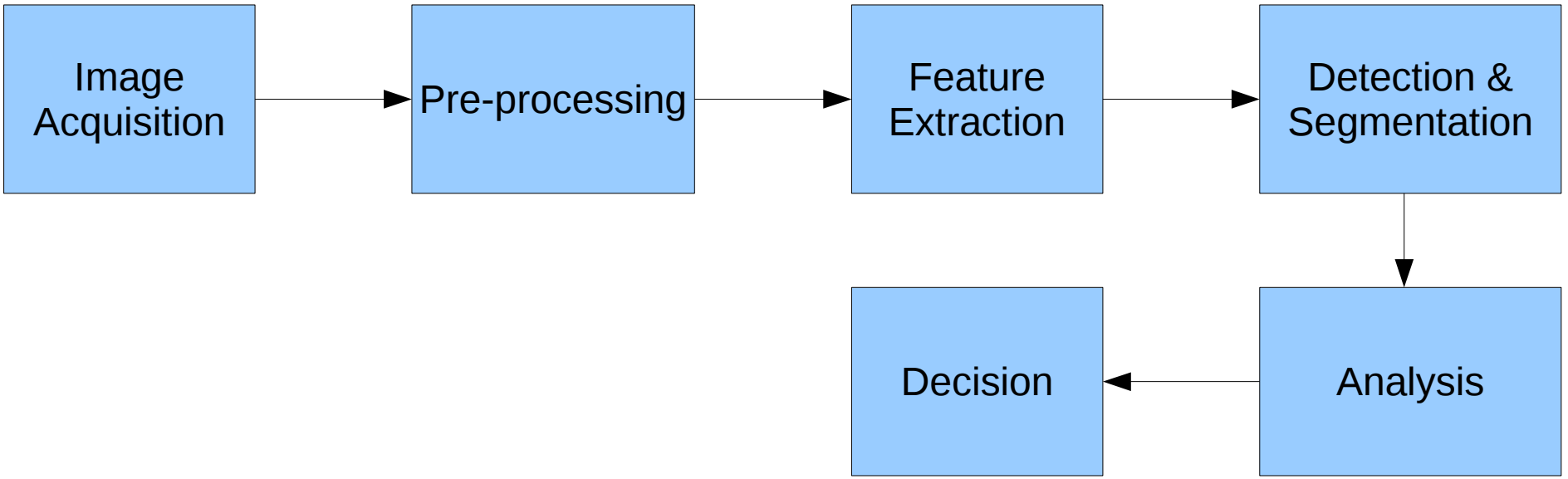
Computer Vision

Aditya Wikan Mahastama

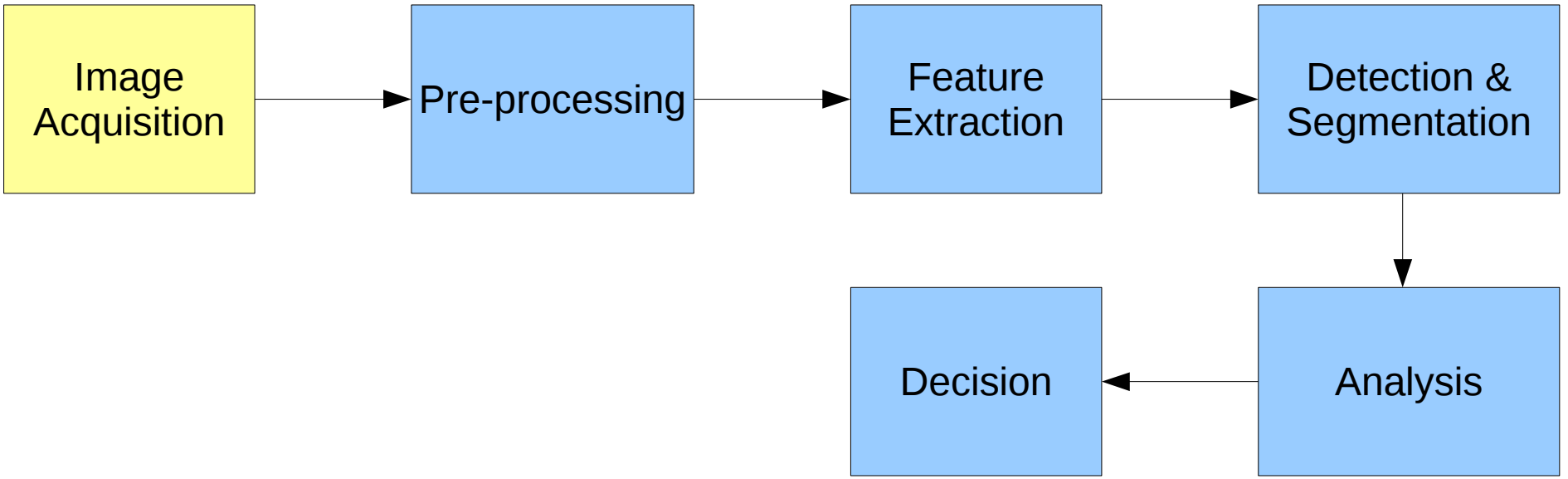
1

Image Acquisition

Computer Vision Process

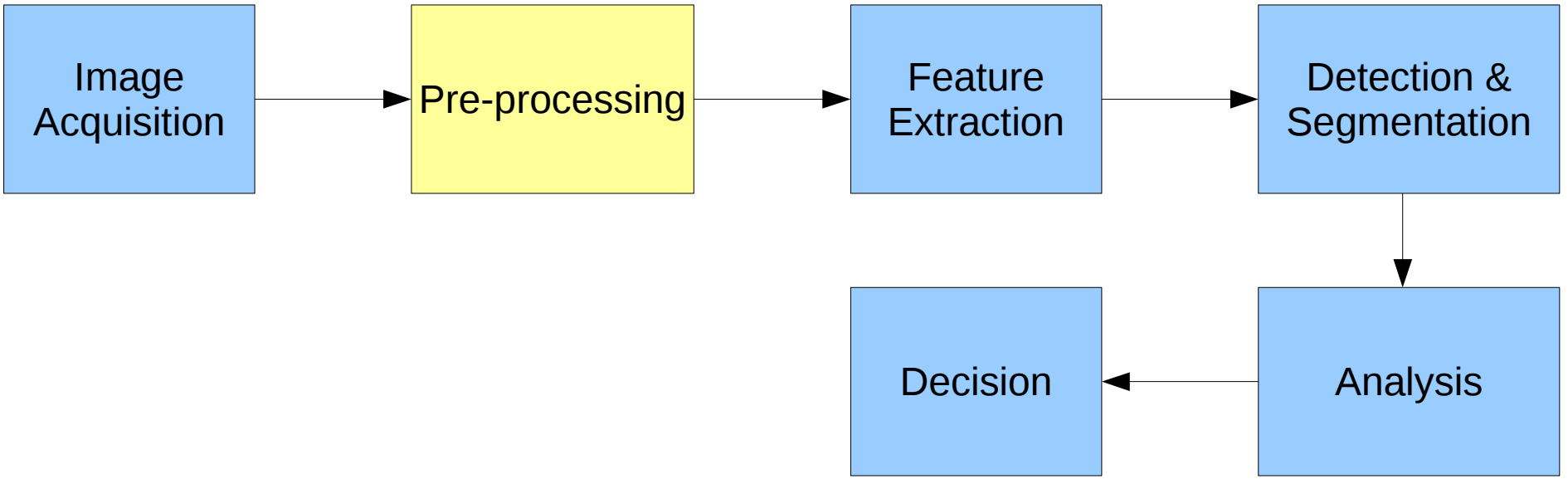


Computer Vision Process



- A digital image is produced by one or several image sensors, which, besides various types of light-sensitive cameras, include range sensors, tomography devices, radar, ultra-sonic cameras, etc.
- Depending on the type of sensor, the resulting image data is an ordinary 2D image, a 3D volume, or an image sequence. The pixel values typically correspond to light intensity in one or several spectral bands (gray images or colour images), but can also be related to various physical measures, such as depth, absorption or reflectance of sonic or electromagnetic waves, or nuclear magnetic resonance.

