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A Quick Review on Image Processing in Artificial Intelligence

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ABSTRACT:

Image refining is the digital processing of images with the aim of better their quality or take out information from them. The combination of image filtering techniques within the domain of Artificial Intelligence (AI) has help in a new era of new visual data analysis and clarification. This review paper gives a full examination of the major types and tools work in the joining of image processing and AI. The paper inspect a wide range of ways image attractive, factor removal, and image upgrate in enhancing the potential of AI systems to realize visual data. This evaluation

paper will take over the major types of image refining tasks and the AI tools that can be used to do them. We will also talk about some of the newest advances in AI-powered image processing, and the latent applications of these approach.

The MATLAB's Image Processing Toolbox offers a wide range of guide-standard algorithms and productivity applications for tasks linked to image processing, analysis, fiction, and the progress of algorithms. With Image Processing Toolkit apps, you can make everyday image clarifying tasks more automatic.

Keywords: SVM, CNN, RNN, pixel, deep learning.

INTRODUCTION

Image processing is the sway and inspection of images using computational methods. It is a wide field that enclose a wide span of techniques, from basic image improvement to complex tasks such as object recognition , identification , and classification. Artificial intelligence (AI) is a quick developing field that is transform many industry and applications. AI techniques are being used to solve a extensive range of problems, together with image processing. The blend of image processing and AI has show to the evolution of powerful new tools and techniques for image analysis. These tools and techniques are being used in a wide range of applications, including:

Industrial inspection: to detect limitation in products and make processes Security and observation: to identify and track people and objects. Remote sensing: to detector the territory and map the Earth's surface. Consumer electronics: To evolve a computer system that can view the quality of a photo in the same way that a human could [3]. Major Types of Image Processing in AI

Low-level image processing: This involves basic operations such as image filtering, noise reduction, and contrast enhancement.

High-level image processing: This involves more complex tasks such as object detection, recognition, and classification. Low-level image processing is typically used to prepare images for high-level image processing tasks. For example, an image may be filtered to remove noise or to enhance certain features. Once the image has been prepared, high- level image processing techniques can be used to extract information from the image like. When we talking about heigh level image processing technique for data extraction from the images we often talk about techniques based on machine learning and deep learning algorithms like **Random Forest**, Support vector machines (**SVM**), Convolutional neural networks (**CNN**), Recurrent neural networks (**RNN**). All these algorithms are used in high-level image processing techniques for information extraction.

Examples of high-level image processing techniques and there uses are:

Object detection: A self-driving car uses object detection to identify and localize pedestrians, vehicles, and other objects on the road. **Object recognition:** A medical imaging system uses object recognition to identify and classify different types of tissue in a medical image.

Image segmentation: A social media platform uses image segmentation to segment photos into different regions, such as foreground and background, to improve the accuracy of its image recommendation algorithms.

Scene understanding: A traffic monitoring system uses scene understanding to extract high-level information from traffic camera footage, such as the location of vehicles, their speed, and the direction they are traveling in. The major types of image processing tasks can be broadly classified into two categories:

Image enhancement: This involves improving the quality of an image for human interpretation. This can include tasks such as noise reduction, contrast enhancement, and sharpening.

Computer vision: This involves extracting information from images for machine perception. This can include tasks such as object detection, tracking, and classification.

BACKGROUND

People tend to prefer visual content over text because the human mind processes images more swiftly than written text. In ancient times, people relied on paintings to convey messages instead of writing them down. Mural art stands as a prime example of this practice, spanning from the Stone Age to the present day.

An image can be viewed as a two-dimensional function, with the image's signal represented as f (x, y). In simpler terms, an image is characterized by its height and width, measured in pixels that range from 0 to 255. A pixel is the smallest constituent of an image, determining its shade, opacity, and colour. Pixels in an image can be expressed in one of three forms: Grayscale, RGB, or RGBA. Image processing operations begin at the pixel level, and the final output can be generated at any desired pixel location.

Each pixel in an image has a unique location defined by its horizontal (x) and vertical (y) coordinates. These coordinates determine where the pixel is situated within the image's grid or matrix, and each pixel's location can be precisely identified by its x and y values. Pixel locations are crucial in image processing as they allow you to pinpoint and manipulate individual pixels within the image to achieve various effects or enhancements.

