



**FUSION BASED UNDERWATER IMAGE
RESTORATION SYSTEM**

**A THESIS SUBMITTED TO THE GRADUATE SCHOOL
OF APPLIED SCIENCES**

**OF
NEAR EAST UNIVERSITY**

**BY
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**IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF SCIENCE**

**IN
COMPUTER ENGINEERING**

NICOSIA 2014



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ACKNOWLEDGMENTS

First of all I would like to extend our sincere and humble gratitude to Almighty Allah whose blessings and guidance has been a real source of all my achievements in my life. I feel a deep sense of obligation and greatly thank to my project supervisor Assist.Prof.Dr. *Boran Şekeroğlu* who is always there for me help and without their help and encouragement, it was impossible for me to achieve this task. I feel greatly indebted for his sincere guidance. I will be failing in my duties if I don't express my warmest thank to Prof. Dr. Rahib H.Abiyev for his guidance and encouragement for his guidance and valuable suggestions in reading materials and other difficulties of the project. All the year he helps me in study problem.

I would like to thank my friends in Near East University Master Program (Muhammad Waheed, Imran Abbas,wameedh Raad Fathel,Rami R. Mustafa , Awad Jihad, Sipan Slivany,). It is my bounden duty to pay tributes to my worthy all staff members of Department of Computer Engineering

At the end I would like to thank all of my Teachers & my Parents.

DEDICATION

I am dedicating this project to my Parents .who always pray for me in the development of software & preparation of thesis. My parents thank you for your unconditional support with my studies I am honoured to have you as my parents. Thank you for given me a chance to prove and improve myself through all my walks of life. Please do not ever change. I love you.

And specially thank to my fiancé who always wish for good luck in my study. Please do not ever doubt my dedication and love for you.

My brothers and sisters: hoping that with this research I have proven to you that these is no mountain higher as long as God is on our side. Hoping that, you will walk again and be able to fulfil your dreams.

ABSTRACT

In this thesis a fusion based image restoration system has been presented to enhance the underwater images as they suffer from non-uniform lighting, low contrast, blurriness and vilified color. The considered strategy is based on fusion based principle which focusses on input images, weight & the weight map and white balance measurement from the degraded or noised underwater image. The method practically aims to yield an image that overcomes the deficiencies of initial image or noised image which lacks clear visibility by employing several weight maps which are Luminance, Contrast, Chromatic and Saliency weight maps. Applying the above mentioned techniques underwater image acquired has the characteristics such as reduction in noise levels and better exposedness of dark regions along with improved global contrast and finest details & edges. The proposed fusion framework with wavelet transform also supports temporal coherence between adjacent frames by performing an effective edge preserving noise reduction strategy

The fusion of images involves combining of two or more images into a single more informative image. The resulting image is reconstructed into a single image to get the better quality of image. By using weight map techniques images is enhanced and using fusion based technique image has been restored for better viewing for observers. By focussing on fusion based techniques certain aspects such as resolution of the initial image has also been compromised, but using this method defining the proper inputs and weights derived from the original degraded image also helps a lot in the image visibility. Enhanced results are being obtained by two input underwater images in a pre-pixel fashion. The overall results have shown that the proposed method has given better quality of the underwater images which has high noised ratio and more color disruption in initial input underwater images.

Key Terms: Image Enhancement, Underwater Image Restoration, Wavelet Transform, Image Denoising.

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ABBREVIATIONS USED

IS	Image Size (semiconductor manufacturing)
IS	Image Studio
II	Image Interpreter/Interpretation
IMG	Image
IM	Image (mathematics)
IP	Image Processing
SET	Image Settings (file name extension)
CCD	Charge-Coupled Device (type of image sensor)
IS	Image Shack (image hosting service)
TIFF	Tag Image File Format (RFC 3302; less common)
IS	Image Stabilizer (camera lens)
IQ	Image Quality
TIFF	Tagged Image File Format (graphics/image file format/extension)
AIWPC	Arles Image Web Page Creator
AMI	Amazon Machine Image (Amazon)
CIS	Centre for Imaging Science (Johns Hopkins University)
CT	Computed Tomography (imaging technique)
OCT	Optical Coherence Tomography (medical imaging technique)
AMICO	Art Museum Image Consortium
DI	Diagnostic Imaging
DTI	Diffusion Tensor Imaging
IT	Interline Transfer (CCD image devices)
DICOM	Digital Imaging and Communications in Medicine
SSI	Solid State Imaging
DMG	Disk Image
TIF	Tagged Image File (file name extension)
FMRI	Functional Magnetic Resonance Imaging
ICIP	International Conference on Image Processing
DWI	Diffusion-Weighted imaging (application of magnetic resonance imaging)
DI	Document Imaging
CIS	Contact Image Sensor
FITS	Flexible Image Transport System
SI	Still Image
MIL	Matrix Imaging Library
MODIS	Moderate Resolution Imaging Spectroradiometer (NASA/EOS instrument)
TWICE	TEG (Test Element Group) with Image Contrast Enhancing
KIPI	KDE (K Desktop Environment) Image Plugin Interface
CIPA	Camera & Imaging Products Association
IPM	Images per Minute
CIS	CMOS Image Sensor
PSNR	Peak Signal Noise Ratio
MSE	Mean Square Error
IFD	Image File Directory
ICIAP	International Conference on Image Analysis and Processing

1. INTRODUCTION

When image are taken in turbid media such as underwater, hazy or noise conditions, the visibility of the scene is degraded significantly This is due to the fact that the radiance of a point in the scene is directly influenced by the medium scattering. Practically, distant objects and parts of the scene suffer from poor visibility, loss of contrast and faded color. Recently, it has been seen a growing interest in restoring visibility of images altered due to such atmospheric conditions. Recovering this kind of degraded images is important for various applications such as oceanic engineering and research in marine biology, archaeology, surveillance etc.

Underwater visibility has been typically investigated by involving acoustic imaging and optical imaging systems. Acoustic sensors have the major advantage to penetrate water much easily despite of their lower spatial resolution in comparison with the optical systems. However, acoustic sensors become very large when aiming for high resolution outputs. On the other hand, optical systems despite of several shortcomings such as poor underwater visibility have been applied recently by analysing the physical effects of visibility degradation. Mainly, the existing techniques employ several images of the same scene registered with different states of polarization for underwater images but as well for hazy inputs. As well, dehazing techniques have been related with the underwater restoration problem but in our experiments these techniques shown limitations to tackle with this problem.

Therefore, it will be important to pre-practice these photographs ahead of exploitation usual graphic running approaches. Today before-processing strategies commonly only center on no-uniform lighting or maybe coloration rectification and quite often involve added information about the planet: equally detail, distance object/television camera or even water system choice. The protocol planned therein thesis is a argument-cost-free criteria which usually decreases subaquatic perturbations, along with helps graphic choice without using almost any understanding and also with virtually no homo argument modification [2][2][3].

Whenever image usually are consumed in cloudy marketing including underwater, bleary or even foggy conditions, the field of vision of the arena is definitely degraded substantially. This can be due to the fact that the shine of an reason for the particular picture will be specifically inspired with the medium dispersion. Nearly, far-away physical objects and also regions of the actual arena experience weak visibility, lack of compare and washed out shades. Recently, it has been seen a developing involvement in reestablishing awareness associated with

pictures adapted as a result of these atmospherically problems. Recouping this sort of debauched graphics is essential for assorted applications for instance oceanic technology in addition to inquiry inwards submarine biology, archaeology, surveillance and so on. [4][5].

Within this dissertation record the structure of Fusion Dependent Under the sea Picture Recovery Method and have descent strategies has been deemed. Your dissertation incorporates release, a few sections, decision, references and appendices.

Chapter 1 is devoted to the descriptions of image processing, history, technique, type and application of image processing.

Chapter 2 describes the Image restoration. The basic important meaningful feature of the restoration images has been described approach and technique for image restoration.

Chapter 3 is Problem analysis about the existing system Disadvantages of Existing System. Proposed System, advantages of Proposed System

Chapter 4 the design stages of underwater restoration image. General structure of the system, the flowcharts of feature extraction methods are described. The fusion bases restoration techniques

Chapter 5.expermatal results of our fusion based method and comparison some recent researches

Finally, Chapter 6 contains the important simulation results obtained from the thesis.

1.1 BACKGROUND

Under the water image is vital with regard to research project and technological innovation and for common actions, however it truly is stricken by very poor awareness weather. On this survey many of us present a pc eye-sight strategy which eliminates debasement personal effects inside subaqueous eye-sight. We psychoanalyze your bodily outcomes of field of vision abasement. It truly is revealed how the briny abjection outcomes could be linked to overtone polarization of sunshine.

So, a formula is introduced, that inverts the style enhancement practices regarding recouping good presence in pictures involving clips. The actual criterion is based on several images considered through a polarizer from unlike orientations. Being a through-product or service, the aloofness road from the view can be extracted. Moreover, this kind of cardstock examines the sounds tenderness of the restoration [just one]. We all successfully exhibited the method inwards experiments done from the marine. Great upgrades involving arena compare as

well as color a static correction ended up attained, just about doubling your subaqueous visibleness array.

One way to obtain problems when producing outside pictures will be the occurrence associated with fog, errors or perhaps cigarette smoking which usually dies out the actual colors and also cuts down on the contrast on the ascertained things. Many of us create a new story formula along with versions for visibility restitution at a individual effigy. Lower than replacement this proposed algorithmic rule in contrast to other can be its velocity: it's complication is usually a linear functionality of the quantity of photograph pixels alone(p) [5]. Your criteria are actually managed merely by a number of guidelines as well as comprises with: atmospheric humeral veil illation, picture restoration in addition to smoothing, sculpt function. In the end, software is introduced to street-noticing removal in greyish stage graphics, showing a person's vision on the technique.

Inside the new one impression dehazing technique the tactic engages A blend-dependent approach of which usually takes as advices a couple adapted versions of the original impression which might be heavy aside establish routes in order to deliver precise fog cost-free final results. The tactic computes in the every-picture element mode currently being square(a) for being applied [7].The good process displays to provide comparative degree and in some cases superior effects compared to more difficult talk about-associated with-your-craft approaches although has got the benefit of become suitable for actual-moment applications [8].

The effect is often a online files data compression considering that the distinction, or maybe miscalculation, image offers lower variance along with randomness, plus the reduced-cross television graphic may possibly represented with lessened taste thickness. Further info compression setting can be accomplished through quantizing the difference images. These types of actions usually are next recurring to be able to reduce the lower-pass impression. Looping on the process in properly enhanced weighing scales generates a chart information construction.

The actual encoding practice matches sample distribution the image along with Laplacian providers of the many scales. Thus, the particular program code is likely to improve most important image characteristics [12].An additional selling point of the current computer code is the fact that it is perfect for numerous image psychoanalysis jobs as well as for graphic contraction. Rapidly calculations are usually referred to for coding and also decipherment

2. IMAGE PROCESSING

2.1 Overview

Digital image processing is the use of computer algorithms to perform image processing on digital images. As a subcategory or field of digital signal processing, the digital image processing has many advantages over analog image processing. It allows a much wider range of algorithms to be applied to the input data and we can avoid problems such as the build-up of noise and signal distortion during processing. Since images are defined over two dimensions digital image processing may be modeled in the form of multidimensional systems.

2.2 Digital Image Analysis

Image research is the descent of important info coming from photos; chiefly coming from electronic digital graphics with a digital picture control strategies. Photograph investigation tasks is usually as easy because meter reading pub coded tag cloud or even as innovative since determining a person via the encounter. Pcs are generally indispensable for that examination of huge numbers of data, pertaining to duties that requirement intricate computation, or for this removal of quantitative information. Then again, we can establish the human being visual area is a great graphic examination apparatus, particularly for extracting higher-degree selective information, and for many applications including practice of medicine, safety measures, as well as rural realizing people analysts nevertheless cannot be changed simply by computer systems. This is why, quite a few important image analysis equipment for example side alarms in addition to neuronal communities are usually inspired through homo beholding designs.

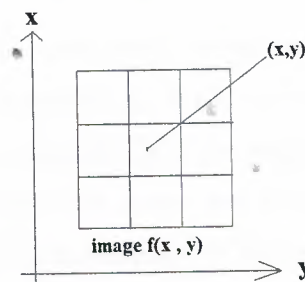


Fig 2.1 digital image [23]

An image we can be defined as a two-dimensional function $f(x, y)$, where x and y are Spatial (plane) coordinates, and the amplitude of at any pair of coordinates (x, y) is called the intensity or gray level of the image at that point. When x , y , and the amplitude values of f are all

finite, discrete quantities, we call the image a digital image. The field of digital image processing refers to processing digital images by means of a digital computer. Note that the digital image is composed of a finite number of elements; each of which has a particular location and value. These elements are referred to as picture elements, image elements, and pixels. Pixel is the term most widely used to denote the elements of a digital image [23].

2.3 History

There are different approaches for digital graphic processing, or even digital camera photo producing as it frequently has been known as, ended up created in the 1960s on the Jet Propulsion Laboratory, Massachusetts Institute associated with Technologies, Buzzer A lab, University involving Maryland, as well as a some other inquiry establishments, together with app to satellite tv for pc symbolism, wire-picture criteria conversion process, aesculapian image resolution, videophone, figure realization, as well as photos enhancement. The price tag on digesting has been reasonably large, however, using the processing equipment of that time. Containing altered from the 1970s, whenever digital camera impression processing grown popular equally less costly computer systems in addition to consecrated equipment grew to become accessible. Images subsequently may very well be refined in real time, for a lot of committed troubles including television requirements the conversion process. Since common-goal computers grew to be more quickly, they did start to take control the office regarding devoted equipment for all but the most special in addition to computer-demanding procedures.

2.4 Image Processing Applications

Science Materials science, also commonly known as materials engineering, is an interdisciplinary field applying the properties of matter to various areas of sciences and engineering fields. This relatively new scientific field investigates the relationship between the structure of materials at atomic or molecular scales and their macroscopic properties. It is incorporates elements of applied physics and chemistry. With significant media attention focused on Nano science and nanotechnology in recent years, materials science is becoming more widely known as a specific field of science and engineering. It is an important part of forensic engineering (Forensic engineering is the investigation of materials, products, structures or components that fail or we do not operate or function as intended, causing personal injury or

damage to property.) and failure analysis, the latter being the key to understanding, i.e. the cause of various aviation accidents. Many of the most pressing scientific problems that are currently faced today are due to the limitations of the materials that are currently available and, as a result, breakthrough in this field is likely to have a significant impact on the future of the technology.

2.4.1 Movies

Digital cameras generally include dedicated digital image processing chips to convert the raw data from the image sensor into a color-corrected image in a standard image file format. Images from digital cameras often receive further processing to improve their quality, a distinct advantages that digital cameras have over film cameras. The digital image processing typically is executed by special software programs that can manipulate the images in many ways. Many digital cameras also enable viewing of histograms of images, as an aid for the photographer to understand the rendered brightness range of each shot of camera more readily.

2.4.2 Medical Industry

Medical imaging is the technique and process used to create images of the human body for clinical purposes (medical procedures seeking to reveal, diagnose, or examine disease) or medical science (including the study of normal anatomy and physiology). Images from old digital cameras usually obtain more processing to raise his or her top quality, a distinct advantages that old digital cameras include in excess of motion picture video cameras.



Fig: 2.2 Medical image [23].

To be a discipline and the largest impression, it really is a part of biologic imagery and features radiology which usually utilizes the particular mental imagery technologies associated with Back button-light beam magnetic resonance imaging, professional medical sonography or even ultrasound, endoscopy, tactual imagination, thermography, medical digital photography and nuclear medicine useful image resolution tactics seeing that positron emission tomography.

