Effective and Optimized Method of Single Image Dehazing based on Multi-Scale Fusion

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Abstract— Due to bad weather conditions the visibility of outdoor images is ruined. Haze and fog are responsible for this, as they absorb the light and spread in the environment. Haze is the slight obscuration of atmosphere, due to which the clarity of the image is degraded. This paper introduces the enhancement in the visibility of the single degraded image. The information from two or more input, images to generate solitary containing more accurate information of the scene than the resources images. There are three parameters: luminance, chromaticity and saliency, the vital features of image are filtered to maintain the good visibility regions. Specific measures followed by Laplacian and Gaussian pyramid representation, are used to weight the derived image to reduce the artifacts. Eventually the resultant image will improve as compared to the resource images. Computer vision, Image processing, automatic object detection, parallel and distributed processing, remote sensing and robotics are the domains in which several studies and research has been completed. The paper demonstrates the virtue and potency of fusion based way of dehazing applied on single degraded image which is altered. The virtue of our method illustrates to give relatively better results than the more complex pre-existing techniques.

Key words: Multi-Scale Fusion, Image Dehazing

I. INTRODUCTION

Image processing techniques are the best way to enhance the quality of a degraded image. The quality of an input image can be upgraded with the help of method known as image fusion. Two distinctive foggy image involvements through the use of a white balance and a contrast enhancing procedure are used to derive fusion-based strategy. As an effect of this we will get an amended quality image than the contribution image. Computer vision, Image processing, automatic object detection, parallel and distributed processing, remote sensing and robotics are the domains in which development and research has been done. All the encyclopedic research performed on some image fusion calculations taking into account their execution is reported in our paper. The paper validates the asset and effectiveness of fusion based way of dehazing applied on single degraded image which is altered. This strategy is unambiguous to execute and work in a pre-pixel manner. With the estimate produced concerning the Image fusion, calculations which are different, formative Pyramid Synthesis algorithm, thesis is concluded.

Many authors, with the objective of enhanced performance have presented variety of methods for efficient single image dehazing. However, there are various margins of these earlier present procedures. Firstly, the concept of patches based computation is used by most of the existing methods where it is considered that, in every patch, air light is constant. Usually, the supposition made by patch based techniques does not seize. Hence, the supplementary post processing steps are introduced further. Secondly, the concept of evaluating the depth map is also used by previous methods in which the complexity of dehazing techniques increases. Under real time environment, these techniques of existing methods are not useful because of its slower performance. Lately, to overcome the above problems one of the method based on fusion has been introduced; however this method needs to be investigated considering the various performance factors. The mechanism used to enrich the quality of information achieved from. Images, is prominent as image Fusion. The enormous details from specified images are combined together by image fusion to obtain a resultant image whose quality is enhanced as compared to any of the input images. With the help of succession of operatives on pictures this is consummate which will make the useful information in each of the input images noticeable. By merging the extravagant information into a single image, which is acquired from consequent the input images we get the resultant image.

In this paper we introduce a substitute single-image based strategy that is capable to precisely dehazed images using only the unique degraded information. A stretched abstract of the core idea has been recently introduced by the authors in [1]. We introduce technique has some equality with the preceding approaches of Tan [2] and Tarel and Hautière [3], which improve the brightness in such hazy image by managing their contrast. Yet, in contrast to existing techniques, we make our way on a fusion technology. We are the first to determine the usefulness and utility of a fusion-based technique for dehazing on a single degraded image. Image fusion is a well-known technology [4], intension to blend impeccably several input images by maintaining only the precise features of the composite output image. In this work, our aim is to build an easy and fast technique therefore, all the fusion processing steps are aimed in order to support these imperative sorts.

The main idea behind our fusion based technique is that we develop two input images from the original input with the goal of improving the brightness for each section of the scene in at least one of them. Furthermore, the fusion enrichment method approximations for each pixel the wanted perceptual based qualities (called weight maps) that controller the effect of each input to the output. In order to illuminate the images that achieve the visibility forecasts (good visibility for each region in at least one of the inputs) essential for the fusion process, we analyze the photophobic model for this sort of degradation. There are two main complications, color cast and lack of visibility. The colure cast that is introduced due to the air light influence and the second is the lack of visibility into unsociable regions due to dusting and dilution occurrences. The first resulting input checks a natural rendering of the output, by jettisoning chromatic casts that are exaggerated by the air light color, while the contrast supplementation step yields an better-quality global visibility, but mainly in the cloudy regions.

