SHEKHAWATI INSTITUTE OF ENGINEERING AND TECHNOLOGY, SIKAR, (RAJASTHAN)

1ST MID TERM EXAMINATION 2017-18 (4th YEAR CSE)

Subject code & Name: **8CS2A DIGITAL IMAGE PROCESSING**

MM: 20 Time: 1:30 hr

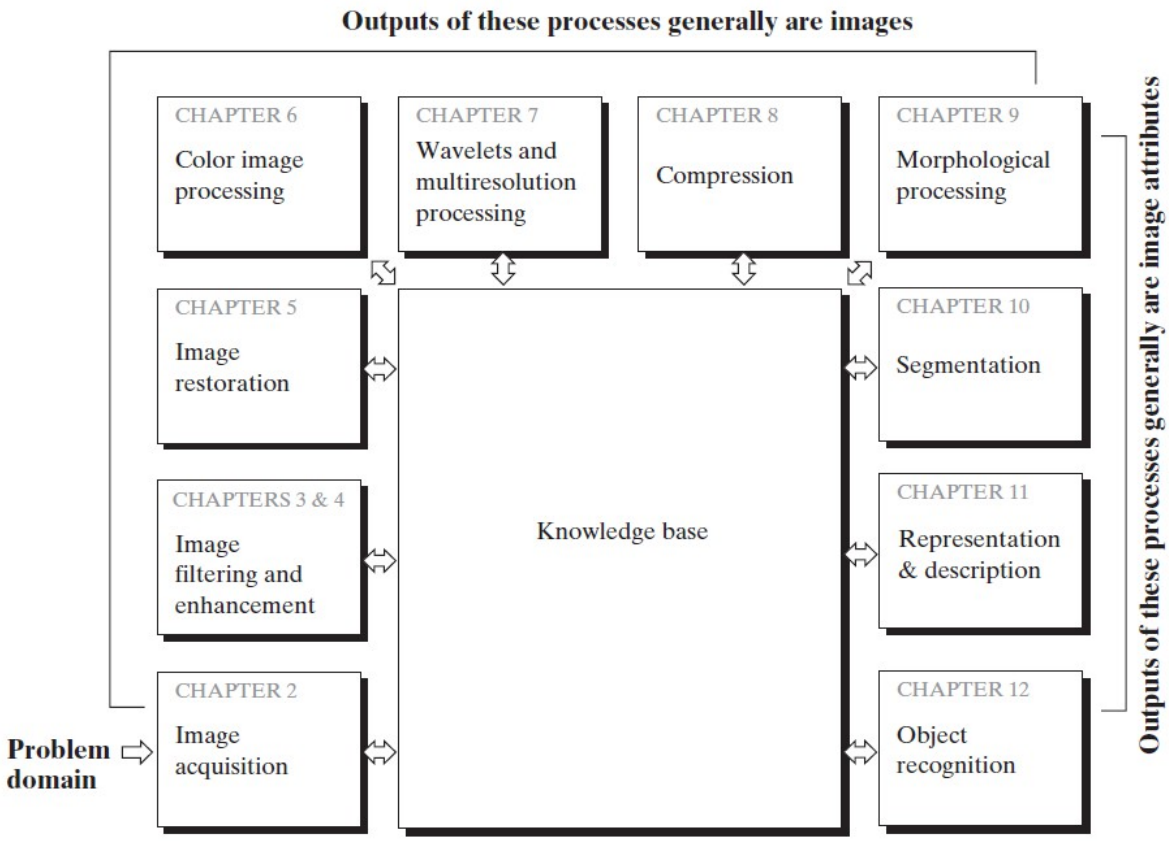
Student Instructions

1. Use pencil for diagrams.
2. **1ST question is compulsory. Attempt any four questions from rest.**
3. **All questions carry equal marks**
4. Write your ID before starting question paper.

8CS2A DIGITAL IMAGE PROCESSING

Q.1. What are the various steps involved in DIP?

