NAME: KAREEM JADESOLA 'TANWA

MATRICULATION NUMBER: 15/ENG02/033

DIGITAL IMAGE PROCESSING

COE 516.

1. Outline the differences between computer vision and digital image processing.

Answer

- **Digital image processing** is a discipline in which both the input and output of a process are images while **computer vision** is to use computers to emulate human vision, including learning and being able to make inferences and take actions based on visual inputs.
- **Digital image processing** refers to processing digital images by means of a digital computer while **computer vision** is programming a computer or device to imitate human vision in acquiring images and also process the images.
- **Digital image processing** is its own field of study comprising of image segmentation as well as image acquisition while **computer vision** is a branch of artificial intelligence (AI) whose objective is to emulate human intelligence.

2. Give a brief account of the origins of digital image processing.

Answer.

This originated back to the newspaper industry, when pictures were first sent by submarine cable between London and New York. The Bartlane cable picture transmission system was introduced in the early 1920s that reduced the transportation time from over a week to less than 3 hours and the system was implemented by using specialized printing equipment coded pictures for cable transmission and then reconstructed them at the receiving end. The issue with this were photograph quality were bad and while printing there were uneven distribution in intensity levels and this

printing method was discontinued at the end of 1921 and a new printing method using photographic reproduction made from tapes perforated at the telegraph receiving terminal. This method produced better quality photographs. The first computers powerful enough to carry out meaningful image processing tasks appeared in the early 1960s. It can be traced to the availability of those machines and to the onset of the space program during that period. Work on using computer techniques for improving images from a space probe began at the Jet Propulsion Laboratory (Pasadena, California) in 1964 when pictures of the moon transmitted by Ranger 7 were processed by a computer to correct various types of image distortion inherent in the on-board television camera.

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

   Answer

   - short-term storage: that is use during processing of images. Methods of providing short-term storage are computers and frame buffers.
   - on-line storage for relatively fast recall and retrieval. It is always called upon frequently.
   - archival storage: characterized by infrequent access and it is a permanent storage. It is characterized by massive storage requirements but infrequent need for access. Magnetic tapes and optical disks housed in "jukeboxes" are the usual media for archival applications.

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

   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. In the case of performing an X-ray on the chest of a patient, 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. Digital images are obtained by one of two methods:

- by digitizing X-ray films; or
- by having the X-rays that pass through the patient fall directly onto devices 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

   Answer

   The by-product of an ultrasound is determining the sex of the baby.

   - The ultrasound system (a computer, a display, etc.) transmits high-frequency sound pulses into the body.
   - The sound pulses 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 pulses are reflected (the bounce back) back to the probe, while some travel on further until they reach another boundary and get reflected (the bounce back).
   - The reflected waves are picked up by the probe and relayed to the computer or display system.

- The machine calculates the distance from the probe to the tissue or organ boundaries using the speed of sound in tissue (about 1540 m/s) and the time of each echo's return.
- The system displays the distances and intensities of the echoes on the screen, forming a two-dimensional image.

6 (a) what is an Angiograph

Answer

An angiogram is an image of blood vessels. Angiography is an area of digital image processing, where image subtraction is used to enhance further the blood vessels being studied.

