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Study of Digital Image Processing Techniques

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Abstract: Image processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it. Image Processing system includes treating images as two dimensional signals while applying already set signal processing methods to them. Image Processing forms core research area within engineering and computer science disciplines. Methods used for Image Processing are Analog and Digital Image Processing. Image analysts use various fundamentals of interpretation while using these visual techniques. Analysts apply a combination of personal knowledge and collateral data to image processing. Digital Image Processing deals with manipulation of digital images through a digital computer. The input of that system is a digital image and the system process that image using efficient algorithms and gives an image as an output. The most common example is Adobe Photoshop

Keywords: Image Processing, Software's, Analog Image Processing, Visualization, Rotation, Image Sharpening and Restoration

I. INTRODUCTION

A picture is worth a thousand words. Pictures concisely convey information about positions, sizes and inter-relationships between objects. They portray spatial information that we can recognize as objects. Human beings are good at deriving information from such images, because of our innate visual and mental abilities. About 75% of the information received by human is in pictorial form.

The digital image processing is deals with developing a digital system that performs operations on a digital image. An image is nothing more than a two dimensional signal. It is defined by the mathematical function f(x, y) where x and y are the two co-ordinates horizontally and vertically and the amplitude of f at any pair of coordinate (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 image digital image processing refers to the processing of digital image by means of a digital computer. A digital image is composed of a finite number of elements, each of which has a particular location and values of these elements are referred to as picture elements, image elements, peels and pixels.

Sometimes a distinction is made by defining image processing as a discipline in which both the input and output of a process are images. We believe this to be a limiting and somewhat artificial boundary. For example, under this definition, even the trivial task of computing the average intensity of an image (which yields a single number) would not be considered an image processing operation. On the other hand, there are fields such as computer vision whose ultimate goal is to use computers to emulate human vision, including learning and being able to make inferences and take actions based on visual inputs. This area itself is a branch of artificial intelligence (AI) whose objective is to emulate human intelligence. The field of AI is in its earliest stages of infancy in terms of development, with progress having been much slower than originally anticipated. The area of image analysis (also called image understanding) is in between image processing and computer vision. There are no clear-cut boundaries in the continuum from image processing at one end to computer vision at the other. However, one useful paradigm is to consider three types of computerized processes in this continuum: low-, mid-, and high-level processes. Low level processes involve primitive operations such as image preprocessing to reduce noise, contrast enhancement, and image sharpening. A low-level process is characterized by the fact that both its inputs and outputs are images. Mid-level processing on images involves tasks such as segmentation (partitioning an image into regions or objects), description of those objects to reduce them to a form suitable for computer processing, and classification (recognition) of individual objects. A mid-level process is characterized by the fact that its inputs generally are images, but its outputs are attributes extracted from those images (e.g., edges, contours, and the identity of individual objects). Finally, higher-level processing involves "making sense" of an ensemble of recognized objects, as in image analysis, and, at the far end of the continuum, performing the cognitive functions normally associated with vision and, in addition, encompasses processes that extract attributes from images, up to and including the recognition of individual objects. As a simple illustration to clarify these concepts, consider the area of automated analysis of text. The processes of acquiring an image of the area containing the text, preprocessing that image, extracting (segmenting) the individual characters, describing the characters in a form suitable for computer processing, and recognizing those individual characters are in the scope of what we call digital image processing.

II. MOTIVATION AND PERSPECTIVE

Digital image processing is deals with manipulation of digital images through a digital computer. It is a subfield of signals and systems but focus particularly on images. DIP focuses on developing a computer system that is able to perform processing on an image. The input of that system is a digital image and the system process that image using efficient algorithms, and gives an image as an output. The most common example is Adobe Photoshop. It is one of the widely used applications for processing digital images.

III. APPLICATIONS

Some of the major fields in which digital image processing is widely used are mentioned below

1) Gamma Ray Imaging- Nuclear medicine and astronomical observations.
2) X-Ray imaging – X-rays of body.
3) Ultraviolet Band –Lithography, industrial inspection, microscopy, lasers.
4) Visual and Infrared Band – Remote sensing.
5) Microwave Band – Radar imaging.

