IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.-6, Issue-7, July 2018 E-ISSN: 2347-2693

# Variational Image Dehazing Based on Multi-Scale Fusion

**B. Jyothi[1], Chandra Mohan Reddy Sivappagari[2]**

[1]M.Tech Student, Department of Electronics and Communication Engineering , JNTUA College of Engineering, Pulivendula, Andhra Pradesh, India
[2]Department of Electronics and Communication Engineering, JNTUA College of Engineering, Pulivendula, Andhra Pradesh, India

*Corresponding Author: billajyoo.sku@gmail.com, Mobile: 9440988946*

**Available online at: www.ijcseonline.org**

Accepted: 16/Jul/2018, Published: 31/Jul/2018

***Abstract***— Dehazing plays a leading role in numerous image processing applications. The visibility of outside images is mostly questioned due to the presence of haze, fog, sandstorms, and other such factors. This paper presents that image dehazing is commonly used in many outside working arrangements. Fusion Based Variational Image Dehazing (FVID) technique that is grounded upon the fusion-based approach. Through white-balance along with a contrast improving technique, two images are deduced from the original hazy image which was blurry in the first place. The inputs that are created, along with their significant characteristics are sorted by computing three weight maps: luminance, chromaticity, and saliency, to areas that have greater visibility levels. These weight maps of the inputs are fused, generates haze free image. Experimental outcomes of an extensive range of hazy images validate that FVID is far better when it comes to preserving the structure of the image on regions that are close by and are less affected by the fog.

***Keywords***— Image Dehazing, Variational Image Processing, Fusion based weight maps, Degraded image, Contrast Enhancement.

## I. Introduction

Images that are clicked in outside locations are degraded on the basis of poor atmospheric conditions. In such cases, atmospheric factors such as fog and haze deteriorates the discernibility of the taken image. Dehazing is needed in computerized vision applications and also in computational photography. Eliminating the haze layer from the input hazy image can considerably elevate the visibility levels of the image. The job of eliminating haze degradation within an image is called image dehazing, and has lately been an important area of research [1].

Bearing in mind that aerosol becomes hazy due to extra particles, portions and distant objects becomes more undetectable within the image, and the reflected light is spread over which further washes out the colours and is differentiated by decreasing contrast. In the last few years an increasing amount of attention has been given to the restoration of images that are captured in particular conditions [2]. Due to an increasing amount of outdoor applications, this task is becoming extremely significant including Surveillance, Intelligent Vehicles, Remote Sensing, Object Recognition and. In different methods of remote sensing, the recorded bands of the reflected lights are processed, so outputs can be recharged. This image dehazing issue is fixated with the help of Multi-image methods through that includes processing of numerous input images that are captured in diverse range of Environmental conditions [3].

Image fusion is a well-researched area or field of knowledge and extensive researches are being carried on it in the present times. This method helps in blending input images by preserving atleast some features of these combined or blended output images. This work aims at developing and proposing an efficient and simple method in which all the fusion steps or stages are carefully planned and designed so changes can be made in the features of the input image. The main theory behind the fusion based model is that two input images are drawn from the original image so that visibility of some regions within the image can be retrieved in atleast one of the images. This technique that deals with enhancing some features of the image estimates one single pixel for the expected perceptual recognised attributes, also known as weight maps; influence the final output drawn from the input. In order to draw pictures that have optimum levels of visibility (good or better visibility in some areas of atleast one image from the two) is required during the fusion method. The mixture of both the bases of information through a fusion process directs to an acceptably dehazed output that is free from enhancement articrafts.

The main objective of this image that is drawn from the fusion process is to form an image to fulfill some requirement. This goal can be attained by processing the number of images which are taken from different cameras or from the same camera based on some property. The image fusion technology can produce a new remote sensing image by processing the multiple remote sensing images of the various platforms and cameras which have same target, which contains the features and information of both input images [4]. The latest fused image can offers more inclusive information; therefore, it provides technical support for the analysis and extraction of remote sensing information. It has become a key technology for Remote sensing Images. This task of reducing haze levels within the image is called as image dehazing, and has been a significant area of research in the concurrent times. Some of the main methods used for reversing or eliminating haze degradation, include Koschmieder's atmospheric scattering just to name a few[5].

$$I(x) = t(x)J(x) + \left(1 - t(x)\right)A \qquad (1)$$

Here, x represents a pixel location, I(x) is the observed intensity, J(x) is the scene radiance of a haze-free image, t(x) is the emission of light in the air, inversely related to the dept of the scene, and A is the airlight, a global vector quantity that is used to represent the ambient light.

