Digital Image Processing and Pattern Recognition

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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 dissstorti on 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.*

Keywords- CSTR-PID-ZN-Fuzzy-MRAM-MATLAB.

I. INTRODUCTION

An image may be defined as a 2D 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 intensity or gray level of image at that point.

Analog Image:

It 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 intensitites. 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, pels and pixels. Pixel is a term most widely used to denote the elements of 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 send 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. The below figure representing as a 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. (From McFarlane [1972].)*

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 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:

a) The invention of the transistor
b) The development of the high-level programming languages like COBOL & FORTRAN
c) The invention of the integrated circuit(IC)
d) The development of OS
e) The development of microprocessor
f) Introduction by IBM of the personal computer and
g) Progressive miniaturization of components, starting with large scale integration (LI).

Some of the most active application areas:

Gamma-Ray Imaging-

Major uses of imaging based on gamma raysinclude 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 a X-ray tube ,which is a vacuum tube with a cathode and a 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 System-

Digital image processing techniques are used extensively to manipulate satellite imagery.

- Terrain classification Metrology
- Weather observation and prediction also are major applications of multi spectral imaging from satellite.

Image processing techniques are extensively used for number plate recognition for speed cameras / automated toll systems.

Fundamental steps in Digital 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 processing operations can be roughly divided into :

Image Classification Image Compression
1) Image acquisition Morphological processing
2) Image enhancement Segmentation
Image Restoration Representation & description
Color image Processing Object Representation
Wavelets

Methods whose input and output are images and methods whose inputs maybe images, but whose outputs are attributes extracted from that images.

- **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

Using geometric shapes,sizes & patterns

➢ Image Acquisition :

The Acquisition of a digital image is a 3 step process.

- Sample & quantize position approximation of a real world
- Quantize intensity for each quantized scene position
- Conversation to binary digits, encoding a digital image
- Digitization of analog aerial photography ,can be very useful for historical studies and ?or high spatial resolution needs
- Direct acquisition using some form of digital imaging sensor

➢ 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 2 main applications

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

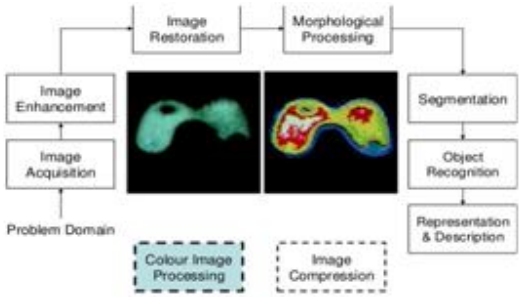
- **Image Compression-**

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.

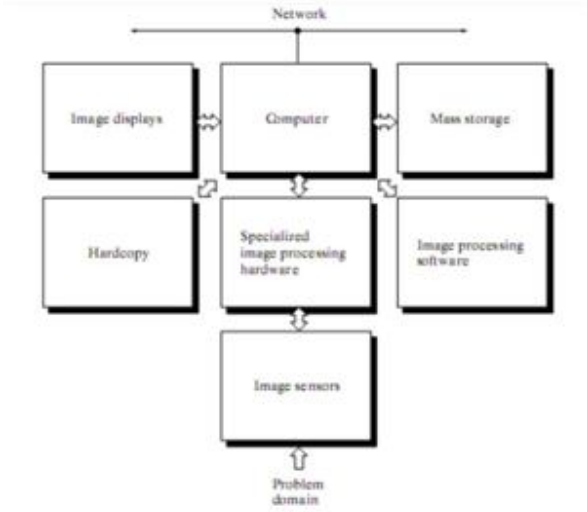
➢ Representation and Description :Suitable for computer processing is almost always follow necessary. The output of a segmentationstage, which is raw pixel data, constituting either the boundary of a region (i.e., the set of pixels separating one image region for another)or all the points in the region itself .In either case, converting the data to a form.

➢ Color image processing- It is an area that has been gaining in importance because of the significant increase in the digital images over the internet.



II. COMPONENTS OF AN IMAGE PROCESSING SYSTEM

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



With reference to sensing ,two elements are required to acquire digital images.

- The first is a physical device i.e., 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 ALU.

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.

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.

III. APPLICATION AREAS OF IMAGE PROCESSING

- Television
- Robot control
- Signal processing
- Visual Communications
- Satellite image processing
- Law Enforcement
- Medical image processing

Pattern recognition

Def: The act of taking in raw data and making an action based on the "category" of the pattern.

Contents of pattern recognition:

- Approaches
- The Design Cycle
- Commercial machines that can recognize patterns
- Learning and Adaption
- Pattern Recognition Systems

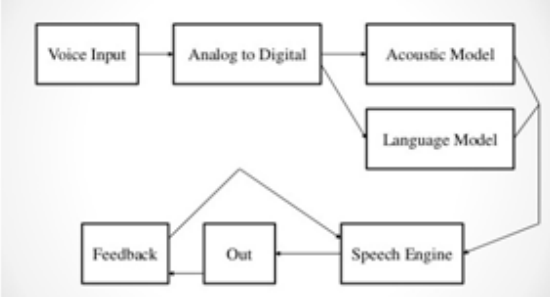
Approaches:

-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.,,

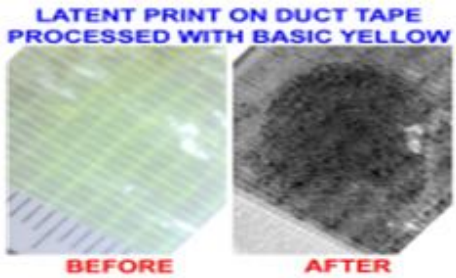
Commercial machines that can recognize patterns :

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

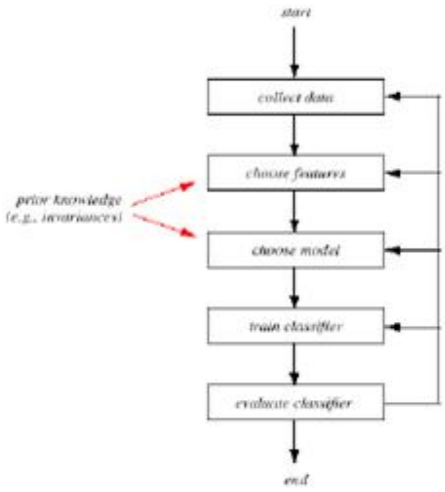
SPEECH RECOGNITION:



FINGER IDENTIFICATION:



Design Cycle :



IV. EXAMPLES OF APPLICATIONS

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**: Water detection
Military application
-**Automated target Recognition (ATR)**
-Image segmentation and analysis (recognition from aerial or satellite photographs).

IV. 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 sub-disciplines like parsing, cluster analysis, feature extraction.

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