Basic Terms and Concepts

- **Computer Vision**
  - Allow machine to see and understand real world

- **Image Processing**
  - Helps emphasize important information for machines or humans

- **Pattern Recognition**
  - Classifying and recognizing patterns in data (including image data)

- **Computer Graphics**
  - Create or synthesize a virtual image

- **Artificial Intelligence**
  - Emulating human intelligence
Computer Vision vs. Computer Graphics

- **Computer vision**
  - Real world $\rightarrow$ machine understanding

- **Computer graphics**
  - Virtual world (machine) $\rightarrow$ looks like real world
Computer Vision / Image Processing Evaluation

• Subjective
  ◦ Human thinks it “looks good”

• Objective
  ◦ Ground truth comparison
    • E.g., mean square pixel error
Image Representation

- Image represented by $f(x,y)$
  - $f(x,y) \rightarrow$ two-dimensional light intensity function
  - $(x,y) \rightarrow$ spatial coordinates
  - Value of $f(x,y) \rightarrow$ intensity / gray level / gray scale

- **Monochrome** images $\rightarrow$ single $f(x,y)$

- **Color** images $\rightarrow$ multiple channels, each with their own $f(x,y)$
  - …or 3D function $f(x,y,c)$ (with $c = \{0,1,2\}$) $\rightarrow$
    - $f(x,y)$ returns 3D vector $\{r,g,b\}$
Digital Image Representation

- Digital image
  - Image $f(x,y) \rightarrow$ 2D array with \textit{discrete} coordinates
    - Each element $\rightarrow$ \textit{pixel}
  - Each pixel value $\rightarrow$ \textit{discrete} brightness levels
    - Often $[0,255] \rightarrow$ one byte of storage
Digital Image Processing Operations

- **Low-level:** Primitive operations
  - INPUT $\rightarrow$ OUTPUT:
    - $\text{Image} \rightarrow \text{Image}$

- **Mid-level:** Image segmentation, classification
  - INPUT $\rightarrow$ OUTPUT:
    - $\text{Image} \rightarrow \text{Attributes}$ (e.g., edges, objects)

- **High-level:** “Making sense” of ensemble of recognized objects; cognitive processing
  - INPUT $\rightarrow$ OUTPUT:
    - $\text{Image} \rightarrow \text{Scene of objects}$