Image processing can be broadly categorized into two main types: Digital image processing and Analog image processing.

Digital Image Processing: In this type, images are processed using digital techniques, typically on a computer. Digital images are represented as discrete samples of a continuous image, with each pixel having a numerical value. Digital image processing techniques involve manipulating these pixel values using algorithms to achieve various goals such as enhancement, restoration, analysis, and more.

Analog Image Processing: Analog image processing, on the other hand, involves processing images in their continuous form, often using analog devices and methods. This approach is less common today, but it was used in the past when digital technology was less prevalent. Analog techniques may include operations like filtering and amplification applied directly to photographic or video signals.

In modern applications, digital image processing is the more prevalent and versatile method due to the advantages of precision, flexibility, and the computational power offered by digital computing devices.

So in this paper I will discuss about digital image processing.

Let talk little bit about images first. In [4] Amandeep Kour reviewed on different approach for image processing. The system requires certain kinds of pictures as input. These images go through computer programs that are designed for each particular image. These programs produce two types of pictures: a noisy one and a magnitude one. In terms of image sizes, there are three options: (512 X 512) pixels, (256 X 256) pixels, and (1024 X 1024) pixels.

There are variety of images file formats are available at present. Like TIFF (Tagged Image File Format), JPEG (Joint Photographic Experts Group), FIF, BMP, etc. image file with .jpg, .jpeg extensions are of JPEG type file image. Types of images:

Intensity images - An intensity image is a digital image in which each pixel has a single value that represents the intensity of the light at that point in the image.

Intensity images are often referred to as grayscale images In an intensity image, each pixel's value corresponds to the level of brightness or intensity at that specific location in the image. These values are often represented using a single channel or a single value per pixel, typically ranging from 0 (black) to 255 (white) in an 8-bit grayscale image. The variations in these intensity values create the visual contrast and patterns in the image, making it useful for various image processing tasks like edge detection, image enhancement, and segmentation.

Fig 1: Intensity image

Binary images: Binary images are images that have only two Pixel values, typically 0 and 1, representing black and white. They are also known as bi-level or two-level images. Binary images are the simplest type of image to process. [5].

Fig 2: Binary image

Indexed images: Indexed images are a type of image that uses a colour palette to represent the colours of the image. Each pixel in the image is assigned an index into the colour palette, and the colour of the pixel is determined by the corresponding colour in the palette.

Fig 3: Indexed image

It has a colour palette of 256 colours, and each pixel in the image is assigned an index into the palette. The colour of each pixel is determined by the corresponding colour in the palette

RGB image: RGB images are a type of digital image that uses three colour channels to represent the colours of the image: red, green, and blue. Each pixel in the image is assigned a value for each of the three colour channels, and the colour of the pixel is determined by the combination of the three values. Each pixel in an RGB image is represented by three 8-bit values, one for each colour channel. This means that each pixel can represent a total of 256 different colours. The colour of a pixel in an RGB image is determined by the combination of the three colour channel values. The red, green, and blue values are combined using an additive colour model to produce the final colour of the pixel. For example, pure red is represented as (255, 0, 0), pure green as (0, 255, 0), pure blue as (0, 0, 255), and white as (255, 255, 255).

Fig 4: RGB image

The size of an RGB image is specified in terms of its dimensions, often given as width x height (e.g., 1920 x 1080 pixels for Full HD).
The total number of pixels in the image is the product of its width and height i.e (w* h).

Image Processing Operations

A) *Image Restoration:* In article [6] Banhma introduces digital image restoration in brief. Restoration. Image restoration in digital image processing is the process of recovering an image that has been degraded by noise, blur, or other distortions. It is a crucial step in many image processing applications, such as medical imaging, remote sensing, security, and digital forensics

Here is the image of a flower before and after restoration.