SOLUTION:



Following are the steps involved in Digital Image Processing:

1. **Before any video or image processing can commence an image must be captured by a camera and converted into a manageable entity. This is the process known as image acquisition. The image acquisition process consists of three steps; energy reflected from the object of interest, an optical system which focuses the energy and finally a sensor which measures the amount of energy.**

2. **Image enhancement is the process of manipulating an image so that the result is more suitable than the original for a specific application. The word specific is important here, because it establishes at the outset that enhancement techniques are problem oriented.**
3. **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. Enhancement, on the other hand, is based on human subjective preferences regarding what constitutes a "good" enhancement result.**
4. **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.**
5. **Wavelets are the foundation for representing images in various degrees of resolution. In particular, this material is used in this book for image data compression and for pyramidal representation, in which images are subdivided successively into smaller regions.**
6. **Compression, as the name implies, deals with techniques for reducing the storage required to save an image, or the bandwidth required to transmit it.**
7. **Morphological processing deals with tools for extracting image components that are useful in the representation and description of shape.**
8. **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. On the other hand, weak or erratic segmentation algorithms almost always guarantee eventual failure. In general, the more accurate the segmentation, the more likely recognition is to succeed.**
9. **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.**
10. **Recognition is the process that assigns a label (e.g., "vehicle") to an object based on its descriptors.**

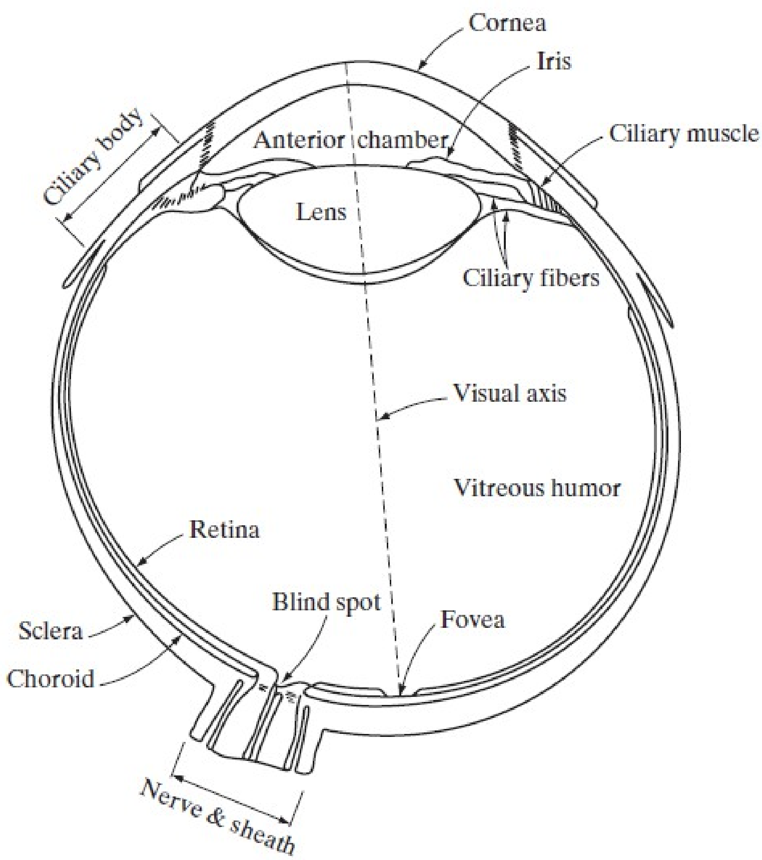
Q.2. **Differentiate photopic and scotopic vision.**