However, by appealing these two operations, the derived inputs taken alone still undergo from poor visibility.

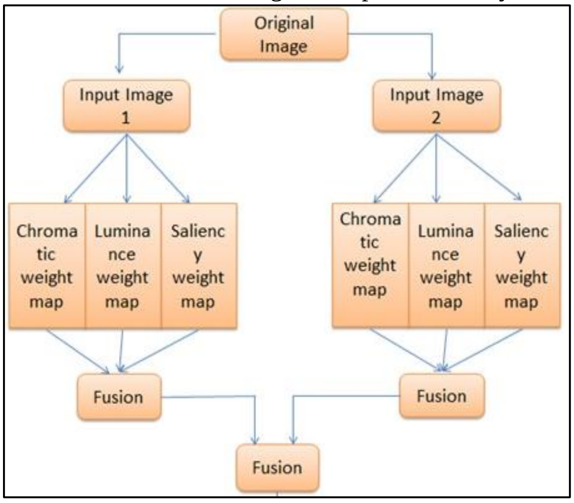

Fig. 1: Outline of the system.

Therefore, to blend effectively the information of the derived inputs, we filter in a per-pixel fashion their key features, by calculating numerous measures weight maps. Consequently, in our fusion framework the derived inputs are weighted by three normalized weight maps (luminance, chromatic and saliency) that aim to preserve the regions with good visibility. Finally, to minimize artifacts introduced by the weight maps, our approach is designed in a multi-scale fashion; using a Laplacian pyramid representation of the inputs collective with Gaussian pyramids of normalized weights. Our method has numerous advantages over preceding single image dehazing approaches. First, our method performs an operational per-pixel calculation, dissimilar from the mainstream of the previous methods [5]–[6] that process patches. A proper per-pixel strategy reduces the amount of artifacts, since patch based methods have some boundaries due to the hypothesis of constant air light in every patch. In general, the expectations made by patch-based techniques do not grasp, and therefore supplementary post treating steps are compulsory. Secondly, since we do not guess the depth transmission map, the density of our approach is lower than most of the previous approaches.

Finally, our system performs faster which makes it appropriate for real-time applications. The key conclusion is that our method is less prone to artifacts; we believe that this is a key advantage of our technique. The rest of paper is structured as follows. In the next section, the related techniques that deal with haze removal are briefly reviewed. In Section III, we introduce our new single image based dehazing technique; the details regarding our fusion technique are discussed in this section. In the next section we report and discuss the results.

II. RELATED WORK

In image processing application fundamental task is to upgrade and enhance the images. Specific policies are required to renovation blurred images, to stun this problematic most of the important methods have emerged. Strategies for dehazing of single image by multi-scale fusion have been suggested by Cosmin Ancuti and Codruta Oraniana Ancuti [7]. Together of them approached fusion based system that is derived from two original hazy resource images by applying white balance along with stretching of contrast. The significant characteristics of the input images are filtered by evaluating the three parameters: luminance, chromaticity and saliency, to merge the information of input images effectively so that areas with good visibility can be maintained.

Estimation on image fusion methods and parameters for analyzing the performance was offered by Dr. H.B. Kekre [8] et al. To integrate information that is added from the various resources into solitary image that is changed, is image fusion. While extracting the information of interest related to particular task, it is also important to reduce redundancy and unreliability. A sequence is proposed using the algorithm of edge detection in inclusion and ways of valuing and estimating the functionality of various pixel level algorithms for image fusion are progressing towards priority. Image fusion algorithms should meet two main requisites. Basically, the fusion algorithm should identify the attributes of significance in the resource images and progress them to resultant solitary image without any reduction in details. Secondly, discrepancies or any artifact should not be introduced by fusion techniques which may misguide the observer or preceding phases of process. Three main phases of fusion are also presented in paper which includes Image Acquisition, Image Registration and Image Fusion. After applying the image fusion algorithm to the input images, we can make sure the communication in between the pixels of an input image. Finally, the procedure of image fusion can be used to optimize the information from set of pixel in resource images into solitary image.

