IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 10, Issue 1, January 2020, ||Series -I|| PP 55-60

Study on Process of Digital Image Processing

Dr. C.N.Deshmukh, Prof. S. S. Tantarpale
Electronics & Telecomm Engg PRMIT&R Badnera, Amravati, India
Research Scholar PRMIT&R Badnera, Amrvati, India
Received 31 December 2019; Accepted 15 January 2020

ABSTRACT: Digital image processing is the process of using computer algorithms to perform image processing on digital images. It permits to apply multiple algorithms to the input data and does not cause the problems such as the build-up of noise and signal distortion while processing. As images are defined over two or more dimensions that make digital image processing "a model of multidimensional systems". The history of digital image processing dates back to early 1920s when the first application of digital image processing came into news. Firstly, the image is captured by a camera using sunlight as the source of energy. For the acquisition of the image, a sensor array is used. These sensors sense the amount of light reflected by the object when light falls on that object. A continuous voltage signal is generated when the data is being sensed. The data collected is converted into a digital format to create digital images. For this process, sampling and quantization methods are applied. This will create a 2-dimensional array of numbers which will be a digital image.
Keywords: Algorithms, sensor, array, acquisition.

I. INTRODUCTION

The main purpose of Image Processing includes visualization of the hidden objects in the image, Enhancement of the image through sharpening and restoration, Seek valuable information from the images, Measuring different patterns of objects in the image and Distinguishing different objects in the image.

PROCESS OF DIGITAL IMAGE PROCESSING

1. Image Acquisition:

Image Acquisition is the first and important step of the digital image of processing. Its style is very simple just like being given an image which is already in digital form and it involves preprocessing such as scaling etc. It starts with the capturing of an image by the sensor (such as a monochrome or color TV camera) and digitized. In case, the output of the camera or sensor is not in digital form then an analog-to-digital converter (ADC) digitizes it. If the image is not properly acquired, then you will not be able to achieve tasks that you want to. Customized hardware is used for advanced image acquisition techniques and methods. 3D image acquisition is one such advanced method image acquisition method. Most of the images which are generated by the combination of an "illumination" source and the reflection or absorption of energy from that source of elements of the "scene" being imaged. Fig. below shows the three principal sensor arrangements used to transform illumination energy into digital images. (i)Single imaging Sensor (ii)Line sensor (iii)Array sensor. The idea is simple: Incoming energy is transformed into a voltage by the combination of input electrical power and sensor material that is responsive to the particular type of energy being detected. The output voltage waveform is the response of the sensor(s), and a digital quantity is obtained from each sensor by digitizing its response[1].

