"TRANSFORMATION AND RESTORATION OF SATELLITE IMAGES USING GIS BASED TECHNIQUE"

Project report Submitted in partial fulfillment of the requirements for the degree of

Bachelor of Technology

In

Computer Science and Engineering/Information Technology

By

Riya Sharma (161367)

&

Tikshika Gupta (161360)

Under the supervision of

Dr. Himanshu Jindal

to

Department of Computer Science & Engineering and Information Technology

Jaypee University of Information Technology Waknaghat, Solan-173234

Himachal Pradesh

CERTIFICATE

CANDIDATE'S DECLARATION

I hereby declare that the work presented in this report entitled **"TRANSFORMATION AND RESTORATION OF SATELLITE IMAGES USING GIS BASED TECHNIQUE"** in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology** in Computer Science and Engineering/Information Technology submitted in the department of Computer Science & Engineering and Information Technology, Jaypee University of Information Technology Waknaghat is an authentic record of my own work carried out over a period from August 2019 to December 2019 under the supervision of **Dr. Himanshu Jindal**, Assistant Professor, Computer Science Department, Jaypee University of Information Technology, Waknaghat.

The matter embodied in the report has not been submitted for the award of any other degree or diploma.

Riya

Riya Sharma (161367)

Tikshika Gupta

Tikshika Gupta (161360)

This is to certify that the above statement made by the candidate is true to the best of my knowledge.

Himanshu Jindal

Dr. Himanshu Jindal

Assistant Professor

Computer Science and Engineering/Information Technology

Dated:

ACKNOWLEDGEMENT

I take upon this opportunity endowed upon me by grace of the almighty, to thank all those who have been part of this endeavor.

I would like to thank my supervisor **'Dr. Himanshu Jindal'** for giving me the right direction to follow and proper guidance regarding the topic. Without their active involvement and the right guidance this would not have been possible.

I sincerely thank our Head of Department **'Prof. Satya Prakash Ghrera'** for giving me the chance as well as the support for all the time being.

Last but not the least, I heartily appreciate all those people who have helped me directly or indirectly in making this tasks a success. In this context, I would like to thank all the other staff members, both teaching and non-teaching, which have extended their timely help and eased my task.

ABSTRACT

In today's digital world an image is defined as digital image. There are different techniques that we can apply on image, image dehazing is one of the important technique among them. This research first of all studied the various processes that can be applied on the images namely: Compression, Watermarking, Contrast Equalization, De-hazing and Enhancement. Image dehazing is taken up for consideration that uses single dehazing approaches like Independent Component Analysis, Dark Channel Prior, and contrast specific; among fast dehazing techniques like Tan's, Fattal and Dark Channel Prior methods. The second step in the research moved to the case study of DCP and fusion techniques along with the advantage and disadvantages of each and every technique of fusion. In this thesis, a strategy has been proposed using Dark Channel Prior and Fusion. DCP is a technique which uses dark channel prior for haze removal from images. The dark channel prior is a sort of measurements to produce open-air fog-free pictures. It underlines the key perception that open-air pictures have a few pixels with low power. This suggests pixels are dull and hard to see with the natural eye. A good quality haze-free image is generated and the technique also estimates the thickness of the image. This method creates top notch profundity map that gives the great estimation of transmission. The downside of DCP is that when articles are like environmental light and no shadow is shaped then this method creates brilliance with lower force. After performing DCP, different fusion techniques have been applied. Fusion is a process that merges the two different input images to produce single output. The new single picture holds significant data from each info picture. Picture combination is an incredible asset used to build the nature of picture. Picture combination builds unwavering quality, diminishes vulnerability and capacity cost by a solitary enlightening picture than putting away various pictures Image combination can happen at three distinct levels pixel, feature and decision level. Pixel level further divided into various fusion methods as Minimum, Maximum, Average, IHS, PCA and Brovey. In the final result, we obtain different images by DCP and fusion techniques. The resultant images provide much better result as compare existing techniques.

CONTENTS

ABBREVIATIONS

DCP	*Dark Channel Prior*
ICA	*Independent Component Analysis*
GIS	*Geographic Information System*
PAN	*Panchromatic*
PCA	*Principal Component Analysis*
IHS	*Intensity Hue Saturation*
PSNR	*Peak Signal-to-Noise Ratio*
MS	*Multi Spectral*

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1 – INTRODUCTION

1.1 Introduction

An image or digital image is a representation of visual information. An image is a picture that has been made or copied and stored in electronic form. An image can be described by a two-dimensional array arranged in rows and columns. A digital image is composed of a set number of segments, all of which parts have a particular value at a particular location. These elements referred to as picture elements, image elements, and pixels. A pixel is most broadly used to denote the components of a digital image.

1.1.1 Types of Images

- **Binary Image:** These types of images take discreet values (0 or 1). Since only two values are taken, hence they are called binary images. The Black color is denoted by 1 and white color by 0.
- **Grayscale images:** These images do not represent any color and are called monochrome images. They only state the level of brightness for one color. They consists of only 8 bytes. 0 denotes black and 255 represents white and in between are various levels of brightness.
- **Colored images:** These images contain three bands namely red, green and blue. The intensity of all the three bands is 8 bytes. The various intensity levels in each band convey the entire colored image. The size of the colored image is 24 bits.

1.1.2 Image Processing

There are certain activities which we can perform on an image so that we can get more information or to isolate some information or to get improved picture. The technique is called Image Processing. It is a kind of signal handling wherein input is an image and yield may be picture or characteristics/features identified with that image. Image processing includes three steps

1. Acquisition tool – to import image

2. Image analysis and manipulation
3. Output – image or report analysis

The Digital Image Processing methods have many advantages such as versatility, repeatability and the preservation of original data. The different Image Processing techniques are[1]:

- **Image segmentation:** Segmentation is one of the key problems in image processing. Image segmentation is the process that subdivides an image into its constituent parts or objects. The level to which this subdivision is carried out depends on the problem being solved, i.e., the segmentation should stop when the objects of interest in an application have been isolated e.g., in autonomous air-to-ground target acquisition, suppose our interest lies in identifying vehicles on a road, the first step is to segment the road from the image and then to segment the contents of the road down to potential vehicles. Image thresholding techniques are used for image segmentation after [1].
- **Image preprocessing:** In image preprocessing, image data recorded by sensors on a satellite restrain errors related to geometry and brightness values of the pixels. These errors are corrected using appropriate mathematical models which are either definite or statistical models. Image enhancement is the modification of image by changing the pixel brightness values to improve its visual impact. Image enhancement involves a collection of techniques that are used to improve the visual appearance of an image, or to convert the image to a form which is better suited for human or machine interpretation sometimes [1].
- **Image enhancement:** Image enhancement is concerned with the modification of images to make them more suited to the capabilities of human vision. Regardless of the extent of digital intervention, visual analysis invariably plays a very strong role in all aspects of remote sensing. Typical image enhancement techniques include gray scale conversion, histogram conversion, color composition, color conversion between RGB and HSI, etc., which are usually applied to the image output for image interpretation [2].

- **Image restoration:** Image restoration is a method through which a corrupted and noisy image is processed in such a way that a perfect image is constructed. Thus, restoration rebuilds those images whose quality is despoiled due to noise or system error. There are various causes for degradation such as noise from the sensor, camera miss focus and atmospheric disturbance [3].

- **Image transformation:** Image Transformation is the process of derivation of new imagery as a result of some mathematical treatment of the raw image bands. Digital Image Processing offers a limitless range of possible transformations on remotely sensed data [2].

- **Feature extraction:** The feature extraction techniques are developed to extract features in synthetic aperture radar images. This technique extracts high-level features needed in order to perform classification of targets. Features are those items which uniquely describe a target, such as size, shape, composition, location etc. Segmentation techniques are used to isolate the desired object from the scene so that measurements can be made on it subsequently. Quantitative measurements of object features allow classification and description of the image [1].

1.1.3 Techniques applied on Images

Following are the few techniques that can be applied on images in the digital world.

1. **Watermarking:** Watermarking system is utilized to install a mystery or secret code into the advanced image. This mystery code is known as watermark. This is also known as watermark embedding process. In image watermarking system, mystery image is covered up by a cover image. A key is utilized for security reason. To keep information from unapproved access, recuperation and control, watermarking technique is utilized.
2. **Zooming:** To enlarge an image zooming technique is used. With a specific end goal to get the detail of an image, for example, more perceivability and clarity, zooming is done. Diverse addition strategies are utilized to perform zooming. In this, pixels are controlled to develop required segment of an image. Due to zooming of an image, the quality of an image decreases.

3. **Histogram Equalization:** Histogram Equalization usually enhances the contrast of an image, particularly when the usable information of an image is characterized by close contrast values. Through this arrangement, the intensity or power can be scattered on the histogram. This considers ranges of lower nearby complexity to pick up a higher contrast. Histogram leveling achieves this by adequately spreading out the most regular force values.
4. **Compression:** The extent of various media documents like pictures, sound records and video documents is decreased by using compression. In images, to create a compressed image from original image a particular algorithm is used. In storage media, vast amount of memory can be engaged by uncompressed images. It requires more amounts of time and investment to exchange images of extensive size starting from one device to another device.
5. **Dehazing:** The clarity of images of outside scenes is spoiled or debased by dreadful atmosphere conditions[4]. Altogether the clarity of the caught image is diminished by the air wonders like fog and mist. This is known as hazing impact that debases the clarity of the images. In region of advanced image handling to expel or remove the impact of haziness and to upgrade the clarity of the caught images is an extremely difficult assignment. In both customer photography and PC based applications dimness expulsion or dehazing is highly desired for the upgrade of images that are taken under poor clarity or bad atmosphere conditions and it has been a great challenge undertaking particularly when just a solitary/single spoiled or debased image is accessible[5]. Numerous researches have been dedicated on the issue of how to get the brilliant de-hazed image from the previous decades[6]. There are two dehazing approaches that are utilized to expel or remove the fog impact and to get the dimness free image. In the primary dehazing approach, from the distinctive atmosphere conditions different images of the same scene have been taken[7]. In any case, this methodology requires particular equipment and other extra data, for example, profundity or depth map[8]. This methodology for the evacuation of dimness is problematic on account of the inaccessibility of the extra data to the clients. The second approach of the fog evacuation depends on single image and it requires a solitary/single

input image. This methodology relies on the true presumptions and then again the method for the scene and recovers the scene information or data considering the earlier information or data from a solitary image. There are various types of dehazing approaches, mainly these categorized into two: single image dehazing and fast image dehazing categories.