By using FPGA, execution of image fusion methods was proposed by M.A. Mohamed and B.M. El-Den [9]. The data from two or images can be merged to create a single identical image. By computing the Root Mean Square Error RMSE, Signal to Noise ratio, Entropy; Mean Square error MSE and Peak Signal to Noise Ratio PSNR are the measures to evaluate the result of image fusion and comparison is achieved in this methods.

The way of estimating the optical transmission of blurred scenes in single input image i.e. the system of dehazing the single image was suggested by R. Fattal et al [6]. According to the estimation, in order to recover an image that is free of haze and to enhance the visibility of image, dispersed light is removed. In this approach the transmission function as well as surface shading is obtained by formulating the refined formulation image model. This method facilitates us to obtain the unambiguous information by seeking for the solution in which resulting shading function and transmission function are statically uncorrelated.

The visibility in bad weather by dehazing the single image was suggested by Robby T [5]. Tan et al. Fog and haze can drastically weaken the visibility of scene. By linearly combining the direct attenuation as well as atmospheric air light are used to represent the absorption and scattering procedures, in computer vision. Many of the design strategies are suggested in accordance with this method and most of them need multiple input images of a scene, which have probably different atmospheric conditions or various degrees of polarization. This constraint is one of the main disadvantages of these methods, because it is not easy to be carried through several scenarios. To solve this problem, we represent an automatic system which takes only single image as an input. This approach depends on two fundamental discoveries: first, images suffering from poor climate have less contrast in comparison to the images with enhanced visibility; second, is the atmosphere-light. The space of the things to the audience largely effects the variance. Considering both of these discoveries, the framework of Markov random fields has introduced a cost function which may be economically improved by various methods, such as graph-cuts or belief propagation. The geometric information of the image is not needed by the system, and is appropriate for both the grey and color images.

The method using dark channel prior for single image dehazing was suggested by K. He. And J. Sun ET a [10]. One of the types of statistics of dehazed outdoor images is dark channel prior. Some of the pixels in haze-free images have hardly high intensities in at least one color channel, is one of the key observation. The dark channel prior used along with the haze imaging model can be instantly estimated by the thickness of haze and regain a high quality dehazed image. This prior is illustrated by acquired outcomes on different outdoor haze images. As a result of by-product, we can also obtain a high quality depth map. Dehazing has great advantage in the fields of consumer/computational photography and computer vision applications. Firstly, elimination of haze enhances the visibility of the scene and change in color caused by air light is also corrected. Fundamentally, the dehazed image provides us the more pleasant vision. Secondly, most of the computer vision algorithms i.e. from low level image-analysis to high level object recognition have supposed that the resource image is scene radiance. Low contrast and biased image radiance are the factors which necessarily affects the performance of vision algorithms. Finally, making the image haze-free is advantageous to produce depth information and advance image editing.

III. PROPOSED WORK

In this paper, our main objective is to develop an easy and fast approach to create a haze free image using fusion based techniques. The main reason behind using fusion based technique is to derive two input images from the initial input image in order to enhance the visibility for every region of the scene, at least in one of them. The fusion based enhancement technique evaluates the interesting observed qualities (called weight maps) which controls the contribution of each pixel ultimately to the result.

A. Significance

The technique should be able to preserve sensitive contents of the image and to extract the less distorted watermark. It has three objectives:

1) To present an analysis of various techniques.
2) To present and confer the method proposed for single image dehazing.
3) To present the practical analysis of the suggested method and its estimation against the pre-existing techniques.

B. Approaches

1) The two input images are derived from the original input image with the objective of recovering the visibility of the every section of the scene, in at least one of them.
   – By applying the white balance, first input image is obtained.
   – By applying the contrast enhancement technique, second input image is obtained.
2) Three weight maps such as luminance, chromaticity and saliency are evaluated and the derived inputs are weighted by three normalized weight maps.
3) To obtain haze free image, the multi-scale fusion using the Laplacian pyramid representation of inputs merged with the Gaussian representation of the normal weights is applied.
4) To obtain haze free image, apply Unsharp Masking (USM) for dehazing the original input hazy images.
5) In order to prove the efficiency of Unsharp Masking method, compare the results obtained from dehazing the image with multi-scale fusion to that obtained from USM.

C. Gaussian Pyramid

The main objective of Gaussian Pyramid is to decompose the images in order to obtain the information at multi-scales, to extract the characteristics or structures of interest, in order to attenuate noise.