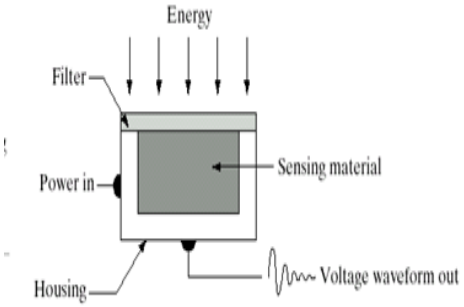

Fig (i) Single Imaging Sensor

Fig (ii) Line Sensor

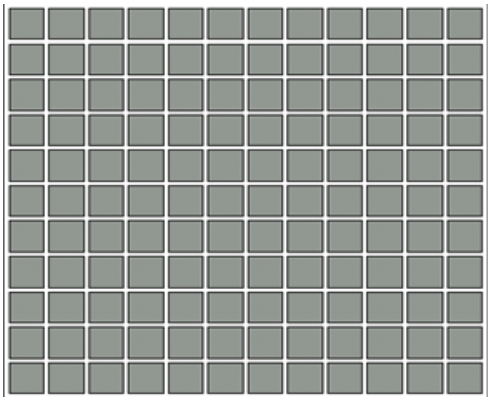

Fig (iii) Array Sensor

2. Image Enhancement:

Image enhancement is one of the easiest and the most important areas of digital image processing. The core idea behind image enhancement is to find out information that is obscured or to highlight specific features according to the requirements of an image. Such as changing brightness & contrast etc. Basically, it involves manipulation of an image to get the desired image than original for specific applications. Many algorithms have been designed for the purpose of image enhancement in image processing to change an image's contrast, brightness, and various other such things. Image Enhancement aims to change the human perception of the images. Image Enhancement techniques are of two types: Spatial domain and Frequency domain. Image enhancement techniques have been widely used in many applications of image processing where the subjective quality of images is important for human interpretation. Contrast is an important factor in any subjective evaluation of image quality. Contrast is created by the difference in luminance reflected from two adjacent surfaces. In other words, contrast is the difference in visual properties that makes an object distinguishable from other objects and the background. In visual perception, contrast is determined by the difference in the colour and brightness of the object with other objects. Our visual system is more sensitive to contrast than absolute luminance; therefore, we can perceive the world similarly regardless of the considerable changes in illumination conditions. Many algorithms for accomplishing contrast enhancement have been developed and applied to problems in image processing[2]. If the contrast of an image is highly concentrated on a specific range, e.g. an image is very dark; the information may be lost in those areas which are excessively and uniformly concentrated. The problem is to optimize the contrast of an image in order to represent all the information in the input image. There are two categories of Spatial domain processing: 1) Intensity Transformations : operate on single pixel, contrast manipulation, and image thresholding. 2) Spatial Filtering : work on a neighborhood of every pixel in an image, image smoothing and image sharpening[1].

3. Image Restoration:

Image restoration involves improving the appearance of an image. In comparison to image enhancement which is subjective, image restoration is completely objective which makes the sense that restoration techniques are based on probabilistic or mathematical models of image degradation. Image restoration removes any form of a blur, noise from images to produce a clean and original image. The image information lost during blurring is restored through a reversal process. This process is different from the image enhancement method. The main defects that degrade an image are restored in this. The objective of image restoration techniques is to reduce noise and recover resolution loss. The most straightforward and a conventional technique for image restoration is deconvolution,[30] [31] which is performed in the frequency domain and after computing the Fourier transform of both the image and the PSF and undo the resolution loss caused by the blurring factors. This deconvolution technique, because of its direct inversion of the PSF which typically has poor matrix condition number, amplifies noise and creates an imperfect deblurred image. Also, conventionally the blurring process is assumed to be shift-invariant. Hence more sophisticated techniques, such as regularized deblurring, have been developed to offer robust recovery under different types of noises and blurring functions. It is of 3 types: 1. Geometric correction 2. radiometric correction 3. noise removal[1].

A model of the Image Degradation/Restoration Process

As fig. shows, the degradation process with an additive noise terms, operates on an input image f(x,y) to produce a degraded image g(x,y). where, g(x,y) have some knowledge about the degradation function H, and some knowledge about the additive noise term n(x,y). The estimated output is desired to be as close as possible to obtain an estimate f(x,y) of the original image.

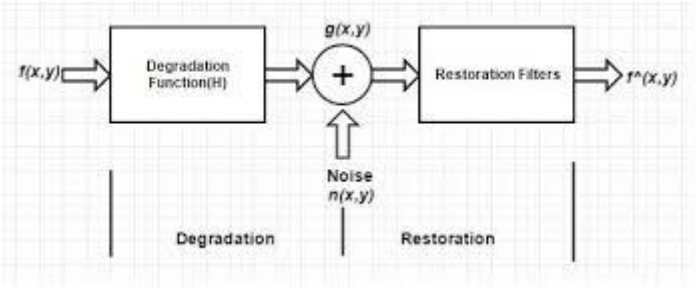

Fig. A model of the image degradation/restoration process.

4. Color Image Processing

Color image processing has been proved to be of great interest because of the significant increase in the use of digital images on the Internet. It includes color modeling and processing in a digital domain etc. There are various color models which are used to specify a color using a 3D coordinate system. These models are RGB Model, CMY Model, HSI Model, YIQ Model. The color image processing is done as humans can perceive thousands of colors. There are two areas of color image processing full-color processing and pseudo color processing. In full-color processing, the image is processed in full colors while in pseudo color processing the gray scale images are converted to colored images. The use of color is important in image processing because: 1) Color is a powerful descriptor that simplifies object identification and extraction. And 2)Humans can discern thousands of color shades and intensities, compared to about only two dozen shades of gray. Color image processing is divided into two major areas:

•**Full-color processing**: Images are acquired with a full-color sensor, such as a color TV camera or color scanner.

