GUC
German University in Cairo

DMET 901: Computer Vision

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Winter 2019

DMET901 – Computer Vision

- Instructor
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- Office Hours
  - Sundays – 2:00pm to 3:00pm (Office: C7-210)

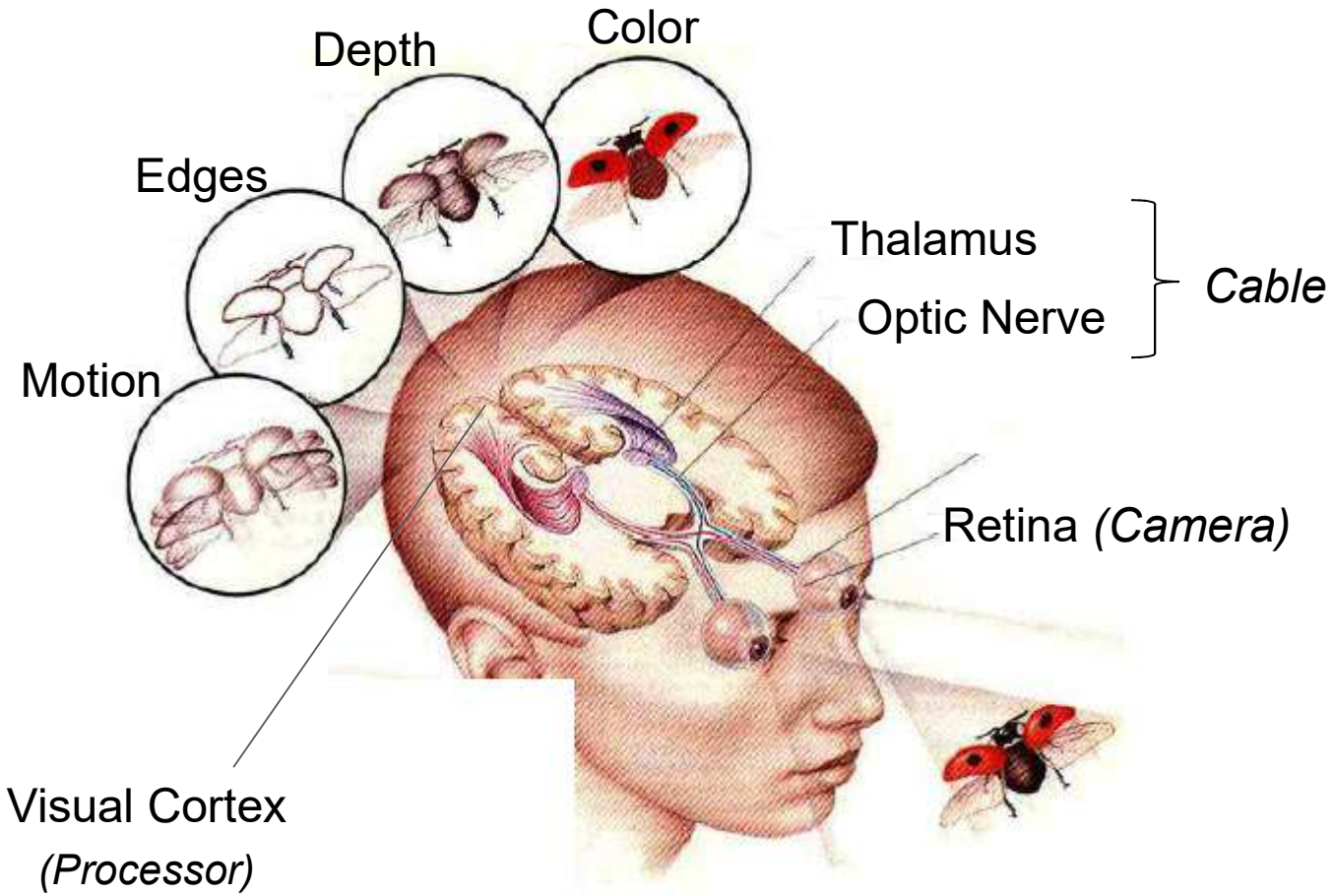
- Textbook
  - "Image processing, analysis and machine vision" by Milan Sonka, Vaclav Hlavac and Roger Boyle, Fourth edition, Thomson Learning, London, 2014

DMET901 – Computer Vision

- Course Evaluation
  - 3-4 Assignments (using Python): 20%
  - Mid-term exam: 25%
  - Quizzes: 15%
  - Final exam: 40%

