OLADIMEJI OLUFUNKE MAYOWA
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COE 516

Question

1. Outline the differences between computer vision and digital image processing
   The major difference is in image processing, transformations are applied to an input image and an output image is returned. While Computer vision uses image processing algorithms to solve some of its tasks. The main difference between these two approaches are the goals (not the methods used).
2. Give a brief account of 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 Bartlane cable picture transmission system in the early 1920s 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 printing method used was abandoned toward the end of 1921 in favor of a technique based on photographic reproduction made from tapes perforated at the telegraph receiving terminal. The early Bartlane systems were capable of coding images in five distinct levels of gray. This capability was increased to 15 levels in 1929. During this period, introduction of a system for developing a film plate via light beams that were modulated by the coded picture tape improved the reproduction process considerably. Although the examples just cited involve digital images, they are not considered digital image processing results in the context of our definition because computers were not involved in their creation. Thus, the history of digital image processing is intimately tied to the development of the digital computer. In fact, digital images require so much storage and computational power that progress in the field of digital image processing has been dependent on the development of digital computers and of supporting technologies that include data storage, display, and transmission.

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. From the 1960s until the present, the field of image processing has grown vigorously. In addition to applications in medicine and the space program, digital image processing techniques now are used in a broad range of applications.

3. List and briefly describe the categories for digital storage for image processing applications

   (1) Short-term storage: this is for use during processing, to provide short-term storage is computer memory
   (2) On-line storage: this is for for relatively fast recall, and is by specialized boards, called frame buffers, that store one or more images and can be accessed rapidly, usually at video rates (e.g., at 30 complete images per second)

(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) This allows virtually instantaneous image zoom, as well as scroll (vertical shifts) and pan (horizontal shifts).

4. X-rays are the oldest sources of EM radiation, briefly describe the working principle of x-rays tube

X-rays for medical and industrial imaging are generated using an X-ray tube, which is a vacuum tube with a cathode and anode. The cathode is heated, causing free electrons to be released. These electrons flow at high speed to the positively charged anode. When the electrons strike a nucleus, energy is released in the form of X-ray radiation. The energy (penetrating power) of X-rays is controlled by a voltage applied across the anode, and by a current applied to the filament in the cathode. Therefore a chest X-ray generated simply by placing the patient between an X-ray source and a film sensitive to X-ray energy. The intensity of the X-rays is modified by absorption as they pass through the patient, and the resulting energy falling on the film develops it, much in the same way that light develops photographic film. In digital radiography, digital images are obtained by one of two methods: (1) by digitizing X-ray films; or (2) by having the X-rays that pass through the patient fall directly onto devices (such as a phosphor screen) that convert X-rays to light. The light signal in turn is captured by a light-sensitive digitizing system.

5. Outline the basic procedures for generating ultrasound images

1. The ultrasound system (a computer, ultrasound probe consisting of a source and receiver, and a display) transmits high-frequency (1 to 5 MHz) sound pulses into the body.

2. The sound waves travel into the body and hit a boundary between tissues (e.g., between fluid and soft tissue, soft tissue and bone). Some of the sound waves are reflected back to the probe, while some travel on further until they reach another boundary and get reflected.

3. The reflected waves are picked up by the probe and relayed to the computer.

4. The machine calculates the distance from the probe to the tissue or organ boundaries using the speed of sound in tissue (1540 m/s) and the time of each echo's return.

5. The system displays the distances and intensities of the echoes on the screen, forming a two-dimensional image.

6 (a) what is an Angiograph

An angiograph is the film or image of the blood vessels, and organs of the body produced by angiography, with particular interest in the arteries, veins, and the heart chambers.

(b) Explain the process of using Angiograph to obtain the aortic angiograph in 6

This procedure is used to obtain images /angiograms of blood vessels. A small, flexible, hollow tube (catheter) is inserted into an artery or vein in the groin. The catheter is threaded into the blood vessel and guided to the area to be studied. When the catheter reaches the site under investigation, an X-ray contrast medium is injected through the tube. This enhances contrast of the blood vessels and enables the radiologist to see any irregularities or blockages. The catheter can be seen being inserted into the large blood vessel on the lower left of the picture.

