COMPUTERISED IMAGE PROCESSING AND PATTERN RECOGNITION BY USING MACHINE ALGORITHMS

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Abstract:

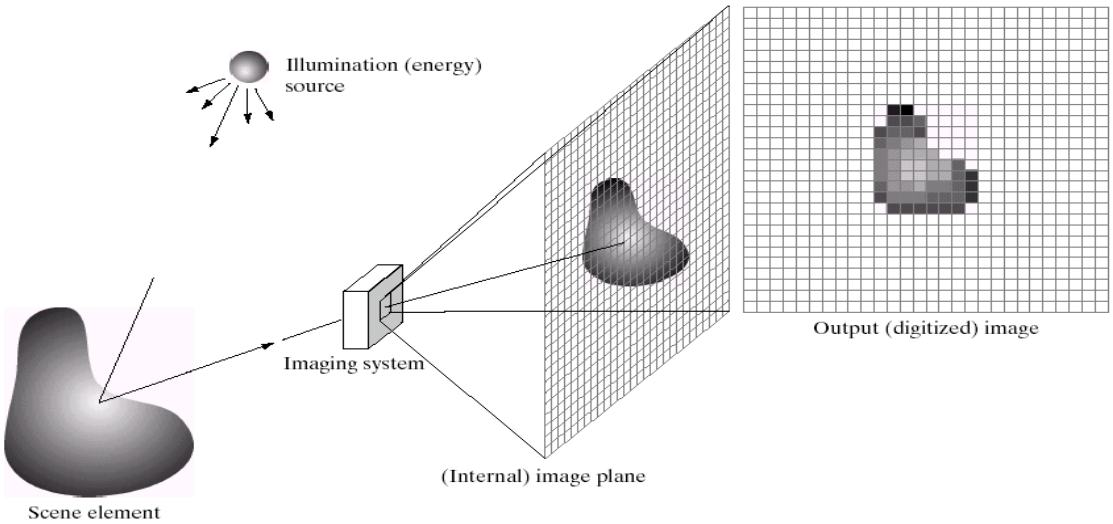
Digital image processing is the use of computer algorithms to perform image processing on digital images. Digital image processing has the same advantages over analog image processing as digital signal processing has over analog signal processing — it allows a much wider range of algorithms to be applied to the input data, and can avoid problems such as the build-up of noise and signal distortion during processing. The most common kind of digital image processing is digital image editing.

Pattern recognition aims to classify data (patterns) based on either a priori knowledge or on statistical information extracted from the patterns. The patterns to be classified are usually groups of measurements or observations, defining points in an appropriate multidimensional space. This is in contrast to pattern matching, where the pattern is rigidly specified.

Key Words: Pattern Recognition, Digital Images, Signal Processing.

Introduction:

Image: An image may be defined as a two-dimensional function(x, y), where x and y are spatial (plane) coordinates, and the amplitude of f at any pair of coordinates (x, y) is called the intensity or gray level of the image at that point.



Analog Image: Can be mathematically represented as a continuous range of values representing position and intensity.

Digital Image:a digital image is restricted in both its spatial coordinates and in its allowed intensities.

The field of digital image processing refers to processing digital images by means of a digital computer. Note that a 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, peels, and pixels. Pixel is the term most widely used to denote the elements of a digital image.

The Origins of Digital Image Processing:

One of the first applications of digital images was in the newspaper industry when pictures were first sent by submarine cable between London and New York. Introduction of the Bart lane cable picture transmission system reduced the time required to transport a picture across the Atlantic from more than a week to less than three hours. Specialized printing equipment coded pictures for cable transmission and then

reconstructed them at the receiving end.Figure1.1was transmitted in this way and reproduced on a telegraph printer fitted with typefaces simulating a halftone pattern**.**

FIGURE 1.1 A digital picture produced in 1921 from a coded tape by a telegraph printer with special type faces. (McFarlane.)

The basis for what we call a modern digital computer dates back to only with the introduction by John von Neumann of two key concepts:
(1) Memory to hold a stored program and data.
(2) Conditional branching.