Computer Vision Process



- Re-sampling in order to assure that the image coordinate system is correct.
- Noise reduction in order to assure that sensor noise does not introduce false information.
- Contrast enhancement to assure that relevant information can be detected.
- Scale-space representation to enhance image structures at locally appropriate scales

Computer Vision Process

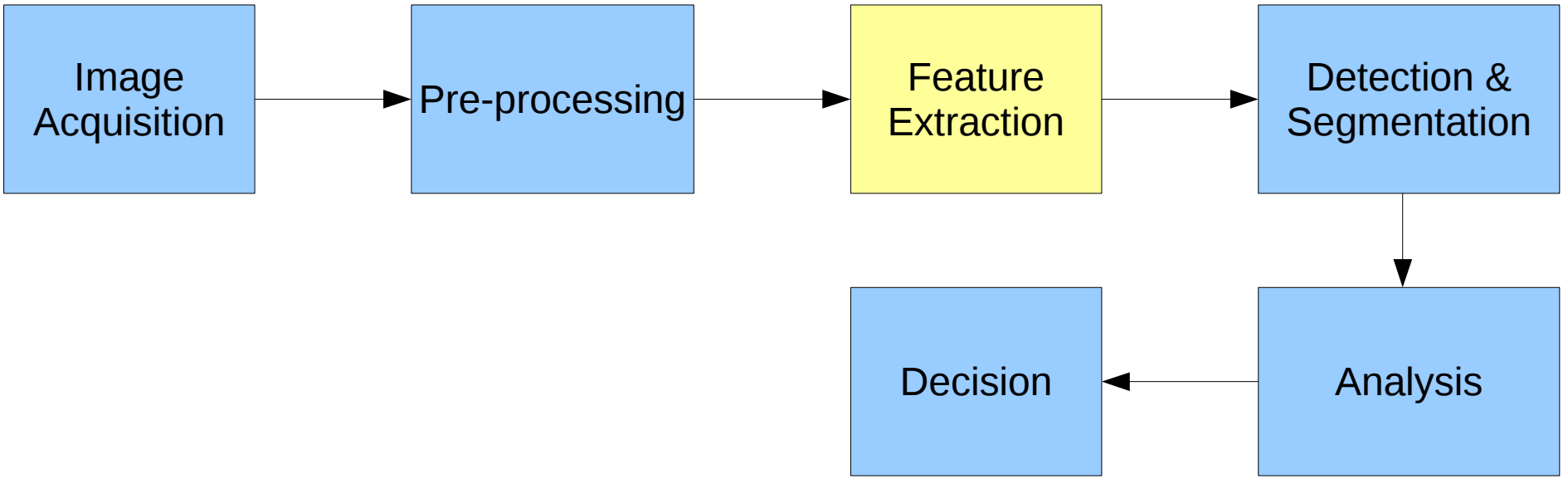


Image features at various levels of complexity are extracted from the image data. Typical examples of such features are:

- Lines, edges and ridges.
- Localized interest points such as corners, blobs or points.

More complex features may be related to texture, shape or motion.