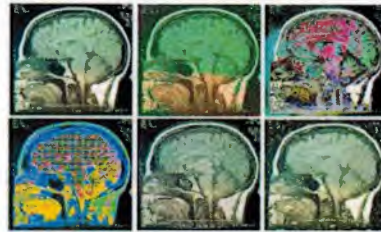


Fig: 2.3 MRI image[23].

Measurement and recording strategies which are not primarily created to produce photographs, such seeing that electroencephalography (EEG), magneto electric machine encephalography electrocardiography (EKG), yet others, but that produce information susceptible for being represented as a parameter chart vs moment or atlases which check information concerning the measurement locations, we may very well be as forms of medical imagination in a small sense.

2.4.3 Machine Vision

Computer vision can be a field that also includes strategies to acquiring, producing, analyzing, and understanding graphics in the main, high-dimensional data from the real world so that you can produce numeral or representational information, electronic.g., inside the kinds of decisions. A style from the growth and development of search engine optimization continues to be to copy the relevant skills of people vision by simply electronically perceiving and understanding a photo in image processing.

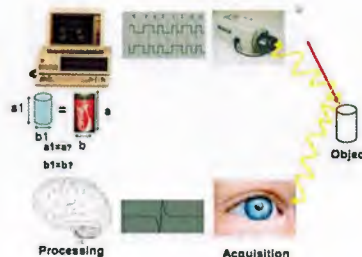


Fig: 2.4 machine vision [24].

Applications vary from chores like manufacturing machine imagination techniques that, we are able to point out, examine containers speeding by over a line, to examine in artificial intelligence and desktops or programs that can recognize the earth approximately these. Your computer vision in addition to unit eyesight grounds possess substantial convergence. Computer system vision includes this magnetic core technological know-how regarding machine-controlled image research which is used in most additional fields. Being a scientific discipline, laptop or computer eyesight can be involved while using the concept of artificial systems of which extract data through photos. The style data could be acquiring many forms, for example online video media sequences, landscapes coming from several cams, or even multiple-dimensional files from the professional medical reader.

2.4.4 Digital Camera Images

Cameras commonly admit dedicated a digital effigy running chips to convert this natural information from the effigy sensing element into a colour-adjusted effigy in a stock picture of extendable. Photographs coming from video cameras generally find additionally producing to improve their own choice, a definite advantages of which digital cameras have above picture video cameras.

The digital image producing normally can be completed by simply especial(a) software packages which can be influencing the photos in numerous other methods



Fig: 2.5 Digital camera images[13].

Quite a few video cameras furthermore enable watching regarding histograms of images, for aid to the lens man is usually comprehend your rendered lighting selection of each and every picture to a greater extent easily

2.5 How Your Computer Stores Image

This chapter on 'The Digital Domain' looks at aspects of digital photography after we have captured the photograph and are sat in the comfort of our computer chair. We will also delve a little deeper into a few of the things we have already touched upon in earlier chapters.

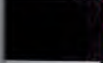


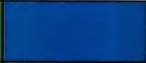



2.5.1 How Images are Stored

We've already seen that an image is made up of individual pixels. If we are shooting at the highest pixel resolution that our camera can handle, then each pixel in the image corresponds to a pixel on the image sensor. Each pixel has specific colours which are defined by the amounts of red, green and blue at that pixel. These separate colours are usually referred to as channels in an image - therefore a full color image requires three channels. In most image formats, each channel requires 1 byte of memory therefore each pixel requires 3 bytes to be store. Each channel has 256 different levels for each color a value from 0 indicating none of that colours and a value of 255 indicating the maximum amount of that colours.

For example if a pixel has an RGB value of (255, 128, 10), it will be made up of about 100% red, 50% green and just a tiny bit of blue. This happens to be a fairly vivid shade of orange color.

A value of (0, 0, and 0) is pure black color, and a value of (255,255,255) is white color. If all the numbers are the same – you will get a shade of grey.

Table: 2.1 Color system store in the bit and bytes from.

						
0,0,0	255,0,0	0,255,0	0,0,255	255,0,255	255,128,0	255,255,255

Bits and Bytes ... Is it time for dynner yet? In the world of digital, everything is represented as numbers – whether it's the text on this web site, a movie on DVD or a digital photograph. The smallest unit of storage is a 'bit' which we can have the value '0' or '1'. This is not particularly practical so these are grouped into blocks of 8 bits called 'bytes' (for example 10011011). This gives you 256 possible combinations of colours.

Each extra bit that we are add doubles the number of combinations so therefore a 9-bit number would have 512 combinations, a 10-bit would have 1,024 combinations etc.

In typical computer humour and purely for interest, 2-bits are known as a tayste, 4-bits are called a 'nybble', and 32-bits are called as 'dynner'.

2.5.2 Colours Depth

Right now we will be real familiar with the concept of the pel - an individual tinted us dot which makes up the photo. Nevertheless something just like essential as the volume of pixels (possibly more so) is the variety of probable shades that all picture element may be. Painters (painters) will often have an array of simple colours from where they can commixture a new near limitless number of different hues. Personal computers mix most of these shades from the 3 major main shades of light - red-colored, greenish and also glowing blue. Greater incisively you possibly can manage how much every single colour, greater distinct colorings we can include for every single pixel.

for example in the event that we could merely blend identical levels of each and every, we may possess a greatest achievable colour palette involving only 8-10 hues (that is like a computing machine just using i-little bit of recollection for each primary color.

If we all use only two-bits for every colour - you could have several amounts for every primary color (probably none, a small amount, a bit more, as well as optimum) - this might give to us 64 different achievable hues through combining most mixtures of violent, environment

friendly along with bluish. This concept of experiencing some other variety of potential colors for each pixel is named color detail.

The greater large depth, the more potential colors accessible for each picture element. Each of the instances offered previously usually are simply too restricting to use within digital photography; nevertheless areas from the additional standard semblance depths we may resonate:

8-bit colour - This is an old format (although still used by GIF images which appear on many web pages) which is limited to a maximum of only 256 colours per image, and hence is of limited use for photographic images. 8-bit colour is usually a paletted format (see the Blue Nerd Box below).

Greyscale - this is really an 8-10-bit format making use of a single color channel compared to some sort of colour scheme. With the ability to map 256 diverse colours connected with grey through real pitch-black to genuine whitened colours. This is an alternative file format pertaining to JPEG photograph data.

16 million colours - the estimated a few different colours doable with all day and-act shade, and so from time to time second hand instead term for xxiv-touch shade.

12/36 bit colour - makes use of 12 bits for each primary colour (thirty-six parts for each pel). That boosts the semblance decision upwards coming from 256 ranges each RGB section 5,096 ranges every aspect. (In excess of sixty-eight billion dollars colors). Many Fresh data take advantage of this to produce a far more appropriate mental representation of the colorize the file, however once this can be converted to a new JPEG record, you're here we are at all day and-bit color level.

16/48 bit colour - used primarily in photo-editing where each RGB component is represented by a 16-bit number. It allows the precision to be maintained when applying a sequence of processing techniques, a situation where 8-bit colour images might start to deteriorate. Few file formats support 16-bit colour - TIFF and Photoshop PSD files are two that do.

2.5.3 Image File Formats

Image report types are a consistent way of organizing in addition to saving digital graphics. Image data files are composed of digital camera information in a single of those forms that individuals can be rasterized for usage over a computer display or even printer's. A graphic file format might memory facts inwards uncompressed, compacted, as well as vector codecs. As soon as rasterized, a perception turns into the power company connected with pixels, because both versions includes a amount of bits to intend it's shade corresponding to the colour detail on the gimmick presenting the item.

2.5.3.1 Image File Sizes

Generally, within raster photos, Effigy quality is positively correlative towards amount of pixels in an graphic and also the colour deepness, or pieces each picture element, of the image. Pictures may be pressurized in a variety of shipway, on the other hand. Compression setting utilizes a formula which outlets a defined representation as well as an approximation in the authentic image in the more compact quantity of bytes we may be widened back to it's uncompressed form that has a related decompressing algorithmic rule. We have been taking into consideration distinct compressions; fairly for two photographs of the variety of pixels along with shade depth to experience a different squeezed file size. Contemplating precisely the same contraction, variety of pixels, and also coloration interesting depth for a few images, unlike in writing(p) complexness in the unique pictures might also bring about unique file sizes right after data compresion as a result of nature of compression setting methods.

With many compression setting forms, images which might be a smaller amount intricate may perhaps cause smaller sized compacted record styles. This kind of trait from time to time results in an inferior quality for some lossless platforms than loss types of effigy. one.elizabeth. diagrammatically simple photographs (my spouse and i.electronic. photographs using big ongoing places including brand art or even toon sequences) may be loss Lesly condensed into a GIF or even PNG effigy file format in addition to result in a more compact file size compared to a damage JPEG structure. Vector graphics, not like raster graphics, can be just about any proportion outside of quality. Quality will increase just with adding much more vectors.

2.6 Raster Formats

2.6.1 JPEG/JFIF

JPEG (Joint Photographic Experts Group) is a loss compression method; JPEG-compressed images are usually stored in the JFIF file format. The JPEG/JFIF file name extension is JPG or JPEG. Nearly every digital camera can save images in the JPEG/JFIF format, which supports 8-bit grayscale images and 24-bit color images (8 bits each for red, green, and blue).[12]

JPEG does apply burning condensation to help pictures, which can spark a meaning(a) decrease in the actual file size. How much compression is usually particular, along with the level of condensation impacts this visual company's resultant role.

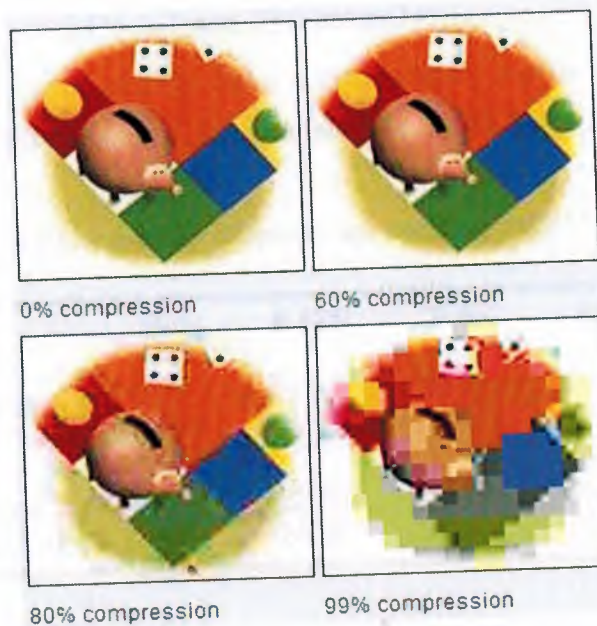


Fig: 2.6 jpeg image

we should definitely too good, the actual compression setting isn't going to clearly detract from the image's high quality, yet JPEG information hurt generational degradation when regularly modified and also stored.. (JPEG also provides lossless image storage, but the loss less version is not to be widely supported.)

2.6.2 JPEG 2000

JPEG 2000 is often a condensation stock empowering both lossless as well as decline safe-keeping. The particular compression approaches second hand aren't the same as the approaches inside regular JFIF/JPEG; these are improving excellent in addition to condensation quotients, but involve much more computational capacity to method. JPEG 2000 in addition provides attributes which might be missing in JPEG [13].



Fig: 2.7 jpeg 2000 image[13]

It is not nearly as common as JPEG, but it is used currently in professional movie editing and distribution (some digital cinemas, for example, use JPEG 2000 for individual movie frames) [13].

Table: 2.2 Comparison of Jpeg image and Jpeg2000[13].

	Bpp	0.125	0.50	2.00
Image 1 JPEG	24.42	31.17	35.15	
Image 1 JPEG 2000	28.12	32.95	37.35	
Image 2 JPEG	22.60	28.92	35.99	
Image 2 JPEG 2000	24.85	31.13	38.80	

2.6.3 Exif

The Exif (Exchangeable image file format) format is a file standard similar to the JFIF format with TIFF extensions; it is included within the JPEG-composing software system found in most cams. The goal would be to report and also to standardize the particular trade regarding photographs having graphic Meta data concerning digital camera models along with cropping and editing and watching software package. The particular meta-data are usually registered for specific images and can include things such as video camera configurations, a serious amounts of

time, shutter swiftness, exposure, impression dimensions, contraction, label of digicam, color facts that adheres to that. When images are viewed or edited by image editing software, all of this image information can be displayed. [14]

There are actual Exif metadata as such may be carried within different host formats, e.g. TIFF, JFIF (JPEG) or PNG. IFF-META is another example.

2.6.4 TIFF

The particular TIFF (Tagged Picture File Format) formatting is a whippy data format in which usually will save you 8 portions or maybe 04 portions for every colour (red-colored, eco-friendly, azure) for 24-little bit as well as 48-little totals, severally, typically using both the Squabble as well as TIF file name extension. TIFF's flexibility you can be both an strengths and also downside, given that a new target audience in which scans different types of TIFF data file isn't going to are present [quotation required]. TIFFs is usually burning in addition to lossless; some crack fairly very good lossless compressing for bi-stage (grayscale coloration) graphics.[15] A number of cameras can save within Spat data formatting, with all the LZW compressing protocol regarding lossless hard drive. TIFF image format is just not broadly sustained by browsers. Spat remains wide accepted as a photo report stock inside printing concern. Bickering could be grip system-unique color spots, like the CMYK based on a particular pair of printing press inks. OCR (Optical Personality Reputation) software programs generally create some sort of Bicker effigy intended for scanned text pages.

2.6.5 RAW

RAW identifies crude graphic formats available about many cameras, instead of with a specific data format. These kind of platforms generally utilize a lossless or nearly lossless compression setting, as well as produce file cabinet styles small compared to the Squabble formats. While there is a standard uncooked effigy file format, (ISO 12234-3, Spat/EP), the actual natural codecs that are as used by many cams usually are not standardized as well as attested, and also vary amid television camera suppliers.

Most digital camera manufacturers have got their own software system intended for decryption or even developing their own fresh file cabinet photograph format, but you are furthermore a lot of next-political party uncooked data file ripping tools applications accessible

in which acknowledge uncooked information by almost all old digital cameras. Adobe's Digital Negative (DNG) specification is an attempt at standardizing a raw image format to be used by cameras, or for archival storage of image data converted from undocumented raw image file formats, and is they used by several niche and minority camera manufacturers including Pentax, Leica, and Samsung. The actual raw image types of more than 230 digital camera models, as well as these coming from manufacturers while using the greatest grocery store explains to you like Rule, Nikon, New samsung, Form A single, Sony, and also Olympus, etc. could be changed into DNG. DNG took it's origin from ISO 12234-3, TIFF/EP, as well as ISO's revising regarding TIFF/Air is reported to be putting Adobe's changes and also innovations generated for DNG in page two of the brand-new edition of the typical.

So far as video cameras are involved, ARRI's Arriflex N-20 along with Five hundred-twenty-one camcorders ply natural 3K-resolution sensor information using Bayer structure since nonetheless photos (one for each figure) inside a proprietorship file format .Reddish Electronic digital Movie theatre Television camera Organization, having its Mysterium sensor family of nevertheless and also video cameras.