1.1.4 Comparison among Dehazing Approaches

In this area, a general examination between physically based approaches and contrast based approaches. In Physical based approaches the first one is ICA, this methodology is physically good and can make magnificent results, however it might be tricky since it doesn't work decently for thick cloudiness. The second approach is DCP that uses delicate soft matting system to recoup a fantastic shadiness free image. The last one is the Bayesian probabilistic that resolves the bi-linear ambiguity. Contrast based approaches boost the visibility of the degraded images by restoring the contrast of the debased images and also the contrast based images upgrades the images without using the additional information such as depth map. A general comparison between the fast dehazing approaches. The main aim of the Tan's strategy is to only increase the contrast of the images. The Tan's strategy lacks of color fidelity. Fattal's strategy reduces the color fidelity but it fails to perform well especially in thick haze regions. DCP strategy is easy to implement, accurate and quite simple. DCP strategy provides good results with the dense haze in lowest execution time than Tan's and Fattal's strategy.

Table 1.1: Comparison among different Image Dehazing Approaches

Approach	**Author**	**Advantages**	**Disadvantages**
Independent Component Analysis	R. Fattal[9]	•It valid physically. •It produces good result.	•It enables to recover in-put images covered with dense haze.

Dark Channel Prior	K. He *et al.*[10]	•It obtains high quality depth map. •Thickness of the can be directly estimated by it.	•It doesn't provide accurate result when scene objects are of same color as airlight does. •It doesn't well for sky regions.
Tan's Strategy	Tan, R. T.[11]	•It is able to handle both colored and grayscale images. •No geometrical structure is required of an image.	•It produces halos and artefacts in an output image. •It doesn't provide the accurate value of airlight.
Fattal's Strategy	R. Fattal[9]	•It removes theambiguity present in the input data. •It is able to handle different types of hazy images.	•Quality of the source images directly affects its performance. •Obtained image is little blurred due to atmospheric scattering.
Contrast Based Approach	Tan, R. T.[11]	•It improves the visibility of the scene. •It enhances the brightness of the scene.	•It doesn't valid for physically. •It produces halo effects in the output image.

1.1.5 GIS Technique

The Geographic Information System (GIS) is a computer-based framework for storage, analysis, and show of geographic information. GIS is used for making and keeping up databases of data ordinarily shown on maps. These databases are spatially situated, the principal incorporating components being their position on the world's surface. This framework comprises of a lot of automated apparatuses and techniques that can be utilized to successfully encode, store, recover, overlay, correspond, control, examine, inquiry, and show land-related data[2].

Advantages of GIS Technique:

- It can improve dynamic trade-off. GIS would then combine programming, equipment, and besides information so as to get, take a gander at, direct thusly show a wide scope of data that are geologically referenced.
- GIS would in like way permit see, having a tendency to, getting, imagining and making an elucidation of the information into various ways which will uncover affiliations, models, and models as globes, maps, structures, and reports.
- Geographic Information System is to give assistance with responding to demand comparatively as manage issues by taking a gander at the information in a manner that is effectively and immediately shared.
- GIS advancement could in like way be joined into the structure of any undertaking data framework.
- In addition, there would be numbers of employment opportunities.

Disadvantages of GIS Technique:

- GIS innovation may be considered as costly programming.
- It additionally requires enormous information input total that is should have been practical for some different assignments thusly the more information that is to placed in.

1.1.6 Application of Images

- The application area of digital image includes image sharpening and restoration in which image enhancement techniques are used.
- Medical field that includes gamma beam imaging, PET scan, X-ray imaging, UV imaging.
- The other application areas are transmission and encoding that is used for security purpose in which one image is hidden over the other image and the technique is called as watermarking.

- Machine robotic in which hurdles are detected by the robotic machine.
- The next is color processing that incorporates handling of hued/colored images and distinctive shading spaces.
- Pattern recognition that is used in artificial intelligence.
- The video processing as a new application area is used for capturing the frames per minute and to reduce the noise reduction.

1.2 Problem Statement

- From the previous barely any decades, the picture dehazing process has not given a superior quality picture.
- No effect removal of fog and blurriness.
- No proper working for contrast images.
- The dehazed picture doesn't give appropriate data.
- Image re-colorization isn't quite certain.
- Image may get twisted as the high recurrence segments may get lost.

1.3 Objectives

The main aim of this research is to propose a new image dehazing technique which provides a better quality image within a short span of time despite of the fact that it should undergo various steps of enhancements that includes existing techniques of dehazing and methods of interpolations. Few Researchers have successfully implemented various techniques to provide dehazed image but there are no signs of improvement in terms of color, blurry, image size etc. The main objective is to provide a better quality dehazed image with less reduction in noise and blurriness.

- To enhance images quality.
- To get minutest details regarding the image.
- To enhance and implement the proposed techniques in railways during fog.
- To provide an image without any loss of information.

- To have interpolated zoomed image to understand unknown points.
- To provide an image that is free from blurriness and noise.
- To yield an image that possesses all the positive attributes in terms of visual clarity and amount of details present in the image.

1.4 Methodology

• **Single Dehazing / Fast Dehazing:** We have studied single dehazing techniques and fast dehazing techniques. Single dehazing techniques are of two types first one is physically based techniques which is further classified as ICA, DCP and Bayesian Probabilistic and second single dehazing technique is Contrast Based technique. Fast dehazing techniques are of three types they are Tan's method, Fattal's method and DCP. DCP is common in both of the dehazing techniques and it is considered as best technique ever due to its satisfactory results and performance.

• **Fusion Techniques:** Average, Maximum, Minimum, Intensity Hue Saturation, Principal Component Analysis and Brovey are used for constructing new data points within the range of a discrete set of known points of the two images. The fusion strategies are broadly used in combination with the dehazing so as to upgrade the given image without losing any details and to improve the quality of the image yielded.

• **Proposed New Technique:** With the previous ongoing techniques studied so far, a new technique would be developed to provide the dehazed images free from noisiness and blurriness. It would also be implemented and fused with another image of same area to know about the unknown points and to find the minutest details of the images.

• **MATLAB:** MATLAB toolbox is a tool for numerical computation and visualization. MATLAB is a programming language developed by Math Works. It started out as a matrix programming language where linear algebra programming was simple. It can be run both under interactive sessions and as a batch job.

• **Dehazed Image:** A dehazed image is obtained by the proposed technique and is further interpolated to get the details of the images.

CHAPTER 2 - LITERATURE SURVEY

- In [1], the author has reviewed the various techniques of image processing. There is an overview given of image processing techniques: preprocessing, image enhancement, image restoration, feature extraction, and classification techniques.

- In [3], the author discussed various image processing techniques like as representation, segmentation, compression, restoration etc. These techniques are used in several areas. The method we are choosing depends upon the application area.

- In [2], the author discussed about GIS technique and implications of image processing in GIS and remote sensing. The author also discussed some digital image processing techniques.

- In [10], the author have proposed a basic however powerful prior, the dark channel prior, for haze removal of single image. The prior depends on the insights of open air cloudiness free pictures. Using this prior with the fog imaging model, we can really check the thickness of the mist and recover a first rate cloudiness free picture. Results on a variety of foggy pictures show the power of the proposed before. Also, a first class significance guide can moreover be gotten as a reaction of mist removal. They have utilized van Herk's calculation to figure least channel and Preconditioned Conjugate Gradient for delicate tangling.

- In [12], the author have proposed a simple but powerful prior, the dark channel prior, for single image haze removal. The prior is based on the statistics of outdoor haze-free images. Utilizing this earlier with the fog imaging model, we can legitimately gauge the thickness of the fog and recuperate a top-notch murkiness free picture. Results on an assortment of foggy pictures exhibit the intensity of the proposed earlier. Besides, a top-notch profundity guide can likewise be gotten as a side-effect of fog expulsion. They perform local min operator using Marcel van Herk's algorithm and soft matting using PCG algorithm. They observed that it may not work for some particular images.

- In [13], author characterized another kind of channel that shares the property of edge-preserving smoothing. They proposed a novel kind of channel – guided channel. Utilizing this earlier with the murkiness imaging model, we can genuinely quantify the thickness of the dimness and recoup a top notch dirtiness free picture. Results on a plan of foggy pictures show the power of the proposed previously. What's more, a top of the line hugeness guide can additionally be gotten as a response of murkiness evacuation.

- In [9], the author presented optical transmission evaluation strategy in foggy scenes given a solitary info picture. In view of estimation, the dispersed light is wiped out to expand scene perceivability and recuperate cloudiness free scene contrasts. In this new approach, they detailed a refined picture development model that records for surface concealing notwithstanding the transmission work.
  This enables them to determine ambiguities in the information via looking for an answer in which the subsequent concealing and transmission capacities are locally measurably uncorrelated. A comparative rule is utilized to assess the shade of the cloudiness.
  Results show the new strategy capacities to evacuate the dimness layer just as give a solid transmission gauge which can be utilized for extra applications.