Solution: **Human eyes have developed to detect a small amount of the electromagnetic spectrum; this amount is called the visible light region. This region ranges in wavelengths from about 380nm or 400nm to 700nm or 780nm, which is very small when compared to the entire electromagnetic spectrum. It can also depend on the individual pair of eyes. Light waves are either absorbed or reflected by objects; humans see the mix of reflected colours in the eyes, giving a certain object a specific colour. If light waves did not reflect back, then all colours would be absorbed and we would only see black. If it was opposite, and all colours reflected to our eyes then we would only see white. Every single colour corresponds to a wavelength to which it was assigned to. The longer wavelengths appear on the red side of the range and the shorter wavelengths appear on the blue/violet side of the visible spectrum.**

Photopic vision: Photopic vision is the vision of the eye under well-lit conditions, normally usual daylight light intensity. It allows colour perception which is mediated by cone cells. Cone cells have a higher visual acuity as well as providing the eye's colour sensitivity. There are three types of cone cells to sense light for three bands of colour. Out of the six to seven million cone cells in the eye,

64% would be considered 'red' cones, 32% would be considered 'green' cones and 2% would be 'blue' cones. (Blue cones also have the highest sensitivity.
Scotopic vision: Scotopic vision is the vision of the eye under low light conditions. Cone cells do not function as well as rod cells in low level lighting so scotopic vision happens completely through rod cells, which are most sensitive to wavelengths of light on the electromagnetic spectrum of 498nm, which would be the blue-green bands of colour.

Q.3. Describe the usage of rods and cons distributed in retina of human eye.
Solution:



The human eye is nearly a sphere, with an average diameter of approximately 20 mm. Three membranes enclose the eye: the cornea and sclera outer cover; the choroid; and the retina. The innermost membrane of the eye is the *retina*, which lines the inside of the wall's entire posterior portion. When the eye is properly focused, light from an object outside the eye is imaged on the retina. Pattern vision is afforded by the distribution of discrete light receptors over the surface of the retina. There are two classes of receptors: *cones* and *rods*. The cones in each eye number between 6 and 7 million. They are located primarily in the central portion of the retina, called the *fovea*, and are highly sensitive to color. Humans can resolve fine details with these cones largely because each one is connected to its own nerve end. Muscles controlling the eye rotate the eyeball until the image of an object of interest falls on the fovea. Cone vision is called *photopic* or bright-light vision.

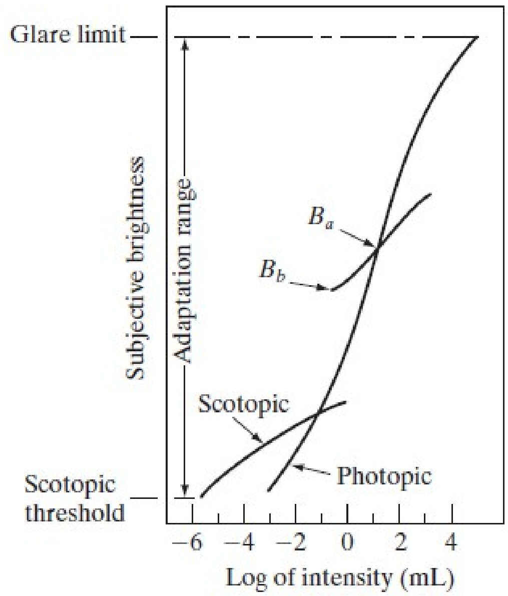
The number of rods is much larger: Some 75 to 150 million are distributed over the retinal surface. The larger area of distribution and the fact that several rods are connected to a single nerve end reduce the amount of detail discernible by these receptors. Rods serve to give a general, overall picture of the field of view. They are not involved in color vision and are sensitive to low levels of illumination. For example, objects that appear brightly colored in daylight when seen by moonlight appear as colorless forms because only the rods are stimulated. This phenomenon is known as *scotopic* or dim-light vision.

Q.4. Give an account of how image processing is being used in modern communication era.