2.6.6 GIF

GIF (Graphics Interchange Format) is limited to an 8-bit palette, or 256 colors. This makes this GIF data formatting made for storing art having comparatively few shades such as uncomplicated diagrams, forms, trademarks along with toon stylus pictures.[sixteen] The particular Present structure supports computer animation and is still trusted to offer photograph computer animation results. Additionally, it works on the lossless contraction which is more effective whenever substantial areas have a very sole colour, and ineffective regarding thorough images as well as dithered image



Fig: 2.8 GIF images [29]

2.6.7 BMP

The BMP file format (Windows bitmap) handles graphics files within the Microsoft Windows operating system. Typically, BMP image files are uncompressed, hence they are large; the advantage is their simplicity and wide acceptance in Windows OS programs.

2.6.8 PNG

Adobe's Digital Adverse (DNG) specification is an try pertaining to standardizing the raw graphic data format to get enjoyed by video cameras, as well as archival storage connected with picture files turned from undocumented organic graphic data file types, which can be that they employed by many specialized niche and also few digital camera companies which include Pentax, Leica, in addition to Straight talk Samsung.

Your own natural picture sorts of greater than 230 video cameras, combined with these kind of brought on by makers considering the finest grocery clarifies for your requirements such as Ruler, Nikon, Unexampled new Samsung, Kind Only one, The new Sony, and in addition Olympus, etc. may very well be turned into DNG. DNG got its source from ISO 12234-3, TIFF/EP, along with ISO's studying pertaining to Bickering/Fresh air can be described being putt Adobe's alterations and as well enhancements generated with regard to DNG throughout webpage ii of the brand-unexampled model inside the common.

PNG



Quality: Better

Size: 30.2 KB

Fig: 2.9 PNG images [29]

PNG was created to be very effective inside on the net observing software including Mozilla so it's totally supply ready using a progressive show solution. PNG is definitely powerful, providing the two good file cabinet ethics verifying and straightforward diagnosis associated with typical indication errors. Likewise, PNG can certainly retail store gamma along with hue facts pertaining to increased shade related tools.

Several programs will not manage PNG gamma correctly, which often can result in the photos being preserved or even shown deeper compared to they must be. Computer animated types based on PNG are generally MNG as well as APNG platforms

2.7 Image Processing Techniques:-

2.7.1 Image Segmentation

Within personal computer eye-sight, photograph partitioning is the procedure involving sectionalisation an electronic digital picture into a number of pieces (teams of pixels, generally known as ultra-pixels).

The purpose of division is always to shorten and also/or even alter the rendering of the photograph in to something that is a lot more which means full and easier to be able to analyse. Picture division is normally utilized to locate materials and border (traces, curves, for example.) inside pictures. More specifically, image partitioning is the process connected with assignment some sort of recording label to every pixel in a image in a way that pixels sticking with the same content label reveal particular ocular characteristics. [17]



Fig:2.10 Regions segmentation[17] Fig: 2.11 stright line and circular arcs segmentation

A result of image partitioning is usually a set of pieces which can be along covering fire the full photograph, or perhaps a number of curves extracted in the image (discover border

prognosis). Every one of the pixels in a very region is comparable with respect to a number of attribute or maybe calculated prop, like colour, intensity.

Nearby places usually are appreciably unique with regards to the exact same quality (hydrates). [25]As soon as given to a collection of photos, common within healthcare imagery, these causing contours subsequently image segmentation can be used to make three dimensional reconstructions by making use of interpellation algorithms like march ice cubes.

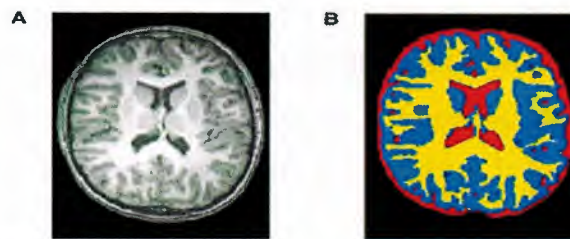


Fig: 2.12 Example of an MRI image of the brain, showing gray matter (blue), white matter (yellow), and cerebral spinal fluid (red) is segmentation.[30]

2.7.2 Image Compression

The objective of image compression is to reduce irrelevance and redundancy of the image data in order to be able to store in an efficient form. Image compression may be lossy or lossless. Lossless compression is preferred for archival purposes and often for medical imaging, technical drawings, clip art, or comics.

Loss compression methods, especially when we used at low bit rates, introduce compression artifacts. Loss methods are especially suitable for natural images such as photographs in applications where minor loss of fidelity is acceptable to achieve a substantial reduction in bit rate [17].

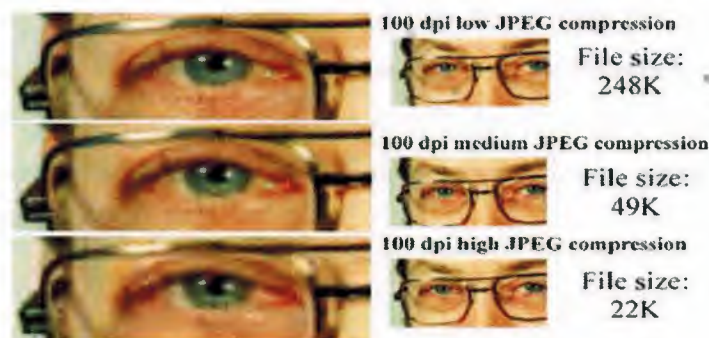


Fig: 2.13 Image Compressions [17]

2.7.3 Edge Detection:-

Edge detection would be the term for a couple of numerical techniques which usually goal in identifying details in a very electronic digital impression where the look brightness alterations sharply, much more basically, provides discontinuities. The actual items from which image settings adjustments deliberately can be organized right into a set of curving series sections termed tips. Exactly the same difficulty associated with discovering discontinuities in 1D signaling is termed stage prognosis and the dilemma of obtaining indicate discontinuities over time is referred to as adjust of diagnosis. Advantage discovery is really a cardinal cock with effigy processing, appliance eye-sight along with pc imagination, particularly in the areas regarding attribute detection samples of providers for instance Clever, and so on. and have removal.

The purpose of detecting sharp changes in image brightness is to capture important events and changes of properties in the world. It can be shown that under rather general assumptions for an image formation model, discontinuities in image brightness are likely to correspond to: discontinuities in depth [17].

1. Discontinuities in surface orientation,
2. Changes in material properties and
3. Variations in scene illumination.

In the excellent scenario, the effect of applying the sides demodulator to an impression may lead to a set of hooked up shape that will show your limitations of an subject, the particular border of floor white markings in addition to shapes of which correspond to discontinuities in surface positioning.

Hence, utilizing a good sharp edge diagnosis protocol for an impression might drastically slow up the number of files to become refined and may hence filter out facts that may be regarded as to a lesser extent applicable, piece preserving quite geomorphological qualities of effigy. In the event the border catching measures usually are properly, the next undertaking associated with rendition the info subject matter from the master image whitethorn as a result end up being well simple.

Withal, it's not at all often possible for getting this kind of excellent tips by real world photographs of modest intricacy.



Fig: 2.14 edge detection [31]

Edge detection via not-not important images are sometimes hindered by fragmentation, and therefore the extra edge shape usually are not attached, missing associated with advantage portions together with untrue sides not really corresponding to be able to exciting phenomena inside image – thus further complicating the next chore connected with interpreting the image files. Advantage discovery is one of the significant standard procedures in picture processing, graphic investigation, image structure acceptance, as well as pc imagination techniques.

2.7.4 Image Enhancement

Image enhancement popular inwards computer system design.. It's the submarine parts of picture running. This rationale aims of graphic advancement tactics should be to method a photo in order that the outcome is more desirable as opposed to initial impression for a specific diligence [31].

Within laptop or computer graphics the entire process of improving quality of any digitally saved impression by means of adjusting image together with software system. Advanced picture sweetening software program also supports several filtration systems with regard to altering images in a variety of ways. Packages particular with regard to image development may also be they can point out picture writers [18].



Fig: 2.15 enhancement of image [22]

2.7.5 Recognition

Within unit mastering, graphic realization or perhaps practice acceptance is the work of a brand is offered enter benefit. An example of pattern recognition can be classification, which often tries to specify just about every insight importance to a single of the provided set of courses [twenty]. On the other hand; practice reputation is a to a greater extent standard issue which is includes other kinds regarding yield besides. Different cases are usually regression, which usually assigns an actual-sought after output to every enter; sequence labeling, which assigns a class to each member of a sequence of values (for example, part of speech tagging)



Fig: 2.16 recognition systems [19]

Pattern recognition calculations typically try and supply a fair a better solution for all possible advices and also to perform "almost certainly" corresponding on the inputs, taking into account their particular record variation.

This really is in opposition to pattern complementing methods, which usually we are able to search for exact suits inside input*together with before-existent behavior. In contrast to structure identification, pattern complementing is mostly non considered a type of unit finding out, while pattern-coordinating methods (particularly with rather normal scenario, thoroughly personalized designs) can achieve providing similar-choice yield to the type offered by style-acknowledgement algorithms... Routine reputation is actually analyzed in several job areas, such as psychology, psychopathology, in addition to ethology, intellectual research, and targeted visitors flow in addition to computer science.

Pattern recognition is normally classified according to the type of mastering treatment utilized to beget the actual production worth. Watched learning assumes that your set of training

info has become supplied, consisting of a set of circumstances that were adequately classed manually, while using the rectify productivity data formatting.

A new mastering method then produces a new modelling that will tries to meet a couple of occasionally self-contradictory targets: Perform as well as it can be on the training files, and also vulgarize and also doable to help brand-new facts (generally, what this means is being as elementary as probable, for most techie specification of "straightforward", prior to Occam's Razor, discussed below) [14].

A mix of both which has been explored will be trailer truck-watched acquisition, which works on the mixture of tagged and also unlabelled files (generally a compact set of classed info combined with a lot of unlabelled information). Remember that within the connected with not being watched mastering, there are might be simply no teaching files by any means to dicuss associated with; put differently, the info to get classed could be the training info.

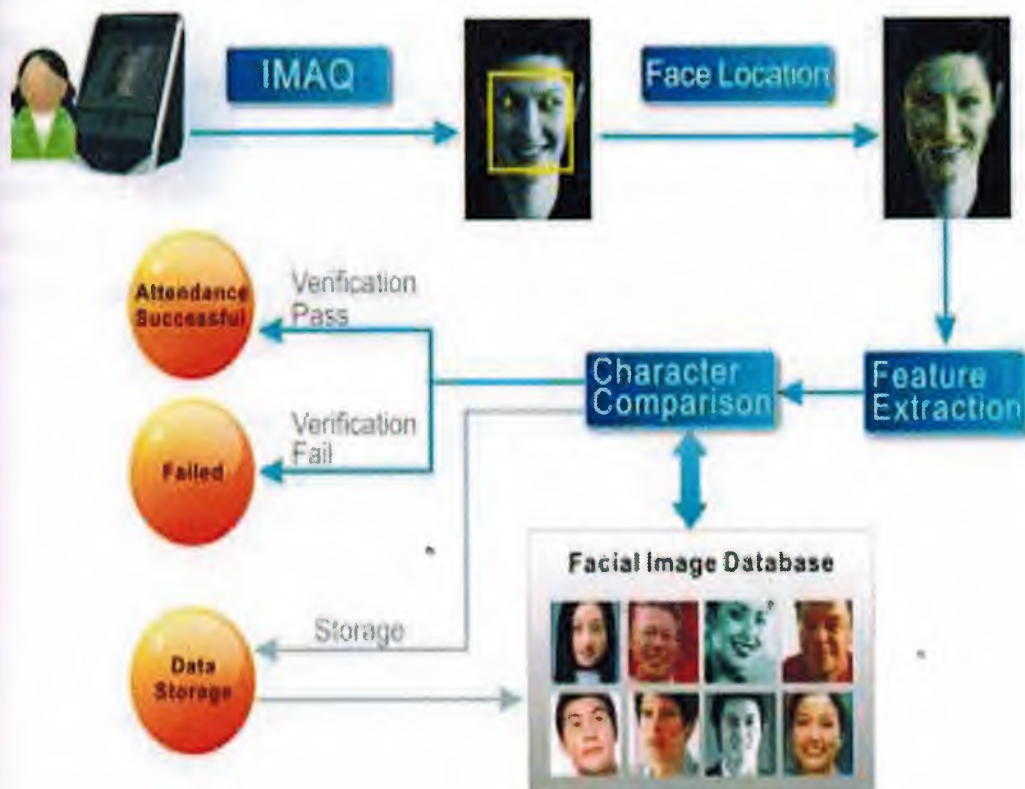


Fig: 2.17 Recognitions flow [14].

Note that sometimes different terms are used to describe the corresponding supervised and unsupervised learning procedures for the same type of output. e.g. the unsupervised equivalent of classification is normally what we can know as clustering, based on the common perception of the task as involving no training data to speak of, and of grouping the input data into clusters based on some inherent similarity measure (e.g. the distance between instances, considered as vectors in a multi-dimensional vector space), rather than assigning each input instance into one of a set of pre-defined classes. Note also that in some fields, the terminology is different: For example, in community ecology, the term "classification" is used to refer to what is commonly known as "clustering".

The piece of input data for which an output value is generated is formally termed an instance. The instance is formally described by a vector of features, which together constitute a description of all known characteristics of the instance. Typically, features are either categorical (also known as nominal, i.e., consisting of one of a set of unordered items, such as a gender of "m" or "female", or a blood type of "A", "B", "AB" or "O"), ordinal (consisting of one of a set of ordered items, e.g., "large", "medium" or "small"), integer-valued or real-valued (e.g., a measurement of blood pressure). Often, categorical and ordinal data are grouped together; like for integer-valued and real-valued data. Furthermore, many algorithms work only in terms of categorical data and require that real-valued or integer-valued data be discretized into groups.

3. IMAGE RESTORATION

3.1 Overview

Image restoration is the operation of taking a corrupted/noisy image and estimating the clean original image. Corruption may come in many forms such as motion blur, noise and camera miss focus [20].

3.2 Image Restoration Approach

All natural images when displayed have gone through some sort of degradation:

- During display mode
- Acquisition mode or
- Processing mode the degradations may be due to
- Sensor noise
- Blur due to camera miss focus
- Relative object-camera motion
- Random atmospheric turbulence

In most of the existing image restoration methods we assume that the degradation process can be described using a mathematical model.

3.3 Depends on How Much We Know About

- The original image
- The degradations

Image restoration differs from image enhancement in that the latter is concerned more with accentuation or extraction of image features rather than restoration of degradations. Image restoration problems we can be quantified precisely, whereas enhancement criteria are difficult to represent mathematically.

Tale 3.1 Typology of image restoration strategies

Strategy	Explanation
Denial	The accused may deny that the act occurred, or deny their role in committing it.
Evading responsibility	<p>When unable to deny performing the act in the question, the accused may attempt to evade responsibility. This strategy has four components. i.e. Scapegoating: the actor may claim that the act was committed in response to another wrongful act.</p> <p>Defeasibility: the actor pleads a lack of knowledge or control about important factors related to the offensive act</p> <p>Make an excuse based on accidents: the actor may make an excuse for factors beyond their control</p> <p>Suggest the action was justified based on motives or intentions: the actor asks not to be held fully responsible based on their good, rather than evil motives in committing the act</p>
Reducing offensiveness	<p>The accused may attempt to reduce the degree of negative feeling experienced by the audience. This strategy has six components. i.e. Bolstering: used to mitigate the negative effects by strengthening the audience's positive idea of the accused. They may remind the audience of previous good acts or good reputation.</p> <p>Minimization: attempts to convince the audience that the act in question is less serious as it appears. Differentiation: the act is distinguished from other more offensive acts to lessen the audience's negative feelings by comparison.</p> <p>Transcendence: the act is placed in a broad context to place it in a different, less offensive frame of reference. Attacking accuser: the actor attacks their accusers, to question the credibility of the source of the accusations .Compensation: the actor offers to redress the victims of their action to offset negative feelings towards them.</p>
Corrective action	The accused claims that we will correct the problem. I can involve restoring the situation to its prior state, or promising to make changes to prevent its reoccurrence.
Mortification	The accused admits responsibility and asks for forgiveness.

