# Pembentukan Citra

## IF4073 Interpretasi dan Pengolahan Citra

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# Model Citra

- Secara matematis fungsi intensitas cahaya pada bidang dwimatra disimbolkan dengan $f(x, y)$, yang dalam hal ini:

$(x, y)$ : koordinat pada bidang dwimatra

$f(x, y)$ : intensitas cahaya (*brightness*) pada titik $(x, y)$

- Karena cahaya merupakan bentuk energi, maka intensitas cahaya bernilai antara 0 sampai tidak berhingga,

$$0 \leq f(x, y) < \infty$$

- Nilai $f(x, y)$ sebenarnya adalah hasil kali:

  $i(x, y)$ =jumlah cahaya yang berasal dari sumbernya (*illumination*), nilainya antara 0 sampai tidak berhingga, dan

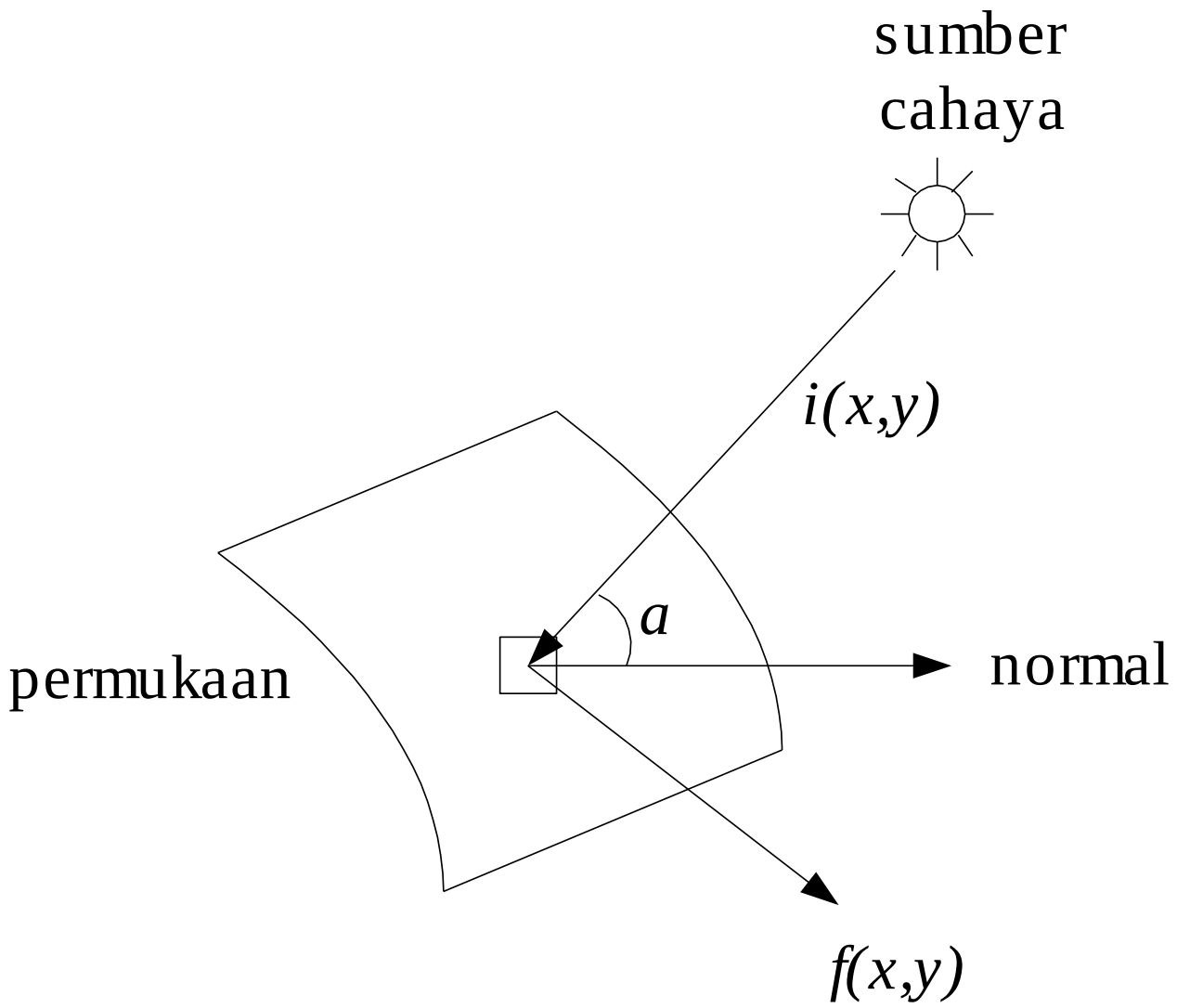
  $r(x, y)$ = derajat kemampuan obyek memantulkan cahaya (*reflection*), nilainya antara 0 dan 1.

