AI Summer School 2025

Medical Imaging Informatics

University of Pittsburgh

Introduction to Computer Vision

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Computational Pathology & AI Center of Excellence

IEEE COMPUTER SOCIETY

Learning Objectives

After completing this lecture, you should be able to:

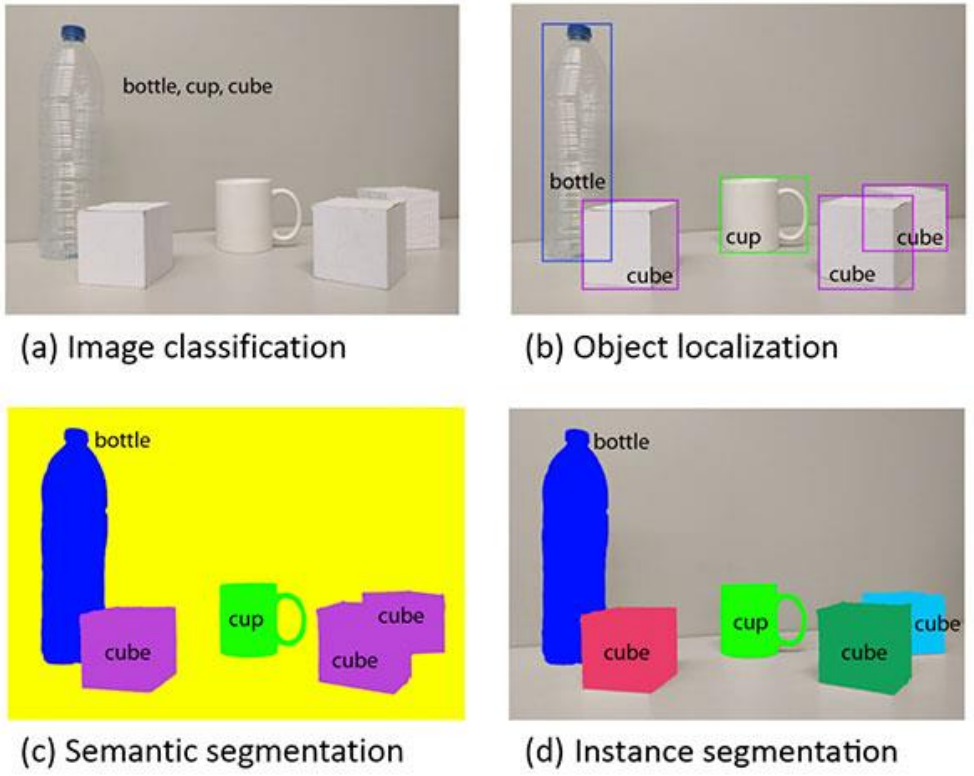
- Understand and explain computer vision briefly
- Explain the motivation of computer vision
- Explain computer vision/imaging informatics application in real-world scenarios
- Discuss computer vision algorithms

Outline

- Computer Vision/Imaging Informatics; What and Why?
- Computer Vision Applications
- Computer Vision Algorithms; Big Picture

Computer Vision | Imaging Informatics

- Computer vision deals with how computers can understand from digital images and video sequences.