Solution: In particular modern research areas include filter design, fast transforms, adaptive filters, spectrum estimation and modeling, sensor array processing, image processing, motion estimation from images, and the implementation of signal processing algorithms through appropriate technologies with real time applications in sonar, radar, speech, geophysics, computer-aided tomography, image restoration, robotic vision, pattern recognition, MPEG video compression for transmission and storage, print quality enhancement, and feature extraction etc. The use of image processing techniques and its associated algorithms in remote sensing is a remarkable area of research expertise including speech recognition and synthesis. The idea of video and image processing provides the ability to display and process high-resolution imagery with the aid of multiple systems that digitize, display, and process digital video. In order to carry out the specific task successfully it is necessary to have a complete suite of video distribution and editing equipment, a real-time MPEG encoder, and an ATM test bed network. Also, digital signal processing must be supported with speech processing, nonlinear DSP, neural networks, design of specialized signals, signal representation, and DSP architectures. In case of electronic imaging systems, image capturing, image rendering, and document processing can be performed with the help of high-resolution and large format printers, high-precision scanners, and high-performance workstations. Video and image compression, computer networks, multimedia authoring, media capture, wireless systems, and a wide variety of applications can also be achieved with the aid of multimedia test bed in addition to investigate and evaluate networked multimedia systems. The occurrence of several data processing technologies and high-end digital computers has enabled the ability to mathematically manipulate data which has formerly relied on the brain for processing such as speech, audio, images, and video. In particular, three major thrusts areas are signal processing which includes audio compression, speech recognition, statistical signal processing, speech synthesis, language identification, wireless sensor networks. Secondly, image processing which includes image enhancement, image compression, image reconstruction, image segmentation, image recognition, image transmission, image storage, remote sensing data analysis, medical image analysis and finally video processing which includes content-based video analysis, object tracking / recognition, visual surveillance, human activity recognition, and multimedia applications, etc. Data processing touches and solves a wide variety of engineering problems, from communication to human computer interface, to medical imaging and multimedia. It is well known that digital image processing is a rapidly evolving area with growing practical applications in both professional markets (computer-aided tomography is extensively employed in life sciences) and consumer markets (digital photography). Indeed, research applications span a wide range of fields which includes medical imaging, collaborative / array / distributed signal processing, speech processing for recognition and synthesis, immersive audio, multimedia signal processing and compression, optical information processing, signal processing for communications, and other multimedia related technologies such as content-based representation and retrieval.

Q.5. What are subjective brightness and brightness adaptation? Explain the relation between them.

Solution: Because digital images are displayed as a discrete set of intensities, the eye's ability to discriminate between different intensity levels is an important consideration in presenting image processing results. The range of light intensity levels to which the human visual system can adapt is enormous—on the order of —10^{10} from the scotopic threshold to the glare limit. Experimental evidence indicates that subjective brightness (intensity as perceived by the human visual system) is a logarithmic function of the light intensity incident on the eye.



The essential point in interpreting the impressive dynamic range is that the visual system cannot operate over such a range simultaneously. Rather, it accomplishes this large variation by changing its overall sensitivity, a phenomenon known as brightness adaptation. The total range of distinct intensity levels the eye can discriminate simultaneously is rather small when compared with the total adaptation range. For any given set of conditions, the current sensitivity level of the visual system is called the brightness adaptation level, which may correspond, for example, to brightness in B_a. The short intersecting curve represents the range of subjective brightness that the eye can perceive when adapted to this level. This range is rather restricted, having a level at B_b and below which all stimuli are perceived as indistinguishable blacks. The upper portion of the curve is not actually restricted but, if extended too far, loses its meaning because much higher intensities would simply raise the adaptation level higher than B_a.

Q.6. What is the basic principle of Image acquisition? What are different techniques for acquiring an image?

Solution: <u>Principle:</u> Incoming energy is transformed into a voltage by the combination of input electrical power and sensor material that is responsive to the particular type of energy being detected. The output voltage waveform is the response of the sensor(s), and a digital quantity is obtained from each sensor by digitizing its response.