- Jadi, $f(x, y) = i(x, y) \cdot r(x, y)$,

  yang dalam hal ini,

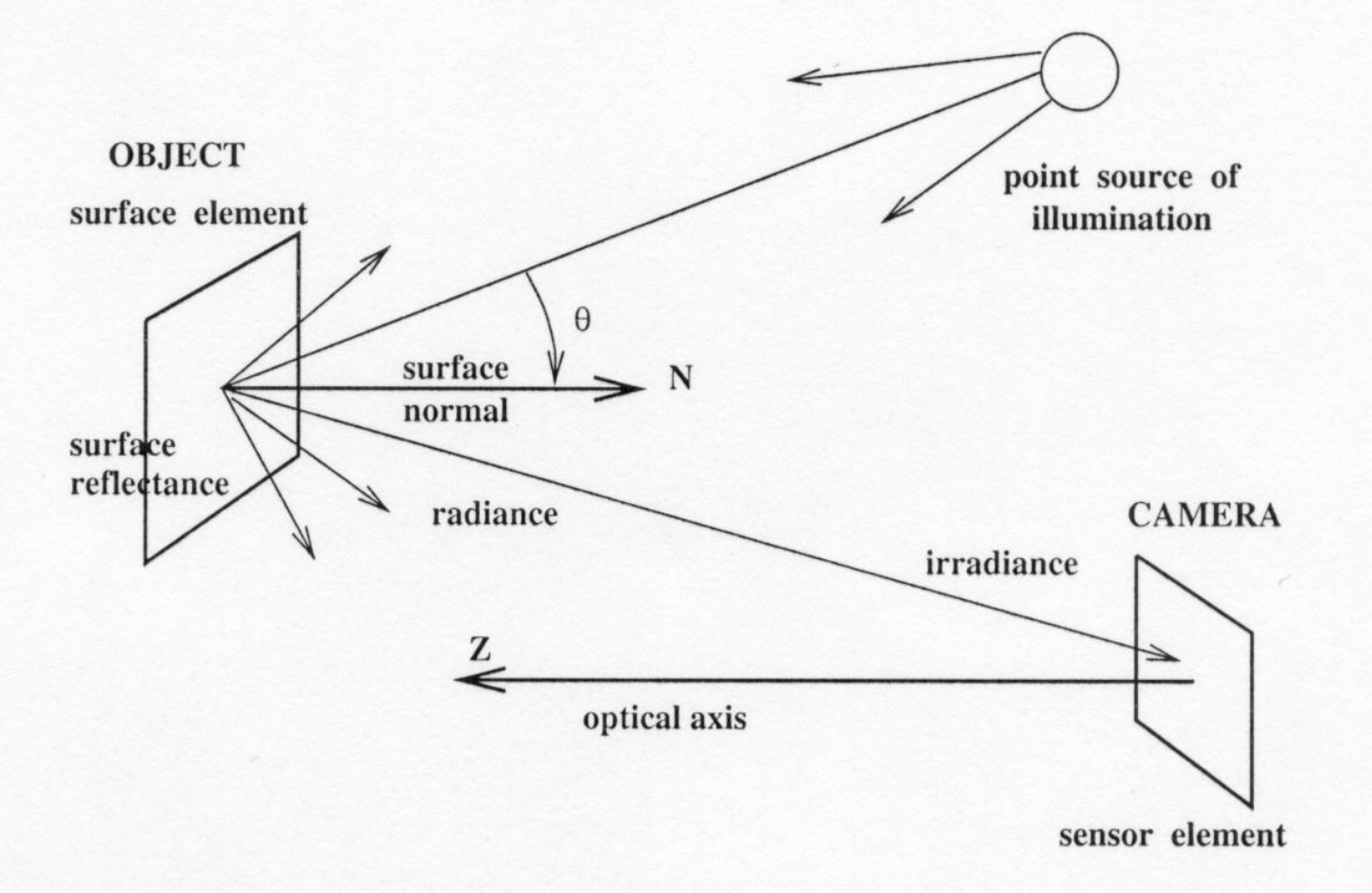
$$0 \leq i(x, y) < \infty$$

$$0 \leq r(x, y) \leq 1$$




Sinyal f(x,y) ini yang ditangkap oleh mata atau kamera

The scene is illuminated by a single source.
The scene reflects radiation towards the camera.
The camera senses it via chemicals on film.