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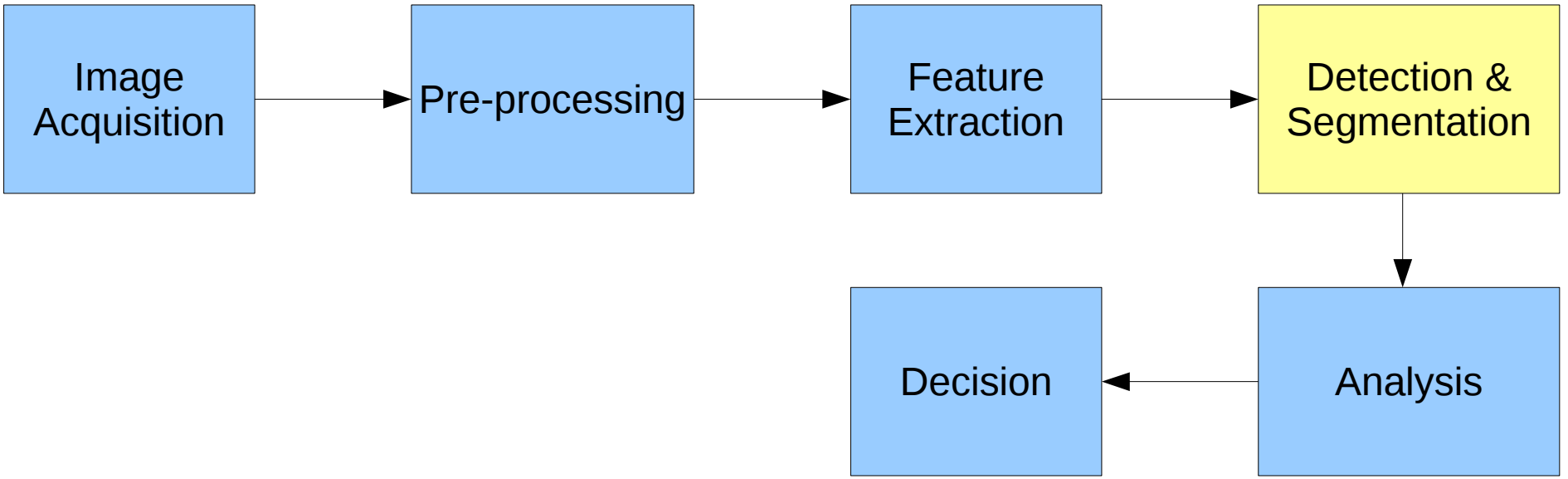
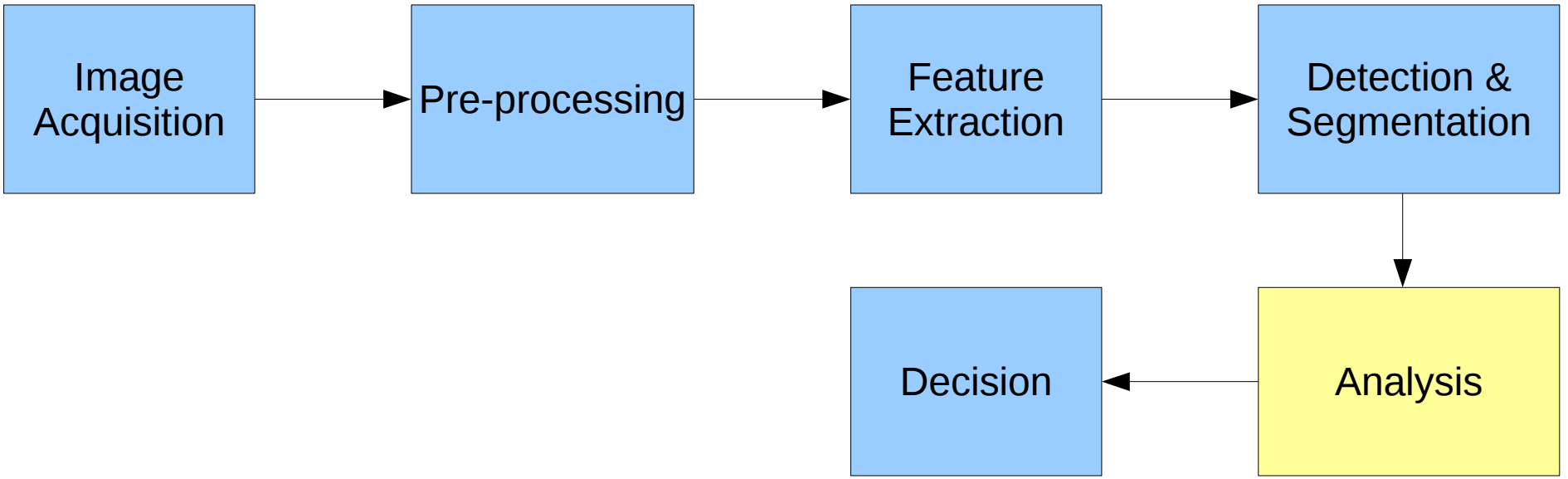


At some point in the processing a decision is made about which image points or regions of the image are relevant for further processing. Examples are:

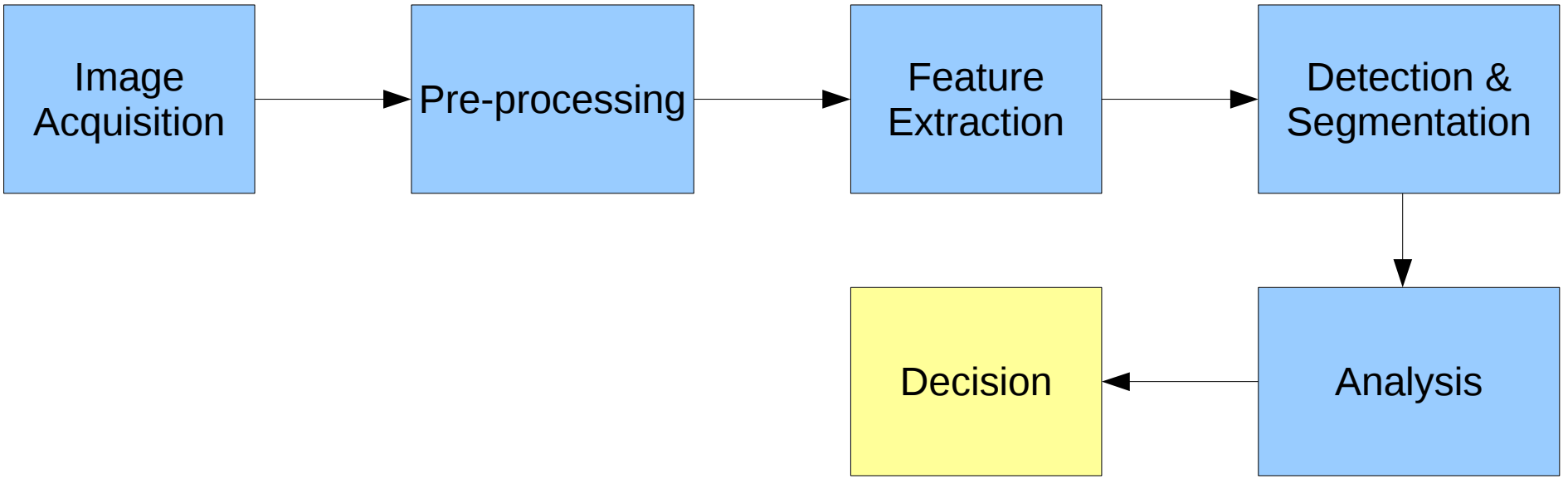
- Selection of a specific set of interest points
- Segmentation of one or multiple image regions which contain a specific object of interest.