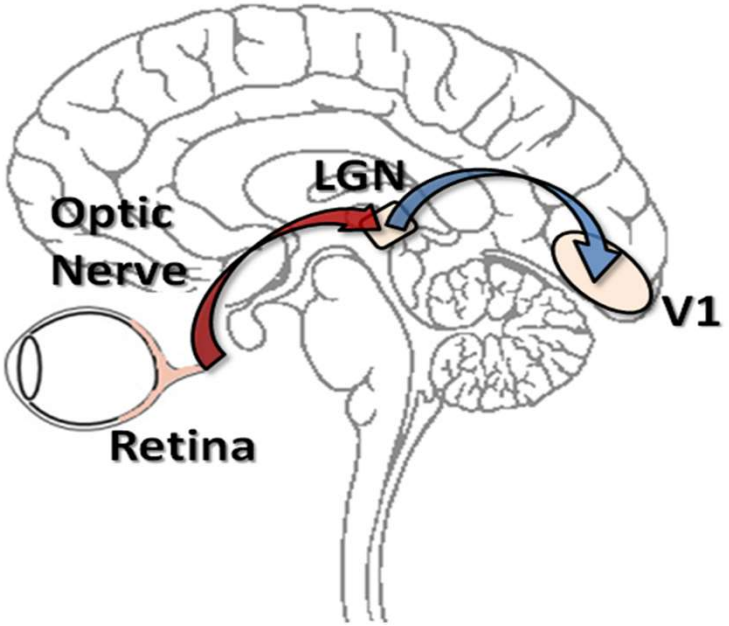
Introduction

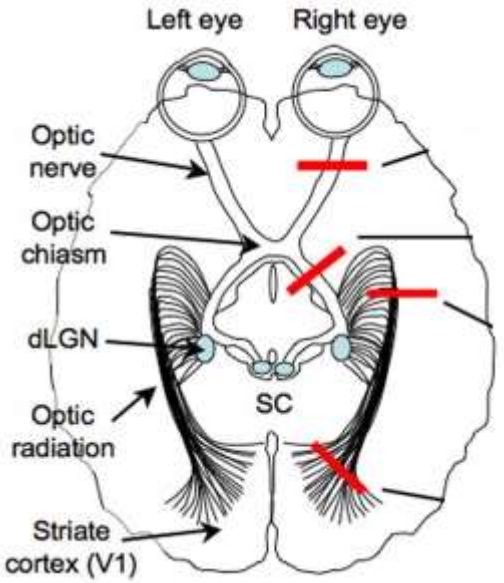
- Vision allows humans to understand the surrounding world



Human Visual System

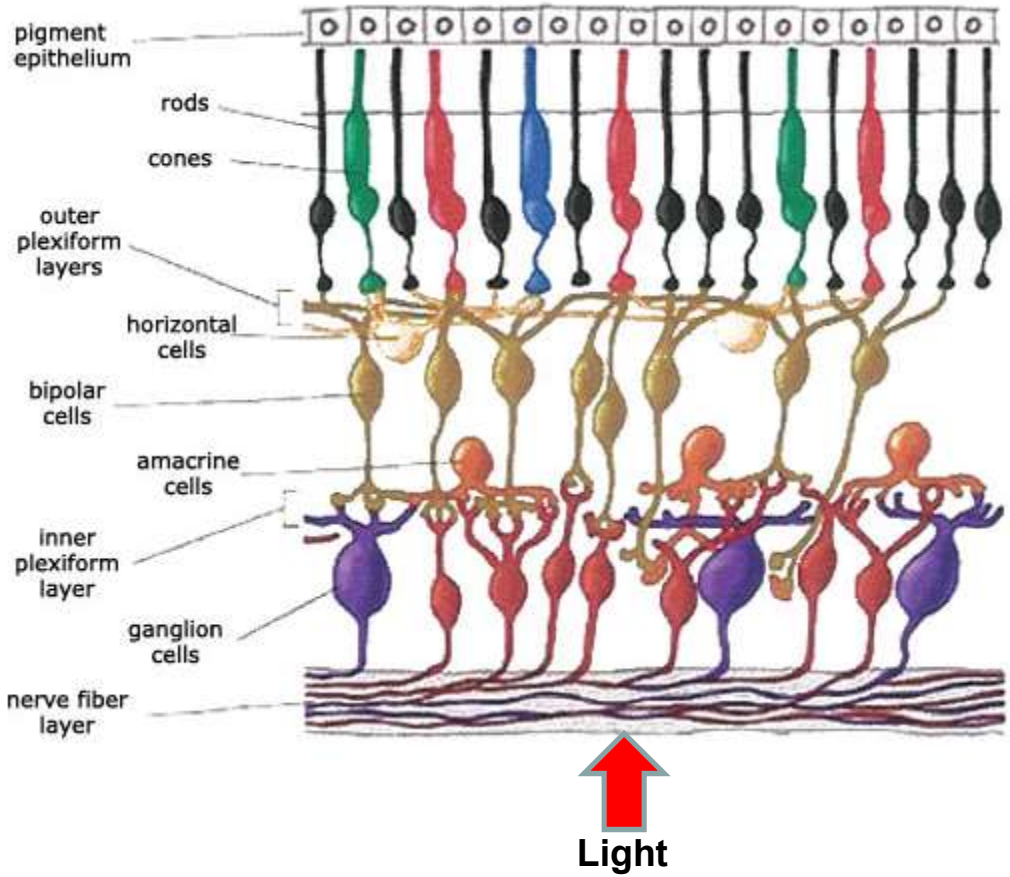
- The visual system consists of 5 major parts:
  - Eye: The lens
  - Retina: Converts light to electrical pulses
  - Optic Nerve: Carries electrical pulses to the brain
  - Lateral Geniculate Nucleus (LGN): Relay point of electrical pulses
  - Primary Visual Cortex (V1): Perception