- Nilai $i(x, y)$ ditentukan oleh sumber cahaya, sedangkan $r(x, y)$ ditentukan oleh karakteristik objek di dalam gambar.

- Nilai $r(x,y) = 0$ mengindikasikan penyerapan total, sedangkan $r(x,y) = 1$ menyatakan pemantulan total.

- Jika permukaan mempunyai derajat pemantulan nol, maka fungsi intensitas cahaya, $f(x, y)$, juga nol.

- Sebaliknya, jika permukaan mempunyai derajat pemantulan 1, maka fungsi intensitas cahaya sama dengan iluminasi yang diterima oleh permukaan tersebut.

Contoh-contoh nilai $i(x, y)$:

- pada hari cerah, matahari menghasilkan iluminasi $i(x, y) \approx 9000$ *foot candles,*
- pada hari mendung (berawan), matahari menghasilkan iluminasi $i(x, y) \approx 1000$ *foot candles,*
- pada malam bulan purnama, sinar bulan menghasilkan iluminasi $i(x, y) \approx 0.01$ *foot candle.*

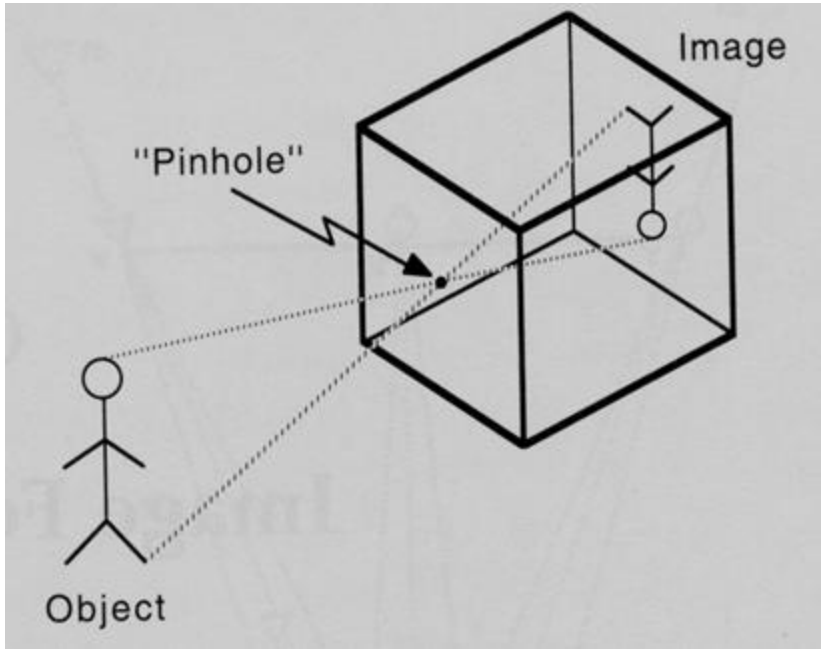
Contoh nilai $r(x, y)$

- benda hitam mempunyai $r(x, y) = 0.01$,
- dinding putih mempunyai $r(x, y) = 0.8$,
- benda logam dari *stainlessteel* mempunyai $r(x, y) = 0.65$,
- salju mempunyai $r(x, y) = 0.93$.