Fig 5.1: Before restoration **Fig 6.2: After restoration**

B) *Image Enhancement:* Image enhancement in digital image processing using AI is the process of using AI techniques to improve the quality of images. This can involve a variety of tasks.
Noise reduction: AI techniques can be used to remove noise from images, which can improve the overall clarity and quality of the image

Image Enhancement techniques in Image Processing Toolbox enable to increase the signal-to-noise ratio and accentuate image features by modifying the colours or intensities of an image. [4]

a) Perform histogram equalization
b) Perform de correlation stretching
c) Remap the dynamic range
d) Adjust the gamma value

Histogram Equalization: Histogram equalization involves transforming the intensity values so that the histogram of the output image approximately matches a specified histogram

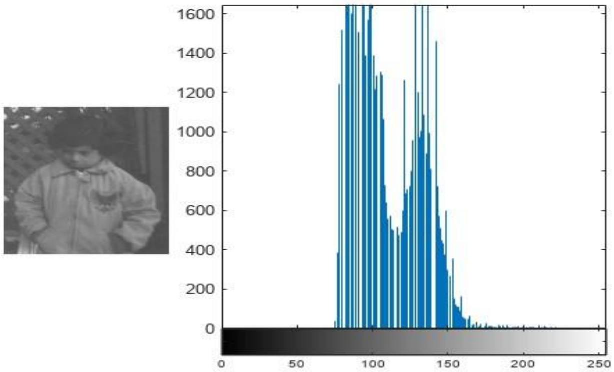

Fig 6: Original Image Histogram [7]

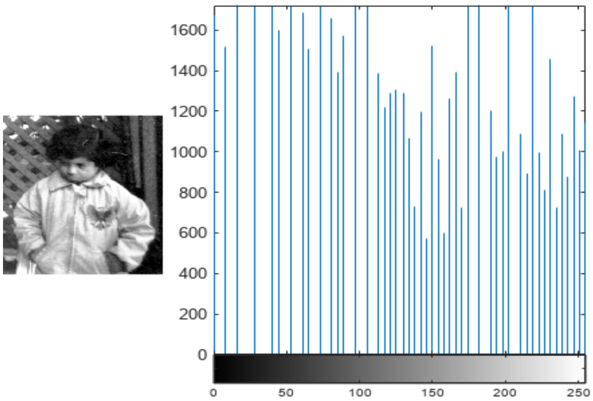

Fig 6.1: Image after contract using Histogram Equalization [7]

Sharpening: Images may be sharpened using AI algorithms, which can highlight edges and other details.
Sharpen image using unsharp masking

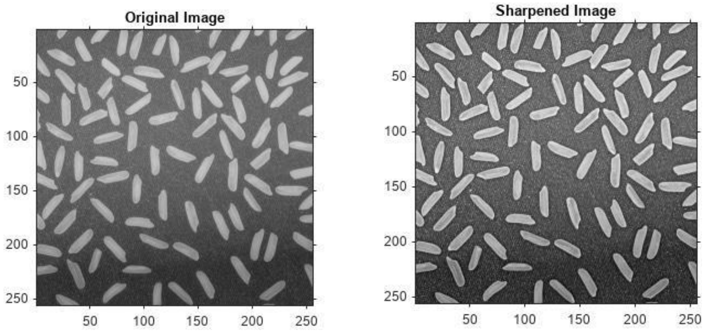

Fig 7, 7.1: [7]Original and Sharpened Image

The contrast between various colors is known as sharpness. A sudden change from black to white seems crisp. A slow change from black to gray to white appears hazy. Images that have been sharpened have more contrast around the edges where various colors converge**.**

C) *Contrast Enhancement*: AI techniques can be used to enhance the contrast of images, which can make the image more visually appealing.

Fig 8: low and high contrast

Color correction: By using AI algorithms, photos' colors may be adjusted to increase its accuracy and realism.
De-correlation Stretch: To highlight the color variations in a picture, decorrelation stretch is an image processing technique. It functions by eliminating the association between the image's various color channels. This may contribute to the image's increased vibrancy and color. This document's goal is to clarify:

a) The conditions that normally appear in multispectral data that indicate that colour enhancement is needed,

b) How a de-correlation stretches addresses those needs,

c) How a de-correlation stretch operates, that is, what steps are taken in terms of computing

What the limitations are to this approach.

D) *Dynamic range remapping*: A digital image processing method called dynamic range remapping (DRR) is used to alter a picture's dynamic range. This may be done to match the dynamic range of a display device, enhance the visibility of specific aspects in the image, or make the image more aesthetically pleasing.