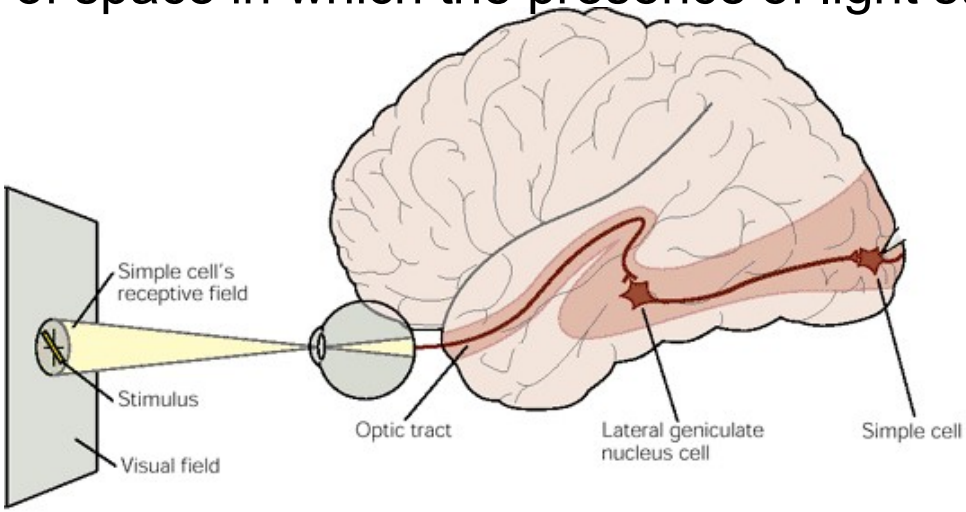
Human Visual System

- Photoreceptors in the retina convert light to electrical pulses
- Two types of photoreceptors:
  - Rods (For low-light vision not sensitive to colors)
  - Cones (For bright-light vision sensitive to colors)

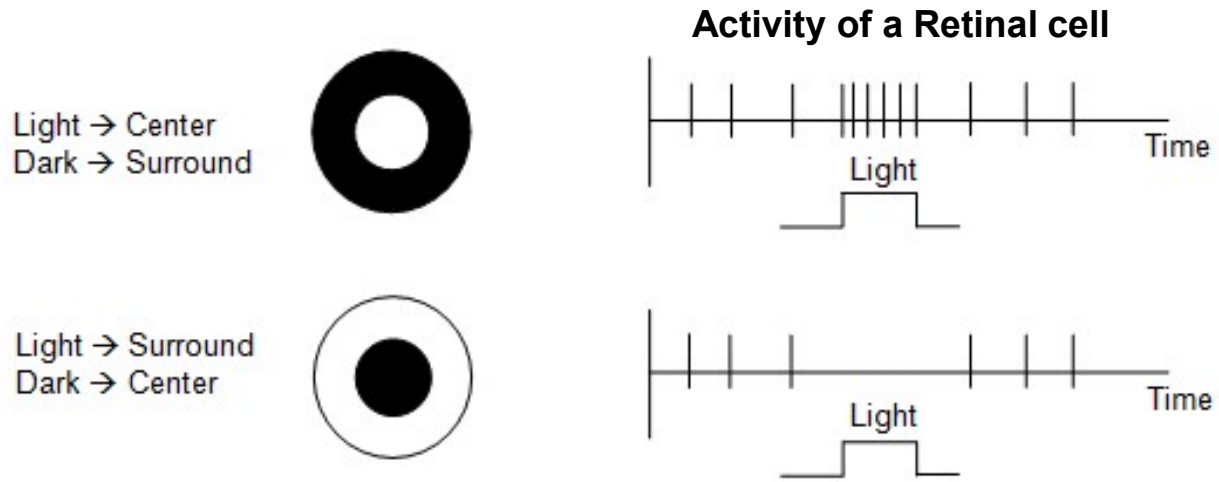


Human Visual System

- Each neuron in the retina and the LGN has a "Receptive Field" which is a region of space in which the presence of light stimulates the neuron