1) Initiate with the original input image, g0.
2) In order to reduce the noise from the images i.e. to obtain "reduced" image, low pass filter is applied.
3) By "reduced" image, we mean that the resolution and spatial density have been decreased.
4) Apply the operations in order to obtain the series of images g0, g1........gn that form the pyramid image construction.

D. Laplacian Pyramid

A series of error images L0, L1........, Ln such that each image with error is the variation among the two levels of Gaussian Pyramid, is the Laplacian Pyramid. Following are the ways given to obtain this:

– Develop the top level of Laplacian Pyramid, Ln.
– Add the developed edition level Ln to Ln-1, in order to obtain gn-1.
– Keep repeating the same operation till we arrive at the base level of pyramid, so that we can obtain fully recovered image. No error image exist for the top level of pyramid, therefore we can treat the image at the top as error image i.e. Ln, Gn = Ln.

E. Process Flow

Following process flow figure show the process flow of fusion system. First of all it originates 2 input images from the new input with the aim of getting better the visibility for every area of the scene in a least of one amongst them by relating white balancing and contrast improvement system. Then to balance efficiently the information of the derived inputs, it filters (in a per-pixel fashion) their necessary features, by computing several measures (weight maps). Consequently, within the fusion outline the derived inputs are weighted by 3 normalized weight maps (luminance, chromaticity and saliency) that aim to preserve the regions with better visibility. Finally, to attenuate artifacts that is introduced by the weight maps, our approach is intended in a multi-scale fashion, employing a Laplacian pyramid representation of the inputs combined with Gaussian pyramids of normalized weights.

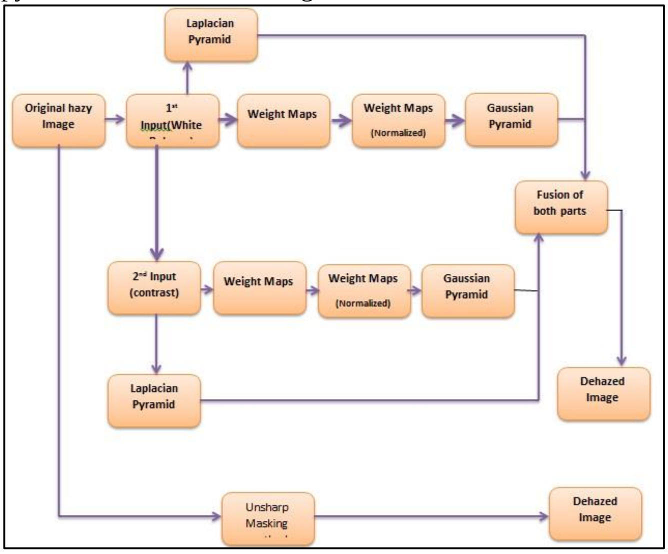

Fig 2: Process Flow

F. *Defined Input*

The technique of fusing images to obtain dehazed image, requires two derived inputs from initial input image. By applying White Balancing first input image is obtained. Unnecessary colorcast can be reduced by applying White balancing, as its main objective is to improve the quality of image in sense of visibility. White Balancing individually is not sufficient to deal with the problem of visibility. Hence, the second input image is derived in order to enhance the contrast of degraded image, in those regions of scene which suffer from air light influence. The second step considerably smoothest the visible area of hazy parts but at the same times it reduces the sharp details of the image. Weight maps are discovered for every input, in order to eradicate this degradation.

G. *Unsharp Masking*

In software of digital image processing, we have an approach Unsharp masking which is an image sharpening method. The term Unsharp is obtained from the reality that it uses blurred, positive image to obtain the mask for an original input image. In order to obtain the image which is less hazy compared to the original image, the unsharp mask is merged with the negative image.