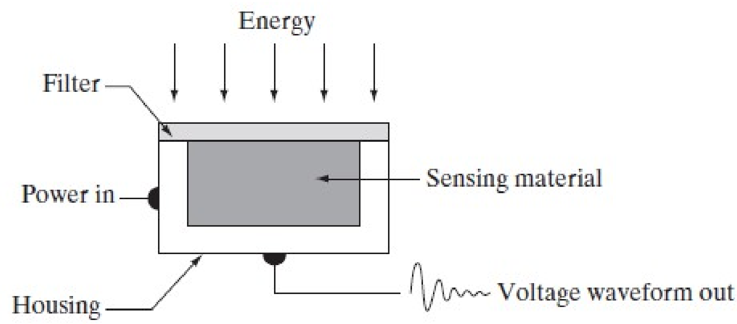
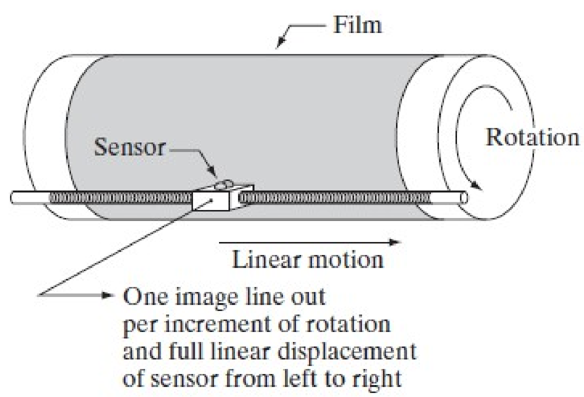
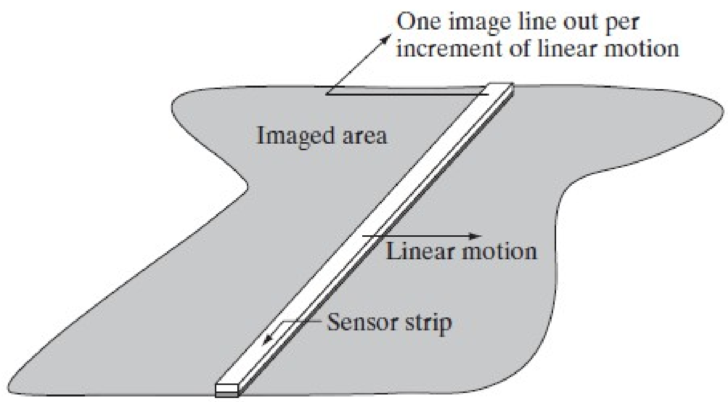


Image Acquisition can be done in 3 ways:

1. **Using a Single Sensor: In order to generate a 2-D image using a single sensor, there has to be relative displacements in both the x- and y-directions between the sensor and the area to be imaged.**

