Image Sensing and Acquisition

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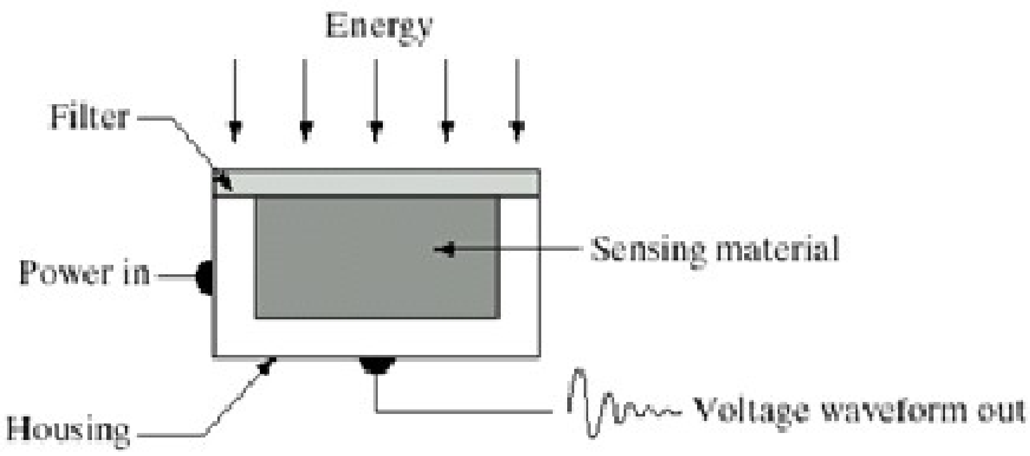
Image sensing and Acquisition

- Images can be generated by the combination of an illuminating source and reflection or absorption of energy from that source by the elements of the scene being imaged.
- The illuminating source could be sun or any other source of electromagnetic energy such as radar, IR rays or X-ray energy.
- Depending upon the nature of source, illumination energy is reflected from or transmitted through object.
- This reflected or transmitted energy is focused onto a photo converter which converts the energy into visible light.

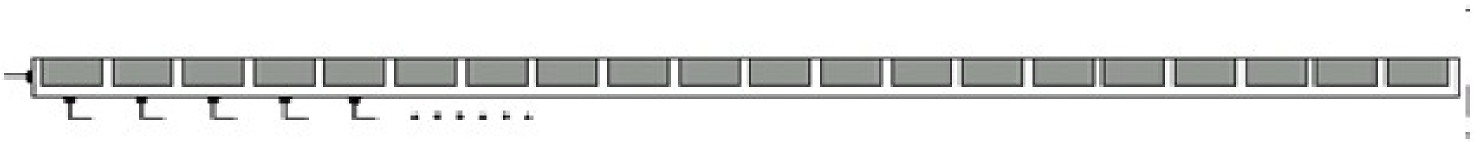
Image sensing and Acquisition

- There are 3 principal sensor arrangements (produce an electrical output proportional to light intensity).
  - (i)Single imaging Sensor
  - (ii)Line sensor
  - (iii)Array sensor