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

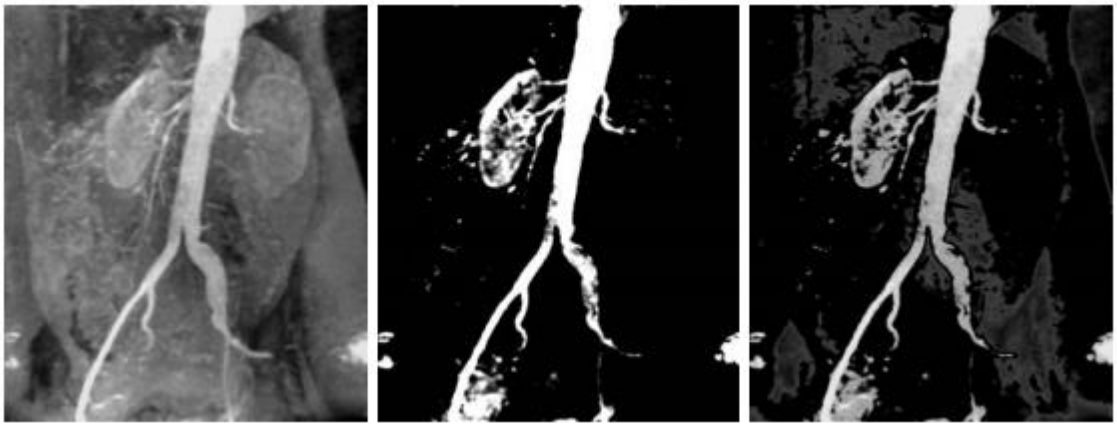
Answer

The catheter is threaded into the large blood vessel and guided to the kidney to the heart where the aorta resides. When the catheter reaches the kidney, 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.

(c) Use graphical illustrations to explain the transformation that has taken place in the fig below:

Answer

Piecewise Linear transformation took place here, using bit- plane slicing

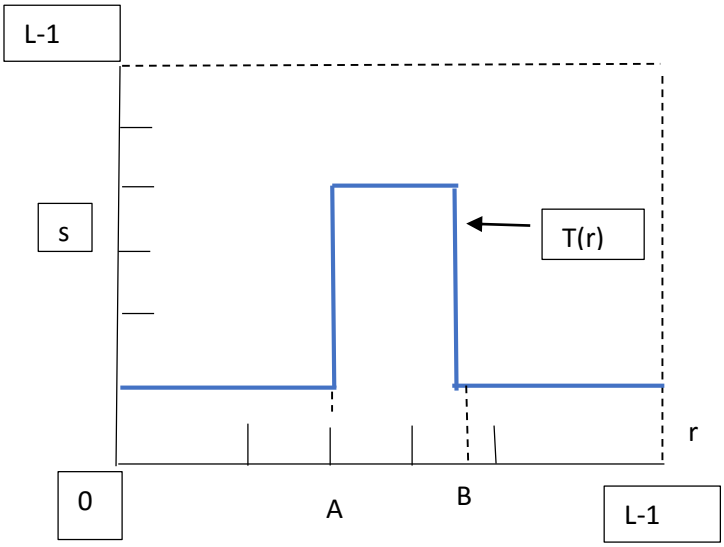


LIGHT IMAGE; original angiogram

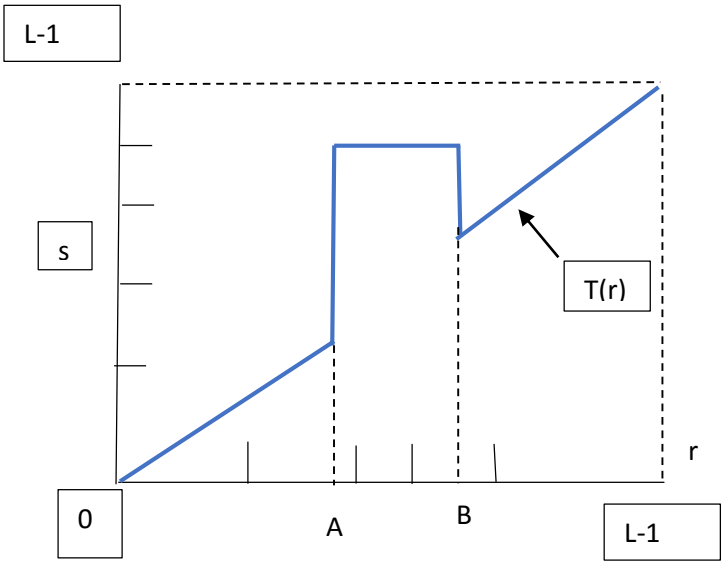
DARK IMAGE with the range of intensities of interest selected in the upper end of the gray scale.

HIGH CONTRAST IMAGE with the selected area set to black, so that grays in the area of the blood vessels and kidneys were preserved.