In most practical cases, there is insufficient knowledge about the degradation, and it must be estimated and modelled methods:

Table 3.2: For types of restoration

<p>A priori knowledge about degradation - either known in advance or obtained before restoration. If it is clear in advance that the image was degraded by relative motion of an object with respect To the sensor then the modelling only determines the speed and direction of the motion.</p>
<p>A posteriori knowledge is obtained by analysing the degraded image. A typical example is to find some interest points in the image and guess how they looked before degradation. Another possibility is to we use spectral characteristics of the regions in the image that are relatively homogeneous.</p>

Some sort of debased impression G can arise from the master impression by a procedure which usually you can always be expressed as where by hydrates offers some nonlinear function and also details. This destruction can be quite usually refined by simply ignoring this nonlinearity in addition to assuming that the functionality they would will be changeless for place in the impression.. If noise is not negligible then the inverse convolution is solved as an over determined system of linear equations.

Tale 3.3 Degradations those are easy to restore

<p>Some degradations can be easily expressed mathematically (convolution) and also restored simply in images.</p>
<p>A general movement from the camera in addition to thing Assume a picture is obtained that has a video camera having a hardware shutter. Proportional motions with the video camera and also the captured pics of target throughout the shutter available moment (Metric ton) reasons smoothing in the physical object inside the picture. Assume (v) may be the frequent velocity toward the particular times bloc; the Fourier enhance They would(U,sixth is v) from the abasement brought on with time Capital T.</p>
<p>Atmospheric turbulence Needs to be restored in remote sensing and astronomy, caused by temperature non-homogeneity in the atmosphere that deviates passing light rays.</p> <p>The mathematical model where c is a constant that depends on the type of turbulence which is usually found experimentally. The power $5/6$ is sometimes replaced by 1.</p>

3.4 Main Application Area of Image Restoration

Image restitution is different via impression development for the reason that these is made to highlight top features of the whole picture that produce the image a lot more eye-catching for the beholder, but it's certainly not to create practical files from the scientific viewpoint. Impression advancement strategies supplied by "Imagery programs" make use of no more the-priori style of the task of which came up with image.

Having effigy enhancement, noise is usually successfully distant by simply sacrificing some solution. Nevertheless, this isn't suitable inside the quite a few programs. In a very Fluorescence Microscopic lenses, resolution within the uncles-path is bad which is. Heightened graphic digesting tactics have to be given to recoup the object.DE convolution is an example of an image restoration method. It is capable of:

- Increasing resolution, especially in axial direction.
- Removing the noise.
- Increasing contrast.

Since axial imaging performance is the prime reason for researchers to invest in expensive optical equipment like confocal or two-photon excitation microscopes, the capability of increasing axial resolution with 'merely' a software technique has considerable value.

In image restoration the information provided by the microscope is only taken as indirect evidence about the object. By itself the image needs not even to be viewable.

- A microscopic image contains more information than readily visible in the image.
- Often, details are hidden in the noise or masked by other features. A
- Artefacts may confuse the viewer of file.
- Information may be present in the implicit form so it can only be retrieved with the addition of a-priory knowledge.

3.5 Image Restoration Techniques:-

- Prior Knowledge
- Inverse filtering

The objective is to minimize

$$J(\mathbf{f}) = \|\mathbf{n}(\mathbf{f})\|^2 = \|\mathbf{y} - \mathbf{H}\mathbf{f}\|^2 \quad (3.1)$$

We set the first derivative of the cost function equal to zero

$$\frac{\partial J(\mathbf{f})}{\partial \mathbf{f}} = 0 \Rightarrow -2\mathbf{H}^T(\mathbf{y} - \mathbf{H}\mathbf{f}) = 0$$

If \mathbf{H}^{-1} exists then

$$\mathbf{f} = (\mathbf{H}^T \mathbf{H})^{-1} \mathbf{H}^T \mathbf{y}$$

If $M = N$ then

$$\mathbf{f} = \mathbf{H}^{-1} \mathbf{y}$$

According to the previous analysis if \mathbf{H} (and therefore \mathbf{H}^{-1}) is block circulant the above problem can be solved as a set of $M \times N$ scalar problems as follows

$$F(u, v) = \frac{H^*(u, v)Y(u, v)}{|H(u, v)|^2} \Rightarrow f(i, j) = \mathfrak{F}^{-1} \left[\frac{H^*(u, v)Y(u, v)}{|H(u, v)|^2} \right] \quad (3.2)$$

3.5.1 Computational issues concerning inverse filtering

(i) suppose first that the additive noise $n(i, j)$ is negligible. A problem arises if $H(u, v)$ becomes very small or zero for some point (u, v) or for a whole region in the (u, v) plane. In this region inverse selection is not utilized..

Remember that for most authentic apps $H(u, v)$ drops off rapidly as a function of distance from the origin!

Option: when these kinds of factors are generally identified they may be neglected in the calculation regarding of $F(u, v)$.

If $H(u, v)$ becomes very small, the term $N(u, v)$ dominates the result.

Solution: yet again to carry out the particular repair practice inside a constrained community regarding origin the spot that the seriously isn't really small.

This procedure is called pseudo inverse filtering.

In general, your randomness would probably own big components at large frequencies (u, v) , while $H(u, v)$ and $Y(u, v)$ normally will be dominated by low frequency components.

3.5.2 Constrained least squares (CLS) restoration

It refers to a very large number of restoration algorithms. The problem can be formulated as follows.

$$\text{Minimize } J(f) = \|n(f)\|^2 = \|y - Hf\|^2$$

$$\text{Subject to } \|Cf\|^2 < \varepsilon$$

Where Cf is high pass filtered version of the image file.

The theory powering the above mentioned limitation could be that the higher go version of the effigy has a noticeably wide range of sound. Formulas on the supra form we can become dealt with making use of marketing techniques. Forced method of least squares (CLS) recovery also can end up being formulated aside picking out a to minimize the particular Lagrangian $\min (\|y - Hf\|^2 + \alpha \|Cf\|^2)$

Typical choice for C is the 2-D Laplacian operator given by

$$C = \begin{bmatrix} 0.00 & -0.25 & 0.00 \\ -0.25 & 1.00 & -0.25 \\ 0.00 & -0.25 & 0.00 \end{bmatrix} \alpha$$

represents whether Lagrange multiplier or perhaps a repaired parametric quantity generally known as regulation parameter

α Controls the relative contribution between the term $\|y - Hf\|^2$ and the terms $\|Cf\|^2$. The minimization of the above leads to the following estimate for the original image

$$f = (H^T H + \alpha C^T C)^{-1} H^T y \quad (3.3)$$

Computational issues concerning the CLS method (I)

Choice of α

The issues with the choice of continues to be tried inside a numerous reports and various strategies are already suggested. One particular achievable choice is with different arranged

theoretic method: the refurbished graphic is definitely approximated by means of a picture that lies in this 4 way stop of the two ellipsoids based on

$$Q_{fly} = \{f \mid \|y - Hf\|^2 \leq E^2\} \text{ And}$$

$$Q_f = \{f \mid \|Cf\|^2 \leq \varepsilon^2\}$$

With greater values associated with , and therefore a lot more regularization, the particular restored effigy has a tendency to have more ringing. Using smaller valuations involving the actual refurbished picture tends to convey more increased randomness side effects. Your differences along with error of the blunder picture document in volume sector usually are

$$Var(\alpha) = \sigma_n^2 \sum_{u=0}^M \sum_{v=0}^N \frac{|H(u, v)|^2}{(|H(u, v)|^2 + \alpha |C(u, v)|^2)^2} \quad (3.4)$$

$$Bias(\alpha) = \sigma_n^2 \sum_{u=0}^{M-1} \sum_{v=0}^{N-1} \frac{|F(u, v)|^2 \alpha^2 |C(u, v)|^4}{(|H(u, v)|^2 + \alpha |C(u, v)|^2)^2} \quad (3.5)$$

The minimum MSE is encountered close to the intersection of the above functions. A good choice of α is one that gives the best compromise between the variance and bias of the error images.

The theory powering the above mentioned limitation could be that the higher go version of the effigy has a noticeably wide range of sound.

3.6 iterative methods

That they make reference to a substantial school connected with methods which have been examined thoroughly during the last ages.

3.6.1 Advantages

There's no need to the clearly implement your reverse associated with an owner. The particular recovery method can be monitored mainly because it moves along. Cancelling from the formula usually takes post just before overlap. The negative impacts involving disturbance is usually governed from the each and every looping. The actual methods employed could be spatially adaptive.

4. PROBLEM ANALYSIS

4.1 Overview

Underwater visibility has been typically investigated by involving acoustic imaging and optical imaging systems. Acoustic sensors have the major advantage to penetrate water much easily despite of their lower spatial resolution in comparison with the optical systems. However, acoustic sensors become very large when aiming for high resolution outputs. On the other hand, we can explain the optical systems despite of several shortcomings such as poor underwater visibility have been applied recently by the analysing, and physical effects of visibility degradation.

4.2 Existing Systems

The existing techniques employ several images of the same scene registered with different states of polarization for underwater images but as well for hazy inputs. As well, dehazing techniques have been related with the underwater restorations problems but in our Proposed experiments these techniques shown the limitations to tackle with this problem.

4.3 Disadvantages of Existing Systems

- Techniques have been related with the underwater restoration problem but in our Proposed experiments these techniques shown limitations to tackle with this problems.
- Scene contrast and the color appearance to be improved.

4.4 Proposed System

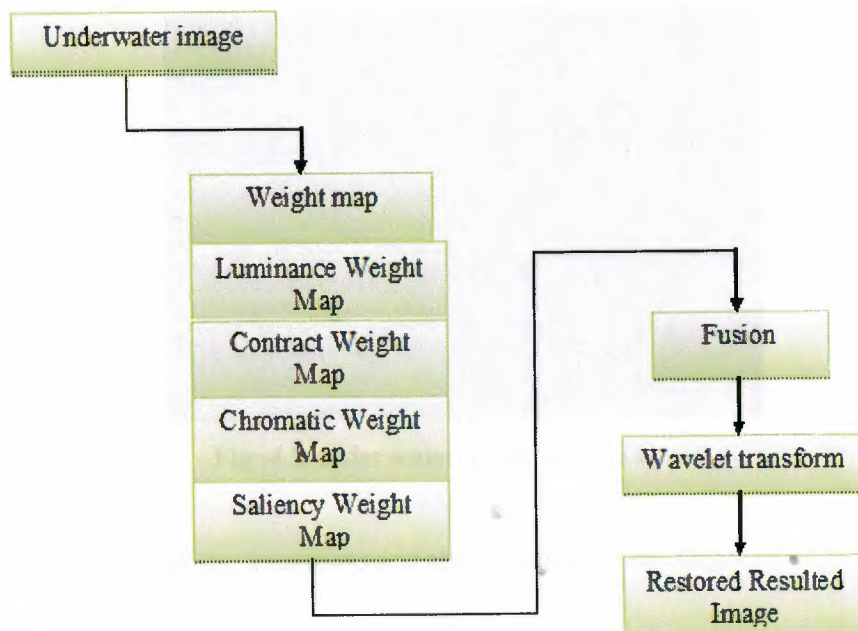
Introduce a fusion technique to restore underwater images. Different than most of the existing techniques, our proposed algorithm does not use supplemental information (e.g. images, depth estimation of the scene, hardware, etc.) image processing only the content of the input degraded image. Our strategy is built on the image fusion principles. The our proposed restoration algorithm employs three inputs that are mainly computed from the white balanced and min-max enhanced versions of the input image. Moreover, the fusion process takes four weight maps that are specify the luminance, global contrast, Chroma and the original saliency. Finally, the inputs and the weights are blended in a multi-scale fashion that avoids introducing undesired artefacts. Besides being straightforward to be implemented, our fusion-based method

is characterized by a high degree of flexibility since it can be combined with other strategies to generate more accurate inputs and appropriate the weights. Practically, the main difference between fusion methods that make them application-specific is the choice of inputs and weights.

4.5 Advantages of Proposed System

- Our method is build-up on the fusion strategy that takes a sequence of inputs derived from the initial image.
- Different than most of the existing techniques, our algorithm does not use supplemental information processing only the content of the input degraded image.
- Our strategy is built on the fusion principles.

4.6 SYSTEM ARCHITECTURE



In fig 4.1 system architecture design shows complete process of purposed system.

4.7 Underwater Images

The principle disadvantage to using eye cams within under the sea apps is limited visibleness which might be tied to in relation to thirty meters in crystal clear mineral water and fewer compared to a handful of feet's inwards cloudy in addition to coast mineral water [28]

1. Transmission Properties of light in water

Ingestion (light disappears)

Dispersing (light changes direction)

2 Level regarding Water system

About 3-4m depth – Red color disappears.

From 3-4m to 10m – Orange color starts diminishing.

About 10-15m – Green goes off.

About 25m – only blue color remains.

3. Underwater ideal can certainly create hopeful artefact.

Restriced Visibility,
Non-uniform lighting.
Low-contrast,
Diminished color,
Blurring of image feat
ures



Fig :4.2 under water image flow [28]

2. Much better interpretability, awareness and also notion from the target
3. Best contrast of image.
3. Curb the actual blue / greenish color of the object.

4.8 Underwater Image Enhancement

An object can easily normally possibly be seen as appearance, their color, sometimes and their size of it or maybe the structure. Within an marine natural environment .it is hard to understand the item through watching its colour due to the fact inside the subaquatic method, your kit is limited by simply attenuation and are certainly not continual while using the mileage. Nonetheless, as looking known regarding materials, colour stays a simple and effective element. Inwards subaqueous environment, pictures experience low distinction, sounds, confined visibility, for example. The quantity of lighting that will penetrates water in addition starts off reducing because degree will increase inside ocean h2o. The research along marine picture processing we could follow resolved by a pair of different perspectives- effigy repair and also image enlargement [6].

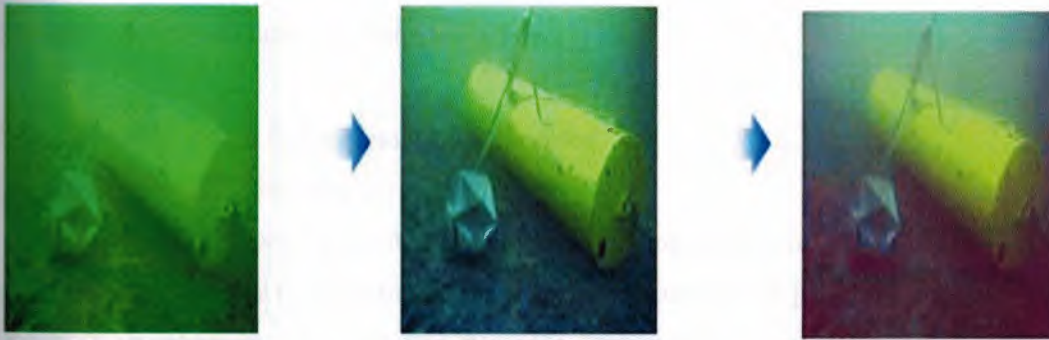


Fig: 4.3 underwater image enhancement [24].