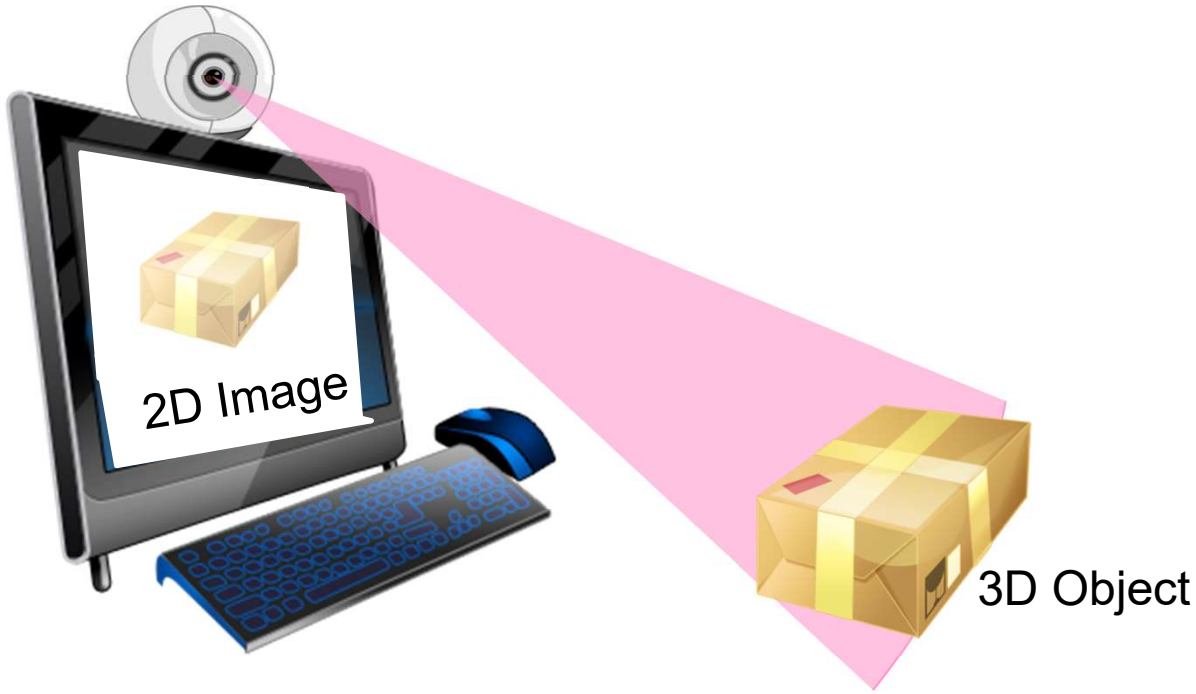


- Receptive fields have ON and OFF regions



Computer Vision

- Computer vision aims at duplicating the effect of human vision by electronically perceiving an image