- In [14], the author The principal study case thinks about the issue of the synthetic aperture radar (SAR) interferometry, where a couple of reception apparatuses are utilized to get a height guide of the watched scene; the subsequent one alludes to the combination of multi-sensor and multi-fleeting (Landsat Thematic Mapper and SAR) pictures of a similar site procured at various occasions, by utilizing neural systems; the third one exhibits a processor to intertwine multi-frequency, multi-polarization and multi-resolution SAR pictures, in view of wavelet change and multi-scale Kalman channel (MKF).

- In [15], the author reviews some popular fusion methods, particularly at the pixel level. Notwithstanding surveying various techniques, shifted approaches for evaluation of intertwined item are additionally introduced. A significant spotlight is on the pixel level remote detecting picture combination. The researched procedures are arranged in four unmistakable classes: CS, MRA, crossover, and model-based strategies.

- In [16], the author explores the significant remote detecting information combination systems at the pixel level and surveys the idea, principals, impediments and favorable circumstances for every method. This paper concentrated on customary methods like intensity-hue-saturation-(HIS), Brovey, Principal Component Analysis (PCA) and wavelet.

- In [17], the author has explained and demonstrated some basic features of the image processing toolbox with the help of the satellite image. The image processing tool kit has broad capacities for some activities like image restoration, enhancement, and information extraction.

- In [18], the author describes the fundamental aspects of digital image processing with unique reference to satellite image processing. Thus, destroying the satellite picture they emptied information which has brought vital terminations, which reveals how picture planning can be moved.

- In [19], the author has reviewed various techniques for image processing. They conclude advantages and disadvantages for each technique. They found that the PCA technique has a good spatial resolution. They have also described the wavelet based image fusion.

- In [20], the author examined the commitment of picture preparing methods to improve intellectual procedures, get vector information and bolster basic leadership. Additionally, the issue of information the executives are tended to and the various methods for information joining are talked about. The paper is centered on the likelihood to help our choices utilizing GIS and information database in blend with raster situated propelled techniques to procure, break down and assess information.

- In [21], the author the maker has proposed has proposed a particularly clear and fit as far as possible encoder and decoder structure for picture dehazing utilizing a convolution neural system. The start to finish encoder model exhausts the impediments found in the dehazing method. The evaluations were done on the standard datasets. The proposed strategy gives the best and productive outcomes over past outcomes utilizing high-power pixel respect

CHAPTER 3 – SYSTEM DEVELOPMENT

3.1 Dark Channel Prior

3.1.1 Background

In computer graphics, the basic method to generate simple image formation model:

$$I(a) = J(a)t(a) + A(1 - t(a)) \tag{3.1}$$

where I denotes to the input image(Hazy Image), J denotes to the output image(Haze free image), A denotes to the atmospheric light, a denotes to the pixel value at each location and t denotes to the transmission media(The way to transfer data).

From these all we have to recover A, J, and I. On the right side of the Equation(2.1), the first term J(a)t(a) represents the direct attenuation and the other term A(1-t(a)) represents the airlight. We have to find final output (J) from the equation by estimating airlight (A(1-t(a))) and transmission media(t). For homogenous environment, the transmission t can be represented as:

$$t(a) = e\ {-\beta d(a)} \tag{3.2}$$

3.1.2 Dark Channel Prior

Dark Channel Prior is use to remove the haze from the outdoor images and it is based on statistics. It is based on some key observations that at least one color channel has low intensity values at some pixels of non sky patches. We define J for an image as:

$$J^{dark}(a) = min_{c\varepsilon(r,g,b)}\ (\ min_{y\varepsilon\Omega(a)}(J^{c}\ (b))) \tag{3.3}$$

where, the color channel of J is J c and local patch is Ω(a). The dark channel of J is J^{dark} and we call this observation as dark channel prior. Shadows, colorful objects and dark objects are the three main reasons of the low intensity in dark channel.

3.1.3 Haze Removal Using Dark Channel Prior

3.1.3.1 Estimating the Transmission

Transmission is a medium by which the light transmit from human eye to object. A patch transmission is represented as t(a). Here, we suppose the atmospheric light A is given and transmission is constant in a local patch. We perform min operator removal of haze from input image Equation(2.1).

$$min_{b\varepsilon\Omega(a)} \ (I^c\ (b)) = t\tilde{}(a)min_{b\varepsilon\Omega(a)}\ (J^c(b)) + (1-t\tilde{}(a))A^c \qquad (3.4)$$

On three color channels, the min operator performed independently. It is equals to:

$$min_{b\varepsilon\Omega(a)}\ (\ I^c\ (b)\ /\ A^c\ ) = t\tilde{}(a)min_{b\varepsilon\Omega(a)}\ (\ J^c(b)\ /\ A^c\ ) + (1-t\tilde{}(a)) \qquad (3.5)$$

At that point, we apply min procedure on three color channels on the above condition and get:

$$min_c(\ min_{b\varepsilon\Omega(a)}\ (\ I^c(b)\ /\ A^c\ )) = t\tilde{}(a)min_c(\ min_{b\varepsilon\Omega(a)}\ (\ J^c\ (b)\ /\ A^c\ ))+ (1-t\tilde{}(a)) \qquad (3.6)$$

As per the DCP, the part of haze-free radiance J i.e. the dark channel J dark seems to be zero:

$$J^{dark}(a) = min_{c\varepsilon(r,g,b)}(\ min_{y\varepsilon\Omega(a)}\ (J^c\ \ (b))) = 0 \qquad (3.7)$$

And Ac is always positive, this seems to:

$$min_c(\ min_{b\varepsilon\Omega(a)}\ (\ J^c(b)\ /\ A^c\ )) = 0 \qquad (3.8)$$

Putting Equation(2.8) into Equation(2.6), we get the transmission t by:

$$t\tilde{}(a) = 1-min_c(\ min_{b\varepsilon\Omega(a)}\ (\ J^c(b)\ /\ A^c\ )) \qquad (3.9)$$

In sky regions, usually the sky shading is fundamentally the same as climatic light A in a hazy picture and we have:

$$min_c\ (\ min_{b\varepsilon\Omega(a)}\ (\ J^c(b)\ /\ A^c\ )) \rightarrow 1,andt\tilde{}(a) \rightarrow 0$$

Here, we alternatively save a limited quantity of fog for far off items by putting steady parameter ω(o < ω <= 1) into Equation(2.9):

$$t\tilde{}(a) = 1-\omega min_c\ (\ min_{b\varepsilon\Omega(a)}\ (\ J^c(b)\ /\ A^c\ )) \qquad (3.10)$$

We fix the value of ω is 0.95 and it is accurately modified the Equation(9) and provide the better depth map.

3.1.3.2 Soft Matting

Image matting equation similar to haze imaging Equation(2.10). An alpha map is same as transmission map. We use soft matting to refine the transmission map[22] refined transmission map is denoted as t(a). t˜(a) and t(x) modify in vector structure as t and t. minimization of cost:

$$E(t) = t^T Lt + \lambda(t - t\tilde{})^T(t - t\tilde{}) \qquad (3.11)$$

Here, Latting Laplacian matrix is L and Regularization parameter is λ. First term is spoken to as smooth term and second is information term. Matrix L's elements(x,y) defined as:

$$\sum_{k|\,(x,y)\in wk} \left(\delta xy - \frac{1}{wk}\left(1 + (Ix - \mu k)\left(\sum_k + \frac{\varepsilon}{wk} U3\right)^{-1} (Iy - Uk)\right)\right) \qquad (3.12)$$

For input image I, I_x and I_y are the colors at each pixels x and y, Kronecker delta is δ_{xy}, mean and covariance matrix of the colors in window wk is μk ,U3 We solve sparse linear system to get optimal value of t by:

$$(L+\lambda U)t = \lambda t\tilde{} \qquad (3.13)$$

Here, U is identity matrix having same size of L. t is softly constrained by t because we take small size value of λ.

3.1.3.3 Recovering Scene Radiance

As the scene radiance can recovered very easily by Equation(2.1). But when the transmission t(a) is zero the direct attenuation would also close to zero. So suppose a small amount of haze present in transmission t(a) that restrict as lower bound t0 that recovered the final radiance:

$$J(a) = I(a)-A / max(t(a),t_0) +A \tag{3.14}$$

The value of t_0 is 0.1. The image looks dim after dehazing because scene radiance is not bright as the atmospheric light[23]. So, increase the value of J(a).

3.1.3.4 Estimating the Atmospheric Light

Airlight scatters the light and produces a hazy image. It can be automatically estimated. For example, highest intensity pixels seem as atmospheric light, can be removed very easily[24].

3.2 Image Fusion Techniques

There are three levels of image fusion which are pixel level, feature level and decision making level[25]. Pixel level image fusion is related to the pixel location which combines the visual information from input images into single image based on the original pixel location[26]. Feature level image fusion use various features like regions or edges and combines source images according to these features to form a fused image[27]. Decision level fusion techniques merge image details directly such as in the form of relational graphs[28]. Pixel level fusion preserves more significant information as compare to feature level and decision level fusion[29]. The different types of image fusion are given as below:

1. **Minimum:** This method is used to pick up the pixels from input images with the least intensity value and derive the final fused image with minimum intensity[30]. It is very simple. Lowest intensity pixels are selected from the input image and assigned to the pixel value of the output image. Selected lowest pixel values (intensity) from input images are assigned to the corresponding pixel values of the output image. This method produces the least focused output image. Only the least pixel intensity is considered.