First transformation produces a binary image.



Second transformation brightens (or darkens) the desired range of intensities but leaves all other intensity levels in the image unchanged.



7. (a) Write short notes on the following

(i) **Spatial domain**: refers to the image plane itself, and image processing methods in this category are based on direct manipulation of pixels in an image. Spatial domain techniques operate directly on the pixels of an image. It is the section of the real plane spanned by the coordinates of an image.

(ii) **Spatial filtering** deals with performing operations, such as image sharpening, by working in a neighbourhood 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 the process of expanding the range of intensity levels in an image so that it spans full intensity range of the display medium.

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

Answer

Decomposing an image into its bit planes is useful for analysing 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, it is also useful for image compression.

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

Answer

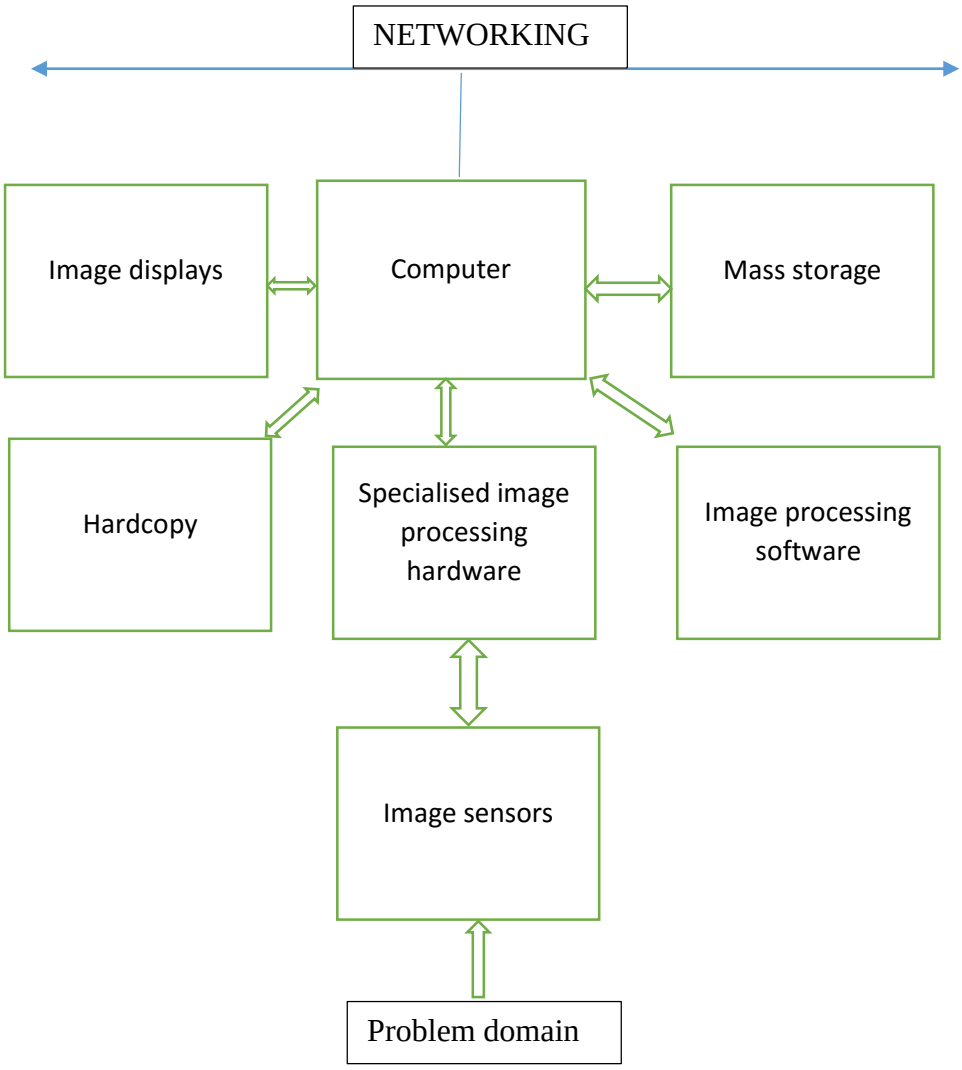


FIGURE: Components of a general-purpose image processing system.