Computer Vision Process



- Verification that the data satisfy model-based and application specific assumptions.
- Estimation of application specific parameters, such as object pose or object size.
- Image recognition: classifying a detected object into different categories.
- Image registration: comparing and combining two different views of the same object.

Computer Vision Process

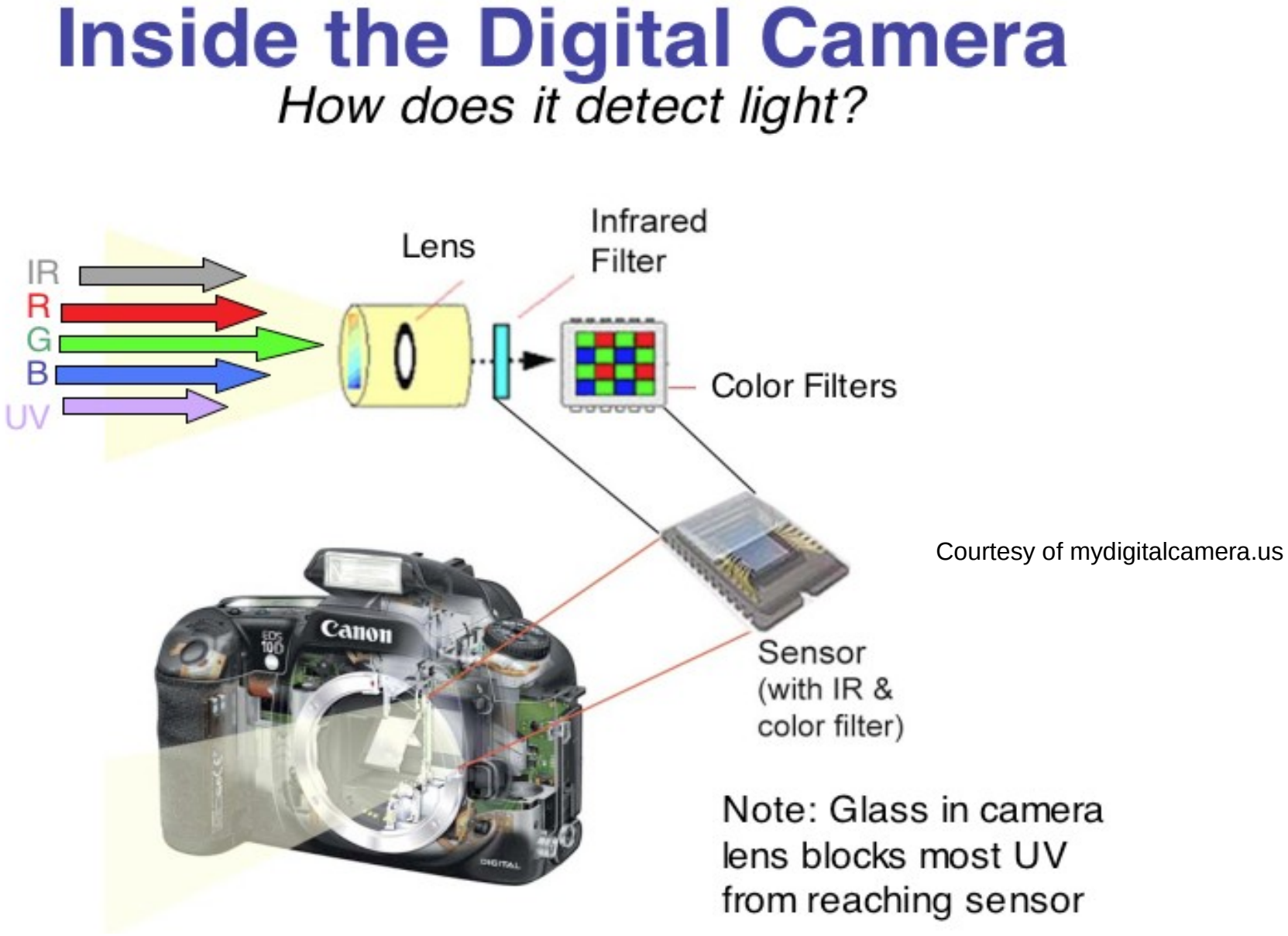


- Pass/fail on automatic inspection applications
- Match / no-match in recognition applications
- Flag for further human review in medical, military, security and recognition applications