2. **Maximum:** This is similar to minimum method. But here, pixels with highest intensity value have been picked up to produce final image[31]. Highly focused output image is produced. Only high intensity pixels are considered.
3. **Average:** Unlike minimum and maximum method here, we get average value of pixels by adding all the pixel values of the input images divided by number of images. In this both good quality and bad quality pixel values have been merged. That's why the final output image doesn't provide the accurate result.
4. **Principal Component Analysis:** Principal component analysis is a transform of spatial domain method. It is used to multidimensional data sets to lower dimension for the analysis purpose. Uncorrelated variables transformed by correlated variables are called principal components. PCA is used to compute compact and optimal description of datasets. Image compression and classification techniques performed by principal component analysis. Principal component analysis applies linear algebra to fuse input images. Input images arrange into column vectors and calculate empirical mean for each column. Final fusion has done by calculate Eigen vector and Eigen values.
5. **Intensity Hue Saturation:** Intensity hue saturation, basically converts R, G, B bands into I, H, S components and applied inverse transformation to get final fused image[32]. This change has the three properties of a shading that give a controlled visual portrayal of a picture. In the IHS space, tone and immersion should be carefully controlled because it contains practically the entirety of the phantom information. During the time spent a combination of high goals PAN picture and multispectral pictures, the real angle information related to high spatial goals is added to the otherworldly data. IHS strategy depends on a standard of supplanting one of the three fixings (I, H, or S) of one informational index with another picture. For the most part the genuine high power course is supplanted. IHS change is done on the low spatial goals pictures and afterward the power fixing is supplanted by the high spatial goals pictures. Switch IHS change is applied to the new arrangement of fixings to shape the melded picture. The IHS procedure is one of the most now and again utilized combination techniques for honing. The fundamental equation is there to change over RGB to IHS segments as:

$$\begin{array}{c} I \\ V1 \\ V2 \end{array} = \begin{array}{ccc} 0.577 & 0.577 & 0.577 \\ -0.408 & -0.408 & 0.816 \\ -0.707 & 0.707 & 1.703 \end{array} \cdot \begin{array}{c} R \\ G \\ B \end{array} \tag{3.15}$$

$$\begin{array}{c} R \\ G \\ B \end{array} = \begin{array}{ccc} 0.577 & -0.408 & -0.707 \\ 0.577 & -0.408 & 0.707 \\ 0.577 & 0.816 & 1.703 \end{array} \cdot \begin{array}{c} I \\ V1 \\ V2 \end{array} \tag{3.16}$$

where v1 and v2 define x and y coordinate and I(intensity) is use to define z coordinate. Saturation and Hue define as :

$$H = tan^{-1}\ (v1 / v2)\ and\ S = \sqrt{}\ v1^2 + v2^2 \tag{3.17}$$

1. **Brovey:** Brovey performs mathematical notations to combine both panchromatic and multi spectral bands.

3.2.3 Comparison among all Fusion Techniques

Table 3.1: Comparison among different Fusion Techniques

Techniques	Advantages	Disadvantages
Minimum	•It finds the noise from darker pixels of the image.	•It produces the blurred image that degrades the quality of an output image.
Maximum	•It provides good information of the data.	•It doesn't provide accurate result for dark pixels.
Principal Component Analysis	•It based on principal components. It able to calculate accurate Eigen vector and values. •It contains spatial quality at high rate	•It degrades the spectral quality of an image.
Brovey	•It helps to fuse images taken by different sensors. •It doesn't effect on the spectral features of the pixels.	•It degrades the spectral quality of an image.
Intensity Hue Saturation	•It is based on replacing principals. •It helps to sharp the edges of the input image.	•It reduces the color contrast of the pixels.
Average	•It runs fast	•It produces blurred image.

As the above table, described the advantages and disadvantages of each and every fusion technique. As IHS performs some replacing components and provide better visibility of image. Even each technique is better but among all PCA and IHS are the best.

CHAPTER 4 – PERFORMANCE ANALYSIS

This chapter focuses on various strategies and techniques that have been used in the proposed methodology and completely analyzing the benefits of using the proposed methodology over the existing ones.

4.1 Proposed Algorithm

i. Input two image, of same place but captured at different time, say I1 and I2.

ii. Select dark channels from input images I1 and I2, by using window of smaller sizes.

iii. From the dark channels, find the airlight (A) and transmission (t) factor.

iv. The difference of airlight from input images I1 and I2 give the scene radiance (Sr).

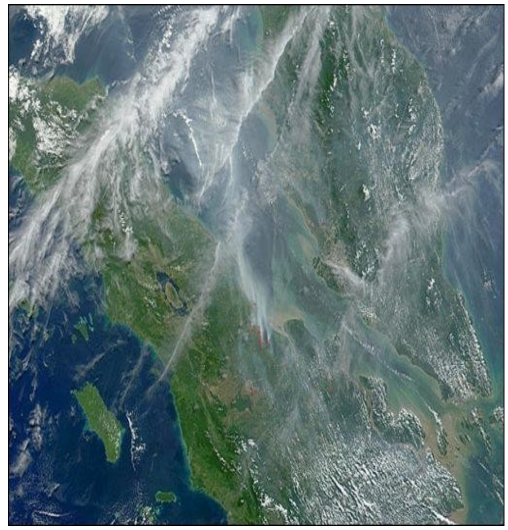
v. By finding all these parameters apply soft matting (Ms) on the transmission of scene radiance. vi. To find the dehazed images (J1 and J2), by putting the values in formula, $I = Jt + (1-t) A$.

vii. Input images are fused by different image fusion techniques to generate a single output image.

4.2 Input Images

We have selected some images using GIS techniques. These images are considered as hazed images of different locations.

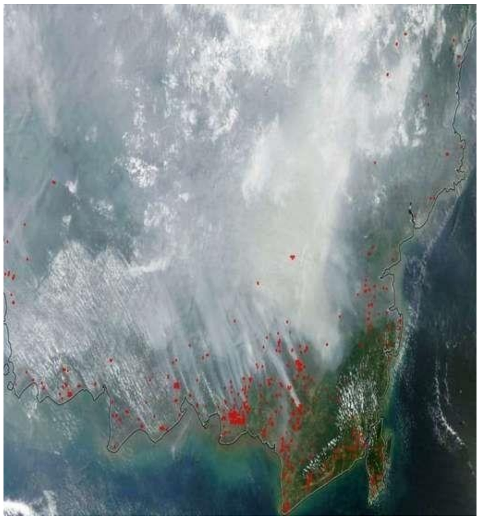
Two images have been taken of the same place at different times. The purpose of using two images is to combine the features of both images to extract more detailed information.



(a) **(b)**

(c) **(d)**

Figure 4.1: Input Images (a) Paris (b) Satellite (c) Sat (d) San Francisco



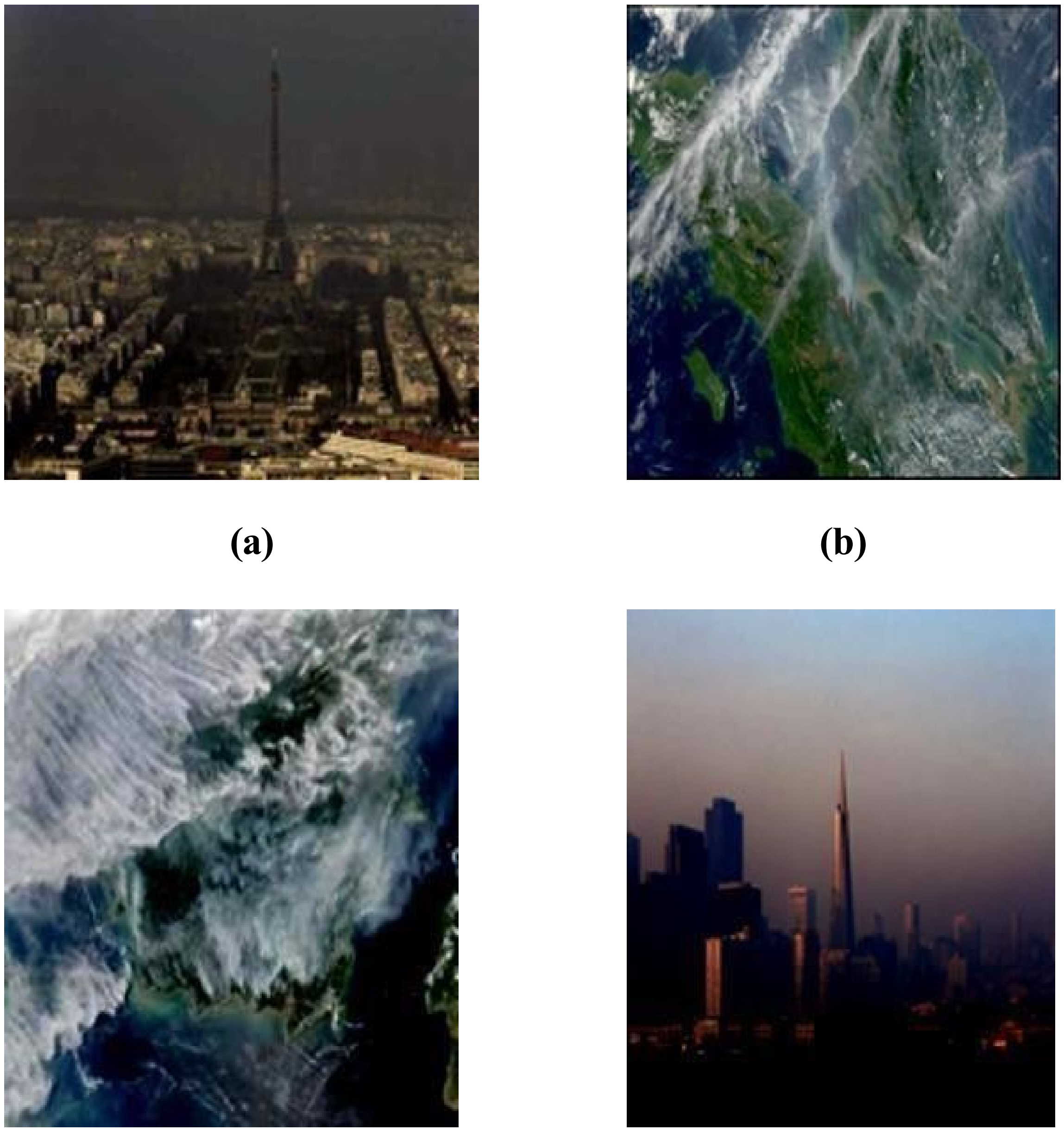
(e) (f)