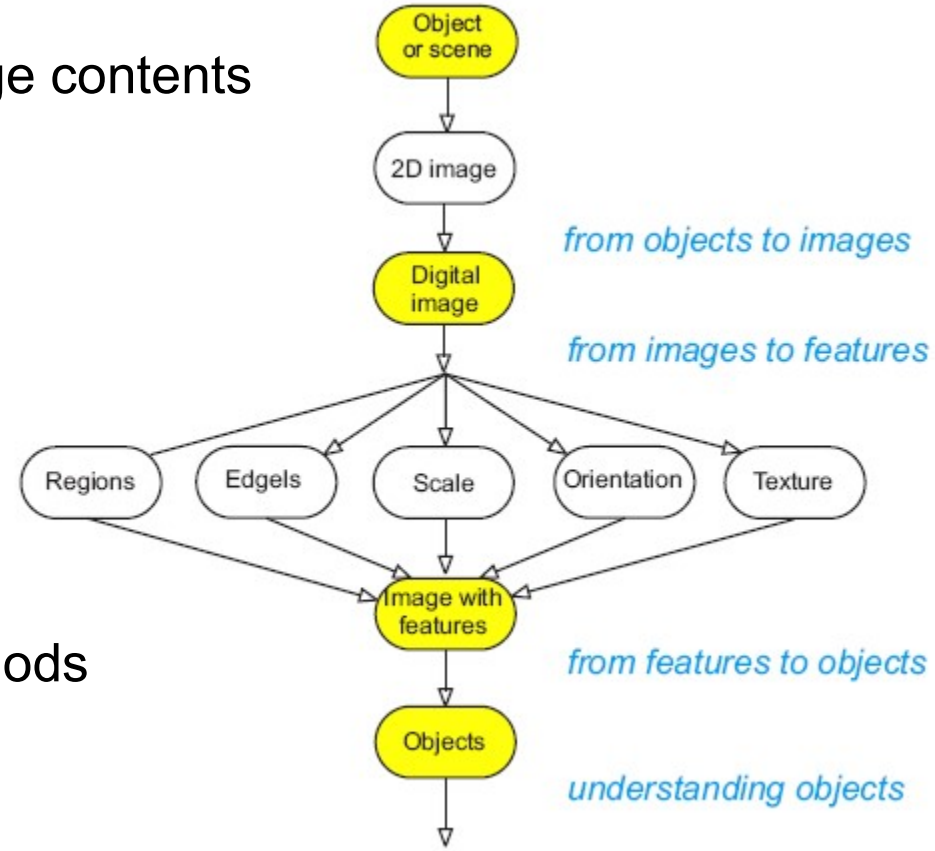
Why is Computer Vision Useful?

- Low-level Processing:

  Little knowledge about the image contents
  - Image Compression
  - Noise Filtering
  - Image Sharpening

- High-level Processing:

  More knowledge, uses AI methods
  - Face Recognition
  - Target Detection



Computer Vision: Examples

- Simple Operations

Original Image

Decrease Brightness

Increase Brightness

Computer Vision: Examples

- Simple Operations

Original Image

Decrease Contrast

Increase Contrast

Computer Vision: Examples

- Simple Operations

Original Image

Rotated by +30°

Rotated by -30°

Computer Vision: Examples

- Simple Operations

RGB → Gray

Computer Vision: Examples

- Noise Filtering

Original Image

Noisy Image

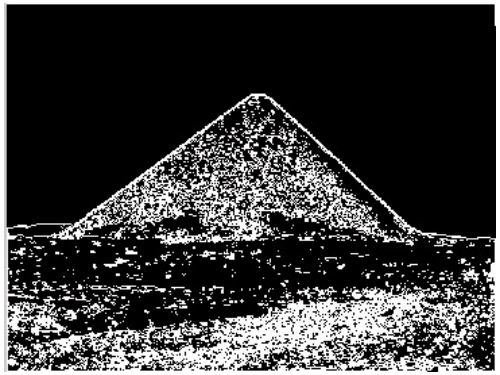
Filtered Image1

Filtered Image2

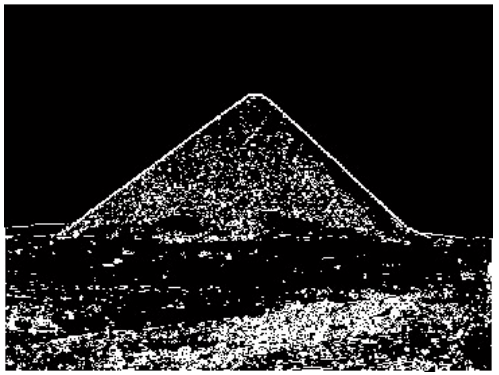
Computer Vision: Examples

- Edge Detection

Original Image



Edge Image 1

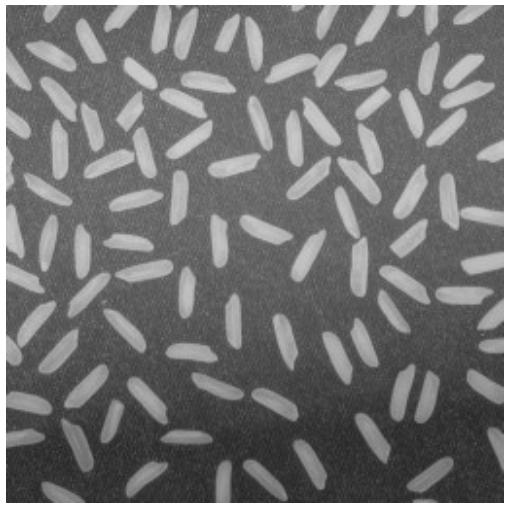