Image Acquisition

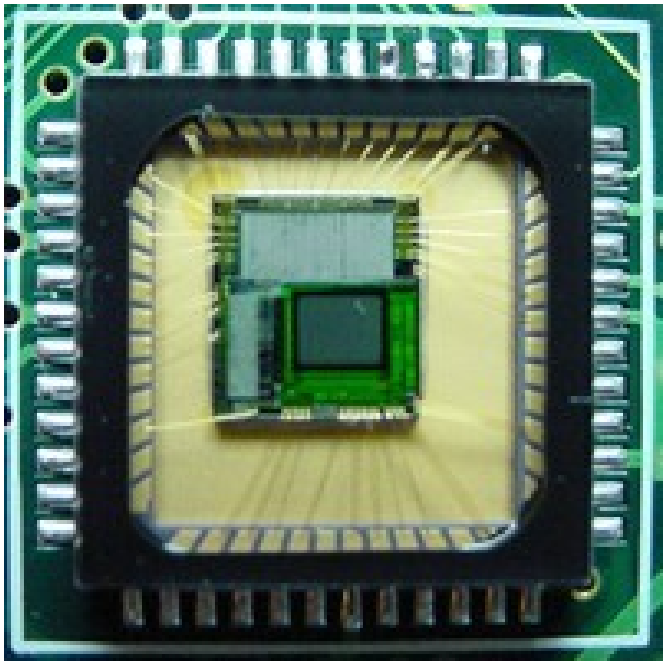
- Proses mendapatkan citra digital melalui sebuah alat:
- Kamera Digital (still/video)
- Scanner
- Sensor (radar, sensor suhu, sonar, dsb.)
- Hasilnya adalah citra 2 dimensi, 3 dimensi atau gambar bergerak (video)

Image Acquisition – Kamera Digital

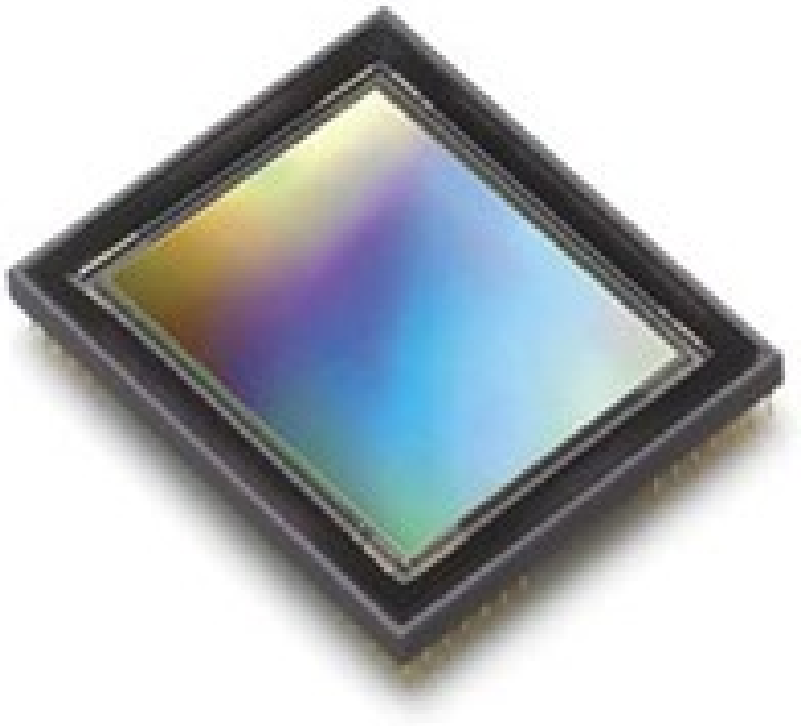


Courtesy of mydigitalcamera.us

Image Acquisition – Kamera Digital



A CMOS Sensor



A CCD Sensor

Courtesy of www.howstuffworks.com

Image Acquisition – Kamera Digital

- Instead of film, a digital camera has a sensor that converts light into electrical charges.
- The image sensor employed by most digital cameras is a charge coupled device (CCD). Some cameras use complementary metal oxide semiconductor (CMOS) technology instead.
- Both CCD and CMOS image sensors convert light into electrons. A simplified way to think about these sensors is to think of a 2-D array of thousands or millions of tiny solar cells. (in this case the sensors are called **photosites**)

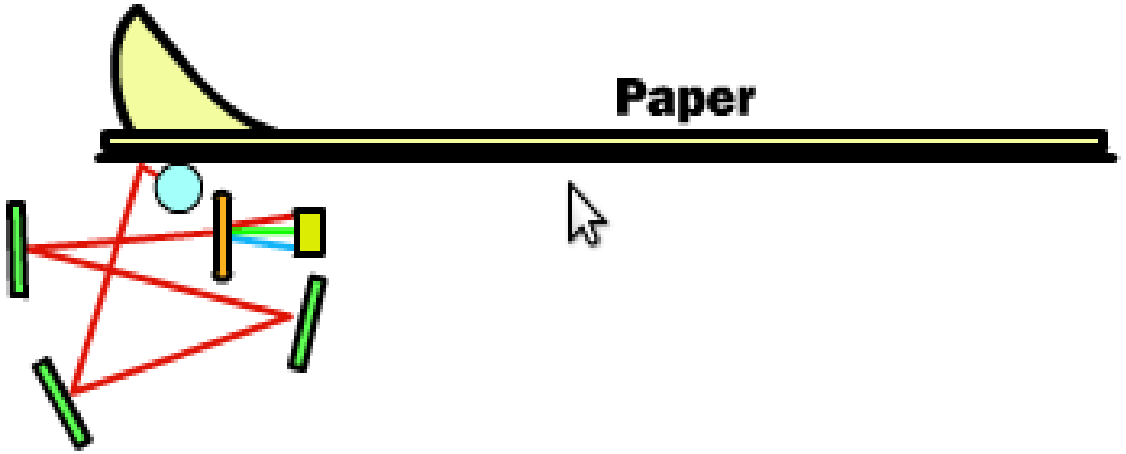
Image Acquisition – Kamera Digital

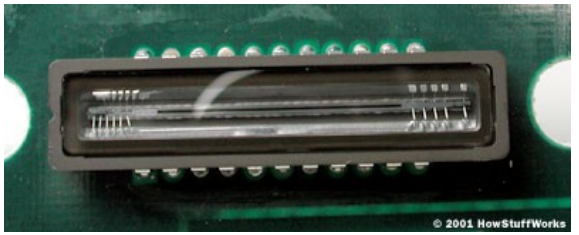
- Once the sensor converts the light into electrons, it reads the value (accumulated charge) of each cell in the image.
- A CCD transports the charge across the chip and reads it at one corner of the array. An analog-to-digital converter (ADC) then turns each pixel's value into a digital value by measuring the amount of charge at each photosite and converting that measurement to binary form.
- CMOS devices use several transistors at each pixel to amplify and move the charge using more traditional wires.