These two ideas are the foundation of a central processing unit (CPU), which is at the heart of computers today. Starting with von Neumann, there were a series of key advances that led to computers powerful enough to be used for digital image processing. Briefly, these advances may be summarized as **follows:** (1) the invention of the transistor 2) the development of the high-level programming languages COBOL and FORTRAN (3) the invention of the Integrated circuit (IC) (4) the development of operating systems (5) the development of the microprocessor (6) introduction by IBM of the personal computer and (7) progressive miniaturization of components, starting with large scale integration (LI) Concurrent with these advances were developments in the areas of mass storage and display systems, both of which are fundamental requirements for digital image processing.

FIGURE 1.4 The first picture of the moon by a U.S. spacecraft. *Ranger 7* took this image on July 31, 1964 at 9:09 A.M. EDT, about 17 minutes before impacting the lunar surface. (Courtesy of NASA.)

In parallel with space applications, digital image processing techniques began in the late 1960s and early 1970s to be used in medical imaging, remote Earth resources observations, and astronomy. The invention in the early 1970s of computerized axial tomography (CAT), also called computerized tomography (CT) for short, is one of the most important events in the application of image processing in medical diagnosis.

Some of the most active application areas:

Gamma-Ray Imaging

Major uses of imaging based on gamma rays include nuclear medicine and astronomical observations. In nuclear medicine, the approach is to inject a patient with a radioactive isotope that emits gamma rays as it decays. Images are produced from the emissions collected by gamma ray detectors.

X-ray Imaging

X-rays are among the oldest sources of EM radiation used for imaging. The best known use of X-rays is medical diagnostics, but they also are used extensively in industry and other areas, like astronomy. X-rays for medical and industrial imaging are generated using an X-ray tube, which is a vacuum tube with a cathode and anode.

Imaging in the Ultraviolet Band

Applications of ultraviolet "light" are varied. They include lithography, industrial inspection, microscopy lasers, biological imaging, and astronomical observations. We illustrate imaging in this band with examples from microscopy and astronomy.

Imaging in the Visible and Infrared Bands

Considering that the visual band of the electromagnetic spectrum is the most familiar in all our activities, it is not surprising that imaging in this band outweighs by far all the others in terms of scope of application.

Geographic Information Systems

- Digital image processing techniques are used extensively to manipulate satellite imagery
- Terrain classification
- Meteorology
- Weather observation and prediction also are major applications of multi spectral imaging
- From satellites

Image processing techniques are extensively used by law enforcers Number plate recognition for speed Cameras/automated toll systems.

Fundamental Steps in Digital Image Processing:

An image is digitized to convert it to a form which can be stored in a computer's memory or on some form of storage media such as a hard disk or CD-ROM. This digitization procedure can be done by a scanner, or by a video camera connected to a frame grabber board in a computer. Once the image has been digitized, it can be operated upon by various image processing operations.

Image Classification:

To determine the land cover identity of each pixel in an image, replacing visual analysis with quantitative techniques

- Spectral pattern recognition: Using only spectral radiances
- Spatial pattern recognition: Using geometric shapes, sizes and patterns

Noise Reduction:

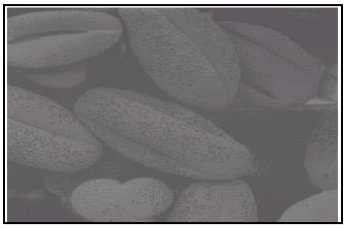
The sources of noise in digital images arise during image acquisition (digitization) and transmission

- Imaging sensors can be affected by ambient conditions
- Interference can be added to an image during transmission

.**Image enhancement:**

There are two broad categories of image enhancement techniques**:**

- Spatial domain techniques: Direct manipulation of image pixel.
- Frequency domain techniques: Manipulation of Fourier transform or wavelet transform of an image

