirable perceptual based quality (called weight maps) that controls the contribution of each input to the final result. Further as an extension an Unsharp Masking Method is being used which gives more clear and enhanced outcome than the prior.

II. Literature Survey

Haze is an annoying factor when it shows up in the image since it causes poor visibility. This is the major problem of several applications in the field of computer vision. Improving and enhancing such hazy image is a fundamental task in several vision and image-processing applications. Repairing blurred images need some specific strategies; so many important methods that were significant have emerged to resolve this difficulty.

A. Dr. H.B. Kekre et al. [2013]

Dr. H.B. Kekre et al. offered an evaluation on image fusion methods and performance analysis parameters. Basically image fusion means to incorporate information that is accompanying from different resources into one image that is fresh. The thought is to reduce redundancy and uncertainty in the output while optimizing useful information specific to a task or an application. Dr. H.B. Kekre et al covered the basic principles of image fusion. Different pixel level algorithms for image fusion and means of assessing and valuing the functionality of these fusion algorithms progress to the precedence and proposed sequence using an edge detection algorithm in inclusion [2].

B. M.A. Mohamed and B.M. El-Den [2010]

M.A. Mohamed and B.M. El-Den proposed execution of image Fusion methods by using FPGA. They combine the data from 2 or even more resource images from an identical scene to create a solitary (single) image. In addition results are assessed by computation of Root Mean Square Error RMSE, Entropy; Mean Square Error MSE, Signal to Noise Ratio SNR and Peak Signal to Noise Ratio PSNR measures for fused images and a comparison is accomplished between these methods. Subsequently it selected the greatest ways to apply them by FPGA [3].

C. R. Fattal et al. [2008]

R. Fattal et al. suggested a system on single image dehazing; he explained the way of calculating the optical Transmission in blurred scenes when only one input image is provided. According to this estimate, the dispersed light is removed to increase image visibility and regain an image that is free of haze. In this method a refined image formulation model is formulated that is responsible for transmission function as well as surface shading. This enables us to solve ambiguities in the information by searching for the solution in which the resulting transmission and shading functions are statically uncorrelated.

D. Robby T. Tan et al. [2008]

Robby T. Tan et al. suggested visibility in poor weather by single image dehazing. Haze and fog, can dramatically weaken a scene's visibility. In computer vision, the absorption and scattering procedures are usually modeled by a linear co-ordination of the atmospheric air light as well as direct attenuation. According to this design strategies are suggested, and a lot of these need multiple-input images of a prospect (scene), with perhaps different atmospheric conditions or distinct degrees of polarization. This requirement is the primary disadvantage of these approaches, because in several scenarios it is not easy to be carried through. To work out the situation, it exposes an automatic system that simply takes single input image [4].

K. He. J. Sun et al. [2009]

K. He., J. Sun et al. suggested a method using dark channel prior for solitary image haze elimination. The dark channel prior is a form of statistics of the haze-relieved outdoor scene images. It is constituted on a key observation that most of the areas in haze-free images include some pixels that have hardly high intensities in leastways one color channel. Utilizing this prior along with the haze imaging model can immediately estimated by the thickness of the haze and regain a high quality haze-free image. This proposed prior is demonstrated by obtained outcomes on various outdoor haze images. Also, a high quality depth map may also be acquired as a by-product of haze removal [5].

In proposed work the fusion-based approach is getting investigated and extended which can be used to effectively enhance hazy and foggy images. This fusion based strategy will be able to solve such problems using only one degraded image. It will be based on selection of appropriate weight maps and inputs, a multi-scale fusion strategy to effectively dehaze images. The main goal is to develop a simple and fast technique.