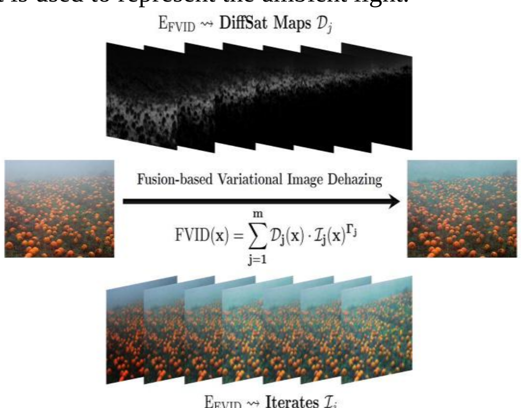



Fig.1. Schematic demonstration of the three steps involved within the FVID technique.

In spite of optimal dehazing abilities of (1), it now and then generates overenhanced outcomes, see fig. 1. However, each generated iterate indirectly transmits some valuable bit of information in relation to the degree or level of enhancement required by each region. This research leads to the development of a technique or method that can be used to draw or extract info such as the progressive difference-of-saturations (DiffSat) maps. After drawing these maps, we can incorporate them for designing and planning the fusion process that helps in blending the Enhanced Variational Image Dehazing (EVID) into a single image, by retaining the viable visual information at each depth of the input layer only.

This paper Section I contains the introduction of related work , Section II contain the related work of previous papers , Section III contain the methodology, Section IV contain the results and discussion, section V contains the conclusion and future scope.

## II RELATED WORK

Dr. H.B. Kekre et al. offered an rating on image fusion methods and execution analysis parameters. Basically image fusion means to contain information that is attendant from different resources into one image that is fresh. The thought is to reduce redundancy and uncertainty in the output while optimise useful information specific to a task or an application [6].

Sahu ,et al. (2012) commend a model for haze removal with colour conservation. Firstly the image is converted from RGB to YrCr. Then key observation and strength of image is computed [7].

## III. METHODOLOGY

Draw two input images from the original image. The main reason behind this is to improve the visibility in all region or areas of the scene in atleast one of the two images (a) First input will be drawn with the help of the white balancing process, (b) the second input will be drawn with the help of the contrast enhancement method, (c) Now compute 3 weight maps for these input images which includes luminance, chromaticity and saliency and the weight of these drawn inputs is normalized by these 3 weight maps, (d) Now apply the multi-scale fusion, by incorporating the Laplacian pyramid delegation for the image inputs which are then combined or blended along with gaussian pyramids that have normalized weights , so that haze can be eliminated from the images.

In the fusion process again the following steps can be carried out .They are as follows

- Weight maps
- Multiscale Fusion
- Gaussian Pyramid
- Laplacian Pyramid

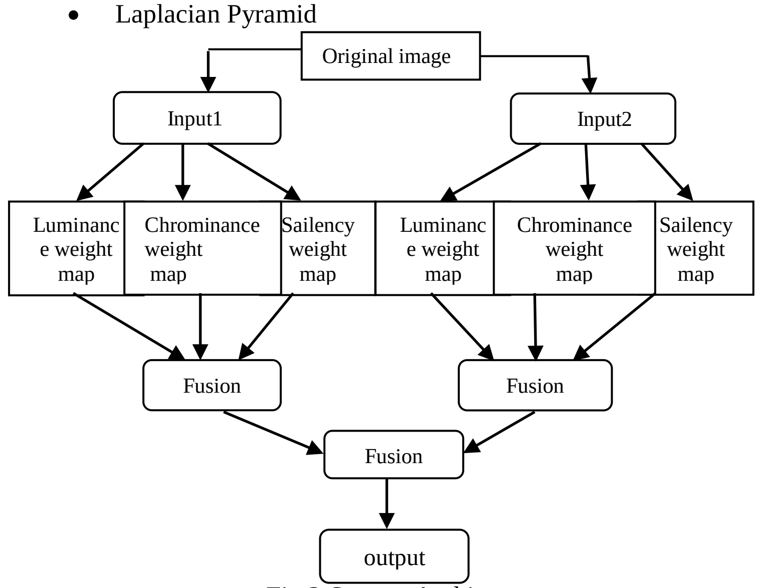



Fig 2:System Architecture

***Weights maps***

Weight maps can be defined as the tool that helps to preserve the regions or areas that have better levels of discernibility in the image. The image inputs are weighted with the help of these weight maps.

***Luminance weight map*:** It helps in computing the visibility levels of each pixel and allocates high values to areas that have greater visibility levels and minor values to the rest of the areas or regions in the image. Luminance weight map is computed with the help of a divergence that takes place between the RGB colour channel and luminance from the image.

***Chromatic weight map*:** this type of weighted map handles the saturation gain levels within the output image. The chromatic weight map is than computed as the distance present between the saturation value and the highest saturation level within the range. Hence minor values are allotted to the pixels that have low saturation levels or degrees whereas the pixels that have high saturation levels or degrees are allotted higher values to the pixels

***Saliency weight map*:** This map measures the degree of salience levels along with info that is relevant to the neighbourhood regions. Visual saliency is what makes an individual, item or pixel stand out in comparison to its neighbours and thus, gets the maximum amount of attention. For different applications like adaptive compression, object segmentation and object recognition detection for images that have visually salient regions or areas play a vital role.