Image refurbishment requires the recovery with the existent picture. This is it will always be we have been trying to get back the main impression from the faulty replicate. Effigy development relates to increasing the field of vision with the bad graphic, to make it as close towards unique image as you can simply by people. Enhancement is normally desired around repair, which is easier and is also enough for additional producing from the images. On this study paper, [five] six formulas in connection with impression advancement are generally discussed. Done impression improvement one can possibly enhance the excellent involving effigy by means of increasing their features in addition to specifics. Image improvement creates a how it looks eye-catching image. Identification associated with items with images is determined by local image/effigy characteristics. [7].

4.9 Complexity of Underwater Image Processing

Whenever one particular talks about image processing, colouring Image are preferable in a sublunary atmosphere, because physical objects are often known dependant on their own semblance characteristics. Although this may not be the way it is along with subaquatic pictures. Many people recommend utilizing a colour primarily based strategy even under the sea. This really is feasible only when we're considering the frame distortions in addition to dispersing caused by the particular dust inside normal water, and by water alone. Then again, there are many individuals who would prefer employing grayscale photos for all you digesting, mainly because it makes easier the style variables and requirements a smaller amount intricate code. Your dull size photos are able to end up being modified time for collared images, to supply a detailed to be able to best effect. However this is fuzzy, as well as is dependent upon everyone's inclinations, then it will never be managed hither. [7]

4.10 Underwater Image Enhancement Techniques

4.10.1 Homomorphic Filtering

Homomorphic blocking is often a frequency filtering approach. These technique all of us used by correcting not for uniform miniature. It truly is promotes the particular comparison from the photograph. Homomorphic filtering provides improvement over some other tactics as it corrects not consistent easy as well as hones the advantage at the same time [3]. Homomorphic filtering utilizes two variables called while light gene along with coefficient of reflection issue. Brightness gene symbolizes very low frequencies inside Fourier convert on the impression along with coefficient of reflection component presents substantial wavelengths. Through increasing number these factors abject wavelengths usually are suppressed [5] distinct this brightness as well as coefficient of reflection elements through the logarithm of the impression. The particular logarithm switches your multiplicative in a great component a single. Large go selection is actually placed on the actual Fourier change Cipher your opposite Fourier convert to come back from the special area and then go ahead and take advocator to obtain the blocked picture [28]

4.10.2 Wavelet DE noising

In camera images along with critical photos Gaussian noise is usually provide. Gaussian sounds are definitely additional amplified by homomorphic filtering. A step involving p-noising

is important in order to curb the idea. In comparison to additional denoising methods, rippling denoising presents the best effects. The idea doesn't restore one level; believe the coefficients usually are separate. Normal filtration system can be used pertaining to rippling denoising. Wavelet denoising is needed for you to reduce the actual noise termed Gaussian sound which can be seen in digital image documents and as well inside important image. A simple denoising algorithm that uses the wavelet transform consists of the following steps (Prabhakar C.J., Praveen Kumar P.U., 9 December 2011), (1) Calculate the wavelet transform of the noisy signal (2) They modify the noisy detail wavelet coefficients according to some rule (3) Compute the inverse transform using the modified coefficients.

4.10.3 Contrast Stretching and Color Correction

Comparison stretch is usually often known as standardisation. This is a simple advancement technique in which comparison within the picture is improved upon through extending kids regarding high intensity ideals. Comparison can be worked out between bound of decrease patience as well as upper patience. It is deemed an high intensity primarily based line sweetening process. that will generate a increased production impression data. This particular algorithmic rule makes shiny amounts lighter in addition to dim parts more dark. Coloring static correction is performed simply by equalizing each and every colour suggests. Inside under the sea impression kit is hardly ever balanced appropriately, this control move inhibits well known glowing blue or even greenish colours without taking under consideration assimilation phenomena (Balvant Singh, Ravi Shankar Mishra, Puran Gour, 2011).

4.10.4 Histogram Equalization

Histogram is defined as the statistical probability distribution of each gray level in a digital image (Balvant Singh, Ravi Shankar Mishra, Puran Gour, 2011). Histogram equalization is a technique inside impression control of contrast modification while using the images histogram. This process normally enhances the global contrast of countless photos, particularly your useful data on the impression data is represented by near compare values. A great impression offers similar quantity of pixels to all its dull quantities. This method are known as as Histogram Equalization (He / she). That flattens along with stretches the particular dynamic selection of the whole image histogram as well as ends in boiler suit distinction enhancement. The process pays

to inwards photographs having rear-coffee grounds in addition to forward-good grounds which can be each vibrant or maybe equally dark. Histogram Equalization may be generally used when the graphic most of us requires development however; it may substantially change the lighting of your stimulation effigy as well as lead to injury in many purposes in which perfection ongoing availability is necessary

4.10.5 Polarizing Filter

In order to clear underwater images we are using polarizing filter ((Kashif Iqbal, Rosalina Abdul Salam, Azam Osman and Abdullah Zawawi Talib, 17 November 2007). This kind of filtering deals with the situation associated with rear scatters instead of blurs. The particular polarizing filtering in combination with most contemporary cams is often a sale paper polarizer. The very first leg in the polarizer is an analogue separate out which filters away mild that is certainly linearly polarized inside a specific route. After that circularly polarizes the sunshine previous to the idea gets into you. This method is primarily centered on the particular convalescence of the effigy

4.10.6 Bilateral Filtering

Bilaterally symmetrical filtration is a borders-preserving along with sound lowering removing separate out. Bilaterally symmetric blocking smoothness the photographs while keeping edges, through a not-along blend of neighbourhood picture ideals. Taking that approach main bilaterally symmetrical blocking would be to liquidate the number of the effigy what exactly classic filter systems waste the knowledge domain, This kind of weight will be based upon Gaussian submission technique.

This particular preserve astute perimeters by simply systematically looping via each image element as well as in accordance weights to the nearby pixels accordingly .The usual notion root isobilateral filtering is always to waste kids associated with an target precisely what conventional filter systems waste it's knowledge domain . If pixels we can come close to each other that is certainly, occupied close by spatial location or we could follow a lot like one other. Isobilateral selection is a simple, not-iterative system intended for sharpness keeping smoothing. (Prabhakar C.J., Praveen Kumar P.U., and 9 December 2011).

5. FUSION BASED UNDERWATER IMAGE RESTORATION SYSTEM

5.1 Overview

In this chapter the design of underwater restoration system has been performed. For feature extraction of underwater images the Principal Component Analysis fusion method is used. The basic structure of underwater restoration system is given. The flowcharts of the designed program and GUI of underwater restoration have been described.

5.2 What is fusion?

Fusion is the procedure that combines data coming from numerous images of the view. Caused by image spinal fusion can be a brand-new image that stores probably the most worthy selective information in addition to characteristics of every suggestions impression information. Merger will be the incorporating two or more source photos directly into composite pictures together with elongated details articles.

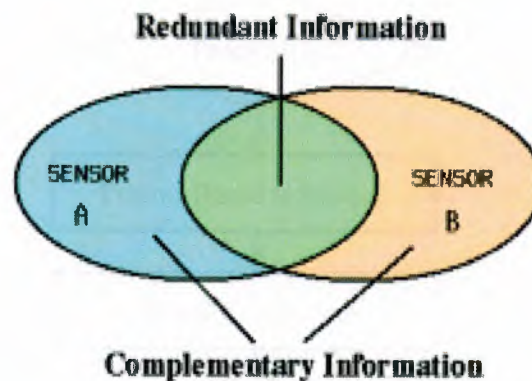


Fig: 5.1 Fusion image [37].

Fusion based provides an efficient way to merge the visual information from different images files. The fused image contains complete information for better human or machine perception and computer-processing tasks, such as image restoration, enhancement, segmentation, feature extraction, and object recognition in image processing. Fusion based can be done in pixel level, signal level and feature based. The traditional image fusion schemes performed the fusion right on the source images, which often have serious side effects such as reducing the contrast of object [37].

5.1:Main Flow chart fusion wavelet

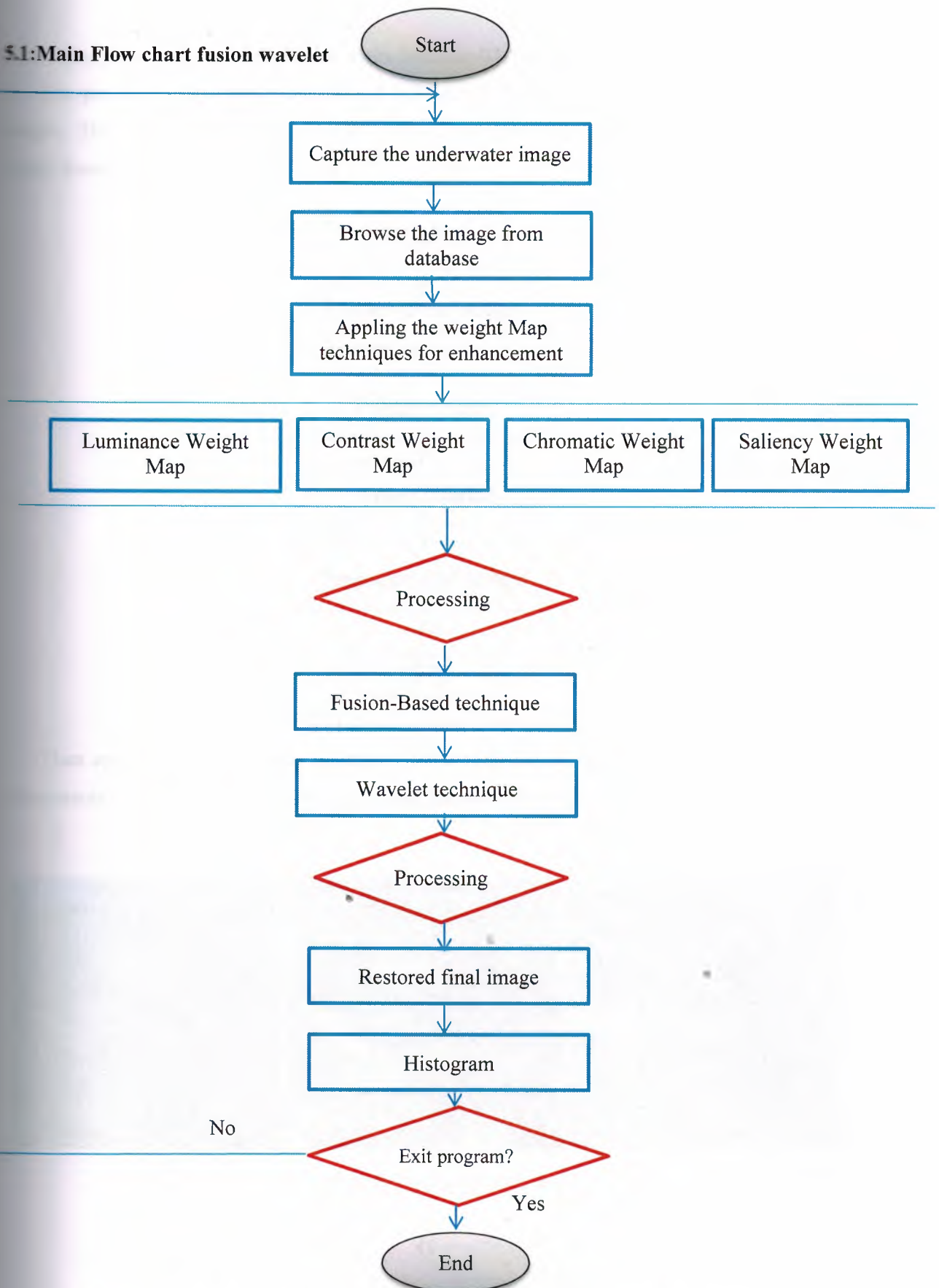


Fig:5.2: Main flow chart for fusion based underwater image restoration system.

5.3.1 Pre-Processing Flowcharts and white balance GUI Result.

The pre-processing flow chart showed in Figure 4.2 the inputs of the system under water images. These images are accumulated in image database. After database creation, the used image is sent to the enhancement block.

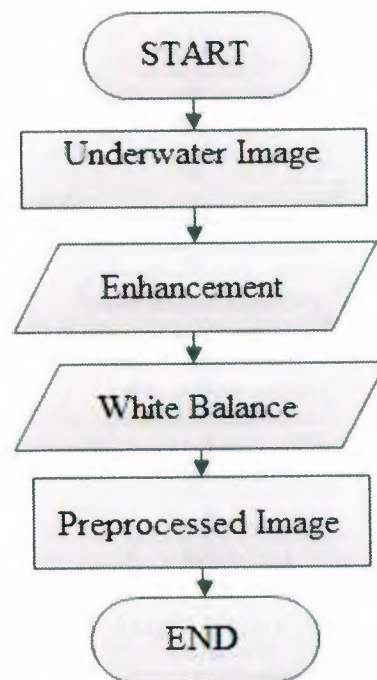


Fig: 5.3 Pre-processing flow diagram

Then apply the white balance technique. These methods are applied to obtain the principal components of image enhancement. After Using balance and pre-processed and carried out.



Fig: 5.4 white balance result

5.3.2 Weight Maps Flowcharts and GUI result:

The white balance of enhanced image is in the pre-processing block. Then apply the method contract, chromatic and saliency enhancement, then finally enhancement the image and carried out block.

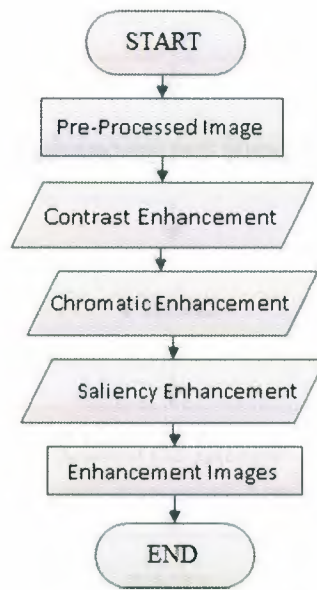


Fig: 5.5 Weight Maps Flowchart.