(g) (h)

Figure 4.2: Input Images (e) Singapore (f) Japan (g) Palm (h) Malaysia

4.3 Results

4.3.1 Dehazed Output Images



(a) (b) (c) (d)

Figure 4.3: Dehazed Output Images (a) Paris (b) Satellite (c) Sat (d) San Francisco

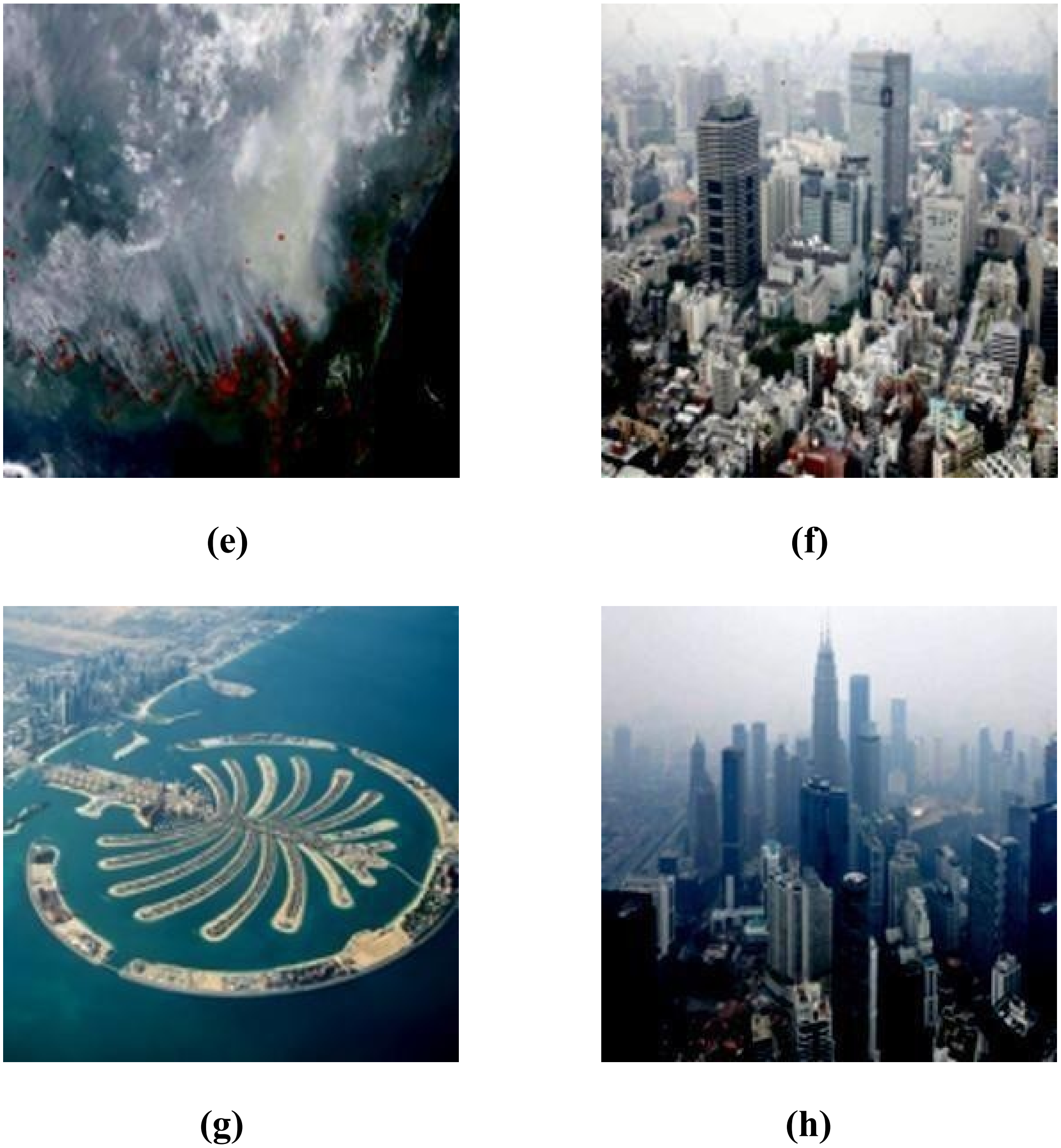


Figure 4.4: Dehazed Output Images (e) Singapore (f) Japan (g) Palm (h) Malaysia

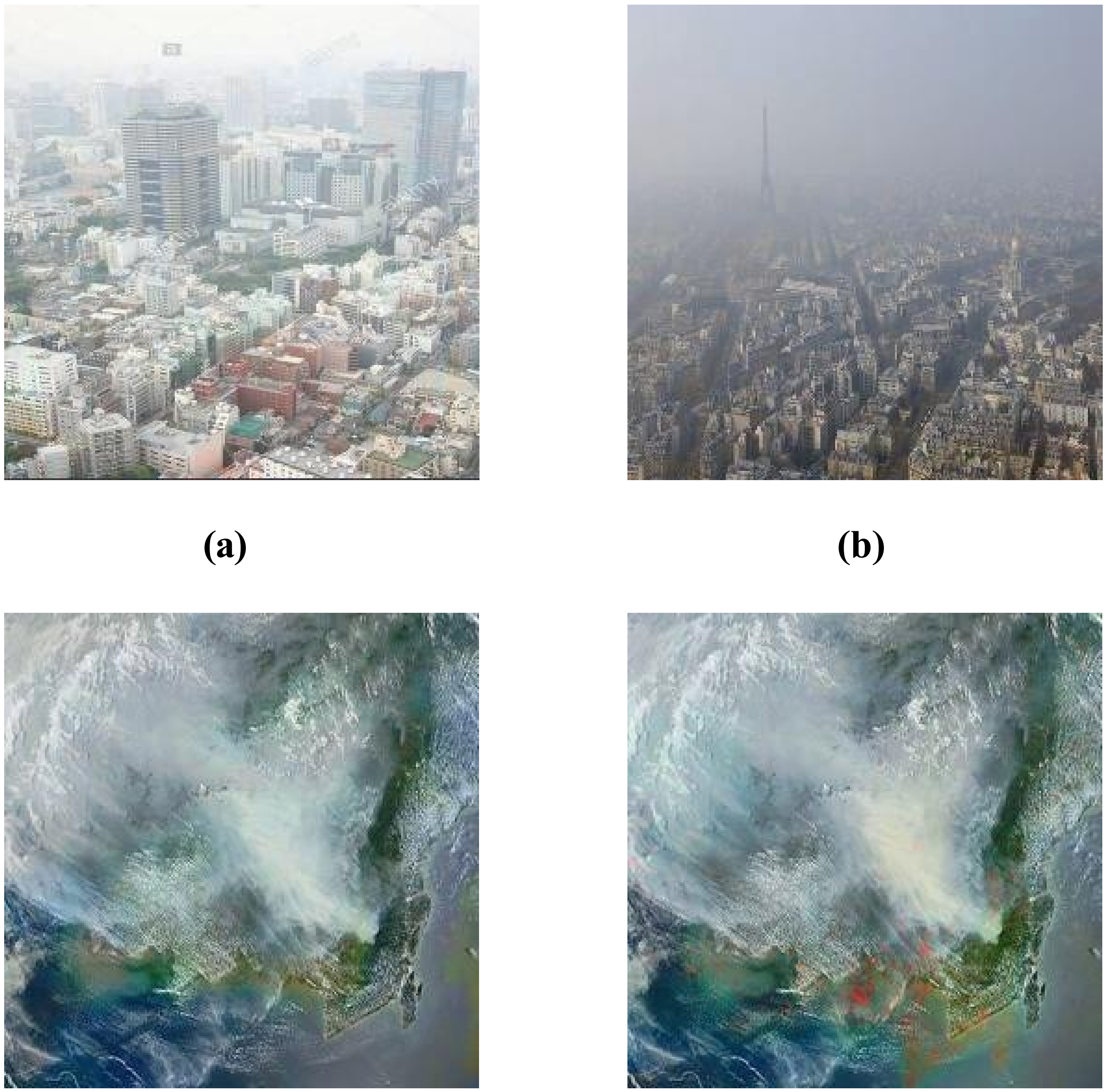
4.3.2 Result by Average Fusion

(a) **(b)**

(c) **(d)**

Figure 4.5: Average Result (a) Japan (b) Paris (c) Sat (d) Singapore

4.3.3 Result by Intensity Hue Saturation Fusion

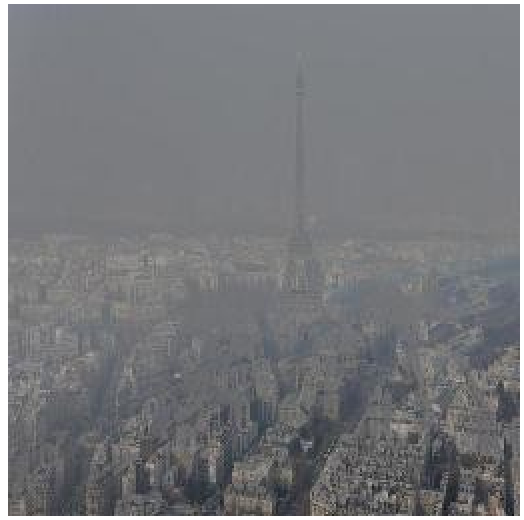


(a) (b) (c) (d)