***Gaussian pyramid*:** The basic purpose of the Gaussian pyramid is to decompose the information within the image at different scales, so that the structures or some features within the concentrated region or areas can be extracted and noise can be reduced within the image.

a) Start the process within an original image$g_0$.

b) Now apply a low pass filter on the original image so that a reduced or decomposed image can be generated.

c) Now the image is “reduced” so that spatial density and resolution of the image can be reduced.

d) This process is initiated so that a group or set of images such as $g_0, g_1, g_2, \dots g_n$ can be configured to arrange a pyramid image structure.

***Laplacian pyramid***:

Clustering the laplacian pyramid is an arrangement of images that are error based such as $L_0, L_1, L_2, \dots L_n$ in a manner that each error within the image is a deviation within the two elevations (levels) of the Gaussian pyramid.

The method or technique to do this is,

a) Firstly increase the level of the top pyramid, $L_n$.

b) Now enhance extended version to $L_n$-1 to form $g_n$-1.

c) This process is repeated until the base of the pyramid is replicated for each level, so that the original image can be mended completely. We can consider the topmost image of the pyramid as an error image $L_n : g_n = L$, since the top of the pyramid does not have an error based image [6].

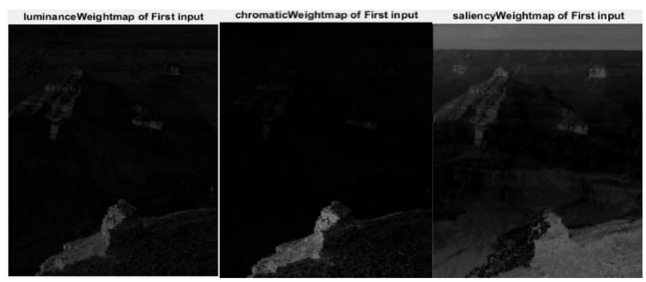
## IV. RESULTS AND DISCUSSION

Original Hazy image is set as input to the MATLAB Program, By Enhancing procedure it produces first and second inputs. Generating inputs computes Luminance, Chrominance, Saliency Weight maps. These weight maps are combined together to get a dehazed image.

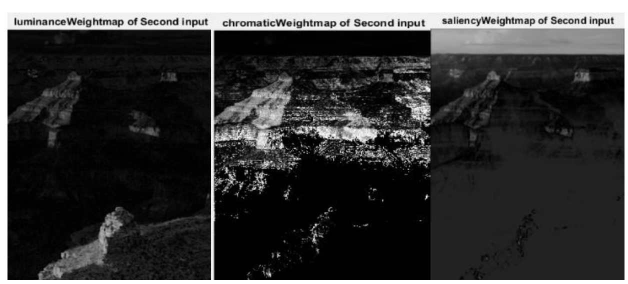
Fig.3 Original hazy image

a) Frist input

b) second input



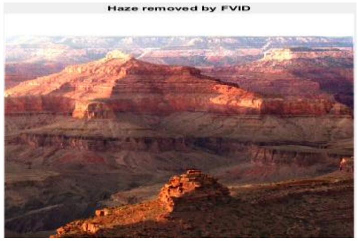

c) Weight maps of first input




d) Weight maps of Second input

The above Shown Fig.3 c), d) are the Luminance, Chrominance, Saliency weight maps of first and second inputs.

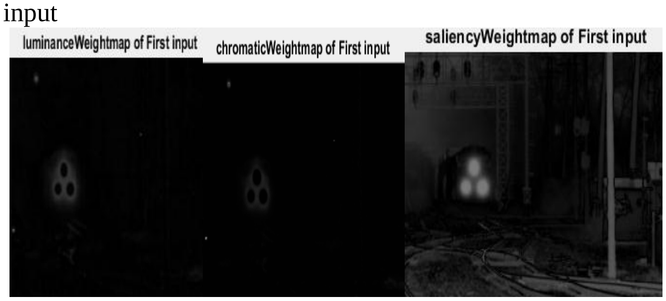



e) output image.

This is the Fusion based dehazed image.The entire process is generated in MATLAB code.

