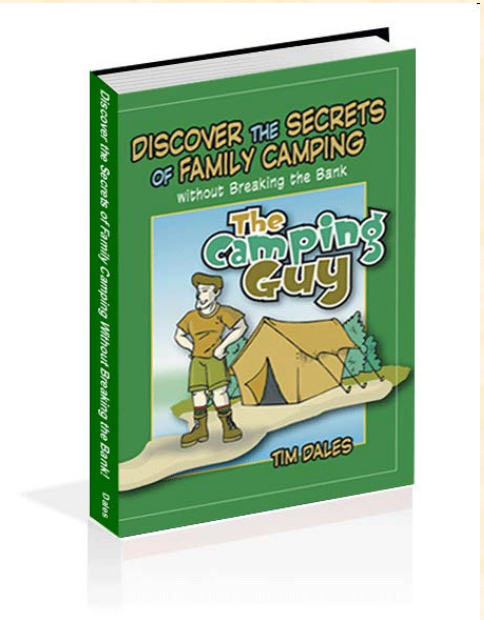
2 – IMAGE ACQUISITION

Image acquisition is the conversion of an optical picture, typically representing a 2D or 3D scene, into a digitized form suitable for use with computers.



Many acquisition systems comprise an input device:

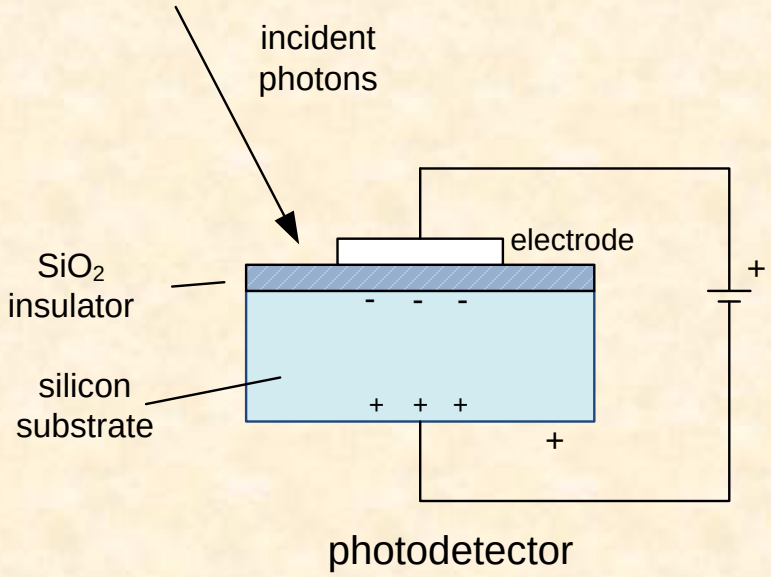
- a scanner, or
- a digital camera, or
- a video camera (possibly with a frame grabber)

SOLID-STATE IMAGE SENSORS

The conversion of optical energy to electrical energy is typically done by a solid-state image sensor, which comprises an array of photodetectors (or photoelements)

The basis of solid-state image sensors is the photo-electric effect: photons incident on a semiconductor such as silicon will generate electron-hole pairs. The amount of charge produced will depend on the light intensity and the exposure time. The charge is converted to voltage, which is the output response of the sensor.

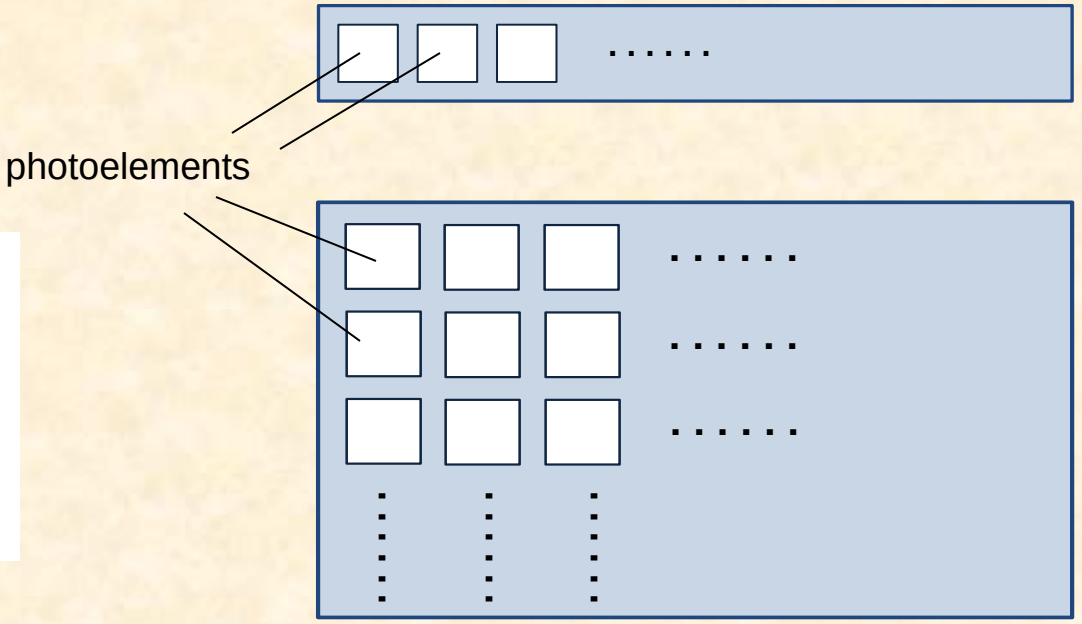
Most solid-state image sensors are based on CMOS or CCD (charge-coupled device) technology.