H. *Weight Maps*

The weight maps main goal to reserve the area with better-quality reflectiveness. The resulting inputs are weighted by following three weight maps. The Luminance weight map processes visibility of every single pixel. It allocates huge values to area with good visibility and small values to the all remaining. Secondary the RGB color channel information this weight map is handled. Luminance weight map is figured on account of the unconventionality between RGB color channel and luminance from input. Yet, it is experiential that this weight map reduces global contrast and color information. So as to beat these belongings two extra weight maps are defined: a Chromatic weight map i.e. color information and saliency weight map means global contrast. The Chromatic weight map is intended to manage fullness gain in output image. The chromatic weight map is only computed as distance between its saturation value and the maximum of saturation range. Therefore small values are allotted to pixels with reduced saturation while the most saturated pixels get high values. This weight map is activated by the actual fact that persons generally prefer images that are categorized by high level of fullness. The Saliency weight map identifies the degree of conspicuousness with meaning 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.

IV. ESTIMATED RESULTS

The features of interest are filtered by computing weight maps from two derived input images in order to effectively merge the information obtained from them. Accordingly, in this structure of fusion, three weight maps i.e. luminance, chromaticity and saliency are used to weight the derived inputs.

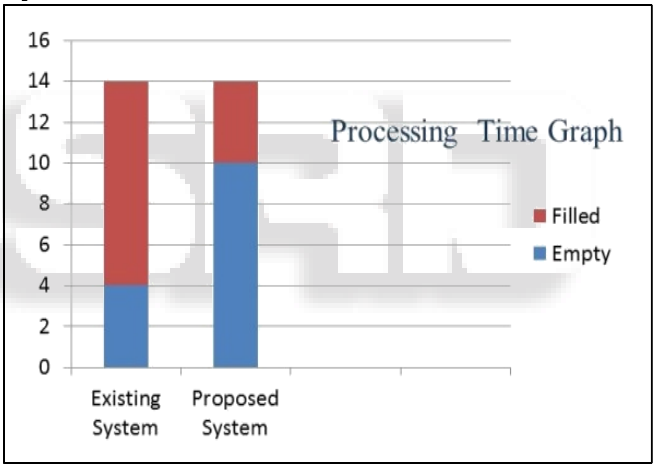

Fig. 3: Processing Time Graph.

In this paper, in order to obtain the effective way to enhance the hazy and foggy images, we are inspecting and expanding the approach of fusing the images. This approach is the first to deal with such problems by taking into account a single degraded image. Multi-scale fusion tactic can also be used potentially to dehaze the images, in this method the selection criteria is appropriate weight maps and inputs. Objective of this method is to propose simple and fast technique. The basic concept which lies behind this technique is to derive two input images from the single image to improve the visibility of each section of the image. In addition, the fusion based technique evaluates the desirable observed quality for each pixel, which controls the involvement of each input pixel to the final result. In order to obtain more dehazed image, we are expanding the developed fusion based technique by applying unsharp masking method to it.

V. RESULTS

The dehazing of an image using image fusion takes two images as an input which are deduced from original authenticate images. The activity of white balance operation is performed on original image to obtain the first input. As a result of white balancing, unwanted colorcasts are discarded because of numerous illuminations and image appearance also enhances, this is considered to be vital processing steps. Further input gets derived in order to enhance the divergence of degraded image as white balancing solely is not able to enhance the visibility. The second input is picked in order to enhance the contrast in those regions that undergo on the account of air light influence. To preserve the regions with good visibility is the objective of weight maps. It utilizes pyramidal representation, to degrade the artifacts acquainted by the weight maps. Per-pixel manipulation is performed by strategic scheme. The outcomes of the experiment shows that this approach gives comparatively better results than the complex state of the art techniques, getting the virtue of being effective for real time applications where the processing of data is fast and adequate in order to sustain with outside processing. The approach is extended by using the unsharp masking method for making the image haze free. The resultant solitary image will be more clear and visible compared to the resource images. The main objective is to introduce simple and fast technique for single image dehazing.

VI. CONCLUSION

This paper confirmed that the hazy and cloudy images can be enriched expeditiously manipulating fusion-based strategy. It stated that, by choosing suitable and appropriate weight maps and inputs, images could be dehazing professionally using a multi-scale fusion approach. The main idea behind the fusion based technique is to derive two 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. Moreover, the fusion enhancement technique estimates for every pixel the required perceptual based quality (called weight maps) that controls the contribution of every input to the ultimate result. The planned strategy is going to be faster than standing single image dehazing schemes and yields precise outcomes. As an extension to this, unsharp masking method for image dehazing is being used. The resulting image will be cleared and enhanced from the prior. Our contribution towards this work will certainly be useful for further processing in image dehazing.

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