Image Acquisition – Kamera Digital

- CCD sensors create high-quality, low-noise images. CMOS sensors are generally more susceptible to noise.
- Because each pixel on a CMOS sensor has several transistors located next to it, the light sensitivity of a CMOS chip is lower. Many of the photons hit the transistors instead of the photodiode.
- CMOS sensors traditionally consume little power. CCDs, on the other hand, use a process that consumes lots of power. CCDs consume as much as 100 times more power than an equivalent CMOS sensor.
- CCD sensors have been mass produced for a longer period of time, so they are more mature. They tend to have higher quality pixels, and more of them.

Image Acquisition – *Scanner* Digital





A Scanner's CCD Sensor

Courtesy of www.howstuffworks.com

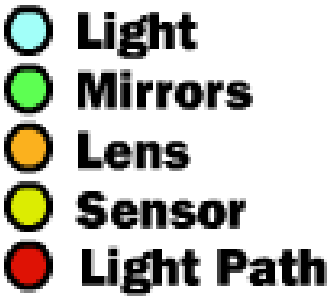
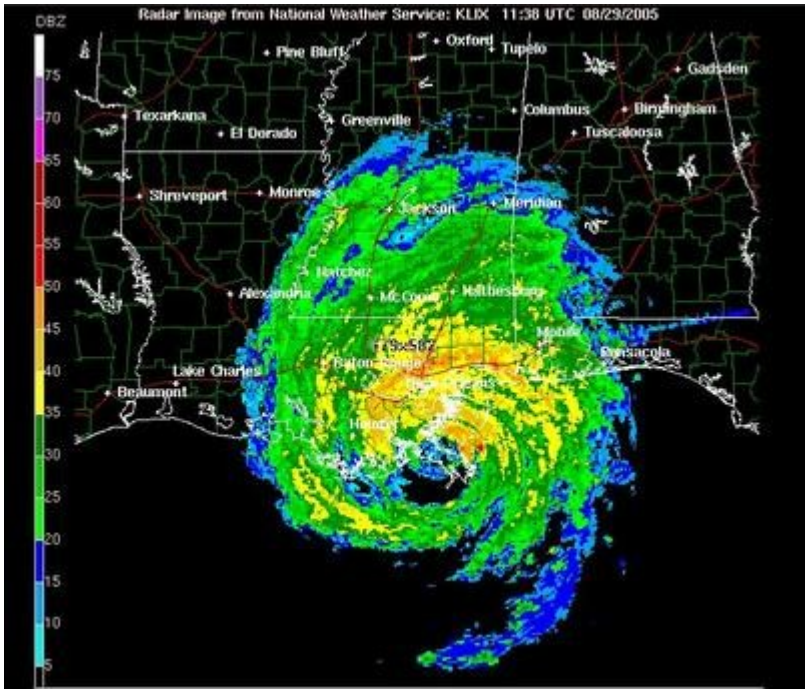


Image Acquisition – *Scanner* Digital

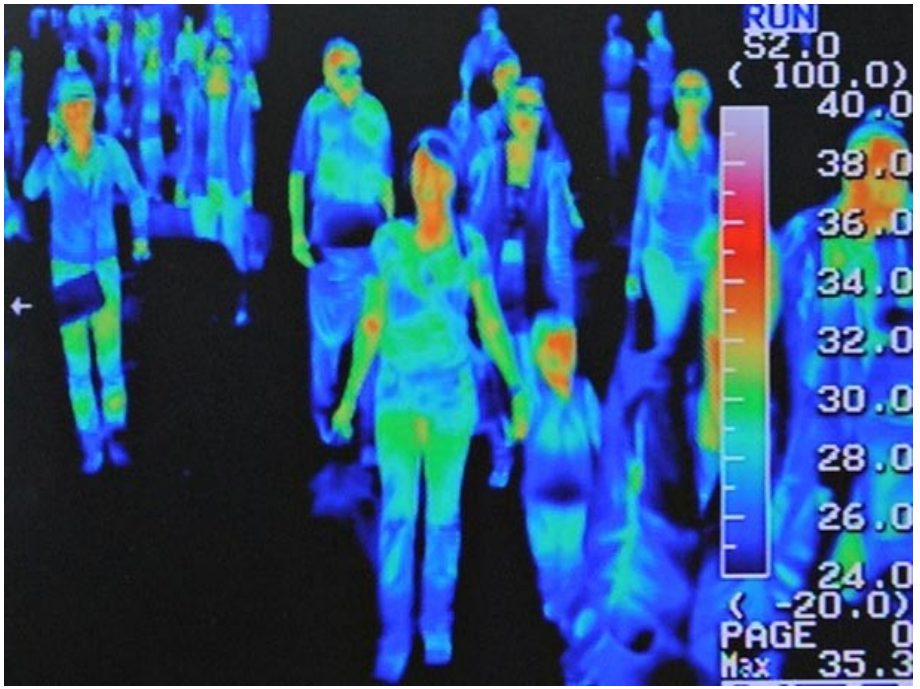
- Most scanners today use the single pass method. The lens splits the image into three smaller versions of the original. Each smaller version passes through a color filter (either red, green or blue) onto a discrete section of the CCD array. The scanner combines the data from the three parts of the CCD array into a single full-color image.
- Another imaging array technology that has become popular in inexpensive flatbed scanners is contact image sensor (CIS). CIS replaces the CCD array, mirrors, filters, lamp and lens with rows of red, green and blue light emitting diodes (LEDs). The image sensor mechanism, consisting of 300 to 600 sensors spanning the width of the scan area, is placed very close to the glass plate that the document rests upon. When the image is scanned, the LEDs combine to provide white light. The illuminated image is then captured by the row of sensors. CIS scanners are cheaper, lighter and thinner, but do not provide the same level of quality and resolution found in most CCD scanners.