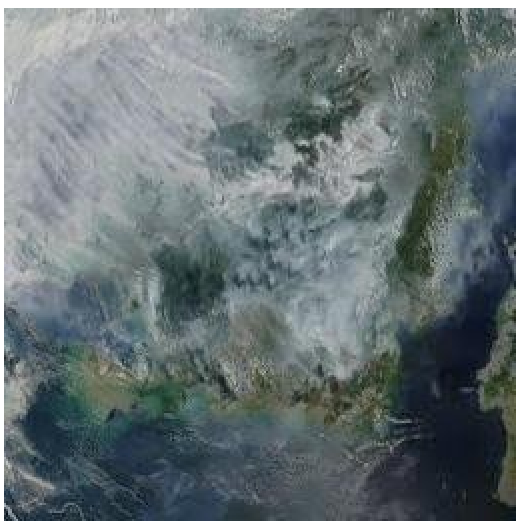
Figure 4.6: IHS Result (a) Japan (b) Paris (c) Sat (d) Singapore

4.3.4 Result by Minimum Fusion

(a)



(b)



(c)

(d)

Figure 4.7: Min Result (a) Japan (b) Paris (c) Sat (d) Singapore

4.3.5 Result by Maximum Fusion

(a) **(b)**

(c) **(d)**

Figure 4.8: Max Result (a) Japan (b) Paris (c) Sat (d) Singapore

4.3.6 Result by Principal Component Analysis Fusion

(a) **(b)**

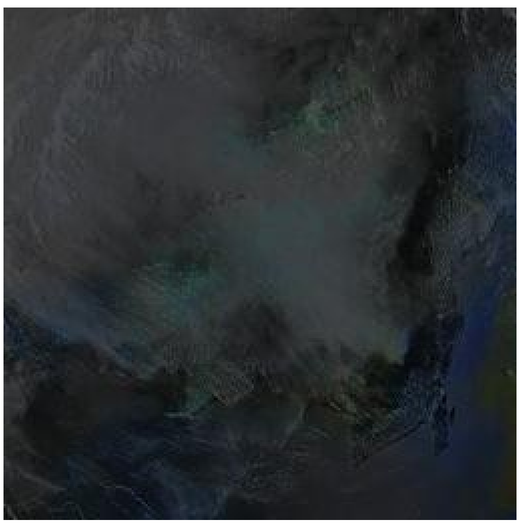
(c) **(d)**

Figure 4.9: PCA Result (a) Japan (b) Paris (c) Sat (d) Singapore

4.3.7 Result by Brovey Fusion

(a)

(b)



(c)

(d)

Figure 4.10: Brovey Result (a) Japan (b) Paris (c) Sat (d) Singapore

4.3.8 Description

We have selected 8 different hazy images. These images are reconstructed using the dehazing schema of Dark Channel Prior (DCP).

- Figures 4.1 and 4.2 shows a different set of input images. On these images, we apply DCP and obtain output images.
- Figures 4.3 and 4.4 shows the haze-free output images. These images have good visibility as compared to input images.

After applying Dark Channel Prior, we selected 4 random images from the set of 8 images. We selected exactly the same images of those 4 random images but from a different time frame and fused these images together using different fusion techniques.

- Figure 4.5 shows images after fusion using the Average Fusion Technique. In this, the output image is the result of fusion by the average pixel intensities from both the images[33].

- Figure 4.6 shows images after fusion using Intensity-Hue-Saturation Fusion Technique. The data is separated into three components: Intensity, Hue, and Saturation[34].

- Figure 4.7 shows images after fusion using the Minimum Fusion Technique. In this, the output image is the result of fusion by the minimum pixel intensities from both the images[33].

- Figure 4.8 shows images after fusion using the Maximum Fusion Technique. In this, the output image is the result of fusion by the maximum pixel intensities from both the images[33].

- Figure 4.9 shows images after fusion using Principal Component Analysis Fusion Technique. Principal Component Analysis is a subspace technique, which decreases the multidimensional informational collections into lower measurements for examination. This technique decides the loads for each source picture utilizing the eigenvector relating to the biggest Eigenvalue of the covariance lattice of each source picture[33].

- Figure 4.10 shows images after fusion using Brovey Fusion Technique. The essential strategy of the Brovey Transform first increases every MS band by the high-goals PAN band and afterward separates every item by the whole of the MS groups[35].

CHAPTER 5 – PROBLEMS WITH DCP and FUSION METHODS

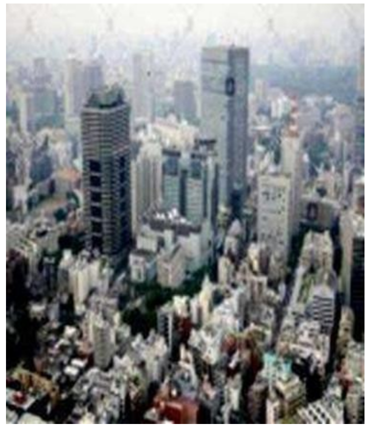
5.1 Problems with DCP

- This method is invalid when seen object is similar to airlight like car headlights and snowy ground.
- It produces some halo effects on the resultant images.
- For airlight estimate assumption is required that only 0.1% brightest pixels are taken.
- Incorrect estimation for the transmission map can lead to some problems such as false textures and blocking artifacts.

5.2 Problems with Fusion Methods

- Pixel level methods are affected by blurring effect which directly affect on the contrast of image.
- In PCA, spatial domain fusion may produce spectral degradation.
- In average method, we do not get clear objects from the set of images.
- Average method reduces the resultant image quality by introducing noise into fused image.

CHAPTER 6 – COMBINED RESULTS

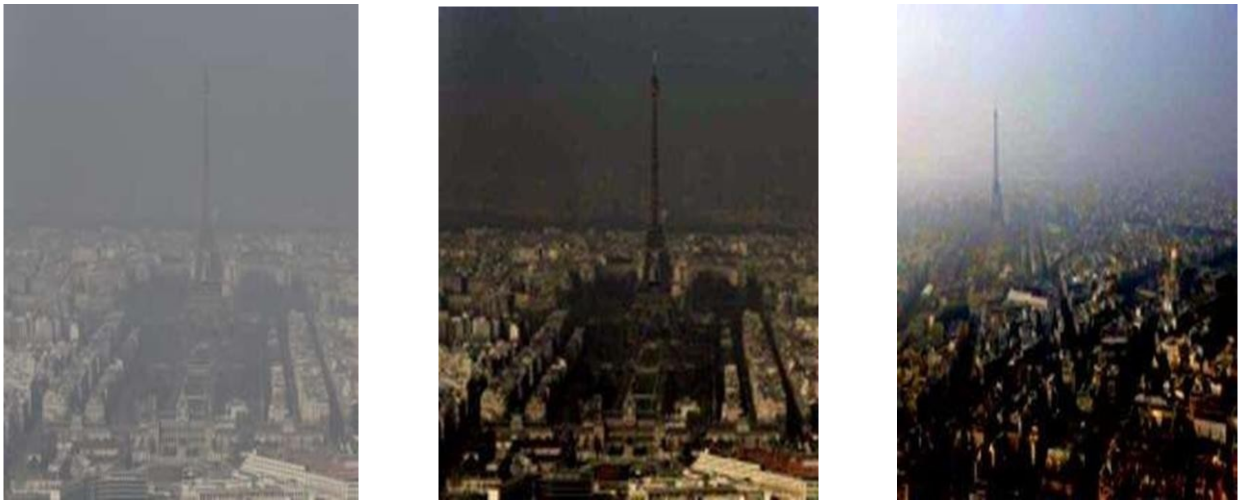




(a) **(b)** **(c)**

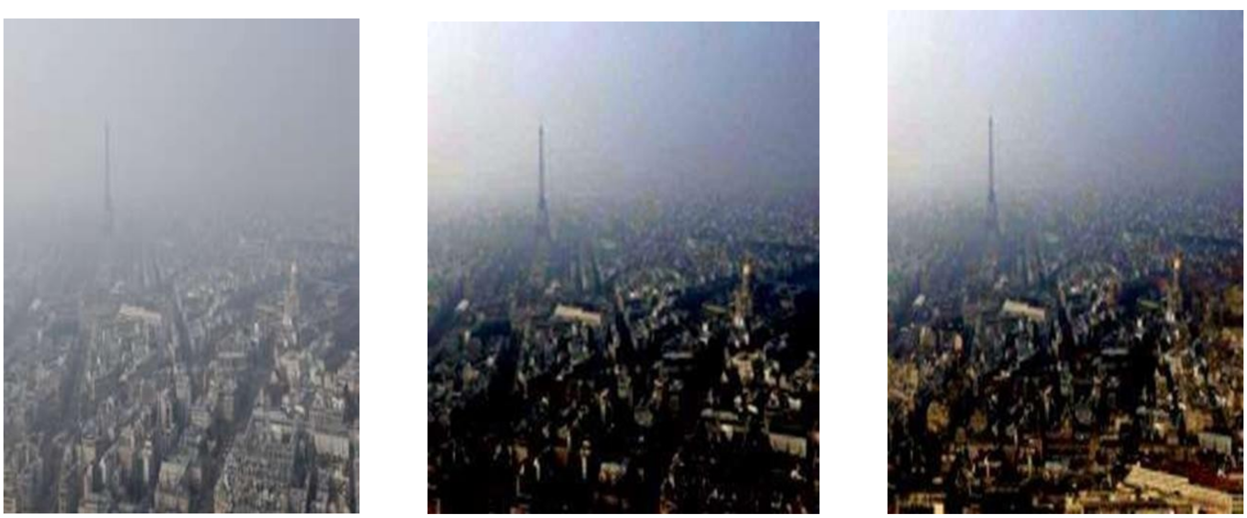


(d) **(e)** **(f)**

Figure 4.11: Combined Result (a) Japan1 (b) Dehazed Japan1 (c) Fused Image1 (d) Japan2 **(e)** Dehazed Japan2 (f) Fused Image2



(a) **(b)** **(c)**



(d) **(e)** **(f)**

Figure 4.12: Combined Result (a) Paris1 (b) Dehazed Paris1 (c) Fused Image1 (d) Paris2 **(e)** Dehazed Paris2 (f) Fused Image2