(c) Use graphical illustrations to explain the transformation that has taken place Fig 1

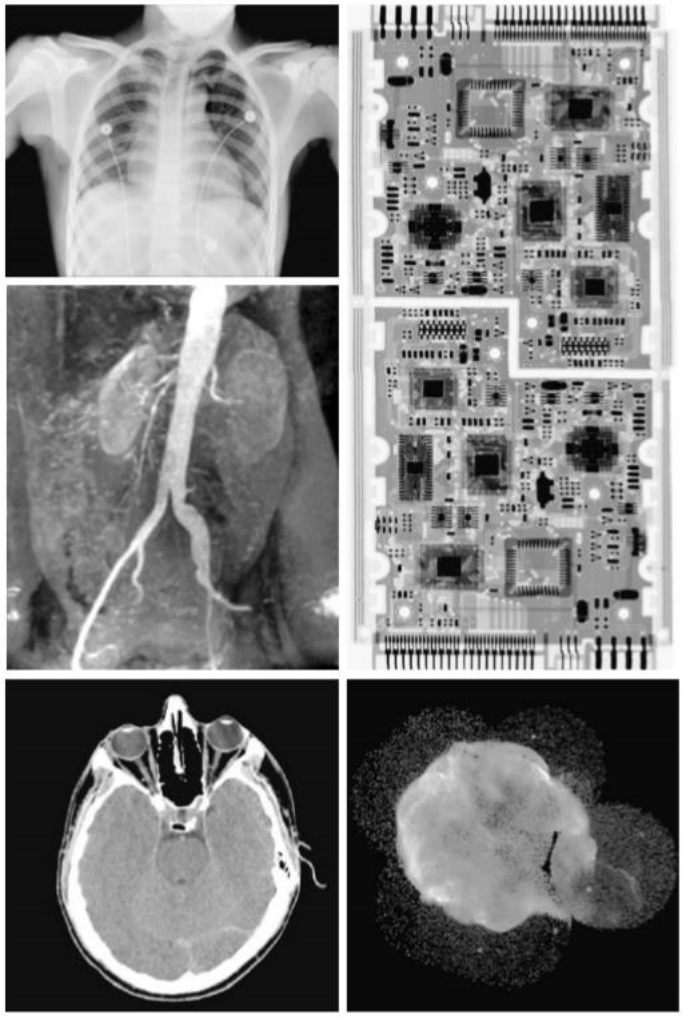


Figure 1 Examples of X-ray imaging.(a) Chest X-ray.(b) Aortic angiogram.(c) Head CT. (d) Circuit boards. (e) Cygnus Loop

7. (a) Write short notes on the following

(i) Spatial domain can be defined as the section of the real plane spanned by the coordinates of an image is called the spatial domain.

(ii) Spatial filtering deals with performing operations, such as image sharpening, by working in a neighborhood of every pixel in an image.

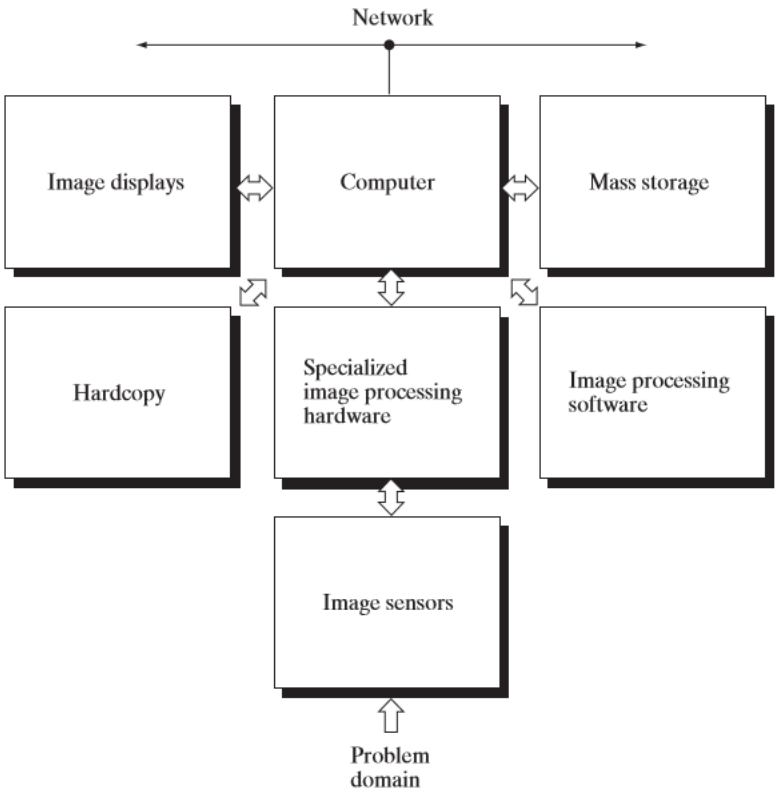
(iii) Image enhancement is the process of manipulating an image so that the result is more suitable than the original for a specific application