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.

Image 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), that 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.

image processing 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.

Mass storage capability is a must in image processing applications. An image of size 1024 x 1024 pixels, in which the intensity of each pixel is an 8-bit quantity, requires one megabyte of storage space if the image is not compressed.

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.

Hardcopy devices for recording images include laser printers, film cameras, heat-sensitive devices, inkjet units, and digital units, such as optical and CDROM disks.

8. What is edge detection?

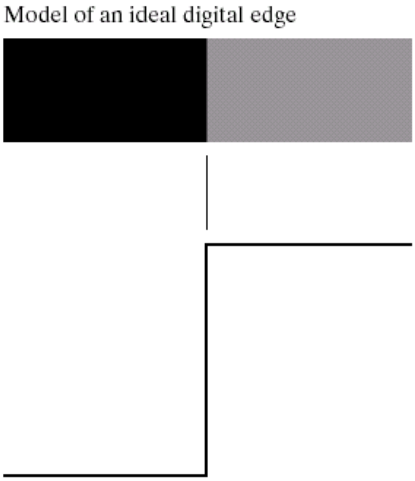
Answer

Edge detection is the approach used most frequently for segmenting images based on abrupt changes in intensity. An edge is detected when there are abrupt changes in intensity between two regions (dark and light). Edge detection typically is followed by linking algorithms designed to assemble edge pixels into meaningful edges and/or region boundaries. There are three fundamental steps performed in edge detection:

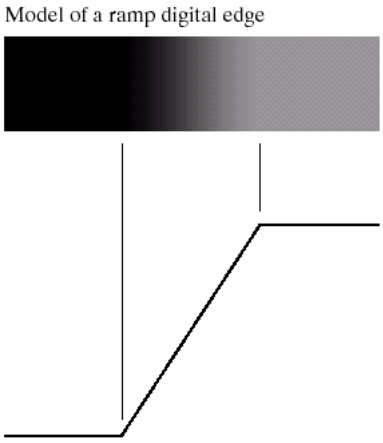
- Image smoothing for noise reduction.
- Detection of edge points.
- Edge localization.

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

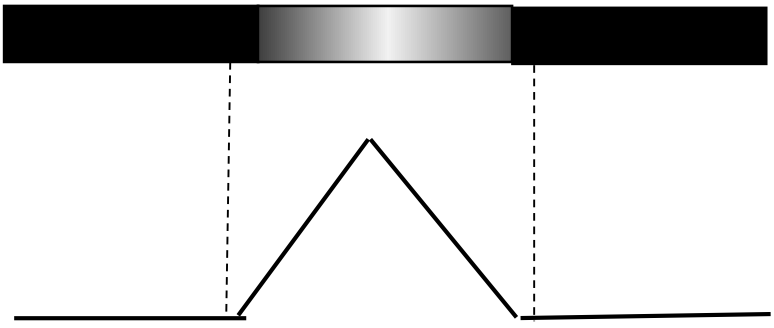
A **step edge** involves a transition between two intensity levels occurring ideally over the distance of 1 pixel.



Ramp edge: The slope of the ramp is inversely proportional to the degree of blurring in the edge.



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

ii) In one sentences give one reason why sobel mask is more preferable to prewitts mask.

Answer

Sobel mask is more preferable because **they have better suppression characteristics.**

11. Write short notes on the following

(i) **Edge pixels** are pixels at which the intensity of an image function changes abruptly. Edges are sets of connected edge pixels.

(ii) **Edge detectors** are local image processing methods designed to detect edge pixels. Edge detection methods are based on filtering an image with one or more masks, with no provisions being made for edge characteristics and noise content.