Image sensing and Acquisition

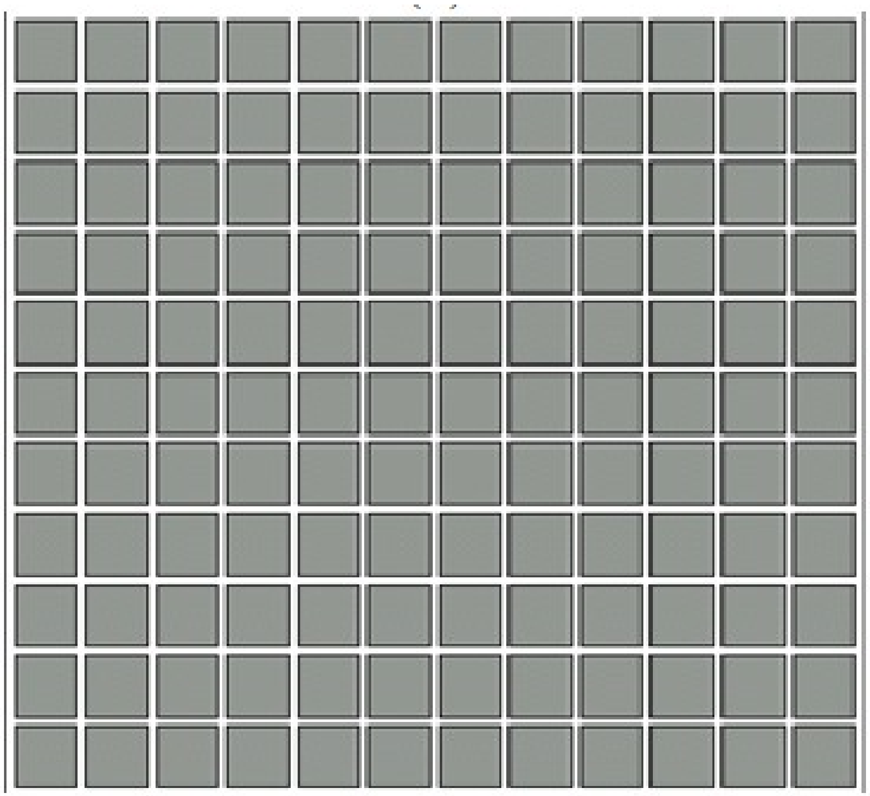


(i)



(ii)

Image sensing and Acquisition



(iii)

Image Acquisition using a single sensor

- The most common sensor of this type is the photodiode, which is constructed of silicon materials and whose output voltage waveform is proportional to light.
- The use of a filter in front of a sensor improves selectivity. For example, a green (pass) filter in front of a light sensor favours light in the green band of the color spectrum.
- As a consequence, the sensor output will be stronger for green light than for other components in the visible spectrum.

Image Acquisition using a single sensor

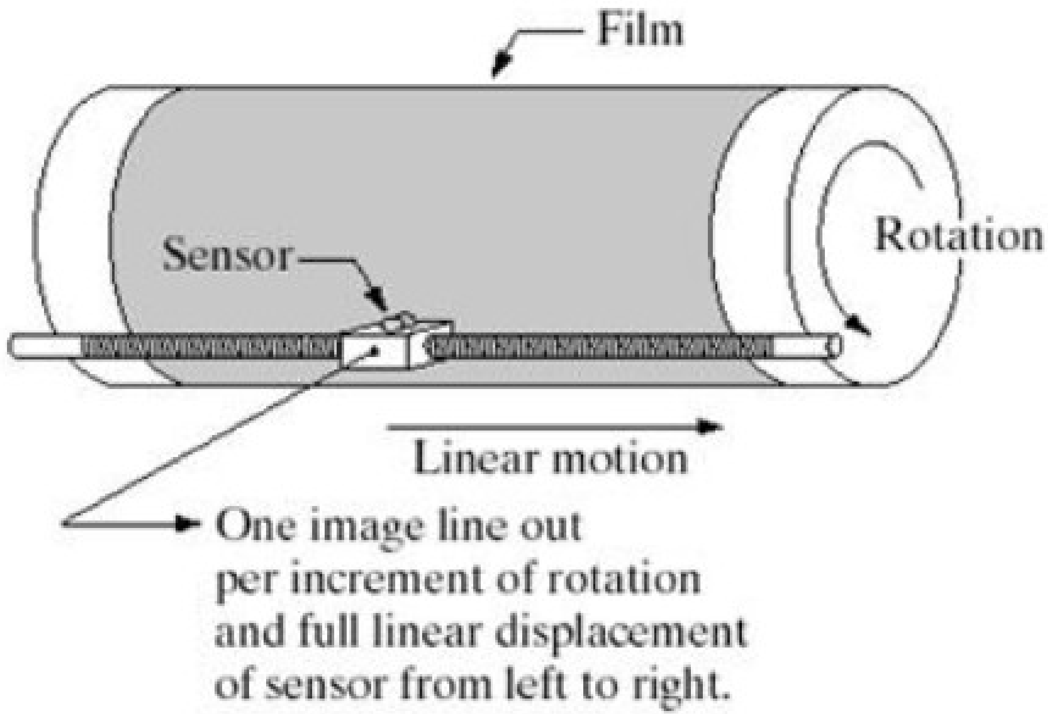


Fig: Combining a single sensor with motion to generate a 2-D image

Image Acquisition using a single sensor

- In order to generate a 2-D image using a single sensor, there have to be relative displacements in both the x- and y-directions between the sensor and the area to be imaged.
- An arrangement used in high precision scanning, where a film negative is mounted onto a drum whose mechanical rotation provides displacement in one dimension.
- The single sensor is mounted on a lead screw that provides motion in the perpendicular direction. Since mechanical motion can be controlled with high precision, this method is an inexpensive (but slow) way to obtain high-resolution images.