E) Steps for remapping the dynamic range in digital image processing:

a. Identify the input and output dynamic ranges. The input dynamic range is the range of values in the original image, and the output dynamic range is the range of values that the image will have after DRR is applied.

b. Select a function for remapping. Several remapping functions, including exponential, logarithmic, and linear remapping, are available for consideration. The intended impact will determine which remapping function is used.

c. Use the image's remapping feature. Numerous image processing software programs may be used for this.

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d. Analyze the outcomes and modify the remapping function's settings as necessary.

The following formula can be used to implement a linear remapping function:

Output = (Input - InputMin) * (OutputMax - OutputMin) / (InputMax - InputMin)

DRR may also be used to improve the visual appeal of photographs. It can be used, for instance, to produce photographs that have a more "cinematic" or "modern" appearance.

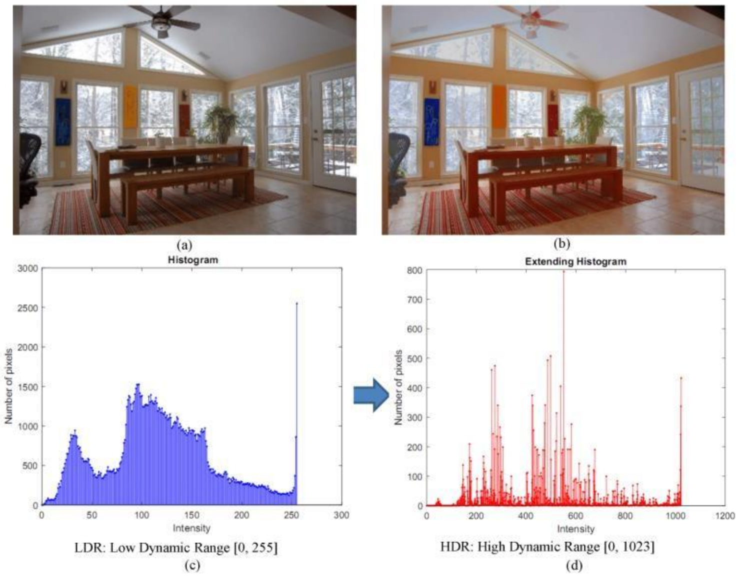

Fig 9: low and high contrast images by using DRR

Adjust the gamma value: [4] Gamma is the correlation between a pixel's numerical value and brightness as it appears on the screen. Your Copyright © 2013 IJECCE, All right reserved 273 International Journal of Electronics Communication and Computer Engineering Volume 4, Issue 1, ISSN (Online): 2249–071X, ISSN (Print): 2278–4209 One might assume that a pixel value of 127 would seem as half of the greatest brightness possible, that a value of 64 would represent one-quarter brightness, and so on, as you are likely already aware that a pixel may have any 'value' of Red, Green, and Blue between 0 and 255. Unfortunately, that isn't the case. This is an illustration of how an image's look can be affected by a change in gamma.

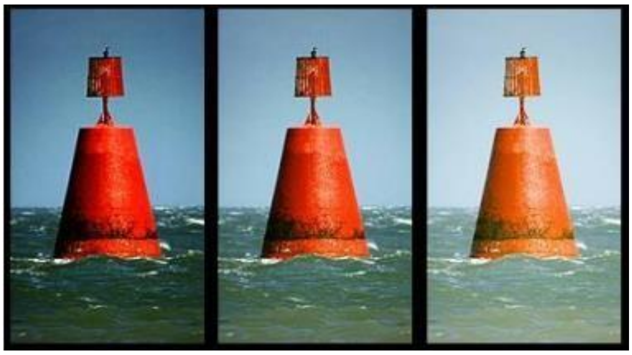

Fig 10. [4] (a) Left (b) Centre (c) Right

The image as it could seem on an uncorrected display is shown on the left. Finally, the right-hand picture illustrates how a system with a linear response [gamma of 1.0] would display the image. The center image should appear right on a monitor with a gamma of about 1.8. Have you noticed how the gamma affects the color's hue and saturation? This implies that you will not be able to see colors and tones as they will look on other people's displays, and they will not view your photos as you intended if your monitor's gamma is not set appropriately.