Sumber: Image Formation Fundamentals, CS491E/791

# Pinhole camera

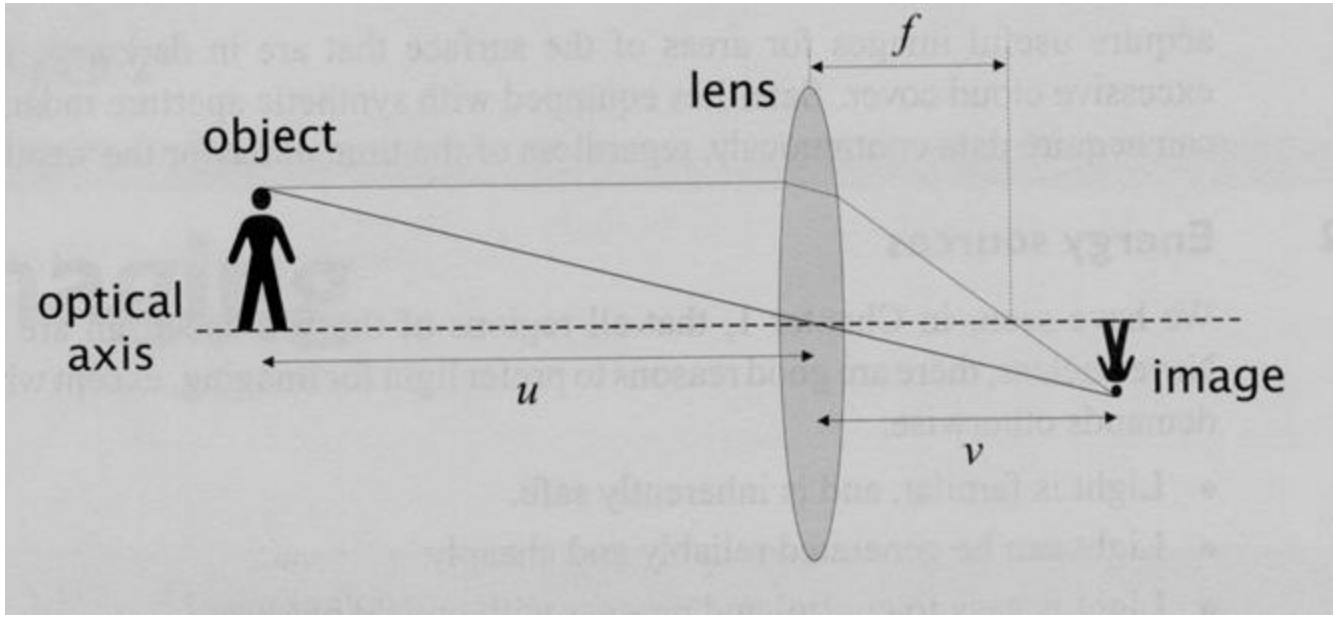
- This is the simplest device to form an image of a 3D scene on a 2D surface.
- Straight rays of light pass through a “pinhole” and form an inverted image of the object on the image plane.



Sumber: Image Formation Fundamentals, CS491E/791

# Camera optics

- In practice, the aperture must be larger to admit more light.
- Lenses are placed to in the aperture to **focus** the bundle of rays from each scene point onto the corresponding point in the image plane



Sumber: Image Formation Fundamentals, CS491E/791

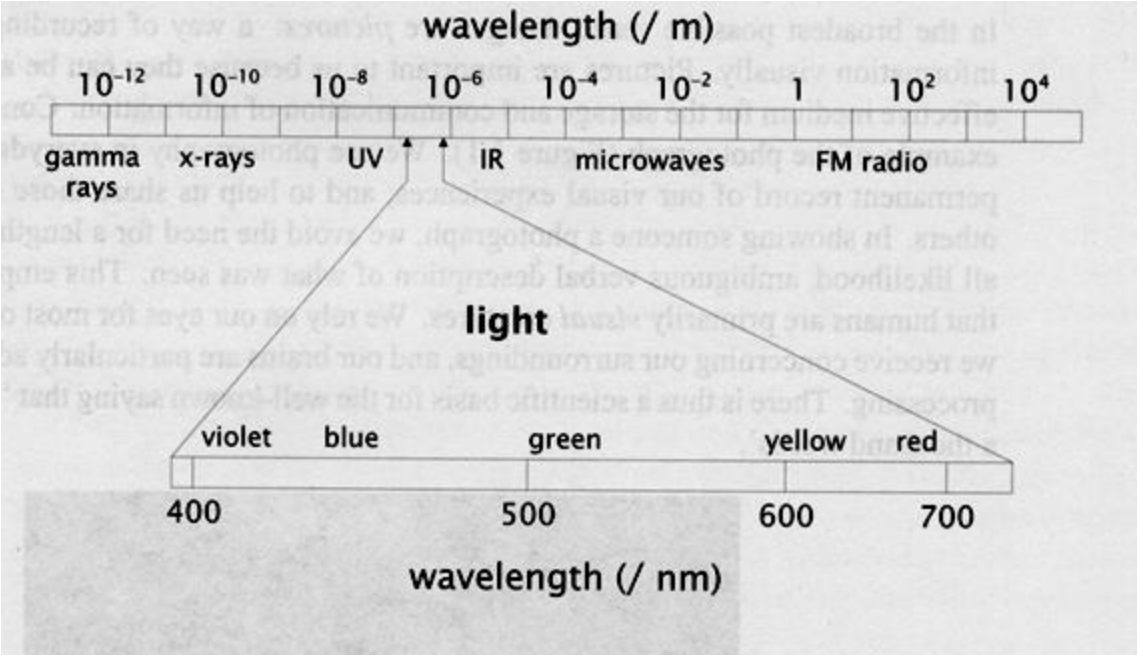
# Image formation (cont'd)

- Optical parameters of the lens
  - lens type
  - focal length
  - field of view
- Photometric parameters
  - type, intensity, and direction of illumination
  - reflectance properties of the viewed surfaces
- Geometric parameters
  - type of projections
  - position and orientation of camera in space
  - perspective distortions introduced by the imaging process

Sumber: Image Formation Fundamentals, CS491E/791

# What is light?

- The visible portion of the **electromagnetic** (EM) spectrum.
- It occurs between wavelengths of approximately 400 and 700 nanometers.