III. System Design

A. System Architecture

Contrary to existing methods, proposed approach is developed based on a fusion strategy. This strategy shows the effectiveness and the power of a fusion-based way for dehazing the single degraded image. Image fusion is a well-studied procedure that plans to blend easily a few input images by maintaining just the particular features of the composite output image. In this work, the aim will be to develop a rapid and simple method and for that reason, as may be demonstrated, all the fusion processing steps are designed in order to support these important features. The key theory behind our fusion based technique is that two input images are derived from the original input with the goal of regaining the visibility for every single area of the image in at least one of them. Furthermore, the fusion enhancement technique approximations for every single pixel the desired perceptual established attributes (called weight maps) that commands the contribution of every input to the final outcome. In order to derive the images that fulfills the visibility assumptions (good visibility for each region in at least one of the inputs) required for the fusion process, we examine the optical model for this type of degradation. There are two issues that are main, the primary one is the color cast which is introduced as a result of the airlight influence as well as the second is having less visibility in to distant areas because of attenuation and scattering occurrences.

The first derived input guarantees a natural rendition of the output, by reducing chromatic casts which can be due to the airlight color, while the contrast enhancement measure gives a better world-wide awareness, but mostly in the areas that are misty. However, by employing both of these procedures, the produced inputs still have problems with poor visibility. Therefore, to blend efficiently the information of the produced inputs, we filter (in a per-pixel trend) their significant characteristics, by calculating several measures (Weight maps). Thus, in the proposed fusion framework the produced inputs are weighted by three normalized weight maps (luminance, chromatic and saliency) that aim to conserve the regions with satisfactory visible clarity. Eventually, to decrease the artifacts introduced by the weight maps, our strategy will be designed in a multi-scale manner, utilizing a Laplacian pyramid delegation of inputs blended along with Gaussian pyramid representations of normalized weights.

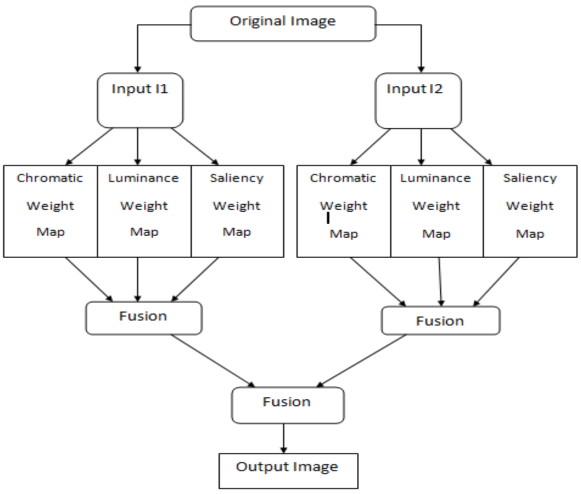

Figure1: System Architecture

B. Methodology

1) Derive two input images from the original input with the aim of recovering the visibility for every region of the scene in at least one of them.
a) First input will be obtained by applying white balancing.
b) Second input will be obtained by applying contrast enhancement technique.
2) Compute 3 weight maps such as luminance, chromaticity and saliency and weight the derived inputs by 3 normalized weight maps.
3) Apply multi-scale fusion, utilizing a Laplacian pyramid delegation of inputs blended along with Gaussian pyramids of normalized weights to obtain the haze free image.
4) Apply (USM) Unsharp Masking method for image dehazing on original hazy input image to obtain the haze free image.
5) Compare the results of single image dehazing using multi-scale fusion method with Unsharp Masking method of single image dehazing to prove the efficiency of Unsharp Masking method.

C. Weight Maps:

The weight maps aim to conserve the regions having good visibility. The derived inputs are weighted by following3 weight maps.

The Luminance weight map measures visibility of every pixel. It assigns high values to regions with good visibility and small values to the rest. Luminance weight map is calculated on account of the deviation between RGB color channel and luminance from input.

Chromatic weight map is determined to manage saturation gain in output image. The chromatic weight map is solely computed as distance between its saturation value and the maximum of saturation range. Therefore small values are allotted to pixels with reduced saturation whereas the most saturated pixels get high values. This weight map is actuated by the actual fact that persons generally prefer images that are characterized by higher saturation level.