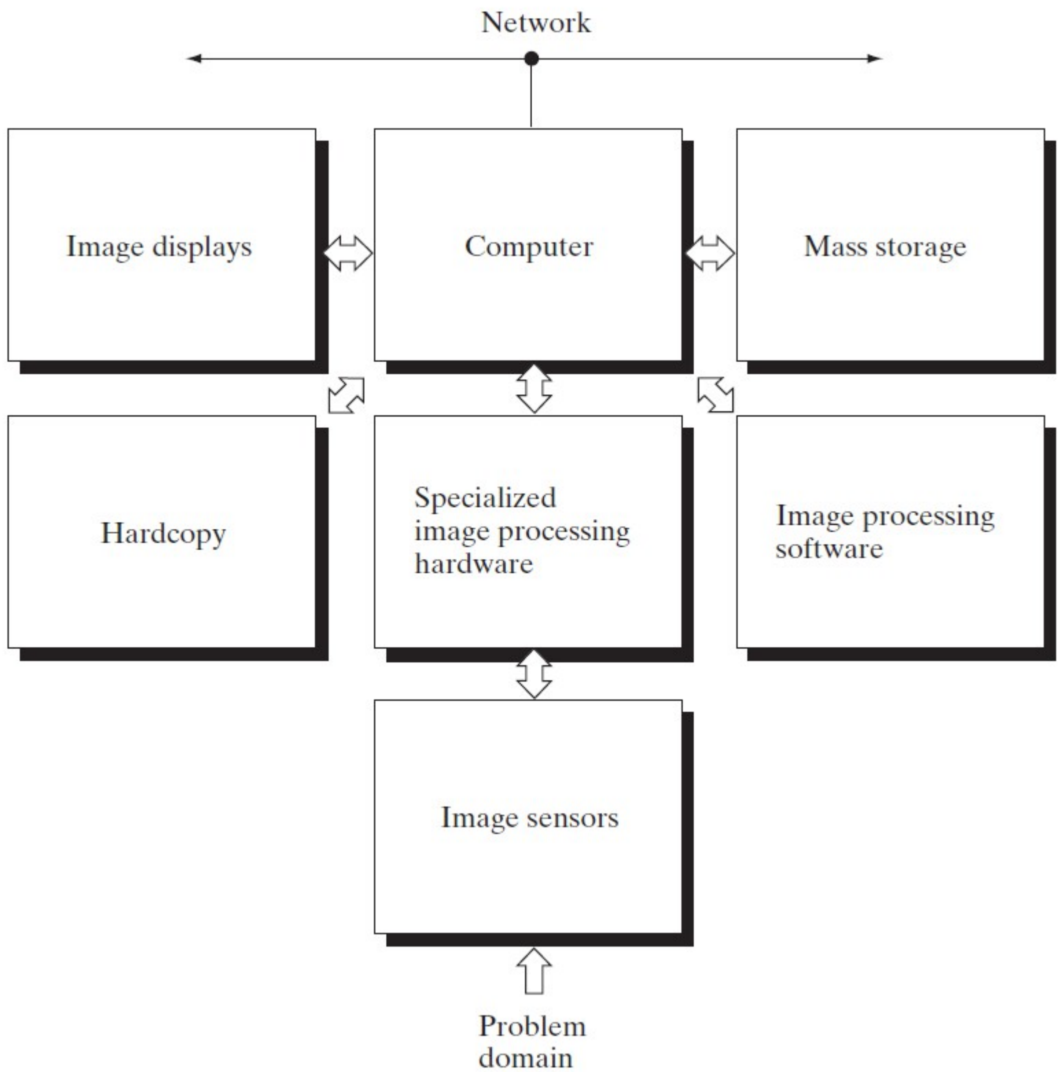


2. **Using Sensor Strips: A geometry that is used much more frequently than single sensors consists of an in-line arrangement of sensors in the form of a sensor strip. The strip provides imaging elements in one direction. Motion perpendicular to the strip provides imaging in the other direction**



3. **Using sensor arrays: Numerous electromagnetic and some ultrasonic sensing devices frequently are arranged in an array format. This is also the predominant arrangement found in digital cameras. A typical sensor for these cameras is a CCD array, which can be manufactured with a broad range of sensing properties and can be packaged in rugged arrays of 4000 x 4000 elements or more. CCD sensors are used widely in digital cameras and other light sensing instruments. The response of each sensor is proportional to the integral of the light energy projected onto the surface of the sensor, a property that is used in astronomical and other applications requiring low noise images.**

Q.7. What are different components of image processing?
Solution:



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. For instance, in a digital video camera, the sensors produce an electrical output proportional to light intensity. 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. One example of how an ALU is used is in averaging images as quickly as they are digitized, for the purpose of noise reduction. This type of hardware sometimes is called a front-end subsystem, and its most distinguishing characteristic is speed. In other words, this unit performs functions that require fast data throughputs (e.g., digitizing and averaging video images at 30 frames/s) that the typical main computer cannot handle. The computer in an image processing system is a general-purpose computer and can range from a PC to a supercomputer. In dedicated applications, sometimes custom computers are used to achieve a required level of performance, but our interest here is on general-purpose image processing systems. In these

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 Image displays Computer Mass storage 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.