(iii) **Morphological watershed segmentation**

The concept of watersheds is based on visualizing an image in three dimensions: two spatial coordinates versus intensity. Three types of points are considered:

(a) points belonging to a regional minimum

(b) points at which a drop of water 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

(b) is called the catchment basin and (c) form crest lines on the topographic surface and are termed divide lines or watershed lines

The principal objective of segmentation algorithms based on these concepts is to find the watershed lines. Suppose that a hole is punched in each regional minimum and that the entire topography is flooded from below by letting water rise through the holes at a uniform rate. When the rising water in distinct catchment basins is about to merge, a dam is built to prevent the merging. The flooding will eventually reach a stage when only the tops of the dams are visible above the water line. These dam boundaries correspond to the divide lines of the watersheds. Therefore, they are the boundaries extracted by a watershed segmentation algorithm. In order to prevent the rising water from spilling out through the edges of the image, we imagine the perimeter of the entire topography being enclosed by dams of height greater than the highest possible mountain, whose value is determined by the highest possible intensity value in the input image.

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

Answer

- The strength (magnitude) of the gradient vector

Let S_{xy} denote the set of coordinates of a neighbourhood centred at point (x, y) in an image. An edge pixel with coordinates (s, t) in S_{xy} is similar in magnitude to the pixel at (x, y) if

$$|\mathbf{M(s, t) - M(x, y)}| \leq \mathbf{E}$$

Where **E** is a positive threshold.

- 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

$$|\boldsymbol{\alpha}\mathbf{(s, t) - }\boldsymbol{\alpha}\mathbf{(x, y)}| \leq \mathbf{A}$$

Where **A** is a positive angle threshold.

A pixel with coordinates (s, t) in S_{xy} is linked to the pixel at (x, y) if both magnitude and direction criteria are satisfied. This process is repeated at every location in the image.

13. Outline the approaches for linking edge using Hough transform.

Answer

Hough transform is a way of finding edge points in an image that lie along a straight line.

- The Hough transform consists of finding all pairs of values of θ and ρ which satisfy the equations that pass through (x, y).
- These are accumulated in what is basically a 2-dimensional histogram.
- When plotted these pairs of θ and ρ will look like a sine wave. The process is repeated for all appropriate (x, y) locations.

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

Answer

The 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.?

Answer

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.

Answer

The cones in the human eyes can be divided into 3 principal sensing categories: red, green and blue. 65% are sensitive to red light, 33% to green light and 2% to blue (but most sensitive). Colours are seen as variable combinations of the primary colours: Red, Green, Blue.

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

Answer

A primary color is defined as one that subtracts or absorbs a primary color of light and reflects or transmits the other two. Primary colours can be added to produce the secondary **colours of light** which are: Magenta (red plus blue), Cyan (green plus blue), Yellow (red plus green). Primary **colours of pigment**: absorb a primary colour of light and reflects or transmits the other two. Cyan, magenta, and yellow are the secondary colors of light or the primary colors of pigments.

Basically, Primary **colours of pigment** are also the secondary **colours of light.**

17. List and describe the attributes of a color.

- Brightness
- Hue
- Saturation

Brightness embodies the achromatic notion of intensity and is one of the key factors in describing color sensation.

Hue is an attribute associated with the dominant wavelength in a mixture of light waves. Hue represents dominant color as perceived by an observer.

Saturation refers to the relative purity or the amount of white light mixed with a hue. The pure spectrum colors are fully saturated.

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

Answer

•**Full-colour processing** approaches fall into two major categories. In the first category, we process each component image individually and then form a composite processed color image from the individually processed components. In the second category, we work with color pixels directly. full-color images have at least three components, color pixels are vectors. e.g. images acquired by colour TV camera or colour scanner.

•**Pseudo-colour processing** is also called false color. It is assigning a colour to a particular monochrome intensity or range of intensities. It consists of assigning colors to gray values based on a specified criterion. The principal use of pseudo-color is for human visualization and interpretation of gray-scale events in an image or sequence of images.

19. State the principal factors motivating color image processing.

Answer

• It is a powerful descriptor that often simplifies object identification and extraction from a scene

•Humans can discern (to recognize or distinct) thousands of colour shades and intensities, compared to about only two dozen shades of gray.