Edge Image 2

Edge Image 3

Computer Vision: Examples

- Segmentation



Original Image

Segmented Image

Computer Vision: Examples

- 3D Vision: Stereopsis

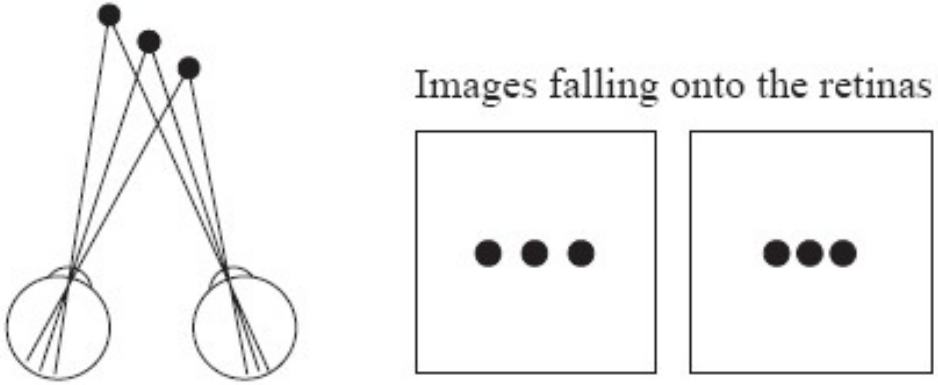


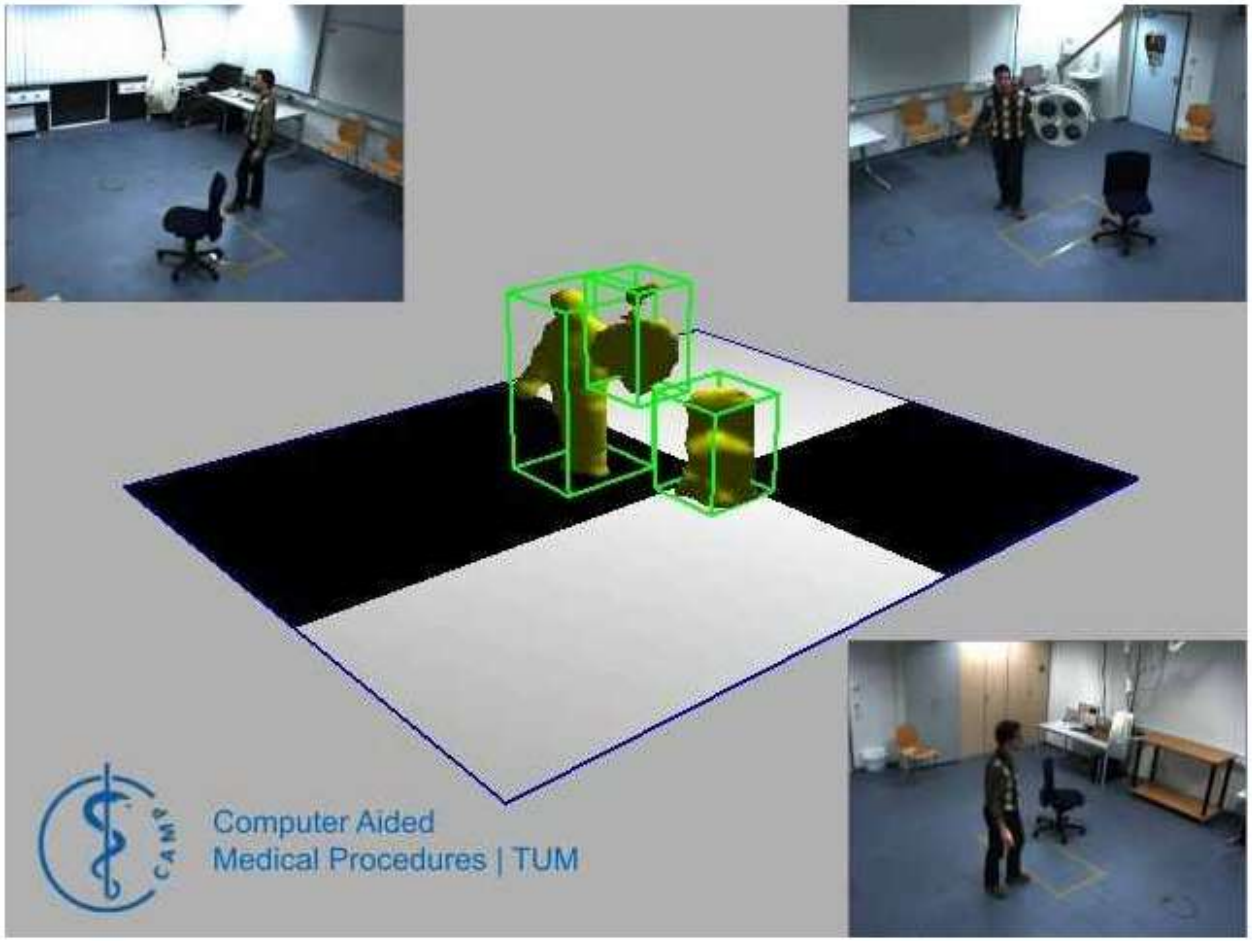
Image 1 **Image 2**

Depth Image

Bright colors indicate close pixels. Dark colors indicate far pixels

Computer Vision: Examples

- 3D Vision: Reconstruction from Multiple Images

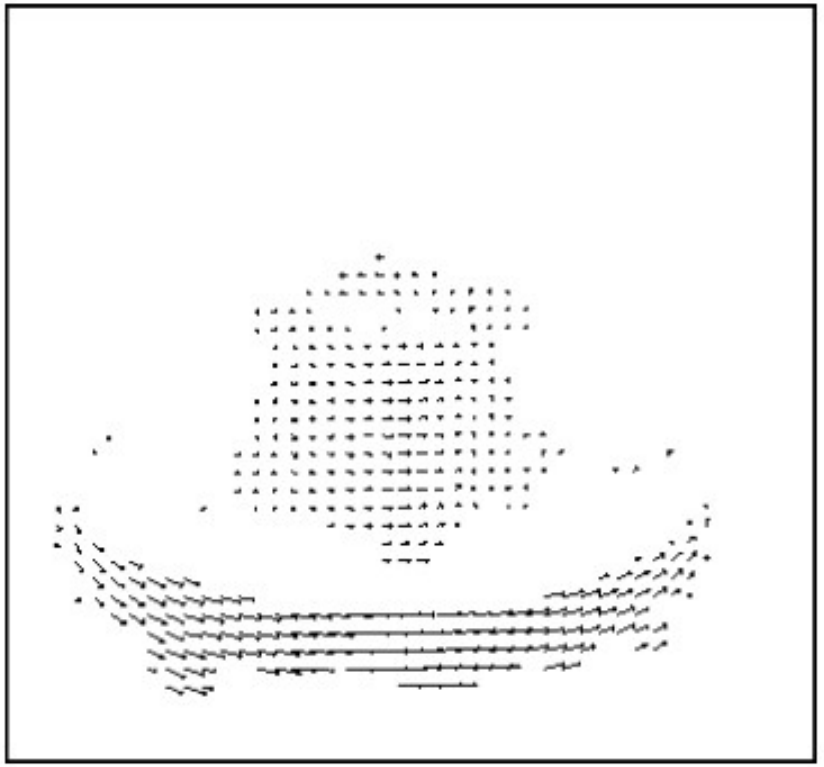


Computer Vision: Examples

- Motion Analysis

Image 1

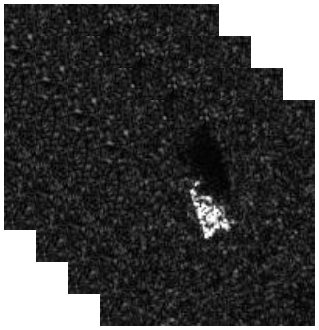
Image 2

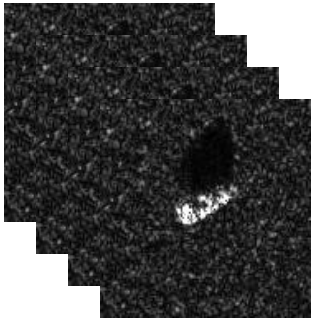


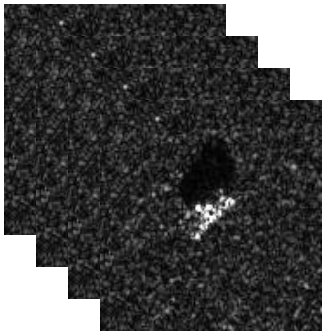
Motion Vectors

Application: Automatic Target Recognition (ATR)