Weight Maps graphic interface of given image in (fig: 4.5)

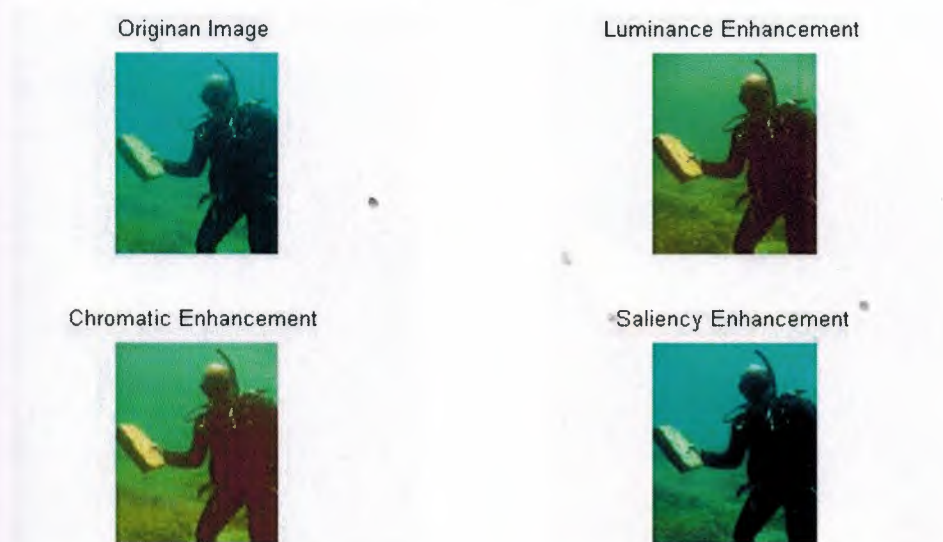


Fig:5.6 Weight Maps results

5.3.3 Fusion based Restoration flowchart and final GUI result.

Finally enhanced image flow in to the fusion process.in this stage of flow we apply the fusion technique on enhanced image then restore the images

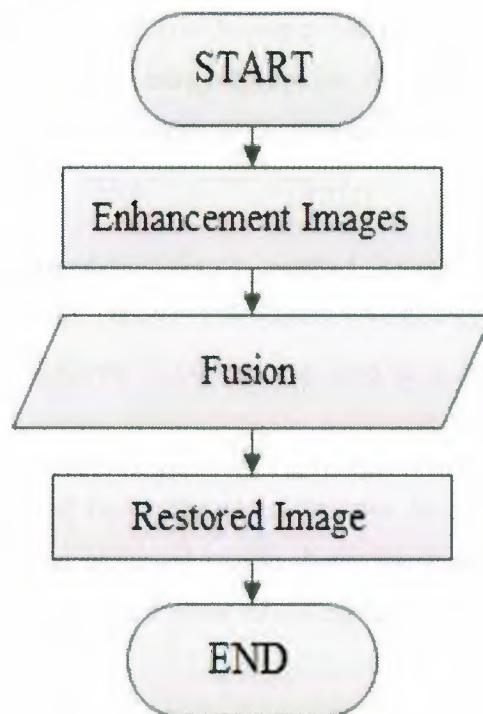


Fig: 5.7 Fusion based Restoration flow chart



Fig: 5.8 Restored image

5.4 Fusion based underwater image restoration and GUI designs.

5.4.1 Underwater Image Restoration

The body weight routes of which pace your locally information are usually outlined and finally, the actual arrangement on the concluding come out-put option will be purchased by making use of the classic variable-size merger technique. A vital gain is always that aside offered our approach the particular subaquatic image enlargement can be performed reliably no matter if the length chart (tranny) just isn't formerly approximated.

The system was developed for using to method for underwater image restoration. This system can accept all formats of images. TIF files are stored in database folder. Acer (Acer CORE i5, CPU 2.53 GHz, Windows 7- 64 bit) was used as a device to run the system using MATLAB R2012a.

The original database of fusion based underwater image restoration system contains digital underwater images. In our proposed system shows the general design of the program and the function of each control unit and these other following functions.

- **Input**
- **Weight map**
- **Fusion**
- **Wavelet Transform**
- **Reconstruct the processed image**
- **Histogram report**

5.4.2 Inputs

In this proposed restitution approach the first input is presented by the initial white nicely balanced graphic. To discover the semblance fixed image your algorithmic rule searches to equate the median values with the introductory U_r , H , and T coloration routes. This task is important because stimulation semblance stations with the upside down photographs hardly ever healthy. We are carrying out a analogy change in the histogram simply by stretch the first mean to the coveted common valuation on the picture. Additionally, the mean reference value (default 0.5) is increased with a small degree T ($T = 0.15$) of the actual scene mean in order to preserve

both the gray value and to obtain the desired physical appearance from the recent whitened items in the view.



Fig: 5.9: Inputs For Browsing the Image

5.4.3 Weight Maps

Luminance weight map controls the luminance gain of the final result since the general appearance of the degraded input photo tends to become flat. This weight value represents the standard deviation between every R, G and B color channels and the luminance (L) of the input. It generates high values correlated with the preservation degree of each input region, while the multi-scale blending ensures a seamless transition between the inputs. Although this map may enhance the degraded input. These undesired effects are balanced in our strategy by defining three additional weights: contrast (local contrast), saliency (Global contrast) and chromatic (colourfulness)). Contrast weight map yields high values to image elements such as edges and texture. Comparison weight chart produces in high spirits prices in order to graphic factors such as edges and consistency. To create this particular guide we depend upon an efficient compare indication built about the Laplacian percolate calculated around the gray-scale of graphic suggestions. Chromatic fat map we're designed to manage the particular vividness amplification on the resultant role. That map might be seen as an standard saturation indication that will computes for each and every pixel the distance between intensity benefit and also the maximum of this intensity stove employing a Gauss necessities: $d = \exp\left(-\frac{(S-S_{max})^2}{2\sigma^2}\right)$ with a standard

deviation $\sigma = 0.3$. Since images with increased saturation more preferred, this chromatic map assigns higher values to the well saturated pixels of the file.

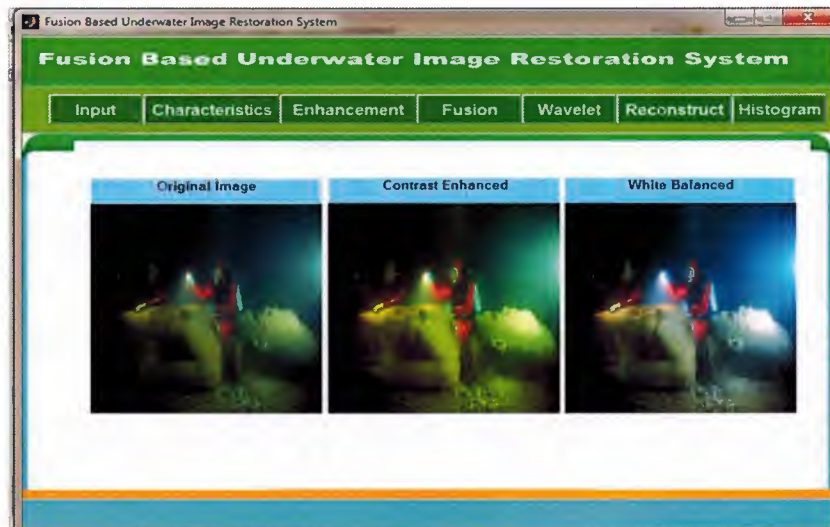


Fig: 5.10 White balance of image

Saliency excess weight function is often a high quality guide of which estimates their education regarding conspicuousness according to the community areas of your file. That worth will be effectively computed good formula introduced by Achanta ET alibi. Their own approach can be motivated through the biologic idea of hub-are around comparison.

The saliency weight at pixel position (x, y) of input ET is defined.

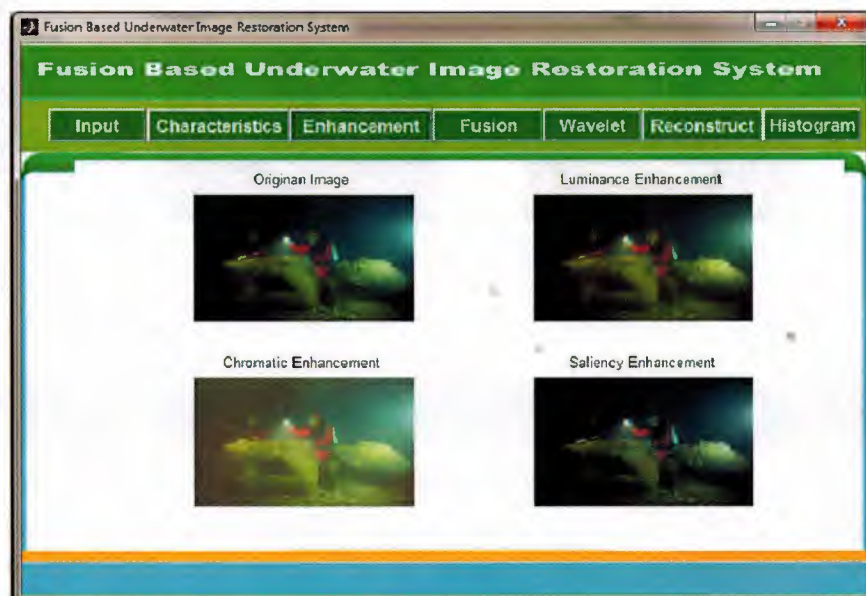


Fig: 5.11 Weight maps of GUI

5.4.4 Fusion

Our single image file approach is built on a multi-scale fusion technique by defining several inputs that are derived from the original input image. To obtain an image with enhanced visibility, each region from the image needs to be characterized by the optimal appearance in the input side sequence. Perfect show in the suggestions part routine.

Our own individual photo file scheme was made on the adaptable-size amalgamation tactic merely by understanding several strategies which can be made by a classic excitement photo. So you can get an image applying increased awareness, every single location from the graphic should be seen as a great the right indicate in the strategies element program.

Our fusion-based proposed approach has the advantages to select based on the weight maps characteristics the appropriate pixels from each input and blend them in a final enhanced version.

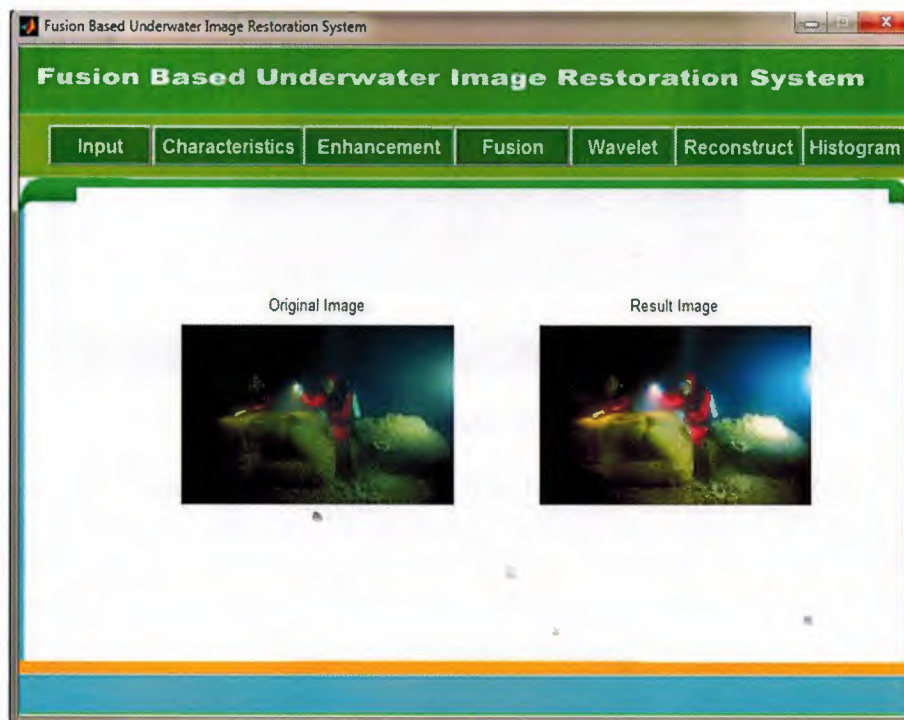


Fig: 5.12 Restored image

The proposed strategy is explained in three principal ways. To start with, most of us gain the routine of stimulation photos characterized by the specified inside information that requirement being conserved inside the renewed consequence.

5.4.5 Wavelet Transform

The wavelet transform has become a useful computational tool for a variety of image processing applications. For example, the wavelet transform is useful for the compression of digital images; smaller images are important for storing images using less memory and for transmitting images faster and more reliably.

Wavelet transforms are also useful for 'cleaning' signals and images (reducing unwanted noise and blurring). Some algorithms for processing astronomical images, for example, are based on wavelet and wavelet-like transforms this is the general form of wavelet transform. If the scaling and wavelet functions are separable, the summation can be composed into two stages. First step is along the x-axis and then calculate along the y-axis each axis, we can apply fast wavelet transform to accelerate the speed.



Fig: 5.13 Wavelet Transform

A schematic diagram is shown in fig below. The two dimensional signal (usually image) is divided into four bands: LL (left-top), HL (right-top), LH (left bottom) and HH (right-bottom). The HL band indicated the variation along the x-axis while the LH band shows the y-axis variation. The power is more compact in the LL band. In the point of coding. We can spend more bits on the low frequency band and less bit on the high frequency band or even set them to zero [39].

5.4.6: final restored image and Histogram report in between fusion and wavelet.



Fig 5.14: Reconstruct the processed image after wavelet

Histogram equalization is a technique for adjusting image intensities to enhance contrast.

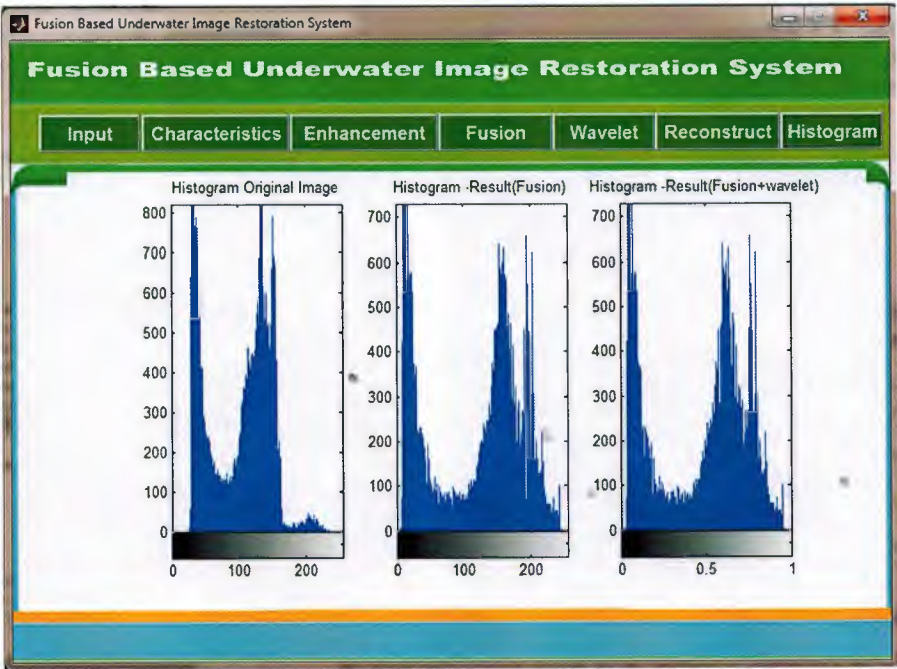


Fig: 5.15 Histogram equalization

6. EXPERIMENTAL RESULTS AND COMPARISON

6.1 Overview

In this section, first give an experiment on underwater to pass from different typical part like browsing the image from data base as input and processed different enhancement technique. Next we give a comparison between the fusion based, mean square error, peak signal to noise ratio and different recent researches .and we proved that our fusion based experimental results of underwater image is much batter then theses researches.

6.2 Fusion based results

A few problems concerning image processing psychoanalysis specially in your wording involving subaqueous image improvement. It's been large-lit of which research workers within the field of operation connected with nautical study normally and computing specifically are struggling with problems about the expertise of the underwater pictures data. For instance difficulties have to be dealt with so that you can do a powerful in addition to demanding research around the underwater image. Most of all, the issues have to be attended to inside the before-producing phase in the laptop or computer eye-sight. I am performing the particular trials to gauge the applied to environment les noised image by simply varying this details before-control technique about degenerate subaqueous image.



Fig: 6.1 Data base images

These two images we take from date data base and passes into fusion based restoration system and get the batter results which are showed in fig 5.8

Table 6.1 Information about image in database.