IV. COMPONENTS OF IMAGE PROCESSING SYSTEM

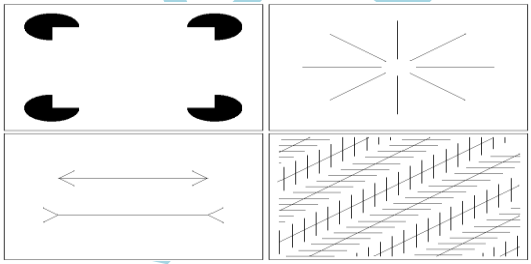
1) *Image Sensors*
With reference to sensing, two elements are required to acquire digital image. The first is a physical device that is sensitive to the energy radiated by the object we wish to image and second is specialized image processing hardware.
2) *Specialize image processing hardware*
It consists of the digitizer just mentioned, plus hardware that performs other primitive operations such as an arithmetic logic unit, which performs arithmetic such addition and subtraction and logical operations in parallel on images.
3) *Computer*
It is a general purpose computer and can range from a PC to a supercomputer depending on the application. In dedicated applications, sometimes specially designed computer are used to achieve a required level of performance.

4) *Software*
It consist of specialized modules that perform specific tasks a well designed package also includes capability for the user to write code, as a minimum, utilizes the specialized module. More sophisticated software packages allow the integration of these modules.
5) *Mass storage*
This capability is a must in image processing applications. An image of size 1024 x1024 pixels, in which the intensity of each pixel is an 8- bit quantity requires one megabytes of storage space if the image is not compressed .Image processing applications falls into three principal categories of storage.
i) Short term storage for use during processing
ii) On line storage for relatively fast retrieval
iii) Archival storage such as magnetic tapes and disks
6) *Image displays*
Image displays in use today are mainly color TV monitors. These monitors are driven by the outputs of image and graphics displays cards that are an integral part of computer system
7) *Hardcopy devices*
The devices for recording image includes laser printers, film cameras, heat sensitive devices inkjet units and digital units

such as optical and CD ROM disk. Films provide the highest possible resolution, but paper is the obvious medium of choice for written applications.
8) *Networking*
It is almost a default function in any computer system in use today because of the large amount of data inherent in image processing applications. The key consideration in image transmission is bandwidth.

V. ELEMENTS OF VISUAL PERCEPTION

1) Optical illusion
In this the eye fills the non existing information or wrongly pervious geometrical properties of objects.



2) Rectification
Rectification is a process of geometrically correcting an image so that it can be represented on a planar surface, conform to other images or conform to a map (Fig. 2). That is, it is the process by which geometry of an image is made plan metric. It is necessary when accurate area, distance and direction measurements are required to be made from the imagery. It is achieved by transforming the data from one grid system into another grid system using a geometric transformation.
Rectification is not necessary if there is no distortion in the image. For example, if an image file is produced by scanning or digitizing a paper map that is in the desired projection system, then that image is already planar and does not require rectification unless there is some skew or rotation of the image.

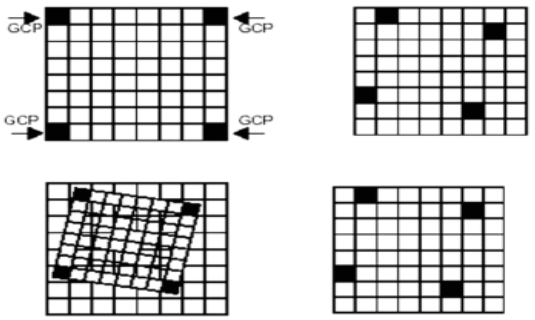
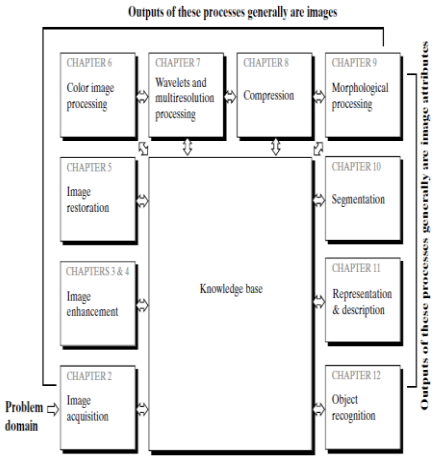