F) Deblurring photos: To fix blurry photos brought on by a number of causes, Image Processing Toolbox offers a rangof deblurring methods, including

1. Out-of-focus optics
2. Camera or subject movement
3. Atmospheric conditions
4. Short exposure time
5. Other factors

   These techniques use a point spread function (PSF), a mathematical description of the blurring process, to deconvolve the blurred picture. The PSF may be known from the imaging system that took the picture, or it may be inferred from the blurred image itself. Although a two-dimensional function is commonly used to depict the PSF, video sequences can alternatively use a three-dimensional function. In order for the total of the PSF function's values to equal one, it is usually normalized.

Here is an example of a PSF for a simple lens:

PSF (x, y) =exp (-(x^2 + y^2) / (2 * sigma^2)) where:

(x, y)are the picture plane coordinates, while sigma is the PSF standard deviation.

In [8], Xiaogang Chen explained the function and algorithm for sharpening blurry images. Additionally, he and his group optimize the formula.:

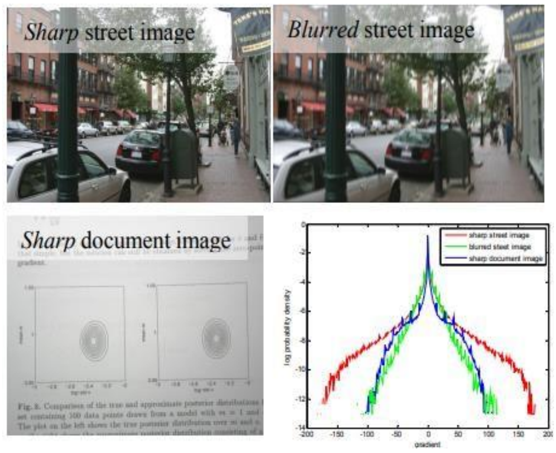

Fig 11. [8] Blurred and Sharp Street image

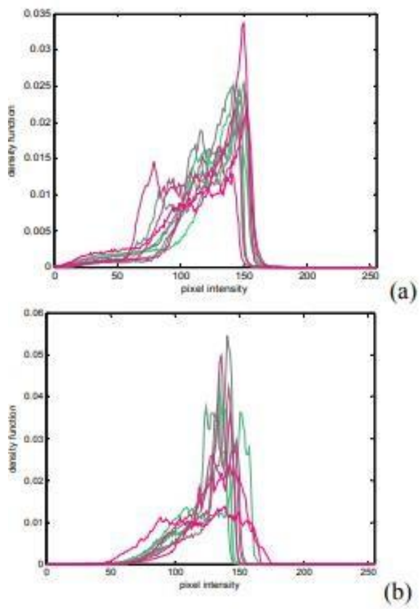

Fig 12: (a) Histograms of ten sharp document images. (b) histograms of ten motion blurred document images. [8]

Algorithm for Document Image Deblurring Algorithm

Input: The blurred image g ; *kernel* size.

Initialization:

compute the divided linear function Ψ ; compute the image M by max filter;
initialize the *PSF* h as a 2D Gaussian function; let the de-blurr image $f = g$.

Repeat:

1. Update f by perpetuation scheme:

for (h = 1 ; h < 2^{10} ; h =h ´ 2) obtain by minim.

$$J(\tilde{f}) = \eta \| \tilde{f} - f \|_2^2 + \lambda \| \Psi(\tilde{f}) \|_1 .$$

obtain and by minimizing update f *by*

$$J(\tilde{f}_x) = \beta \| \tilde{f}_x \|_1 + \eta \| f_x - \tilde{f}_x \|_2^2 .$$

$$f = \mathbb{F}^{-1}\left\{\frac{wH^{*}G + \eta \sum_{k=x,y} D_k^{*}\widetilde{F_k} + \eta\widetilde{F}}{wH^{*}H + \eta \sum_{k=x,y} D_k^{*}D_k + \eta}\right\},$$

2. Update h by minimizing (8). Gradient slump method is take on and it repeats $N1$ times.

Until it is merge or maximum iterations $N2$ have been performed.