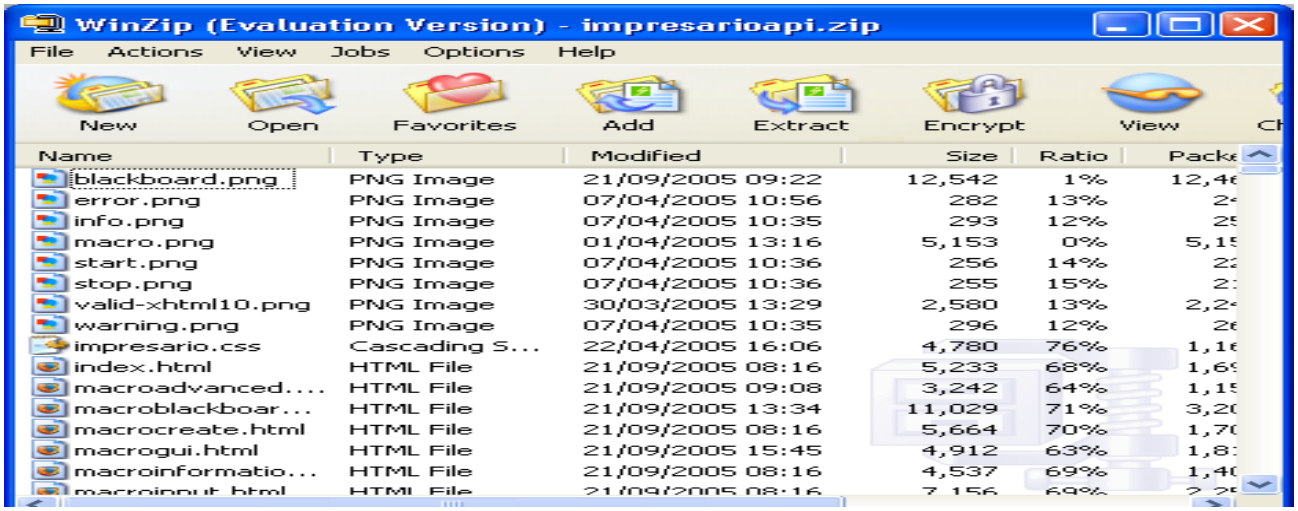


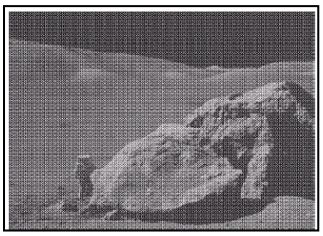
Basically, the idea behind enhancement techniques is to bring out detail that is obscured, or simply to highlight certain features of interest in an image.

Image Restoration

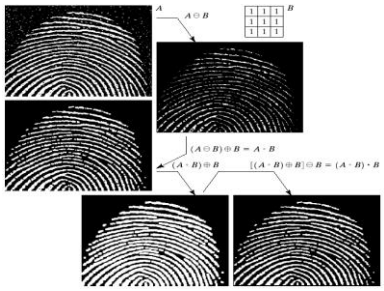
Image restoration is important for two main applications

1. Removing sensor noise
2. Restoring old, archive film and images

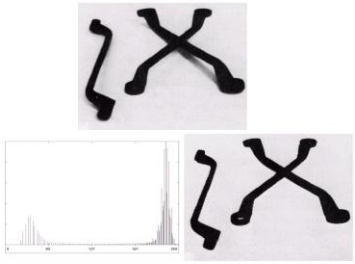




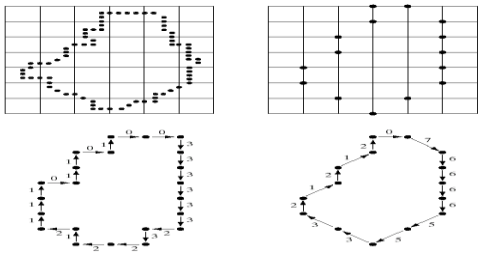

Compression as the name implies, deals with techniques for reducing the storage required to save an image, or the bandwidth required to transmit it.
Morphological processing deals with tools for extracting image components that are useful in the representation and description of shape.