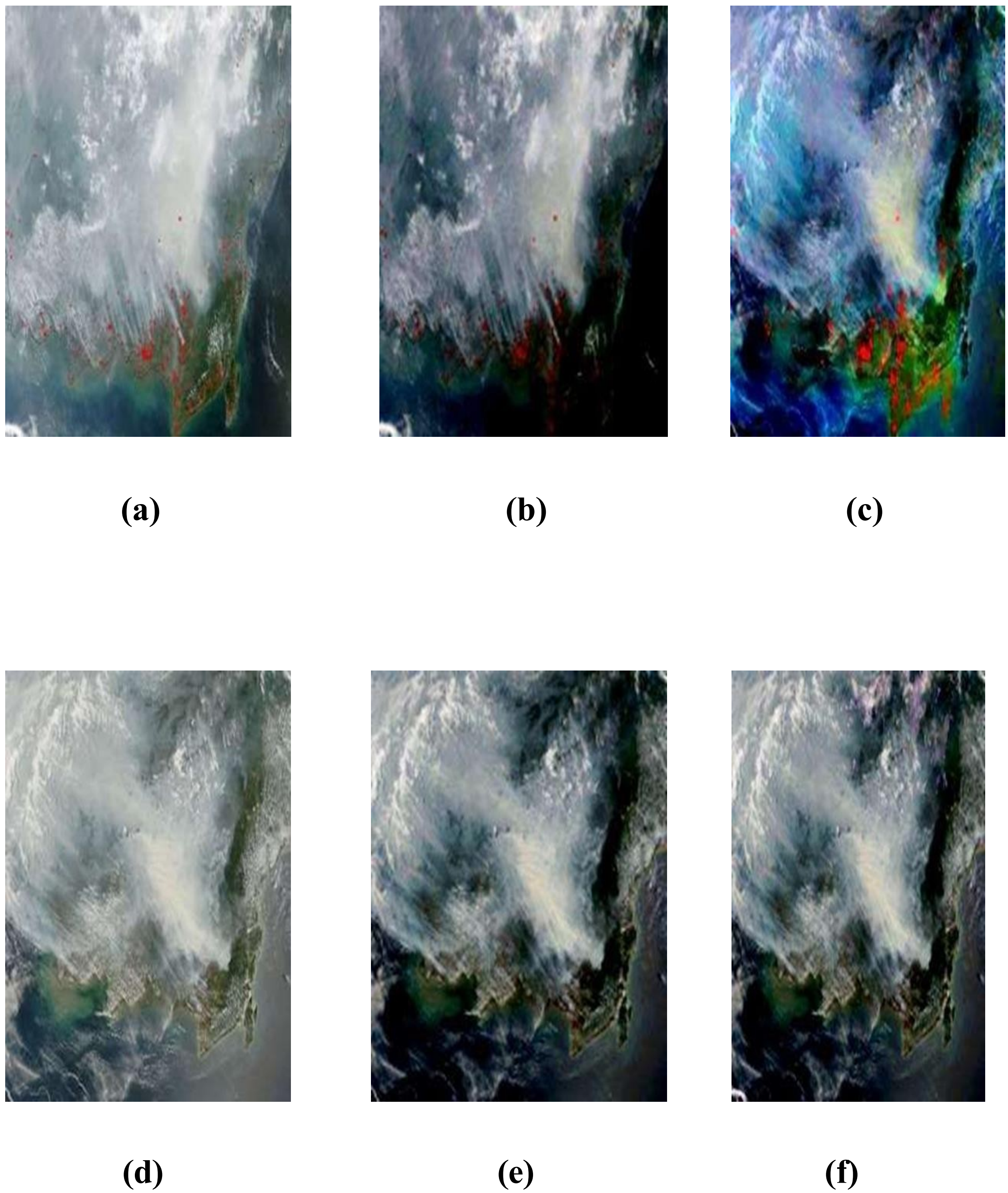


Figure 4.13: Combined Result (a) Sat1 (b) Dehazed Sat1 (c) Fused Image1 (d) Sat 2 **(e)** Dehazed Sat 2 (f) Fused Image2

CHAPTER 7 – IMAGE QUALITY ASSESSMENT

7.1 Image Quality

Quality is a significant parameter for all articles and their functionalities. In picture based item acknowledgment, the picture quality is a prime basis. Picture quality Assessment is considered as a trademark property of a picture. Corruption of saw pictures is estimated by picture quality appraisal. The decrease like a picture is influenced by the noise.

7.2 Quality Measurement Techniques

There are many techniques used for quality assessment of image such as mean square error, peak signal to noise ratio, etc.

1. **MSE (Mean Square Error):** MSE is the most notable estimator of the image quality estimation metric. It is a full reference metric and the characteristics progressively like zero are the better. It is the second depiction of the mix-up. The contrast between the estimator and its inclination is both melded with a mean squared bumble. The MSE is the vacillation of the estimator if there ought to be an event of a toll estimator. It has vague units of estimation from the square of the sum being resolved like a distinction. The MSE presents the Root-Mean-Square Error (RMSE) or Root-Mean-Square Deviation (RMSD) and consistently suggested as the standard deviation of the distinction. The MSE can moreover be said the Mean Squared Deviation (MSD) of an estimator. The estimator is insinuated as the technique for assessing an in the mystery measure of pictures. The MSE or MSD measures the ordinary of the square of the bungles. The goof is the differentiation between the estimator and the evaluated outcome. It is a part of the risk, considering the typical estimation of the squared bungle disaster or quadratic setback.

2. **PSNR (Peak Signal to Noise Ratio):** PSNR is used to calculate the ratio between the maximum possible signal power and the power of the distorting noise which affects the quality of its representation. This ratio between two images is computed in decibel form. The PSNR is usually calculated as the logarithm term of decibel scale because of the signals having a very wide dynamic range. This dynamic range varies between the largest and the smallest possible values which are changeable by their quality. The Peak signal-to-noise ratio is the most commonly used quality assessment technique to measure the quality of reconstruction of lossy image compression codecs. The signal is considered as the original data and the noise is the error yielded by the compression or distortion. The PSNR is the approximate estimation to human perception of reconstruction quality compared to the compression codecs. In image and video compression quality degradation, the PSNR value varies from 30 to 50 dB for 8-bit data representation and from 60 to 80 dB for 16-bit data. In wireless transmission, accepted range of quality loss is approximately 20 - 25 dB.

3. **Structure Similarity Index Method (SSIM):** Structural Similarity Index Method is a perception based model. In this method, image degradation is considered as the change of perception in structural information. It also collaborate some other important perception based fact such as luminance masking, contrast masking, etc. The term structural information emphasizes about the strongly inter-dependant pixels or spatially closed pixels. These strongly inter-dependant pixels refer some more important information about the visual objects in image domain. Luminance masking is a term where the distortion part of an image is less visible in the edges of an image. On the other hand contrast masking is a term where distortions are also less visible in the texture of an image. SSIM estimates the perceived quality of images and videos. It measures the similarity between two images: the original and the recovered. There is an advanced version of SSIM called Multi Scale Structural Similarity Index Method (MS-SSIM) that evaluates various structural similarity images at different image scale. In MS-SSIM, two images are compared to the scale of same size and resolutions. As Like as SSIM, change in luminance, contrast and structure are considered to calculate multi scale structural similarity between two images.

7.3 Final Results

The final results of the project are computed as follows:

After the fusion of the images by different techniques, we calculate the PSNR value of the original image and the fused image. Then, based on the results obtained, the image which has a higher value of PSNR among both the images is considered to be a good quality noise-free image.

We perform this comparison on a different set of images and compare all the values obtained.

CHAPTER 8 – CONCLUSION

Conclusion

The main motive of this research work is to develop a strategy to dehaze an image without affecting the image quality as well as to provide noise free images. The thesis has considered Dark Channel Prior and various image fusion techniques to produce good quality images. The results are obtained by applying these techniques on some well-known benchmark images. It is found that fusion techniques such as Maximum method, PCA and IHS are found to be the most prominent among all these in combination of DCP. Also the comparison of the proposed method with the existing techniques clearly depicts that the existing strategies lag much behind the proposed methodology.

Future Scope

- The proposed methodology can be further extended in remote sensing areas.
- The proposed methodology can also be further modified for mammography.

REFERENCES

[1] B. Chitradevi and P. Srimanthi, "An Overview on Image Processing Techniques," *ISRN Signal Process.*, vol. 2, no. 11, pp. 6466–6472, 2014.

[2] A. A. Manjrekar and R. V Mane, "Implication of Image Processing in GIS and Remote Sensing," no. June 2012, 2014.

[3] N. Rani, "Image Processing Techniques : A Review," *J. Today's Ideas – Tomorrow's Technol.*, vol. 5, no. 1, pp. 40–49, 2017.

[4] C. Liu *et al.*, "Automatic Estimation and Removal of Noise from a Single Image," vol. 30, no. 2, pp. 299–314, 2008.

[5] A. Veeraraghavan and A. Mohan, "Dappled Photography : Mask Enhanced Cameras for Heterodyned Light Fields and Coded Aperture Refocusing," vol. 26, no. 3, pp. 1–12, 2007.

[6] K. K. Tan and J. P. Oakley, "Enhancement of color images in poor visibility conditions," in *IEEE International Conference on Image Processing*, 2000, vol. 2, pp. 788–791.

[7] G. W. Larson, H. Rushmeier, and C. Piatko, "Operator for High Dynamic Range Scenes," vol. 3, no. 4, pp. 291–306, 2011.

[8] S. Shwartz, E. Namer, Y. Y. Schechner, T. Israel, and I. Technology, "Blind Haze Separation," 2006.

[9] R. Fattal, "Single image dehazing," *ACM Trans. Graph.*, vol. 27, no. 3, 2008.