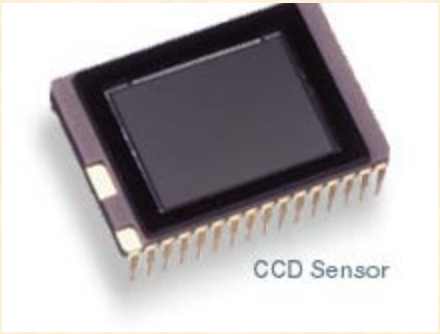
photodetector

Solid-state image sensors are constructed in the form of a linear (1D) or area (2D) arrays of individual photodetectors (or photoelements).

1D array

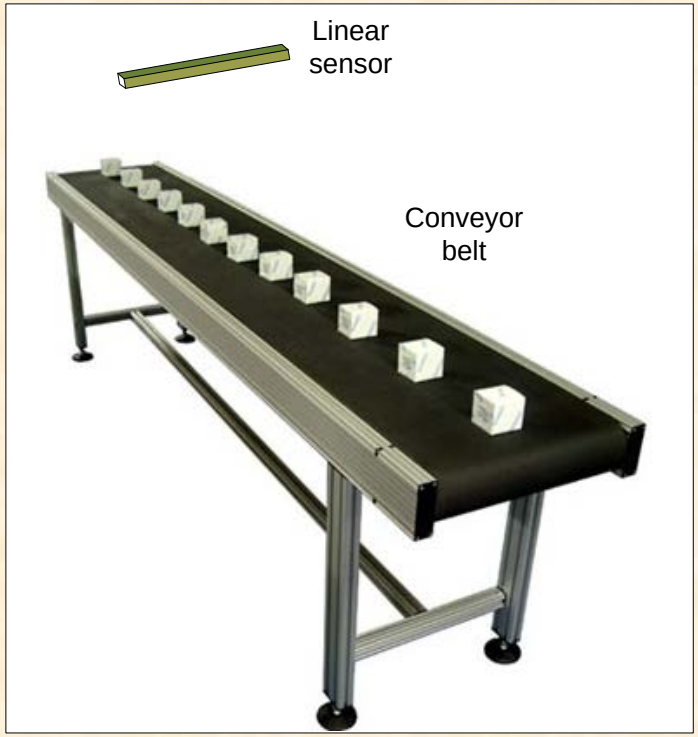


2D array



The arrays come in a wide range of sizes: linear (1D) arrays up to 14,000 photoelements and area (2D) arrays up to 7216×5214 photoelements.

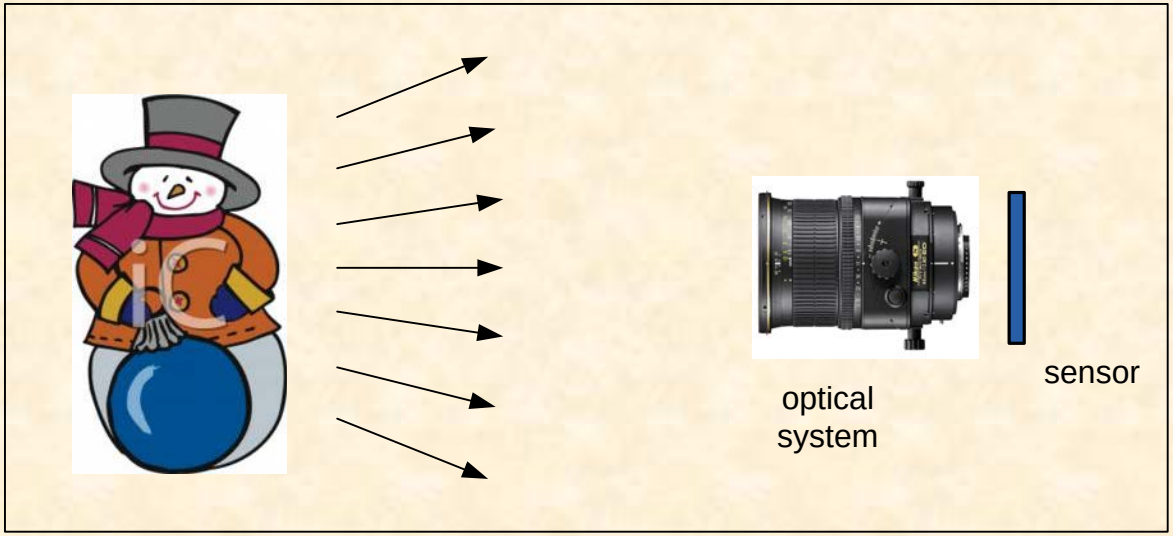
Linear arrays may be used when measurements along only one dimension is needed or when a 2D picture can be obtained because the sensor or object is moving at a constant velocity.