The Saliency weight map determines the extent of conspicuousness along with relevance to the neighborhood regions. Visual saliency is that the perceptual quality that makes a person, object or pixel stand out relative to its neighbors and thus, captures our attention. For applications like adaptive compression, object segmentation and object recognition detection of visually salient image regions plays vital role.

D. Multi-Scale Fusion:

There in practice, by employing Laplacian operator at completely different scales each and every input is dissolved into pyramid. Laplacian pyramid of image is obtained by applying band pass filter followed by down sampling operation. As a band pass filter, pyramid construction tends to enhance image features such as edges that plays necessary role for image interpretation. Every level in Laplacian pyramid represents the distinction between successive levels of Gaussian pyramid. In a similar way, Gaussian pyramid is estimated for each normalized weight map. Gaussian pyramid is a sequence of images obtained by applying low pass filter followed by down sampling operation. Currently considering that both Gaussian and Laplacian pyramids have an equivalent variety of levels, fusion or mixing between Laplacian inputs along with Gaussian normalized weight map is performed at every level independently yielding fused pyramid that is taken into account as dehaze version of original hazy degraded image. Fusion based dehazing strategy has several benefits over current dehazing strategies. First, it performs an efficient per-pixel computation, different from the bulk of existing strategies that processes patch. Second, complexity of this approach is less than most of the previous strategy because it isn't necessary to estimate depth map. Finally, this approach performs quicker, which makes it appropriate for real-time applications.

E. Gaussian pyramid:

The goal of Gaussian pyramid is to decompose images into information at multiple scales, to extract features or structures of interest, to attenuate noise.
a) Start with an initial image g0.
b) Apply low pass filter on original image to obtain a "reduced" image.

c) The image is "reduced" in the impression so that both resolution and spatial density are attenuated.
d) This operation can be carried on to receive a set of the images as g0, g1, g2. . . .gn that configure the pyramid image structure.

F. Laplacian pyramid:

Clustering The Laplacian pyramid is a sequence of error imagesL0, L1,. . . . . Ln such that every error image is the variation between two elevations (levels) of the Gaussian pyramid.
The way to do this is,
a) Expand the top pyramid level, Ln.
b) Add the expanded version to L_{n-1} to form g_{n-1}.
c) Until we reach the base of the pyramid, this process is repeated for every level where the original authentic image is fully recovered. We can treat the topmost image of the pyramid as the error image Ln :gn = Ln, Since the top of the pyramid doesn't have an error image.

G. Unsharp Masking:

Unsharp Masking (USM) is an image sharpening method. Most digitized images and out-of-focus photographs usually require a sharpness correction. This is by reason of the digitizing mechanism that must divide a color sequence up in points along somewhat distinct colors: elements that are thinner as compared to the sampling frequency will be averaged into a uniform color. So that the sharp boundaries are rendered to a slight blurred. While printing color dots on the paper, the same aspect appears. Unsharp Mask filter sharpens edges of the elements without expanding blemish or noise. Unsharp Mask filter is the king of the sharpen filters. The name "unsharp" derives from the fact that the technique utilizes a blurred, or "unsharp", positive image to produce a mask of the original image. USM is frequently addressable in digital image processing software. The unshaped mask is then blending with the negative image, so as to create an image that is less hazy than the original hazy image. In terms of signal processing, an unsharp mask is commonly a linear or nonlinear filter which intensifies the high-frequency factors of a signal in image.