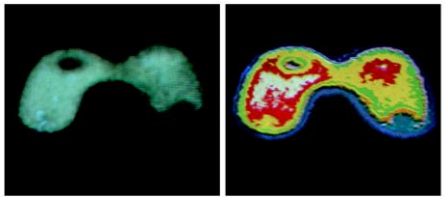
Segmentation:
Segmentation procedures partition an image into its constituent parts or objects. In general, autonomous segmentation is one of the most difficult tasks in digital image processing. A rugged segmentation procedure brings the process a long way toward successful solution of imaging problems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



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. In either case, converting the data to a form suitable for computer processing is necessary. Color image processing is an area that



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.



Components of an Image Processing System:

The side figure shows the basic components comprising a typical general-purpose system used for digital image processing.

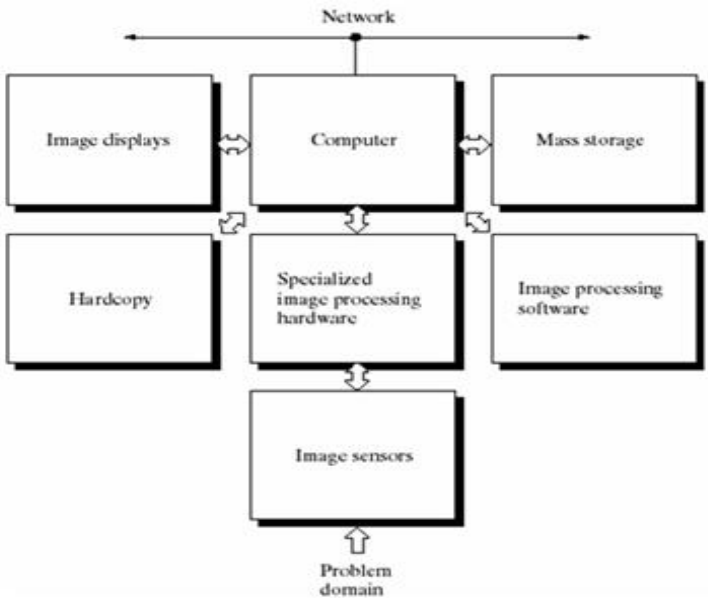


FIGURE 1.24 Components of a general-purpose image processing system.

With reference to sensing, two elements are required to acquire digital images. The first is a physical device that is sensitive to the energy radiated by the object we wish to image. The second, called a digitizer, is a device for converting the output of the physical sensing device into digital form. Specialized image processing hardware usually consists of the digitizer just mentioned, plus hardware that performs other primitive operations, such as an arithmetic logic unit (ALU), which performs arithmetic and logical operations in parallel on entire images. The computer in an image processing system is a general-purpose computer and can range from a PC to a supercomputer. Software for image processing consists of specialized modules that perform specific tasks. 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. Hardcopy devices for recording images include laser printers, film cameras, heat-sensitive devices, inkjet units, and digital units, such as optical and CD-ROM disks. Networking 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. Digital image processing focuses on two major tasks:

- Improvement of pictorial information for human interpretation.
- Processing of image data for storage, transmission and representation for autonomous machine perception

Application Areas of Image Processing:

- Television
- Signal Processing
- Satellite Image Processing

Medical Image Processing

- Contents of pattern recognition:
- Approaches
- Commercial machines that can recognize patterns

- Pattern Recognition Systems

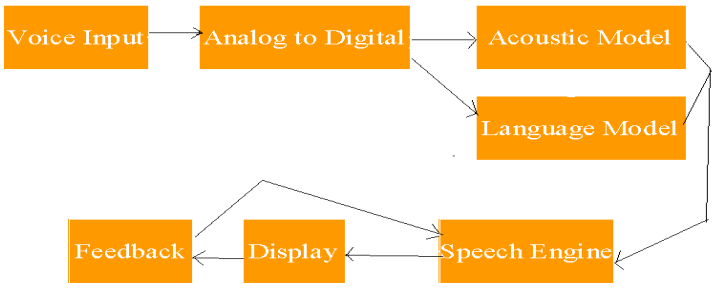
Approaches

- Statistical PR: based on underlying statistical model of patterns and pattern classes.
- Structural (or syntactic) PR: pattern classes represented by means of formal structures as grammars, automata, strings, etc.