Image Acquisition using Sensor Strips

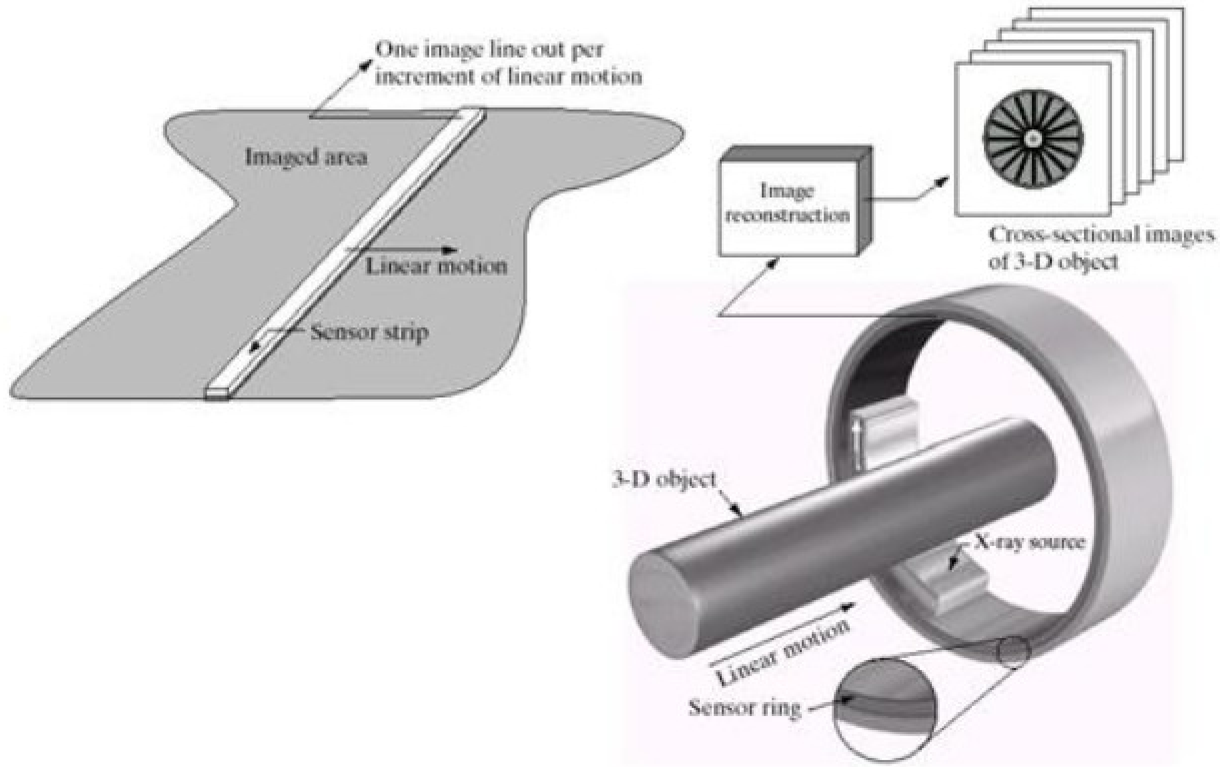


Fig: (a) Image acquisition using linear sensor strip (b) Image acquisition using circular sensor strip.

Image Acquisition using Sensor Strips

- The strip provides imaging elements in one direction. Motion perpendicular to the strip provides imaging in the other direction.
- This is the type of arrangement used in most flatbed scanners.
- Sensing devices with 4000 or more in-line sensors are possible. In-line sensors are used routinely in airborne imaging applications, in which the imaging system is mounted on an aircraft that flies at a constant altitude and speed over the geographical area to be imaged.

Image Acquisition using Sensor Strips

- One-dimensional imaging sensor strips that respond to various bands of the electromagnetic spectrum are mounted perpendicular to the direction of flight.
- The imaging strip gives one line of an image at a time, and the motion of the strip completes the other dimension of a two-dimensional image.
- Sensor strips mounted in a ring configuration are used in medical and industrial imaging to obtain cross-sectional (“slice”) images of 3-D objects.