IV. Results

This Fusion based dehazing access takes 2 inputs deduced from original authenticate image. The first input is achieved by activity of white balance operation on original image. White balancing is a vital processing step that aims to enhance the image appearance by discarding unwanted colorcasts, because of numerous illuminations. Nevertheless, white balancing solely isn't able to solve the problem of visibility, and so further input gets derived in order to enhance the contrast (divergence) of degraded image. The alternative input is picked so as to increase contrast in those regions that endure on account of the air light influence. The weight maps aim to conserve the regions having good visibility. Further the strategy is designed in a multiscale manner. In order to denigrate the artifacts acquainted by the weight maps, it utilizes a pyramidal representation. The strategic scheme performs a per-pixel manipulation. The experimental results show that the approach gives outcomes comparative to and even a lot better than more complex state of the art techniques, getting the reward of being beneficial for real-time applications where the data processing is fast adequate so as to sustain with an outside processing. As an extension to this strategy unsharp masking method for image dehazing is being used. The resulting image will be cleared and enhanced from the prior.
The main goal of investigated method is to develop a simple and fast technique. Figure 2 shows the outcome of Multi-scale fusion and unsharp mask methodology.

(1) **(2)** **(3)**

Figure 2: (1) Input hazy image (2) Result obtained using Multi-Scale fusion (3) Result obtained using USM

Figure 3 shows the Comparisons of processing time for existing system verses proposed system

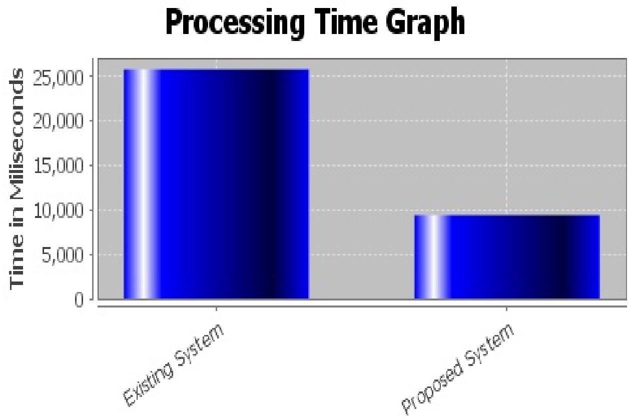

Figure 3: Comparisons of processing time for existing system verses proposed system

V. Conclusion

This paper demonstrated that the hazy and foggy images can be enhanced expeditiously exploiting fusion-based strategy. It stated that, by choosing appropriate and acceptable weight maps and inputs, images could be dehaze efficiently using a multi-scale fusion approach. The main concept behind the fusion based technique is to derive 2 input images from the original input with the aim of recovering the visibility for every region of the scene in a minimum of one amongst them. Furthermore, the fusion enhancement technique estimates for every pixel the desirable perceptual based quality (called weight maps) that controls the contribution of every input other ultimate result. Our fusion-based enhancement process is driven by several weight maps. The weight maps of our algorithm assess several image qualities that specify the spatial pixel relationships. These weights assign higher values to pixels to properly depict the desired image qualities[6]. Finally, our process is designed in a multi-resolution fashion that is robust to artifacts. Compared with previous dehazing methods, our algorithm has three main advantages: (i) it performs an effective per-pixel computation, different than the majority of the previous methods that consider patches. A proper per-pixel strategy reduces the amount of artifacts since patch-based methods have some limitations due to the assumption of a constant air light in every patch. In general this assumption is not true and therefore additional post processing is required (e.g. the method of He et al. [8] needs to smooth the transmission map by alpha-matting); (ii) the complexity of our method is more reduced than the previous strategies; (iii) our technique performs faster being suitable for real-time applications. The planned strategy is going to be quicker than existing single image dehazing schemes and yields accurate outcomes.

ACKNOWLEDGMENT

I would like to take this opportunity to acknowledge the contribution of certain people without which it would not have been possible to complete this paper work. I am thankful to the Principal Dr. R. K. Jain, Guide, Head, Coordinators, Colleagues of the Department of Computer Engineering, Dr. D. Y. Patil Institute of Engineering and Technology, Pimpri, Pune, Maharashtra, India, for their support, encouragement and suggestions. I would like to express my special appreciation and thanks to my guide Professor Dr. Akhil Khare, you have been a tremendous mentor for me.

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