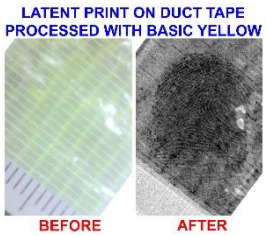
Commercial machines that can recognize patterns:

- Automated speech recognition
- Fingerprint identification
- Optical character recognition
- DNA sequence identification
- Blood cells
- Printed text

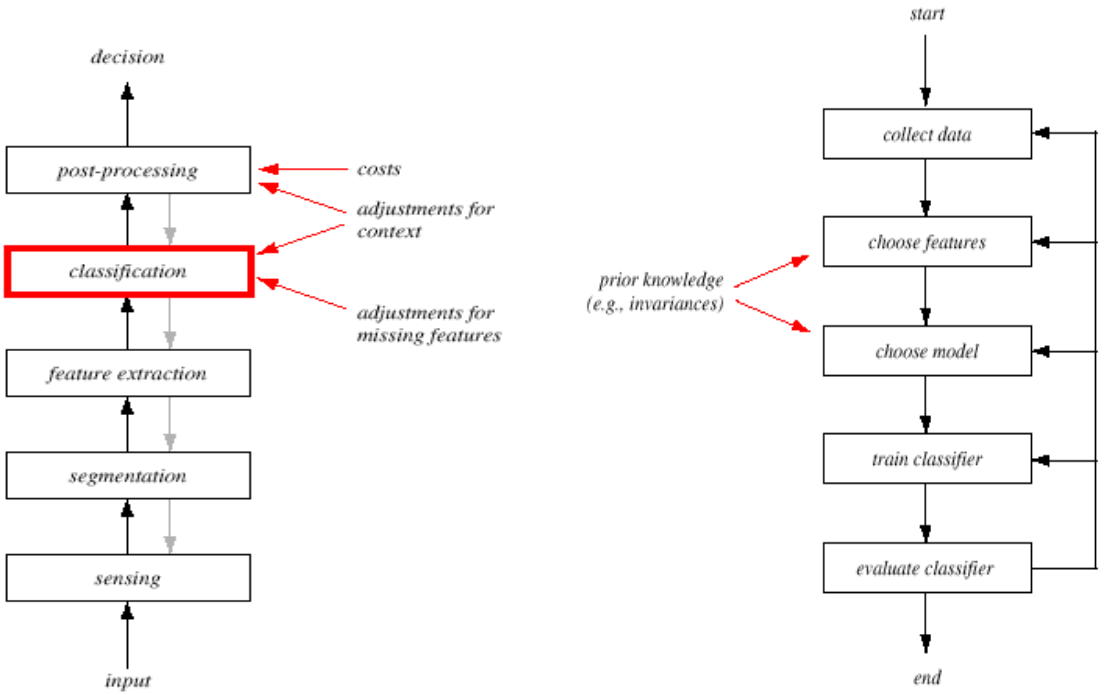
Speech recognition



Fingerprint identification



Design cycle



Examples of Application

Optical Character Recognition (OCR)

- Handwritten: sorting letters by postal code, input device for PDA‘s.
- Printed texts: reading machines for blind people, digitalization of text documents.

Biometrics

- Face recognition, verification, retrieval.
- Finger prints recognition.
- Speech recognition.

Diagnostic systems

- Medical diagnosis: X-Ray, EKG analysis.
- Machine diagnostics, waster detection

Military applications

- Automated Target Recognition (ATR).
- Image segmentation and analysis (recognition from aerial or satelite photographs).
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CONCLUSION:

Digital image processing has become a vast domain of modern signal technologies. Its applications pass far beyond simple aesthetical considerations, and they include medical imagery, television and multimedia signals, security, portable digital devices, video compression, and even digital movies. We have been flying over some elementary notions in image processing but there is yet a lot more to explore. Pattern recognition is the research area that studies the operation and design of systems that recognize patterns in data. It encloses subdisciplines like discriminant analysis, feature extraction, error estimation, cluster analysis, grammatical inference and parsing. Important application areas are image analysis, character recognition, speech analysis, man and machine diagnostics, person identification and industrial inspection.

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