•**Pseudocolor processing**: The problem is one of assigning a color to a particular monochrome intensity or range of intensities[1].

5. Image Compression:

Image compression is defined as the process of reducing the amount of data needed to represent a digital image. This is done by removing the redundant data. The objective of image compression is to decrease the number of bits required to store and transmit without any measurable loss of information. Compression involves the techniques that are used for reducing storage necessary to save an image or bandwidth to transmit it. If we talk about its internet usage, it is mostly used to compress data. Algorithms acquire useful information from images through statistics to provide superior quality images. Compression can reduce the file sizes up to 60-70% and hence many files can be combined into one compressed document which makes the sending easier. It helps to reduce the consumption of excessive resources such as hard disc space and transmission bandwidth. Compression can fit more data in small memory and thus it reduces the memory space required as well as the ***cost*** of managing data. Two types of digital image compression are 1). Lossless (or) Error – Free Compression and 2). Lossy Compression [1]

6. Morphological Processing:

Morphology a branch of biology that deals with the form and structure of animals and plants. Morphological image processing is used to extract image components for representation and description of region shape, such as boundaries, skeletons, and the convex hull connectivity analysis, blob analysis etc[1]. It is used to develop methods (region filling, thinning, thickening, and pruning) that are frequently used in conjunction with the algorithms as pre or post processing steps[33].

7. Segmentation:

Segmentation involves dividing an image into its constituent parts or objects. Generally, autonomous image segmentation is one of the toughest tasks in digital image processing. It is a rugged segmentation procedure that takes a long way toward a successful solution of imaging problems that require objects to be identified individually. In simple terms, image segmentation means partitioning an image into multiple segments for simplification and changing the representation of the image.[26] Image segmentation is to classify or cluster an image into several parts (regions) according to the feature of image, for example, the pixel value or the frequency response. Up to now, lots of image segmentation algorithms exist and be extensively applied in science and daily life. According to their segmentation method, we can approximately categorize them into region-based segmentation, data clustering, and edge-base segmentation[18][20]. Image segmentation is the operation of partitioning an image into a collection of connected sets of pixels. They are of three types 1) Regions based, which usually cover the image

2) linear structures, such as line segments and curve segments
3) 2D shapes, such as circles, ellipses and ribbons (long, symmetric regions). As shown below

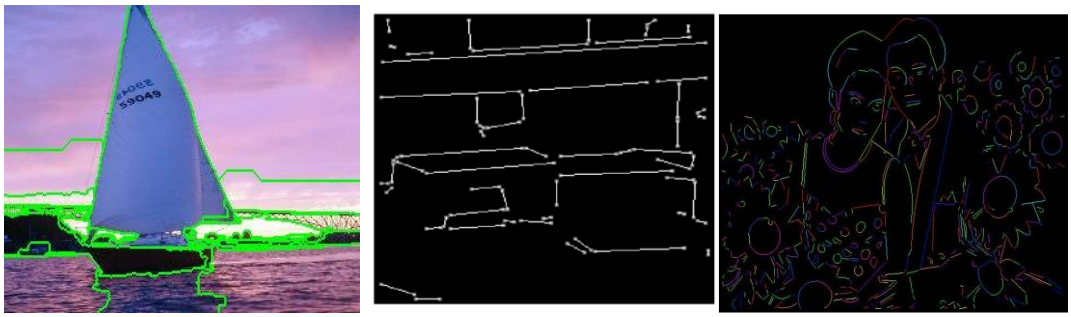

Fig. (a) Region Based (b) Straight lines (c) Lines & circular Arcs

8. Object recognition:

An object recognition system finds objects in the real world from an image of the world, using object models which are known a priori. This task is surprisingly difficult. Humans perform object recognition effortlessly and instantaneously. Recognition involves assigning of a label, such as, "vehicle" to an object completely based on its descriptors. It is a method of recognising a specific object in an image or video. There are certain techniques and models for object recognition like deep learning models, bag-of-words model etc.[1]

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Dr. C.N.Deshmukh,et.al. "Study on Process of Digital Image Processing." *IOSR Journal of Engineering (IOSRJEN)*, 10(1), 2020, pp. 55-60.