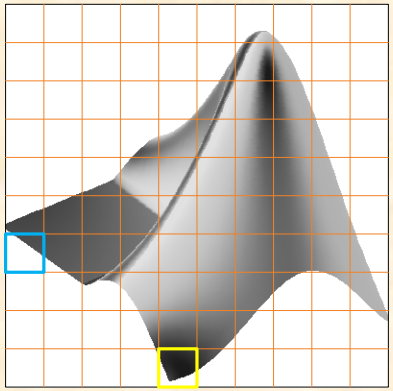
Other factors will have to be considered in deciding between linear and area arrays, e.g.,

- ease of calibration of individual photodiodes
- higher resolution of the linear sensor
- cost.

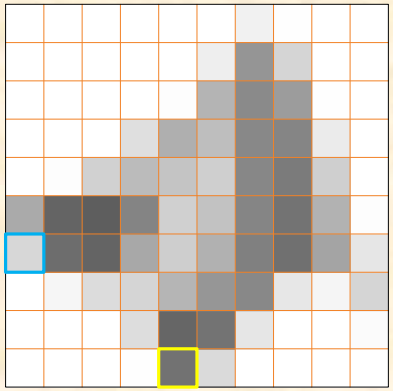
In the process of image acquisition, an optical system collects the incident light energy and focuses it onto the sensor array. The image of the scene on the sensor is a continuous function; it is sampled by the array to give a spatially discrete image function.



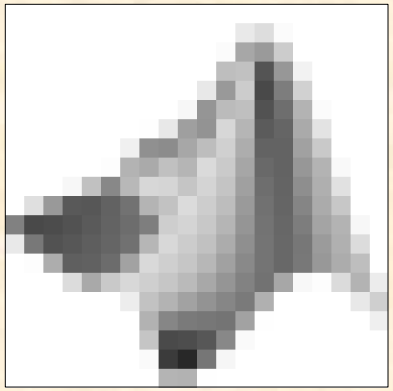
The quality of the acquired image is determined to a large degree on the number of photoelements in the sensor array.



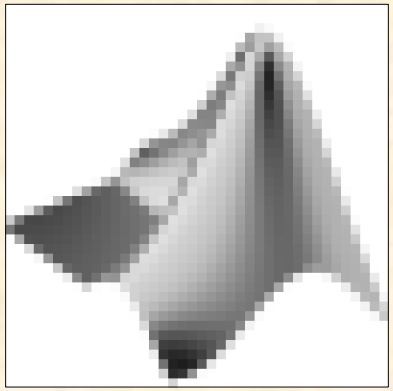
Continuous image and
10x10 sensor array



10x10



20x20



40x40

SCANNERS

Scanners are used for producing a digital image of a document. The document lies on top of a glass window. A source of uniform illumination is turned on and a linear sensor array is moved across the page. Pixels are acquired row by row.

The output of a scanner is a digital signal which is sent to a computer for storage.

Optical resolution goes up to 2,400 d.p.i., with 8-14 bits/pixel for monochrome images and 24-42 bits/pixel for color images.

DIGITAL CAMERAS

- Spatial resolutions of up to 7360×4912 (about 36 megapixels) are available.
- The digitised images are usually stored in removable flash-memory cards.
- Compression of images means more images may be stored in the camera.
- Many mobile phones come with built-in digital cameras, but these generally are of lower quality.

VIDEO CAMERAS

Video cameras are used for continuous monitoring of time-varying (or dynamic) scenes. The image sensor is usually a solid-state device.

- Camcorders can record the digitised video data to miniDV tapes, flash memory devices or optical disks.
- Industrial digital video cameras are meant for industrial and scientific applications.
- The video outputs may be digital or analogue; in the case of the latter, the signal has to be digitized before the data can be processed by a computer.

COMPUTER-CAMERA INTERFACE

A frame grabber is needed to sample and digitize the analogue video signal from a video camera.

The card which plugs into the computer bus, draws power and timing signals from the bus.

Some cards have additional components (specially designed computational ICs or digital signal processing ICs) to speed up processing time for operations such as convolution, image averaging and Fourier transformations.

Lytro (light field camera)

New concept in digital photography

Traditional cameras have a limited depth of field.

The Lytro camera uses special lenses and sensors to capture the image. After that, you can select the focus plane to view the object of interest.

LYTRO

LYTRO

LYTRO