(iv) Contrast stretching is a process that expands the range of intensity levels in an image so that it spans the full intensity range of the recording medium or display device.

(b) Outline the significance of decomposing an image into its bit plane

Decomposing an image into its bit planes is useful for analyzing the relative importance of each bit in the image, a process that aids in determining the adequacy of the number of bits used to quantize the image. Also, this type of decomposition is useful for image compression.

(c) With the aid of suitable diagram, discuss the components of a general purpose image processing system



- The computer in an image processing system is a general-purpose computer and can range from a PC to a supercomputer.. In general purpose systems, almost any well-equipped PC-type machine is suitable for off-line image processing tasks.
- 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.
- Image displays in use today are mainly color (preferably flat screen) TV monitors. Monitors are driven by the outputs of image and graphics display cards that are an integral part of the computer system. Seldom are there requirements for image display applications that cannot be met by display cards available commercially as part of the computer system. In some cases, it is necessary to have stereo displays, and these are implemented in the form of headgear containing two small displays embedded in goggles worn by the user.

- Hardcopy devices for recording images include laser printers, film cameras, heat-sensitive devices, inkjet units, and digital units, such as optical and CDROM disks. Film provides the highest possible resolution, but paper is the obvious medium of choice for written material. For presentations, images are displayed on film transparencies or in a digital medium if image projection equipment is used. The latter approach is gaining acceptance as the standard for image presentations.
- 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. In dedicated networks, this typically is not a problem, but communications with remote sites via the Internet are not always as efficient. Fortunately, this situation is improving quickly as a result of optical fiber and other broadband technologies.

8. What is edge detection?

Edge detection is an image processing technique for finding the boundaries of objects within images. It works by detecting discontinuities in brightness. Edge detection is used for image segmentation and data extraction in areas such as image processing, computer vision, and machine vision.

9 List and explain the existing edge models with the aid of a suitable diagram

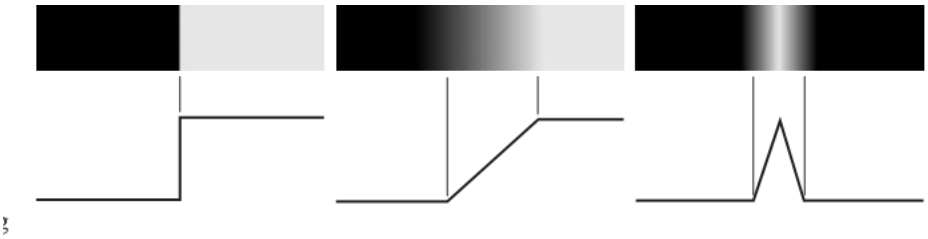


Figure 2From left to right, models (ideal representations) of a step,a ramp,and a roof edge,and their corresponding intensity profiles.

- A step edge involves a transition between two intensity levels occurring ideally over the distance of 1 pixel.
- The slope of the ramp is inversely proportional to the degree of blurring in the edge. In this model, we no longer have a thin (1 pixel thick) path. Instead, an edge point now is any point contained in the ramp, and an edge segment would then be a set of such points that are connected.
- Roof edges are models of lines through a region, with the base (width) of a roof edge being determined by the thickness and sharpness of the line.