Return f and h

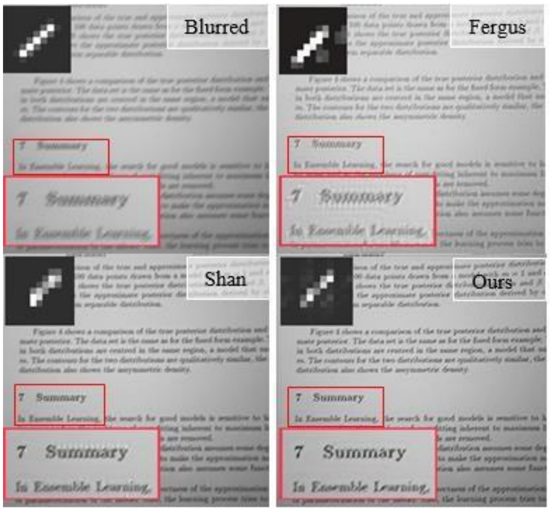

Fig 13: [8] Experiments on synthesized image

G) Image Compression: [4] To supply these images, and create them obtainable over network (e.g. the internet), compression techniques are need. Image compression address the problem of lessen the amount of data need to represent a digital image.

Need for contracting

The following example decorate the need for compression of digital images.

a) To store a colour image of a average size, e.g. 512×512 pixels, one needs 0.75 MB of disk space.

b) A 35mm digital slide with a intention of 12 μm requires 18 MB.

c) One second of digital PAL (Phase Alternation Line) video requires 27 MB.

An [11] image, 1024 pixel×1024 pixel×24 bit, without constriction, would require 3 MB of storage and 7 minutes for transmission, make use to a high speed, 64 Kbits/s, ISDN line. If the image is compressed at a 10:1 compaction ratio, the storage demand is reduced to 300 KB and the carrying time drop to less than 6 seconds. Types of sqeezing [11] Lossless coding techniques:

a) Run length encoding

b) Huffman encoding

c) Arithmetic encrypting

d) Entropy coding

e) Area coding

Loss coding techniques:

a) Predictive coding

b) Transform coding (FT/DCT/Wavelets)

Edge detection: Several methods of edge detection live in empirical. The procedure for decide edges of an image is similar everywhere but only difference is the use of masks. Different types of masks can be sue such as

a) Sobel

b) Prewitt

c) Kirsch

d) Canny

Motivation behind Edge Detection: The purpose of find cutting changes in image bright-ness is to capture important events and changes in stuff of the world. For an image formation model, hiatus in image brightness are likely to correspond to:

a) Discontinuities in depth

b) Discontinuities in surface attitide

c) Changes in material properties

d) Variations in scene dazzle

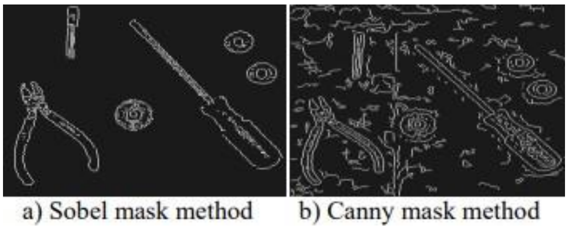

Fig 14: [4] Edge-detection

Thresholding [4]*:* Once we have comput a measure of edge strength (typically the gradient immensity), the next stage is to sue a threshold, to choose whether edges are current or not at an image point. The low the threshold, the more edges will be locate , and the result will be increasingly open to noise and detecting edges of immaterial features in the image. Contrarily a high threshold may miss subtle edges, or result in explode edges.

H) *Feature Extraction* [4]: Two methods are talk through here

a) To extract characteristic of a face at first the image is change into a binary. From this binary image the centroid (X, Y) of the face image is calculated using equation 1 and 2.

$\boldsymbol{X}$ = Sigma $(\boldsymbol{mx})$/Sigma$(\boldsymbol{m})$---------------- (1)

$\boldsymbol{Y}$ = Sigma$(\boldsymbol{my})$/Sigma$(\boldsymbol{y})$ ----------------- (2)

Where x, y is the co-ordinate values and m=f (x, y) = 0 or1. Then from the centroid, only for face has been crop and converted into the silvery level and the features have been collected.

CONCLUSION

In this review paper, we have talk about different types of digital image rectifying algorithms and their applications. We have also discuss the different types of digital images and the different types of working that can be carry out on them to better their quality, such as strop, go against, and edge detection. Also, we have examined the role of filtering in image refining and the use of diagram to represent image things.

Overall, digital image clarifying is a influential tool that can be used to add to and inspect images for a change of motive. The algorithms and techniques chew over in this paper impact a foundation for comprehension and apply digital image processing to real-world problems.