Training Dataset





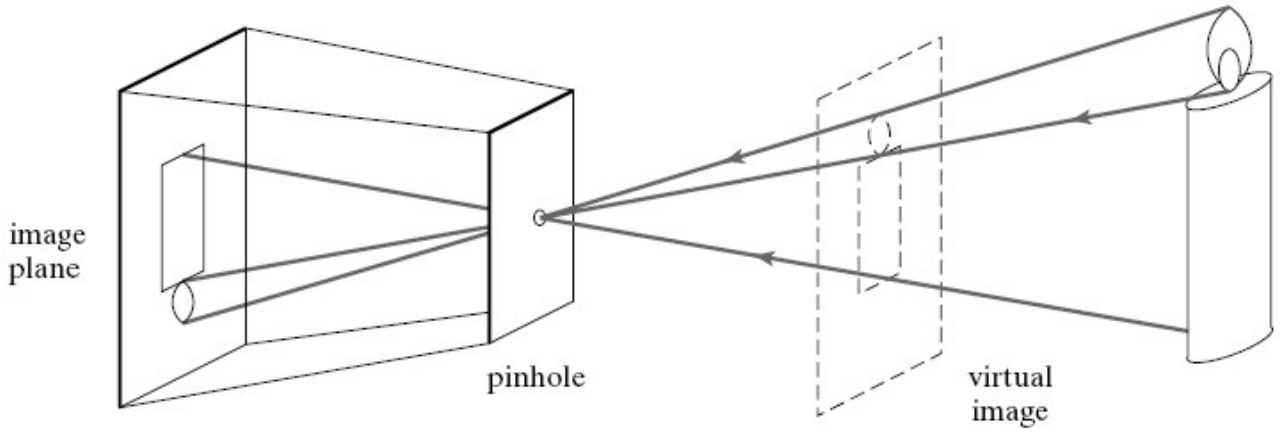


Which target is it?

How many targets are classified correctly?

Why is Computer Vision Difficult?

- Loss of information in 3D → 2D



- Because of the single view, a small object close to the camera appears the same as a larger object far from the camera

- Interpretation of images:

  - Machine learning algorithms can do this job by providing some experience data

  - Examples: Face detection and cancer detection

Why is Computer Vision Difficult?

- Noise:

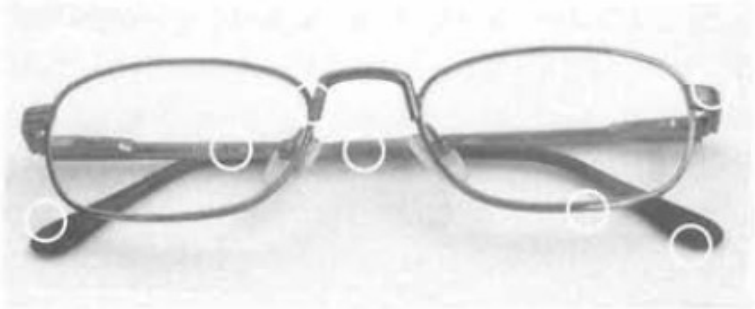
  - Can be electronic due to defects in the sensor or mechanical due to movement during image capture

- Large size of data:

  - An A4 sheet scanned at 300 dpi at 8 bits/pixel corresponds to 8.5 MB

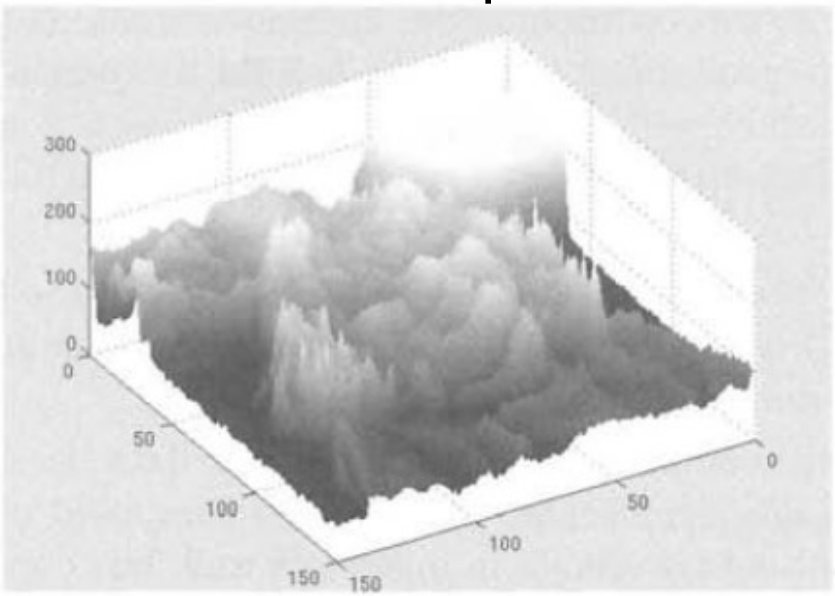
- Local window vs. need for global view:

  - The computer sees the world through keyholes



Why is Computer Vision Difficult?

What the computer sees



What we see

- A lot of a priori information is used by humans to interpret images

Course Outline

- Image Representation and Properties
- Image Pre-processing
- Image Filtering
- Edge Detection
- Image Segmentation

Image Processing Basics

- Interest Points Detection
- Local Feature Extraction
- 3D Vision
- Motion Analysis
- Object Recognition

Computer Vision