Image Acquisition – Other Sensors



Weather radar image

Courtesy of www.atmos.washington.edu



Thermal image

Courtesy of http://www.time.com

Hasil Image Acquisition – Citra Digital

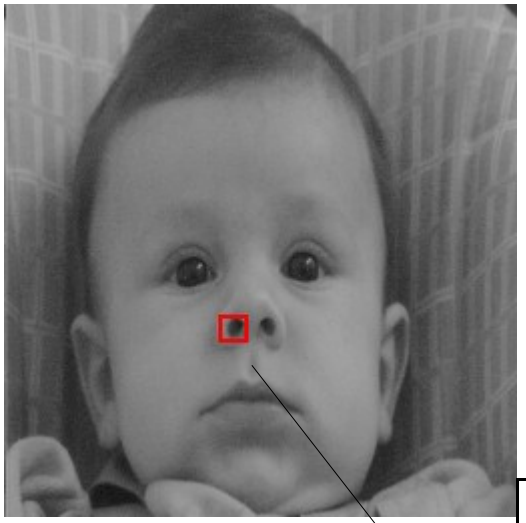
- The basic two-dimensional image is a monochrome (greyscale) image which has been digitised.
- Describe image as a two-dimensional light intensity function f(x,y) where x and y are spatial coordinates and the value of f at any point (x, y) is proportional to the brightness or grey value of the image at that point.
- A digitised image is one where

  - spatial and greyscale values have been made discrete.

  - intensity measured across a regularly spaced grid in x and y directions

  - intensities sampled to 8 bits (256 values).
- For computational purposes, we may think of a digital image as a two-dimensional array where x and y index an image point. Each element in the array is called a **pixel** (picture element).

Hasil Image Acquisition – Citra Digital



99	71	61	51	49	40	35	53	86	99
93	74	53	56	48	46	48	72	85	102
101	69	57	53	54	52	64	82	88	101
107	82	64	63	59	60	81	90	93	100
114	93	76	69	72	85	94	99	95	99
117	108	94	92	97	101	100	108	105	99
116	114	109	106	105	108	108	102	107	110
115	113	109	114	111	111	113	108	111	115
110	113	111	109	106	108	110	115	120	122
103	107	106	108	109	114	120	124	124	132