Fig.4 original hazy image

a) First input b) second input

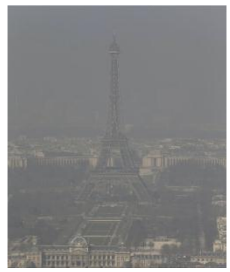


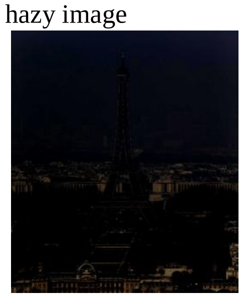

d)weight maps of first input


e) Weight maps of second input


e) Output image

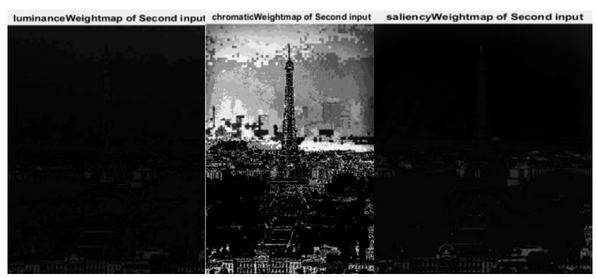
FIG.5 Original hazy image



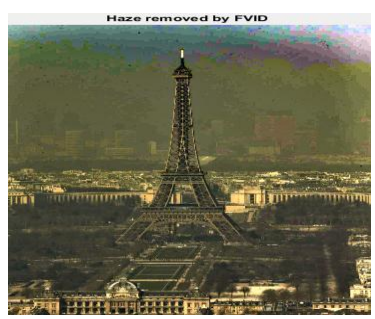


a) First input b) second input


c) Weight maps of First input




d) Weight maps of second input




e) output image

Parameter values for different images can be shown in Table1.

TABLE1

| Parameters | Fig3 | Fig4 | Fig5 |
|---|---|---|---|
| Gray scale | 0.5364 | 0.5156 | 0.4824 |
| MSE | 2.0621e+04 | 1.8082e+04 | 1.5163e+04 |
| PSNR | 40.0435 | 41.1849 | 42.7141 |
| SNR | 84.85259dB | 72.76182dB | 106.00287dB |
| SSIM | 0.0047 | 0.0057 | 0.0049 |

## V .CONCLUSION AND FUTURE SCOPE

This paper validates that hazy images can improve swiftly by manipulating or exploiting the fusion-based stratagem. Findings indicate that by selecting an appropriate and standard weight map and input, images can dehaze effectively with the help of fusion approach. The process that the researcher has designed is a multi-resolution method that backs the objects and is robust in nature. This Fusion based dehazing process, draws 2 input images from the original image. The first input is attained through white balance operation activity that takes place on the original image. White balancing is a very significant stage of the process that helps in increasing the 4overall appearance of the image by removing the colorcasts that are redundant and appear due to frequent illuminations. The weight maps aim to support the regions that have optimum discernibility factor. Furthermore this approach is planned for hazy videos in a Multiscale-Fusion manner which would be discussed in future researches. As an addition to this approach Koschmieder's Atmospheric Scattering model is being incorporated for image dehazing.

## REFERENCES


[1] Adrian Galdran, Javier Vazquez-Corral, David Pardo, and Marcelo Bertalm´ıo" Fusion-based Variational Image Dehazing" IEEE SIGNAL PROCESSING LETTERS, VOL. N, NO. N, MAY 2016

[2] Codruta Orniana Ancuti and Cosmin Ancuti single image dehazing by multi-scale fusion ieee transactions on image processing, vol. 22, no.8, august 2013.

[3] Dr. H.B. Kekre et al. review on image fusion techniques and performance evaluation parameters International Journal of Engineering Science and Technology (IJEST) Vol. 5 No.04 April 2013.

[4] Ma, Z., Wen, J., Zhang, C., Liu, Q., & Yan, D. (2016). An effective fusion defogging approach for single sea fog image. Neurocomputing, 173, 1257-1267.

[5] H. Koschmieder, Theorie der horizontalen Sichtweite: Kontrast und Sichtweite. Keim & Nemnich, 1925.

[6] Neha Padole1, Akhil Khare2"Improved Method of Single Image Dehazing based on Multi-Scale Fusion" Neha Padole et al, (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 6 (3) , 2015, 2945-2949.

[7] Nicy Johnson, Afrah Abdul Kader ,Jiss Paul#3, Shemil PS, Rizwana A "Haze Removal using Colour Attenuation prior" International Journal of Computer Trends and Technology (IJCTT) – Volume 48 Number 2 June 2017.


## Authors Profile


***Billa Jyothi*** completed B.TECH from SKUniversity, Anantapur. Currently pursing Master of technology in Digital Electronics and Communication Systems from JNTUA College of Engineering Pulivendula.

***Dr. Chandra Mohan Reddy Sivappagari*** is currently working as Associate Professor of ECE, JNTUA College of Engineering Pulivendula, Andhra Pradesh, India since 2006. He is a member of IEEE, life member of IE (I), ISTE and IAENG. He has published more than 40 research papers in reputed both in international and national journals and conferences. His main research work focuses on Signal & Image Processing and Internet of Things. He has 17 years of teaching experience and 8 years of research experience.