Image Acquisition using Sensor Strips

- A rotating X-ray source provides illumination and the portion of the sensors opposite the source collect the X-ray energy that pass through the object (the sensors obviously have to be sensitive to X-ray energy).
- This is the basis for medical and industrial computerized axial tomography (CAT) imaging.

Image Acquisition using Sensor Array

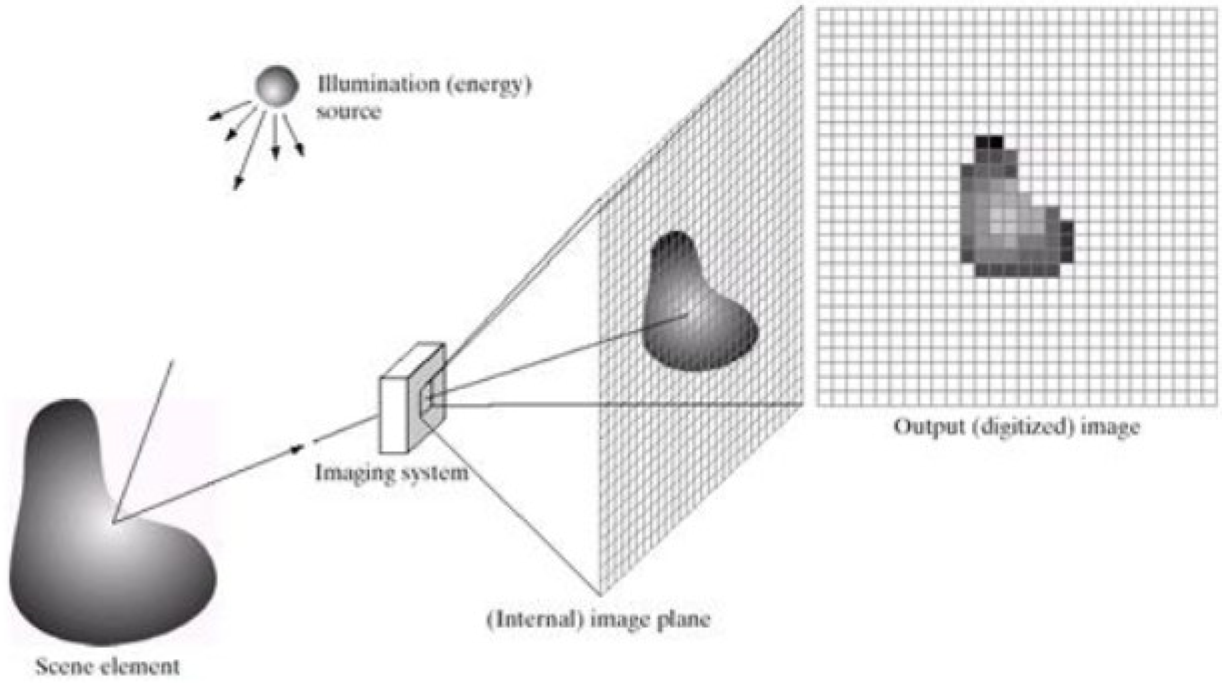


Fig: An example of the digital image acquisition process (a) energy source (b) An element of a scene (d) Projection of the scene into the image (e) digitized image

Image Acquisition using Sensor Array

- This type of arrangement is 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 * 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.

Image Acquisition using Sensor Array

- The first function performed by the imaging system is to collect the incoming energy and focus it onto an image plane.
- If the illumination is light, the front end of the imaging system is a lens, which projects the viewed scene onto the lens focal plane.
- The sensor array, which is coincident with the focal plane, produces outputs proportional to the integral of the light received at each sensor.

Simple Image formation model

- Images can be denoted by 2D functions as f(x,y)
  - Where the value of the amplitude f at the spatial coordinates x,y is a positive scalar quantity whose value is determined by the source of light.
  - Thus $0<f(x,y)< a$
  - This function f(x,y) is characterized by two components.
  - (1) The amount of source illumination incident on the scene i(x,y) and (2) amount of reflectance component r(x,y).
- Therefore $f(x,y)= i(x,y).r(x,y)$ where

  $0 \leq (x,y) \leq a$ and

  $0< i(x,y) < a$

  $0< r(x,y) < 1$

  reflectivity depends on the characteristics of the image.

Simple Image formation model

- When the illuminating object is normal visible light, reflectivity function becomes the main factor for image formation.
- When the image is formed of a chest through X-ray instead of reflectivity light transmitivity function helps in formation of images

Thank you

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