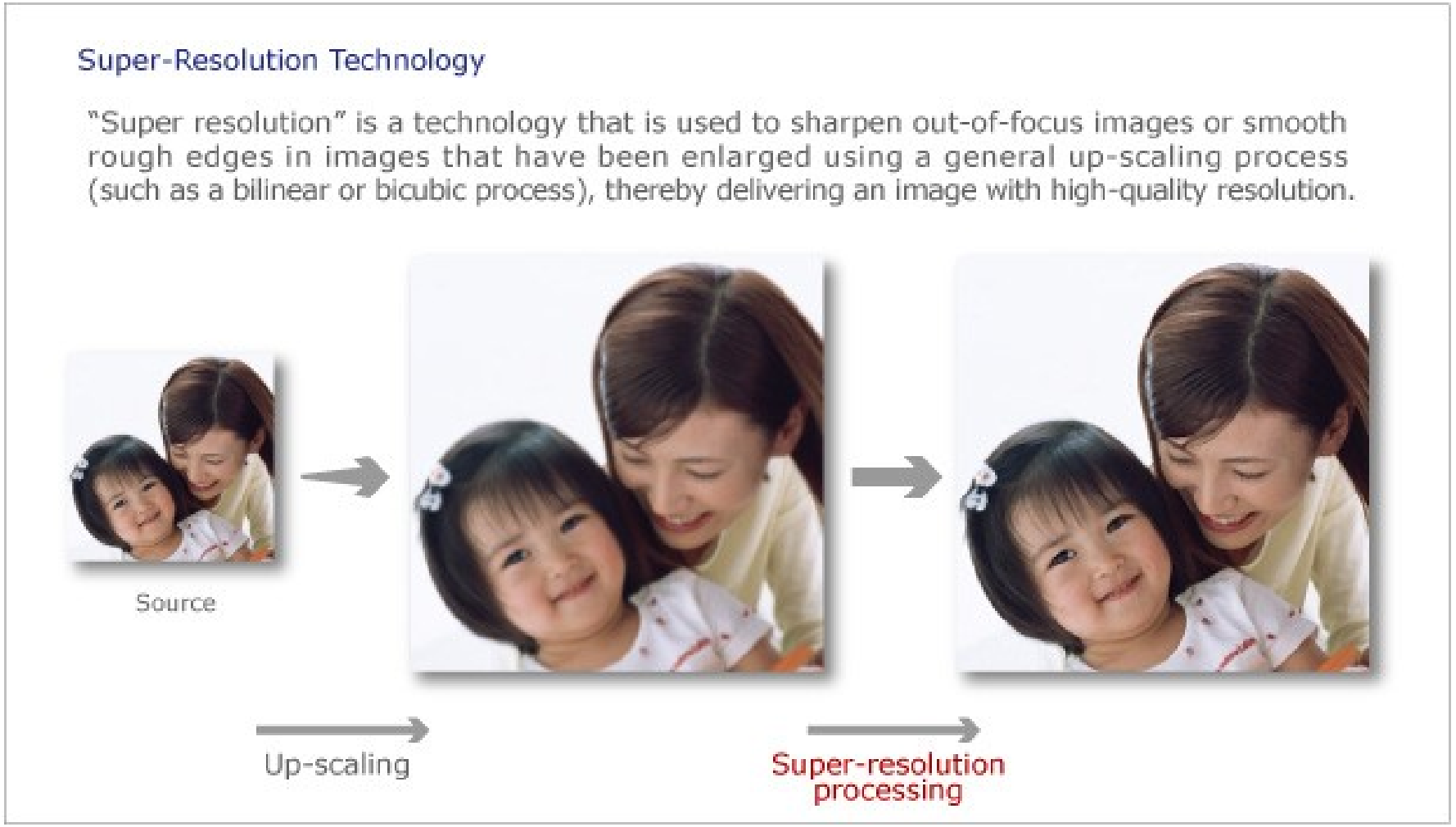
Hasil Image Acquisition – Citra Digital

- Resolusi: hasil perkalian jumlah piksel horizontal dan vertikal
- Kedalaman warna (colour depth): jumlah warna individual yang dapat dimiliki oleh sebuah citra.

  Grayscale: **8-bit**: 256 intensitas warna keabuan
  True color: **24-bit** (8+8+8 bit, masing-masing untuk intensitas warna R(merah), G(hijau) dan B(biru), menghasilkan 2^{24} intensitas kombinasi dari ketiga warna tersebut (16 juta warna).
- Bagaimana dengan yang lain? 16-bit warna, 8 bit berwarna?

Hasil Image Acquisition – Citra Digital

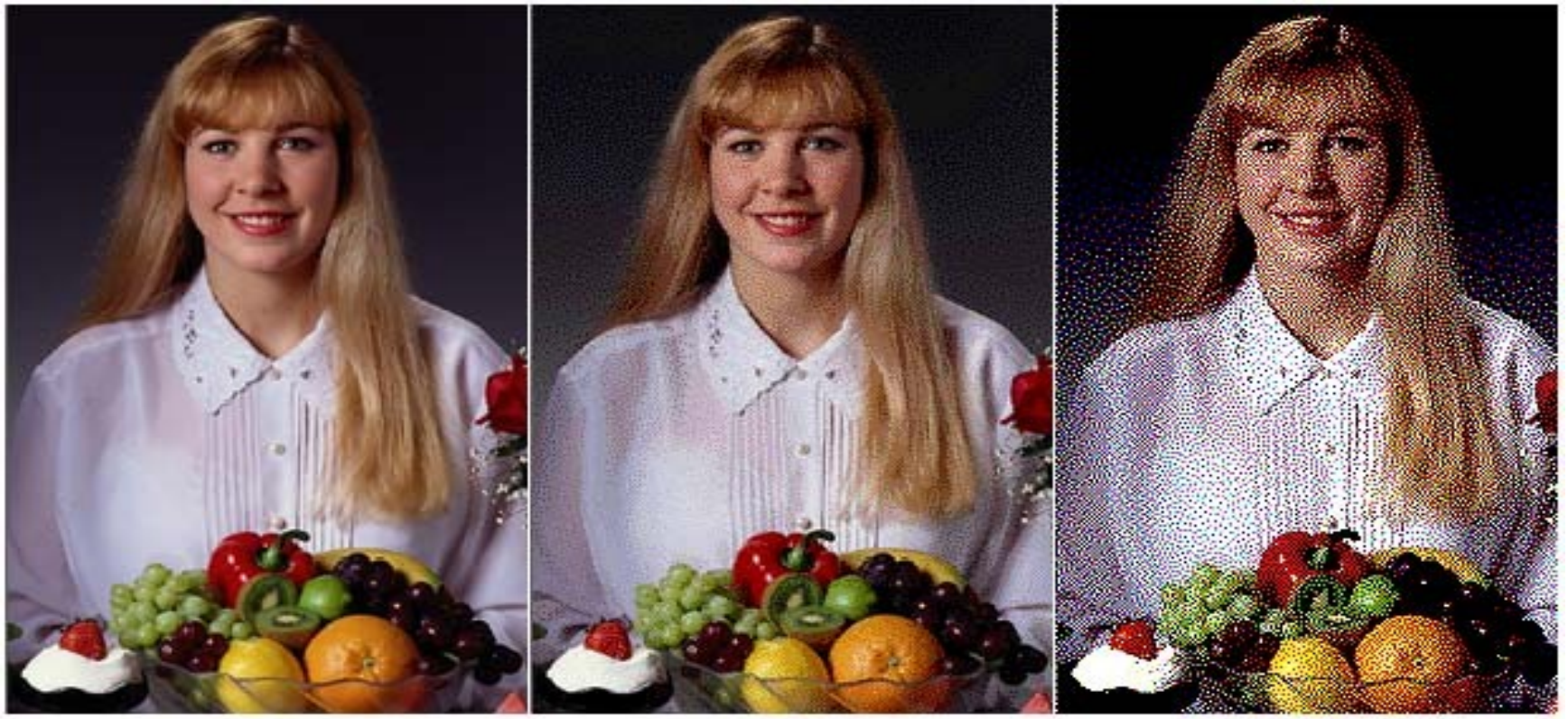
- Resolusi tinggi berarti detail yang lebih jelas



Courtesy of http://www.renesas.com

Hasil Image Acquisition – Citra Digital

- Kedalaman warna yang tinggi: persepsi objek yang lebih nyata (kelompok warna juga lebih jelas)



Masalah pada Image Acquisition

- Fotografi: resolusi, fokus (blur, tremor), pencahayaan (terlalu gelap), sensor jelek (noise, salah warna)
- Scanning: sensor jelek (noise, salah warna), resolusi
- Sensor lain: citra yang didapat “apa adanya” karena keterbatasan alat.

CITRA DIGITAL di sini bukan berarti sesuatu yang diciptakan melalui image editor, walaupun bisa digunakan yang semacam itu ketika testing.