Information about images in database	
Extension of images	jpeg
Size of images	640 × 480
Bit	24
Horizontal resolution	96 dpi
Vertical resolution	96dpi
Size	49.0 kb

6.3 Original Images used for the evaluation.

6.3.1 Contrast Enhancement and White Balance

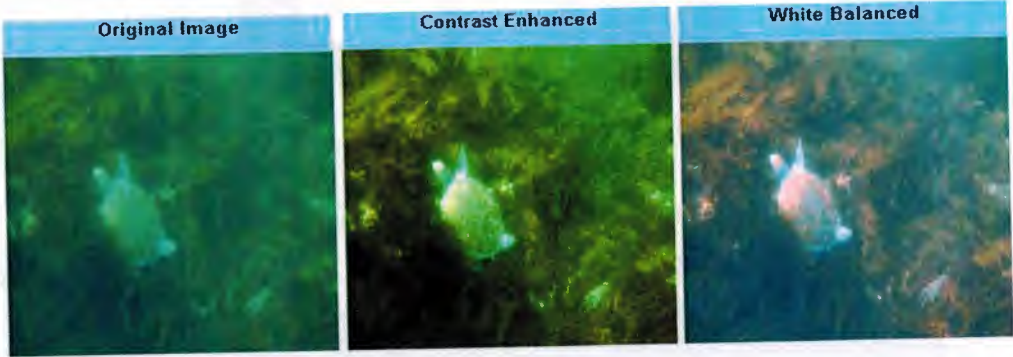


Fig: 6.2 White balances

6.3.2 Weight maps results

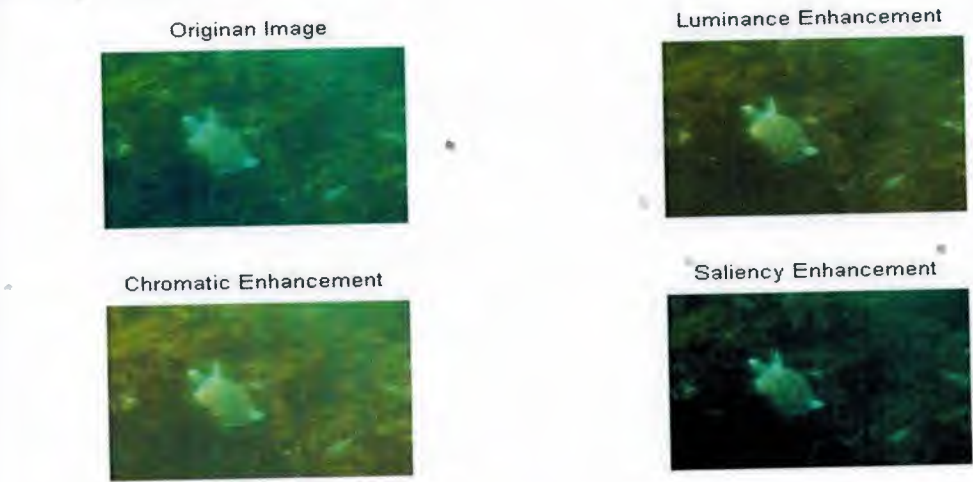


Fig: 6.3 Weight maps Enhancement results

6.3.3 Fusion wavelet based Restored Image and histogram.

Restored image after fusion process and histogram of before and resulted image.

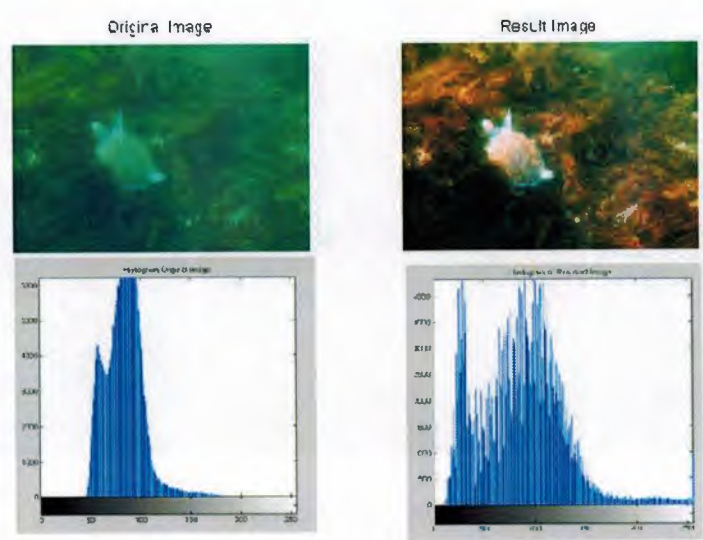


Fig: 6.4 Fusion based Image Result and histogram

Next Table 6.2: Information about images and matrices in database in second simple of image.

Information about images in database	
Extension of images	Jpeg
Size of images	475 × 265
Number of images in database	25
Bit	24
Horizontal resolution	72 dpi
Vertical resolution	72dpi
Size	93.5 kb

6.4 Contrast Enhancement and White Balance for second image.



Fig:6.5 White Balance

6.5 Weight Based Enhancement



Fig: 6.6 Weight Based Enhancement

6.6 Fusion wavelet based restored image and histogram:



Fig:6.7 fusion based result second resotred image



Fig: 6.8 Wavelet restored image:

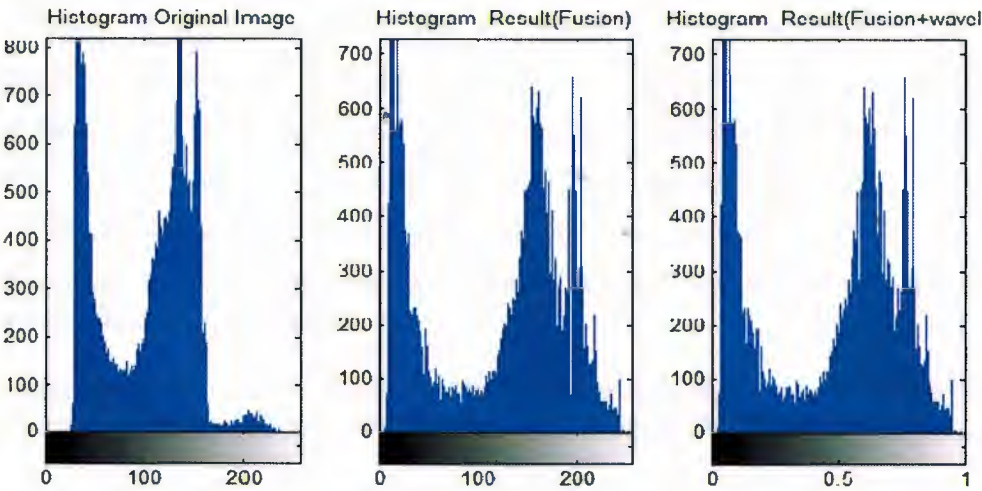


Fig: 6.9 Histogram for original image and fusion + wavelet restored image.

6.7 Comparison of wavelet technique with recent researches.

6.7.1 Polarization analysis.

An algorithm is presented, which inverts the image formation process for recovering good visibility in images of scenes. The algorithm is based on a couple of images taken through a polarizer at different orientations. As a by-product, a distance map of the scene is also derived. In addition, this paper analyses the noise sensitivity of the recovery. We successfully demonstrated our approach in experiments conducted in the sea. Great improvements of scene contrast and color correction were obtained, nearly doubling the underwater visibility range [40].

6.7.2 Fusion-based strategy:

Employs a fusion-based strategy that takes as inputs two adapted versions of the original image that are weighted by specific maps in order to yield accurate haze free results. The method computes in a per-pixel fashion being straightforward to be implemented [40]

6.3 Proposed Wavelet Fusion Strategy:

In this thesis we introduce a novel technique to restore underwater images. Different than most of the existing techniques, our algorithm do not use supplemental information processing only the content of the input degraded image. Our strategy is built on the image fusion principles. The proposed restoration algorithm employs three inputs that are mainly computed from the white balanced and min-max enhanced versions of the input image. Moreover, the fusion process takes four weight maps that specify the luminance, global contrast, Chroma and the original saliency. Finally, the inputs and the weights are blended in a multi-scale fashion that avoids introducing undesired artefacts. The fusion based method is characterized by a high degree of flexibility since it can be combined with other strategies to generate more accurate inputs and appropriate weights. Practically, the main difference between fusion methods that make them application-specific is the choice of inputs and weights.

- The fusion method is build-up on the fusion strategy that takes a sequence of inputs derived from the initial image.
- Different than most of the existing techniques, our algorithm does not use supplemental information processing only the content of the input degraded image.
- Our strategy is built on the image fusion and wavelet principles.

6.9 Comparison between existing and proposed system from GUI results.

Comparison results with other research and I have compared the different image and we proved that our fusion based results are much batter then following research, results are following below.

6.9.1 Comparison between Schechner & Averbuch with wavelet based



Figure 6.10 Comparison between Schechner & Averbuch with fusion wavelet based

Considering the initial underwater image (left side of the first image) our strategy is able to enhance better the finest details compared with the specialized technique of [Schechner and Averbuch 2007][38].

6.9.2 Comparison between Ancuti et al and wavelet based:



Fig 6.11 Comparison between Ancuti et al and fusion wavele tbased:

The recent single image dehazing methods [26, 27] are limited to restore accurately underwater images. Image cour-tesy to Tom Cuypers; and last image is our fusion based resulted image which is batter then Ancuti results.

6.9.3 Comparison between fusion wavelet based and Tarel & Hautiere.

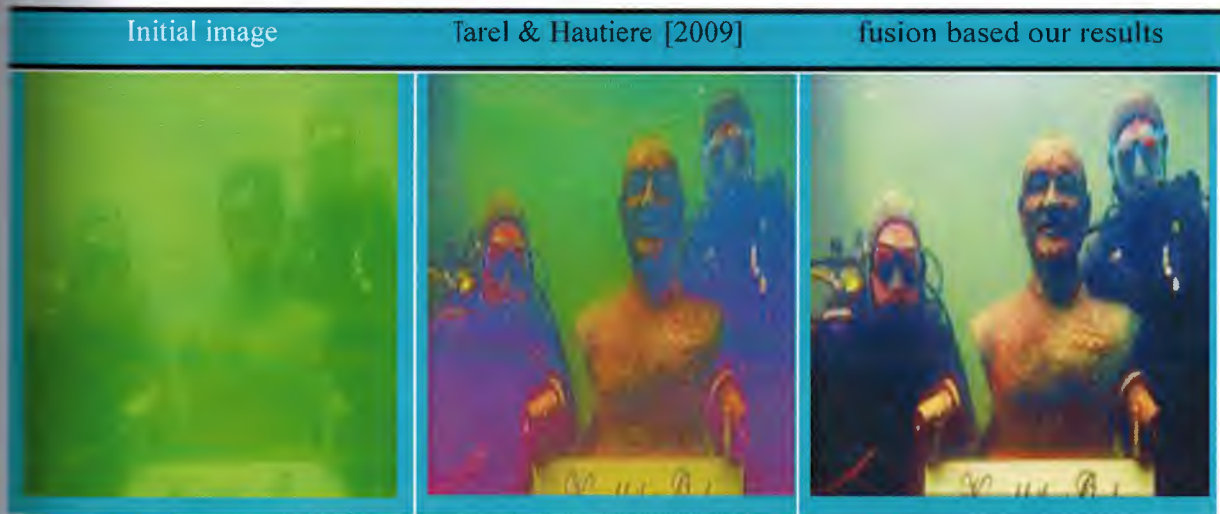


Fig: 6.12. Comparison between wavelet fusion based and Tarel & Hautiere.

The recent single image dehazing methods [28] are limited to restore accurately underwater images. Image cur- testy to Tom Cuypers is Comparison with our fusion based results.

The current approaches employ many graphics of the identical view registered with different declares of polarisation with regard to marine photos [29, 30] nevertheless at the same time for brumes advices [30]. Too, dehazing techniques [28,35] happen to be related with the subaqueous clean up difficulty but also in the findings these types of methods revealed limitations for you to take on with this particular issue .Throughout spinal fusion primarily based we introduce a new method to restore underwater graphics.

6.9.4 Comparison between bazeille tarel and our final fusion wavelet result.

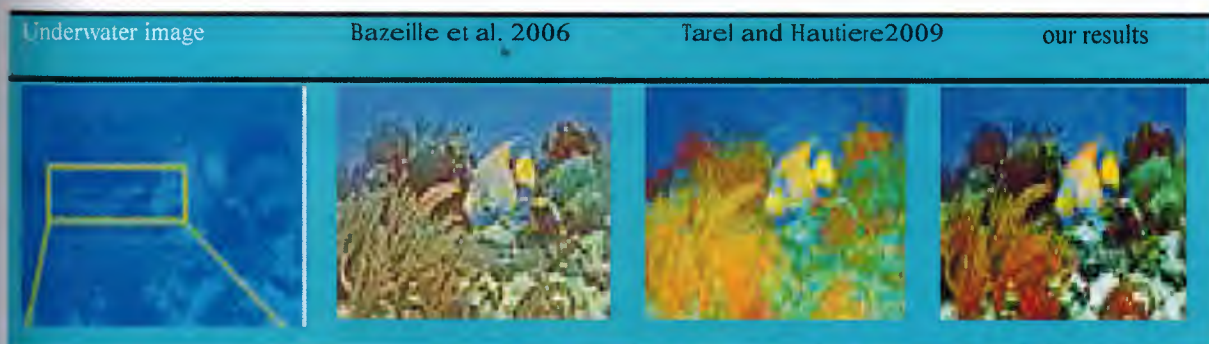


Fig: 6.13 Comparison between bazeille tarel and our final fusion wavelet result.

Compare with the outputs of other enhancing methods our result is less prone to halos and color distortions.

6.9.5 Comparison of fusion wavelet based with white balance.

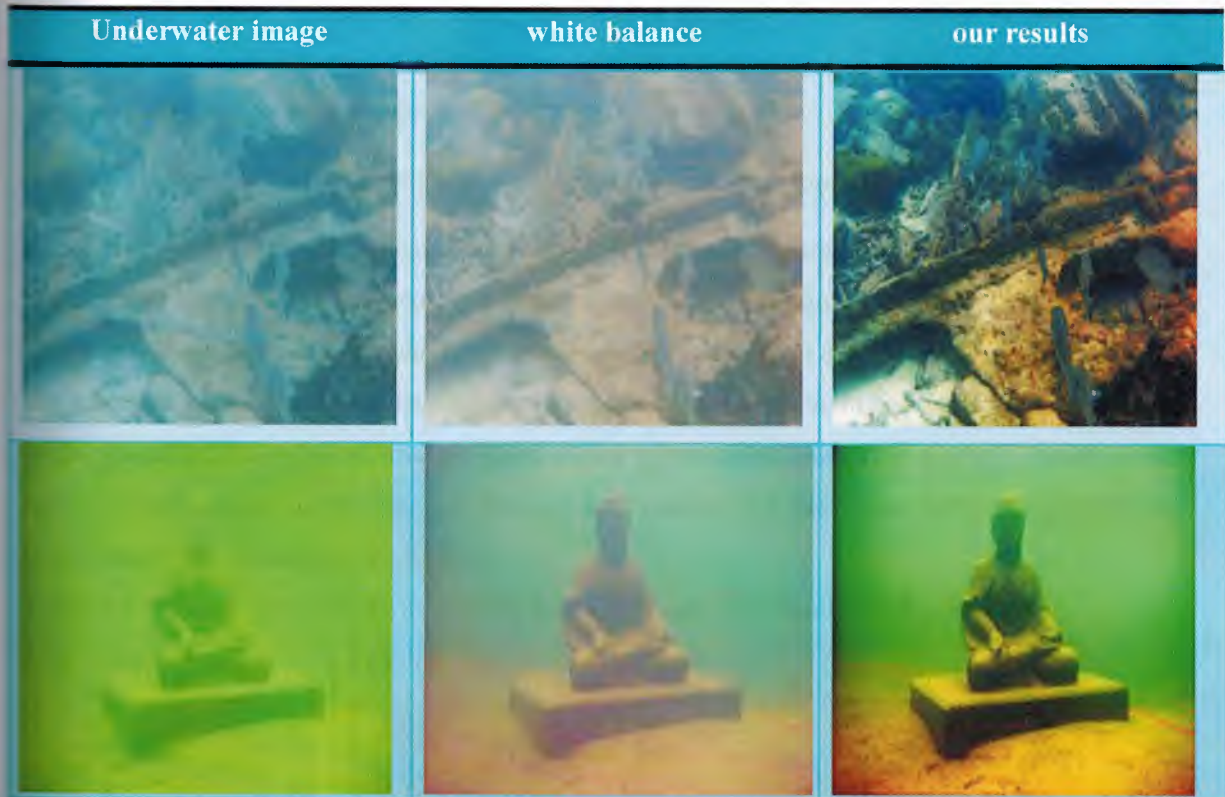


Fig: 6.13 Comparison of fusion wavelet based with white balance.