# Short wavelengths

- Different wavelengths of radiation have different properties.
- The **x-ray** region of the spectrum, it carries sufficient energy to penetrate a significant volume or material.

# Long wavelengths

- Copious quantities of **infrared** (IR) radiation are emitted from warm objects (e.g., locate people in total darkness).

# Long wavelengths (cont'd)

- "**Synthetic aperture radar**" (SAR) imaging techniques use an artificially generated source of microwaves to probe a scene.
- SAR is unaffected by weather conditions and clouds (e.g., has provided us images of the surface of Venus).

Sumber: Image Formation Fundamentals, CS491E/791

# Range images

- An array of distances to the objects in the scene.
- They can be produced by sonar or by using laser rangefinders.

Sumber: Image Formation Fundamentals, CS491E/791

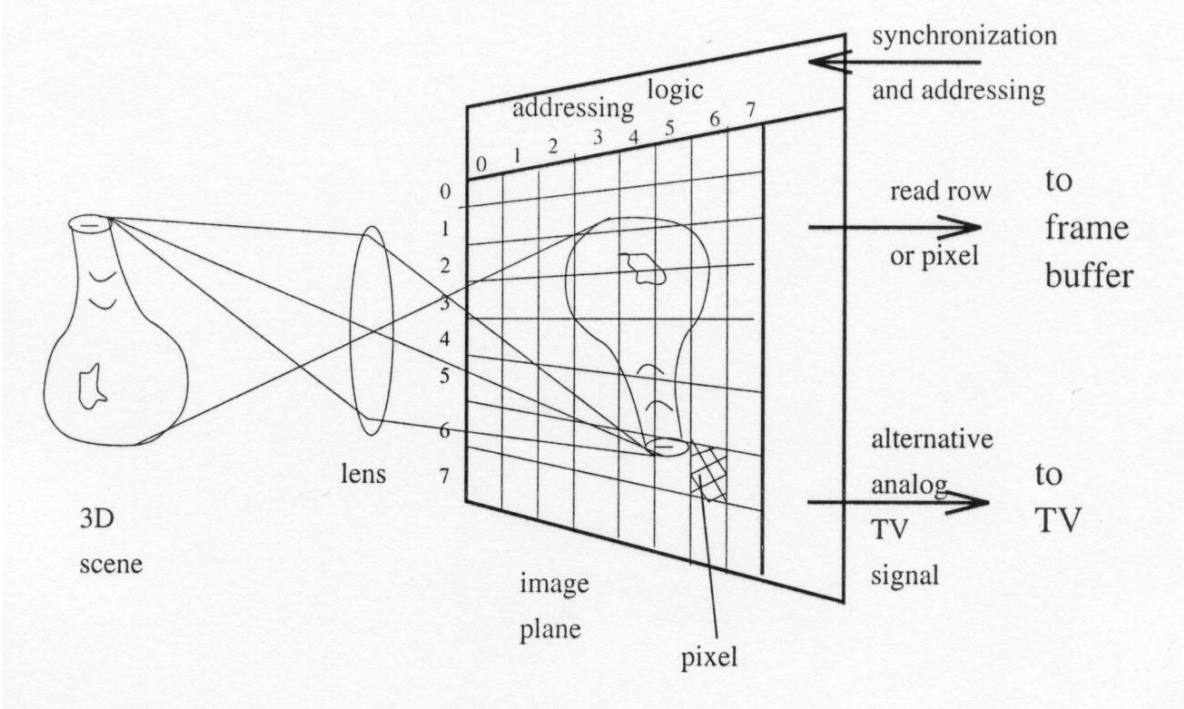
# Sonic images

- Produced by the reflection of sound waves off an object.
- High sound frequencies are used to improve resolution.

Sumber: Image Formation Fundamentals, CS491E/791

# CCD (Charged-Coupled Device) cameras

- Tiny solid state cells convert light energy into electrical charge.
- The image plane acts as a digital memory that can be read row by row by a computer.



Sumber: Image Formation Fundamentals, CS491E/791

# Frame grabber

- Usually, a CCD camera plugs into a computer board (**frame grabber)**.
- The frame grabber digitizes the signal and stores it in its memory (**frame buffer**).