Fig.1 Image Rectification (a & b) Input and reference image with GCP locations, (c) using polynomial equations the grids are fitted together, (d) using re-sampling method the output grid pixel values are assigned (source modified from ERDAS Field guide)

Scanning and digitizing produce images that are planar, but do not contain any map coordinate information. These images need only to be geo-referenced, which is a much simpler process than rectification. In many cases, the image header can simply be updated with new map coordinate information. This involves redefining the map coordinate of the upper left corner of the image and the cell size (the area represented by each pixel). Ground Control Points (GCP) are the specific pixels in the input image for which the output map coordinates are known. By using more points than necessary to solve the transformation equations a least squares solution may be found that minimizes the sum of the squares of the errors. Care should be exercised when selecting ground control points as their number, quality and distribution affect the result of the rectification. Once the mapping transformation has been determined a procedure called re sampling is employed. Re sampling matches the coordinates of image pixels to their real world coordinates and writes a new image on a pixel by pixel basis.

Since the grid of pixels in the source image rarely matches the grid for the reference image, the pixels are re sampled so that new data file values for the output file can be calculated.

VI. Fundamental Steps in Digital Image Processing



1) Image Acquisition

Image acquisition is the first process shown in Fig. Note that acquisition could be as simple

As being given an image that is already in digital form. Generally, the image acquisition stage involves preprocessing, such as scaling. Image enhancement is among the simplest and most appealing areas of digital image processing.

2)Image Enhancement

The idea behind enhancement techniques is to bring out detail that is obscured, or simply to highlight certain features of interest in an image. A familiar example of enhancement is when we increase the contrast of an image because "it looks better." It is important to keep in mind that enhancement is a very subjective area of image processing.

3) Image Restoration

Image restoration is an area that also deals with improving the appearance of an image.

However, unlike enhancement, which is subjective, image restoration is objective, in the

Sense that restoration techniques tend to be based on mathematical or probabilistic models of image degradation.

4)Color Image Processing

Color image processing is an area that has been gaining in importance because of the significant increase in the use of digital images over the Internet. Wavelets are the foundation for representing images in various degrees of resolution.

5) Wavelets & multi-resolution Processing

Wavelets are the foundation for representing images in various degrees of resolution.

6)Compression

Compression deals with techniques for reducing the storage required saving an image, or the bandwidth required transmitting it. Although storage technology has improved significantly over the past decade, the same cannot be said for transmission capacity.

7)Morphological Processing

It deals with tools for extracting image components that are useful in there presentation and description of shape.

8)Segmentation Procedures

Segmentation procedures partition an image into its constituent parts or objects. In general, autonomous segmentation is one of the most difficult tasks in digital image processing. A rugged segmentation procedure brings the process a long way toward successful solution of imaging problems that require objects to be identified individually.

9)Representation and Description

Representation and description almost always follow the output of a segmentation stage, which usually is raw pixel data, constituting either the boundary of a region (i.e., the set of pixels separating one image region from another) or all the points in the region itself.

Object Recognition

Recognition is the process that assigns a label (e.g., "vehicle") to an object based on Its descriptors. We conclude our coverage of digital image processing with the development of methods for recognition of individual objects.

VII. Conclusion

Software for image processing consists of specialized modules that perform specific tasks. A well-designed package also includes the capability for the user to write code that, as a minimum, utilizes the specialized modules. More sophisticated software packages allow the integration of those modules and general-purpose software commands from at least one computer language. Mass storage capability is a must in image processing applications. An image of size 1024*1024pixels, in which the intensity of each pixel is an 8-bit quantity, requires one megabyte of storage space if the image is not compressed. When dealing with thousands, or even millions, of images, providing adequate storage in an image processing system can be a challenge. Digital storage

for image processing applications falls into three principal categories: (1) short-term storage for use during processing, (2) on-line storage for relatively fast re-call, and (3) archival storage, characterized by infrequent access. Storage is measured in bytes (eight bits), Kbytes (one thousand bytes),

Mbytes (one million bytes), Gbytes (meaning giga, or one billion, bytes), and Tbytes (meaning tera, or one trillion, bytes). One method of providing short-term storage is computer memory.

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