The left hand first column presents the input underwater images. Proposed restored results (third last column) demonstrate a significant improvement of the visibility range even compared with the white balanced versions (middle Colum).

6.10 Mean Square Error and Peak Signal to Noise ratio Results.

Mean Square Error (MSE) results for the experiment of fusion based underwater image Restoration. The mean square error and peak signal to noise ratio are two errors metrics used to compare the quality of the output image .mean square error is the cumulative square error between the resultant output image and initial input image. Mean square is shown in following below equation.

$$MSE = \frac{1}{M \times N} \sum_{M,N} [I_1(m,n) - I_2(m,n)]^2 \dots\dots\dots \text{Equation (6.1)}$$

$I_{1(m,n)}$ And $I_{2(m,n)}$ represent the input and improved image. $M \times N$ show the sides of the image where m and n indicate the x and y , location of the pixel in the metrics of the image.





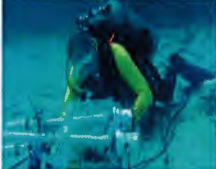



PSNR indicate the ratio of maximum possible signal and noise. Peak signal to noise ratio is given by the below equation [41].

$$PSNR=20 \log_{10} \frac{(2^B-1)}{\sqrt{MSE}} \dots\dots\dots \text{Equation (6.2)}$$

B represents the bit per sample and MSE is the mean square error. The best final image is indicated by low mean square error and high peak signal noise ratio.

The below table show the comparative value of mean square ratio and peak signal noise ratio for the resultant image of fusion based restoration system. As show in the table the quantitative performance of fusion based method stand ahead of the other method in terms of mean square ratio and peak signal noise ratio. The fusion based method has the lowest MSE compared to the others and PSNR values are the highest.

Table 6.3 Comparison in the term of MSE and PSNR and GUI results of fusion based.

S.No	Input image	Resulted image	Method	MSE	PSNR
1			H.E	751.25	9.45
			Proposed result	65.109	31.52
2			H.E	811.17	13.25
			Proposed result	65.109	31.52
3			H.E	651.25	13.56
			Proposed result	71.21	33.81
4			H.E	619.73	10.69
			Proposed result	67.17	30.81

These above data image in table no resultant values are show that fusion based method successfully reduced the noise and reasonable value increase the reasonable information in the

And we tested about 150 under water images for the average value of the MSE and PSNR. The result are show in the below table. The fusion based method lead the other method by having the lowest value of the MSE and highest values of peak signal noise ratio. These two values MSE and PSNR show that there is the level of improvement in term of construct and noise of the output image produced using by the fusion based method.

And we tested about 150 under water images for the average value of the MSE and PSNR. The result are show in the below table. The fusion based method lead the other method by having the lowest value of the MSE and highest values of peak signal noise ratio. These two values MSE and PSNR show that there is the level of improvement in term of construct and noise of the output image produced using by the fusion based method.

Table 6.4 Average results value of mean MSE and PSNR about 150 underwater images.

Method	MSE	PSNR
H.E	680.15	12.52
Proposed result	65.10	33.56

As stated in the result, the fusion based method has successfully achieved to improve the restored and color of the underwater image. In addition, the noise could be reduced significantly compare to other method. The fusion based method is hopefully could help the further underwater researches.

6.11 Conclusion

Fusion based underwater image restoration approach has been considered for underwater images. Detailed comparisons revealed that the fusion based technique used for under water images has greatly enhanced the visibility as compared to the dehazing technique which involves the amalgamation of two input images. Thorough evaluation also reveals that dehazing technique does not also solve the problem of restoration of underwater images, the problem of restoration of the color along with the enhancement of contrast has been sorted out better by using the fusion based technique then dehazing technique. Usage of different polarization filters also yielded better results as compared to White balancing method in above mentioned problem of restoration of color and the enhancement of contrast. By the use of diverse polarization filter systems better viewing of the under image water has been generated, as compared to the conventional techniques thus far being used while keeping in check that no special environment factors and hardware issues taken into consideration. On the contrary there is one major restriction has also been observed by using fusion based technique is of noise or disturbance level has also amplified

significantly while using the depth glorious unseen show for distant areas. This will be the work for future to find optimal techniques and filters to reduce the ambiguity of noise or disturbance in the underwater images, while enhancement and restoration has been of better viewing than the techniques being used previously[25][26]. Emergent upside down image resolution approaches along with system pass are important to adapt and expand in the techniques devised, which can greatly help in evaluating the data coming from 3 dimensional landscape data. However a close look assures to have more information revealing underwater images as compared to the techniques previously used involving sub-aqueous life.

6.12 Future Enhancement:

A main limitation of fusion based method is represented by the fact that the noise contribution may be amplified significantly with the depth yielding undesired appearance of the distant regions. We can improve this in future.

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APPENDIX

Functions we use fusion based under water image restoration system:

- enhance_contrast(inputImg);
- color_balance(inputImg);
- luminance(inputImg);
- chromatic(inputImg);
- saliency(inputImg);
- wavelet Transform
- FuseImages(w_balance, lumi, chromo, sal);
- Reconstruction of image
- Histogram

```
function [output_img]= enhance_contrast(input_img)
my_limit=0.5;
low_limit=0.008;
up_limit=0.992; |
%-----
img=input_img;
[m1 n1 r1]=size(img);
%-----
if r1==3
    my_limit2=0.04;my_limit3=-0.04;
    a=rgb2ntsc(img);|
    mean_adjustment=my_limit2-mean(mean(a(:,:,2)));
    a(:,:,2)=a(:,:,2)+mean_adjustment*(0.596-a(:,:,2));
    mean_adjustment=my_limit3-mean(mean(a(:,:,3)));
    a(:,:,3)=a(:,:,3)+mean_adjustment*(0.523-a(:,:,3)); |
else
    a=double(img)./255;
end
%-----
mean_adjustment=my_limit-mean(mean(a(:,:,1)));
a(:,:,1)=a(:,:,1)+mean_adjustment*(1-a(:,:,1)); |
if r1==3
    a=ntsc2rgb(a);
end
%-----
img=a.*255;
%-----calculation of vmin and vmax-----
for k=1:r1
    arr=sort(reshape(img(:,:,k),m1*n1,1));
    v_min(k)=arr(ceil(low_limit*m1*n1));
    v_max(k)=arr(ceil(up_limit*m1*n1));
end |
%-----
if r1==3
    v_min=rgb2ntsc(v_min);
    v_max=rgb2ntsc(v_max);
end
%-----
```

Açıklama [k1]: Function to enhance contrast

Açıklama [k2]: Adjustment values for contrast

Açıklama [k3]: If color image

Açıklama [k4]: Convert rgb to ntsc color

Açıklama [k5]: Adjusting values in the matrix g and b matrix

Açıklama [k6]: Adjusting in r matrix

Açıklama [k7]: Finding min and maximum in the matrix

```

img=(img-v_min(1))/(v_max(1)-v_min(1));
output_img=uint8(img.*255);
%Program for white balancing and weight map
%Author : rashid_khan
%usage : W=imbalance(im)
%im is the color image array to be corrected.
function W=color_balance(im)
im2=im;
iml=rgb2ycbcr(im);
Lu=iml(:,:,1);
Cb=iml(:,:,2);
Cr=iml(:,:,3);
[x y z]=size(im);
tst=zeros(x,y);
Mb=sum(sum(Cb));
Mr=sum(sum(Cr));
Mb=Mb/(x*y);
Mr=Mr/(x*y);
Db=sum(sum(Cb-Mb))/(x*y);
Dr=sum(sum(Cr-Mr))/(x*y);
cnt=1;
for i=1:x
    for j=1:y
        b1=Cb(i,j)-(Mb+Db*sign(Mb));
        b2=Cr(i,j)-(1.5*Mr+Dr*sign(Mr));
        if (b1<(1.5*Db) & b2<(1.5*Dr))
            Ciny(cnt)=Lu(i,j);
            tst(i,j)=Lu(i,j);
            cnt=cnt+1;
        end
    end
end
cnt=cnt-1;
iy=sort(Ciny,'descend');
nn=round(cnt/10);
Ciny2(1:nn)=iy(1:nn);
mn=min(Ciny2);
c=0;
for i=1:x
    for j=1:y
        if tst(i,j)<mn
            tst(i,j)=0;
        else
            tst(i,j)=1;
            c=c+1;
        end
    end
end
R=im(:,:,1);
G=im(:,:,2);
B=im(:,:,3);
R=double(R).*tst;
G=double(G).*tst;
B=double(B).*tst;

```

Açıklama [k8]: Updating values in the min max area.

Açıklama [k9]: Color balance function

Açıklama [k10]: Convert image to ycbcr format

Açıklama [k11]: Getting r, g and b.

Açıklama [k12]: Test color balance zero matrix

Açıklama [k13]: Calculating sum values

Açıklama [k14]: Updating test color balance.

Açıklama [k15]: Balance the tst values

```

Rav=mean(mean(R));
Gav=mean(mean(G));
Bav=mean(mean(B));
Ymax=double(max(max(Lu)))/15;
Rgain=Ymax/Rav;
Ggain=Ymax/Gav;
Bgain=Ymax/Bav;
im(:,:,1)=im(:,:,1)*Rgain;
im(:,:,2)=im(:,:,2)*Ggain;
im(:,:,3)=im(:,:,3)*Bgain;
W=im;

```

Açıklama [k17]: Calculate mean values

Açıklama [k18]: Final adjustment in the r,g,b

```

function [out]=luminance(input_img)

my_limit2=0.04;
my_limit3=-0.04;
img=input_img;
if size(img,3)==1 error('AUTOCOLOR IS ONLY FOR COLORED IMAGES');
end
a= rgb2ntsc(img);
mean_adjustment=my_limit2-mean(mean(a(:,:,2)));
a(:,:,2)=a(:,:,2)+mean_adjustment*(0.596-a(:,:,2));
mean_adjustment=my_limit3-mean(mean(a(:,:,3)));
a(:,:,3)=a(:,:,3)+mean_adjustment*(0.523-a(:,:,3));
a=ntsc2rgb(a);
out=uint8(a.*255);

```

Açıklama [k19]: Calculate luminance of the image by adjustment limit values of mean.

Açıklama [k20]: Chromatic fuction to correct distortion

```

function [out]=chromatic(input_img)

my_limit=0.5;
%-----
img=input_img;
%-----
if size(input_img,3)==3
    my_limit2=0.04;my_limit3=-0.04;
    a=rgb2ntsc(img);
    mean_adjustment=my_limit2-mean(mean(a(:,:,2)));
    a(:,:,2)=a(:,:,2)+mean_adjustment*(0.596-a(:,:,2));
    mean_adjustment=my_limit3-mean(mean(a(:,:,3)));
    a(:,:,3)=a(:,:,3)+mean_adjustment*(0.523-a(:,:,3));
else
    a=double(img)./255;
end
%-----
mean_adjustment=my_limit-mean(mean(a(:,:,1)));
a(:,:,1)=a(:,:,1)+mean_adjustment*(1-a(:,:,1));
if size(input_img,3)==3
    a=ntsc2rgb(a);
end
out=uint8(a.*255);

```



```
function rgb = saliency(I);
Image_rgb = I;
Image_hsv = rgb2hsv(Image_rgb);
```

Açıklama [k21]: Get saliency of Image.

```
H = Image_hsv(:,:,1);
S = Image_hsv(:,:,2);
I = Image_hsv(:,:,3);
```

Açıklama [k22]: Hsv space

```
[p,q] = size(I);
```

```
a=I(1:p*q);
a=double(a);
D=var(a);
E=mean(a);
```

```
gamma = 1.2;
I1 = imadjust(I,[ ],[0 1],gamma);
S_1 = imadjust(S,[ ],[0 1],gamma);
```

Açıklama [k23]: Adjust portions in gamma

```
Image_hsv(:,:,1) = H;
Image_hsv(:,:,2) = S_1;
Image_hsv(:,:,3) =
Data_normalized(I1); % (premmx(Y0)+ones(p,q))/2;%abs(premnmx(Y0))
```

Açıklama [k24]: Normalize result.

```
c=Image_hsv(:,:,3);
b=c(1:p*q);
b=double(b);
D1=var(b);
E1=mean(b);
```

```
C = abs((D1 - D)/D);
L = abs((E1 - E)/E);
```

```
rgb = hsv2rgb(Image_hsv);
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%555
```

```
function [normalized_matrix,cmin,cmax] = Data_normalized(matrix)
input_matrix=abs(matrix);
Max_input=max(input_matrix(:));
Min_input=min(input_matrix(:));
min_matrix=ones(size(input_matrix)).*Min_input;
normalized_matrix=(input_matrix-min_matrix)./(Max_input-Min_input+eps);
cmin=Min_input;
cmax=Max_input;
```

Açıklama [k25]: Normalize function

```
function fusedImg = FuseImages(input_img,lumi,chromo,sal)
```

Açıklama [k26]: Image fusion function

```
bgImg = double(lumi);
fgImg = double(chromo);
```

```

alphaFactor = 0.5;%
fgImgAlpha = alphaFactor .* fgImg;
bgImgAlpha = (1 - alphaFactor) .* bgImg;

fusedImg = fgImgAlpha + bgImgAlpha;
my_limit=0.5;
low_limit=0.008;
up_limit=0.992;
%-----
img=input_img;
[m1 n1 r1]=size(img);
%-----
if r1==3
    my_limit2=0.04;my_limit3=-0.04;
    a=rgb2ntsc(img);
    mean_adjustment=my_limit2-mean(mean(a(:,:,2)));
    a(:,:,2)=a(:,:,2)+mean_adjustment*(0.596-a(:,:,2));
    mean_adjustment=my_limit3-mean(mean(a(:,:,3)));
    a(:,:,3)=a(:,:,3)+mean_adjustment*(0.523-a(:,:,3));
else
    a=double(img)./255;
end
%-----
bgImg = double(chromo);
fgImg = double(sal);
mean_adjustment=my_limit-mean(mean(a(:,:,1)));
a(:,:,1)=a(:,:,1)+mean_adjustment*(1-a(:,:,1));
if r1==3
    a=ntsc2rgb(a);
end
%-----
img=a.*255;
%-----calculation of vmin and vmax-----
for k=1:r1
    arr=sort(reshape(img(:,:,k),m1*n1,1));
    v_min(k)=arr(ceil(low_limit*m1*n1));
    v_max(k)=arr(ceil(up_limit*m1*n1));
end
%-----
if r1==3
    v_min=rgb2ntsc(v_min);
    v_max=rgb2ntsc(v_max);
end
%-----
img=(img-v_min(1))/(v_max(1)-v_min(1));

fusedImg=uint8(img.*255);

```

Açıklama [k27]: Getting parameters

Açıklama [k28]: Fuziong image.

Açıklama [k29]: Setting limits to update fusion image

Açıklama [k30]: Updating adjustments

Açıklama [k31]: Result image.