[10] K. He, J. Sun, and X. Tang, "Single image haze removal using dark channel prior," *IEEE Trans. Pattern Anal. Mach. Intell.*, 2011.

[11] R. T. Tan, "Visibility in Bad Weather from a Single Image," no. June 2008, 2014.

[12] K. He, J. Sun, and X. Tang, "Single Image Haze Removal Using Dark Channel Prior," vol. 33, no. 12, pp. 2341–2353, 2011.

[13] M. F., R. D., O. G., L. R., and B. R., "Guided Image Filtering Kaiming," *Eur. Geriatr.*

Med., vol. 8, p. S69, 2017.

[14] G. Simone, “Image fusion techniques for remote sensing applications,” vol. 3, pp. 3–15, 2002.

[15] H. Ghassemian, “US CR,” *Inf. Fusion*, 2016.

[16] R. Gharbia, A. Azar, A. Baz, and A. Hassanien, “Image Fusion Techniques in Remote Sensing,” *Arxiv*, 2014.

[17] D. N. Kumar, “Satellite Image Processing with MATLAB,” *Image (Rochester, N.Y.)*, no. i.

[18] B. Sreenivas and B. N. Chary, “Processing of satellite image using digital image processing,” 2011.

[19] C. N. Deshmukh and N. G. Bajad, “A COMPARATIVE STUDY OF DIFFERENT IMAGE FUSION TECHNIQUES FOR TONE-MAPPED IMAGES,” vol. 7, no. 2, pp. 474–478, 2016.

[20] P. Jan, P. Jiri, and N. Milan, “INTERNATIONAL JOURNAL OF MATHEMATICAL MODELS AND METHODS IN APPLIED SCIENCES OCR systems based on convolutional neocognitron network,” vol. 5, no. 7, pp. 1257–1264, 2011.

[21] H. Rashid *et al.*, “ScienceDirect ScienceDirect Single Image Dehazing using CNN Single Image Dehazing using CNN from,” *Procedia Comput. Sci.*, vol. 147, pp. 124–130, 2019.

[22] A. Levin, D. Lischinski, and Y. Weiss, “A Closed-Form Solution to NaturalImage Matting,” vol. 30, no. 2, pp. 228–242, 2008.

[23] J. M. Paul Debevec, “Recovering High Dynamic Range Radiance Maps fromPhotographs Paul E . Debevec,” in *ACM Transactions on Graphics*, 1998.

[24] E. Hsu and T. Mertens, “Light Mixture Estimation for Spatially Varying White Balance,” vol. 27, no. 3, pp. 1–8, 2008.

[25] S. G. Narasimhan and S. K. Nayar, “Chromatic Framework for Vision in Bad Weather ,”

2000.

[26] S. Krishnamoorthy, “Implementation and Comparative Study of Image Fusion Algorithms,” vol. 9, no. 2, pp. 25–35, 2010.

[27] H. Wu, “Pixel-based Image Fusion Using Wavelet Transform for SPOT and ETM+ Image,” pp. 936–940, 2010.

[28] N. Mitianoudis and T. Stathaki, “Pixel-based and region-based image fusion schemes using ICA bases,” vol. 8, pp. 131–142, 2007.

[29] D. L. I. A. Godse, “WAVELET BASED IMAGE FUSION USING PIXEL BASED,” no. April, 2015.

[30] C. Pohl and J. L. Van Genderen, *Review article Multisensor image fusion in remote sensing : Concepts , methods and applications*, vol. 1161. 2010.

[31] A. Dogra and P. Bhalla, “CT and MRI Brain Images Matching Using Ridgeness Correlation,” vol. 7, no. 2, pp. 691–696, 2014.

[32] F. A. Al-Wassai, N. V. Kalyankar, and A. A. Al-Zuky, “The IHS Transformations Based Image Fusion,” 2011.

[33] K. Rani and R. Sharma, “Study of Different Image fusion Algorithm,” *Int. J. Emerg. Technol. Adv. Eng.*, vol. 3, no. 5, pp. 288–291, 2013.

[34] P. Chaudhari, P. M. B. Chaudhari, and P. S. D. Panchal, “A Review on Image Fusion Techniques,” *Int. J. Adv. Eng. Res. Dev.*, vol. 1, no. 03, pp. 342–347, 2014.

[35] K. G. Nikolakopoulos, “Comparison of nine fusion techniques for very high resolution data,” *Photogramm. Eng. Remote Sensing*, vol. 74, no. 5, pp. 647–659, 2008.

report-chapters.pdf

ORIGINALITY REPORT

18%	10%	7%	16%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.scirp.org Internet Source	2%
2	www.irjet.net Internet Source	2%
3	Submitted to Jaypee University of Information Technology Student Paper	2%
4	Submitted to University of Strathclyde Student Paper	1%
5	ijoer.com Internet Source	1%
6	Kaiming He, , Jian Sun, and Xiaoou Tang. "Single Image Haze Removal Using Dark Channel Prior", IEEE Transactions on Pattern Analysis and Machine Intelligence, 2011. Publication	1%
7	Kaiming He. "Single image haze removal using	1%

dark channel prior", 2009 IEEE Conference on

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

PLAGIARISM VERIFICATION REPORT

Date: 16-Jul-2020

Type of Document (Tick): **PhD** | **M.Tech Dissertation/** | **B.Tech Project** ✔ | **Paper**

Name: Riya Sharma, Tikshika Gupta **Department:** CSE **Enrolment No** 161367, 161360

Contact No. 8350919576, 9805035064 **E-mail.** riyasharmajnr98@gmail.com, tikshika99@gmail.com **Name of the Supervisor:** Dr. Himanshu Jindal

Title of the Thesis/Dissertation/Project Report/Paper (In Capital letters): TRANSFORMATION AND RESTORATION OF SATELLITE IMAGES USING GIS BASED TECHNIQUE

UNDERTAKING

I undertake that I am aware of the plagiarism related norms/ regulations, if I found guilty of any plagiarism and copyright violations in the above thesis/report even after award of degree, the University reserves the rights to withdraw/revoke my degree/report. Kindly allow me to avail Plagiarism verification report for the document mentioned above.

Complete Thesis/Report Pages Detail:

- Total No. of Pages = 53
- Total No. of Preliminary pages = 9
- Total No. of pages accommodate bibliography/references = 3

Tikshika Gupta

(Signature of Student)

FOR DEPARTMENT USE

We have checked the thesis/report as per norms and found **Similarity Index** at 18 (%). Therefore, we are forwarding the complete thesis/report for final plagiarism check. The plagiarism verification report may be handed over to the candidate.

Himanshu Jindal

(Signature of Guide/Supervisor) **Signature of HOD**

FOR LRC USE

The above document was scanned for plagiarism check. The outcome of the same is reported below:

Copy Received on	Excluded	Similarity Index (%)	Generated Plagiarism Report Details (Title, Abstract & Chapters)	
	• All Preliminary Pages • Bibliography/Images/Quotes • 14 Words String		Word Counts	
Report Generated on			Character Counts	
		Submission ID	Total Pages Scanned	
			File Size	

Checked by
Name & Signature **Librarian**

06/2009
Publication

8	Raanan Fattal. "Single image dehazing", ACM Transactions on Graphics, 08/01/2008 Publication	1%
9	tel.archives-ouvertes.fr Internet Source	1%
10	ijarcet.org Internet Source	<1%
11	Submitted to Higher Education Commission Pakistan Student Paper	<1%
12	Submitted to Indian Institute of Technology Student Paper	<1%
13	Submitted to University of Teesside Student Paper	<1%
14	www.mdpi.com Internet Source	<1%
15	Submitted to The University of Buckingham Student Paper	<1%
16	Submitted to University of Mustansiriyah Student Paper	<1%
17	Submitted to SASTRA University Student Paper	<1%

18	Submitted to Charotar University of Science And Technology Student Paper	<1%
19	Submitted to Heriot-Watt University Student Paper	<1%
20	Submitted to South University of Science and Technology of China Student Paper	<1%
21	Submitted to Lovely Professional University Student Paper	<1%
22	Huzaifa Rashid, Nauman Zafar, M Javed Iqbal, Hassan Dawood, Hussain Dawood. "Single Image Dehazing using CNN", Procedia Computer Science, 2019 Publication	<1%
23	etheses.whiterose.ac.uk Internet Source	<1%
24	Submitted to AUT University Student Paper	<1%
25	Haoran Xu, Jianming Guo, Qing Liu, Lingli Ye. "Fast image dehazing using improved dark channel prior", 2012 IEEE International Conference on Information Science and Technology, 2012 Publication	<1%

26	Sulami, Matan, Itamar Glatzer, Raanan Fattal, and Mike Werman. "Automatic recovery of the atmospheric light in hazy images", 2014 IEEE International Conference on Computational Photography (ICCP), 2014. Publication	<1%
27	studentsrepo.um.edu.my Internet Source	<1%
28	Fan Guo. "Automatic Image Haze Removal Based on Luminance Component", 2010 International Conference on Computational Intelligence and Software Engineering, 09/2010 Publication	<1%
29	Submitted to Macau University of Science and Technology Student Paper	<1%
30	ijarcsse.com Internet Source	<1%
31	Submitted to Indian Institute of Technology, Madras Student Paper	<1%
32	dspace.lib.cranfield.ac.uk Internet Source	<1%
33	Submitted to University of Hertfordshire Student Paper	<1%

34	Baojun Qi. "Real-Time Detection of Small Surface Objects Using Weather Effects", Lecture Notes in Computer Science, 2011 Publication	<1%
35	Riaz, Irfan, Teng Yu, Hyunchul Shin, and Jingchun Piao. "Real-time single image dehazing using block-to-pixel interpolation and adaptive dark channel prior", IET Image Processing, 2015. Publication	<1%
36	Submitted to Savitribai Phule Pune University Student Paper	<1%

Exclude quotes	On	Exclude matches	< 10 words
Exclude bibliography	On		