10 (i) List the factors responsible for the occurrence of disconnection of edges after its detection

- Noise
- Non uniform illumination
- Motion

(ii) In one sentences give one reason why sobel masks more preferable to prewitts mask

The fact that the Sobel masks have better noise-suppression /smoothing characteristics makes them preferable.

11. Write short notes on the following

(i) Edge pixels are pixels at which the intensity of an image function changes abruptly, and edges (or edge segments) are sets of connected edge pixels.

(ii) Edge detectors Edge detectors are local image processing methods designed to detect edge pixels

(iii) Morphological watershed segmentation; The concept of watersheds is based on visualizing an image in three dimensions: two spatial coordinates versus intensity. We consider three types of points:(a) points belonging to a regional minimum;(b) points at which a drop of water, if placed at the location of any of those points, would fall with certainty to a single minimum(c) points at which water would be equally likely to fall to more than one such minimum.

12 Using relevant equation identify and characterize the two criteria's used for establishing Similarity in edges pixel

- the strength (magnitude); An edge pixel with coordinates (s, t) in S_{xy} in is similar in magnitude to the pixel at if $|M(s, t) - M(x, y)| \leq E$
- the direction of the gradient vector; An edge pixel with coordinates (s, t) in S_{xy} has an angle similar to the pixel at (x, y) if $|\alpha(s, t) - \alpha(x, y)| \leq A$ where is a positive angle threshold.

13 Outline the approaches for linking edge using Hough transform

- Obtain a binary edge image using any of the techniques discussed earlier in this section.
- Specify subdivisions in the $\rho\theta$-plane
- Examine the counts of the accumulator cells for high pixel concentrations.
- Examine the relationship (principally for continuity) between pixels in a chosen cell.

14 (a) What is the difficulty encountered in implementing Hough transform using slope-intercept representation of straight lines

A practical difficulty with this approach is that a (the slope of a line) approaches infinity as the line approaches the vertical direction.

(b) How can the identified problem in a(i) be solved.?

One way around this difficulty is to use the normal representation of a line:

$$x \cos \theta + y \sin \theta = \rho$$

15 Briefly explain how human visual system perceive colors.

The colors that humans perceive in an object are determined by the nature of the light reflected from the object. Light is composed of a relatively narrow band of frequencies in the electromagnetic spectrum. A body that reflects light that is balanced in all visible wavelengths appears white to the observer. However, a body that favors reflectance in a limited range of the visible spectrum exhibits some shades of color. For example, green objects reflect light with

wavelengths primarily in the 500 to 570 nm range while absorbing most of the energy at other wavelengths.

16 Explain in details the difference between colors of light and pigments

Differentiating between the primary colors of light and the primary colors of pigments or colorants is important. In the latter, a primary color is defined as one that subtracts or absorbs a primary color of light and reflects or transmits the other two. Therefore, the primary colors of pigments are magenta, cyan, and yellow, and the secondary colors are red, green, and blue. A proper combination of the three pigment primaries, or a secondary with its opposite primary, produces black.

17 List and describe the attributes of a color

- Hue is an attribute associated with the dominant wavelength in a mixture of light waves. Hue represents dominant color as perceived by an observer. Thus, when we call an object red, orange, or yellow, we are referring to its hue,
- Brightness embodies the achromatic notion of intensity.
- Saturation refers to the relative purity or the amount of white light mixed with a hue. The pure spectrum colors are fully saturated. Colors such as pink (red and white) and lavender (violet and white) are less saturated, with the degree of saturation being inversely proportional to the amount of white light added.

18 Distinguish between full color processing and pseudo color processing**.**

Full-color and pseudo-color processing. In the first category, the images in question typically are acquired with a full-color sensor, such as a color TV camera or color scanner. In the second category, the problem is one of assigning a color to a particular monochrome intensity or range of intensities.

19 State the principal factors motivating color image processing.

The use of color in image processing is motivated by two principal factors. First, color is a powerful descriptor that often simplifies object identification and extraction from a scene. Second, humans can discern thousands of color shades and intensities, compared to about only two dozen shades of gray. This second factor is particularly important in manual image analysis.