3D Surface Reconstruction

Object Localization and Semantic Segmentation
https://www.pyimagesearch.com/

Motivation: Sight (Vision), Sound (Hearing), Smell, Taste, and Touch

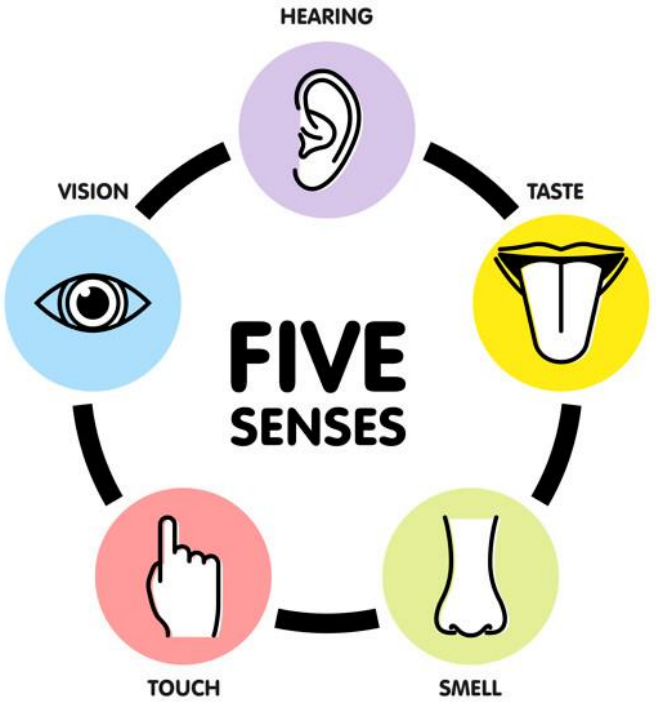
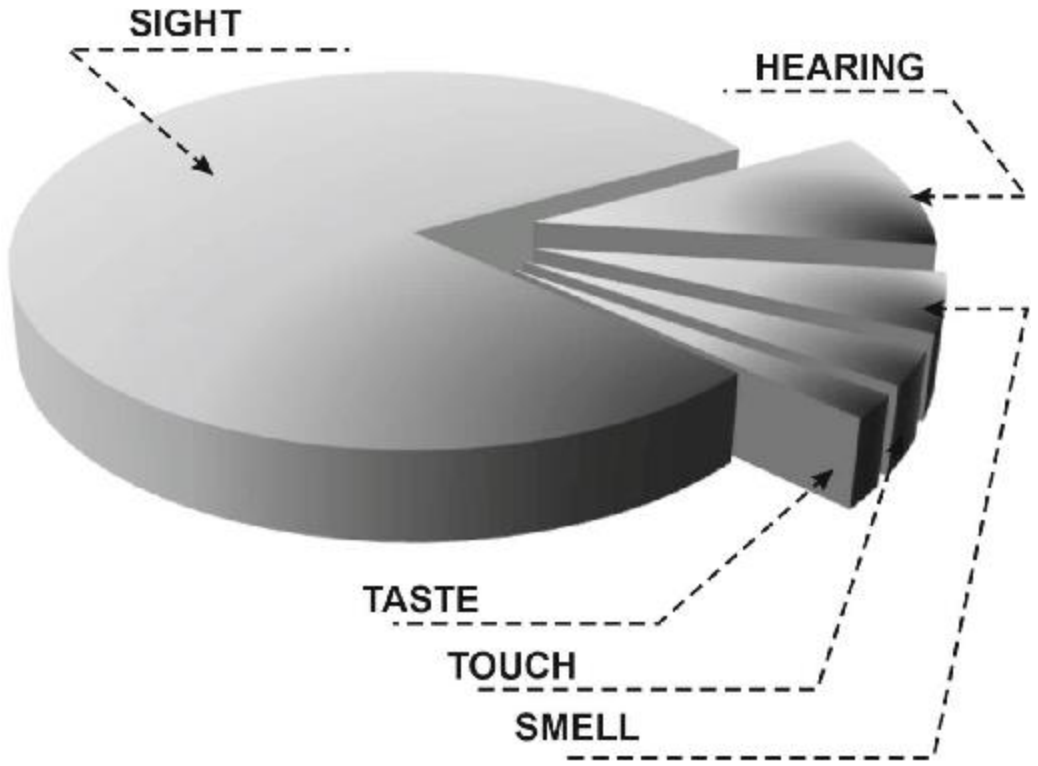
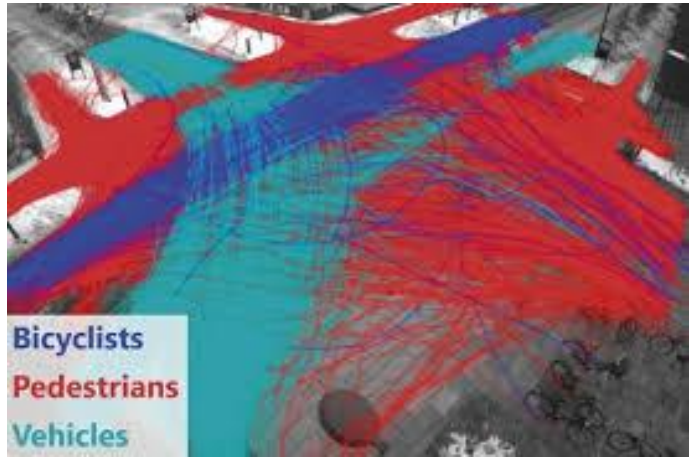


Image from: https://www.freepik.com

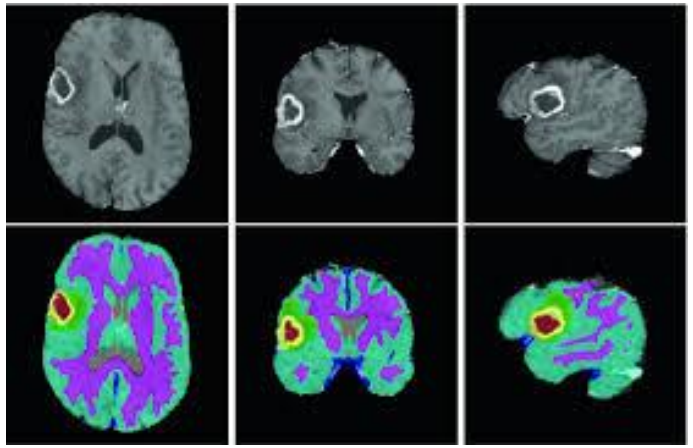


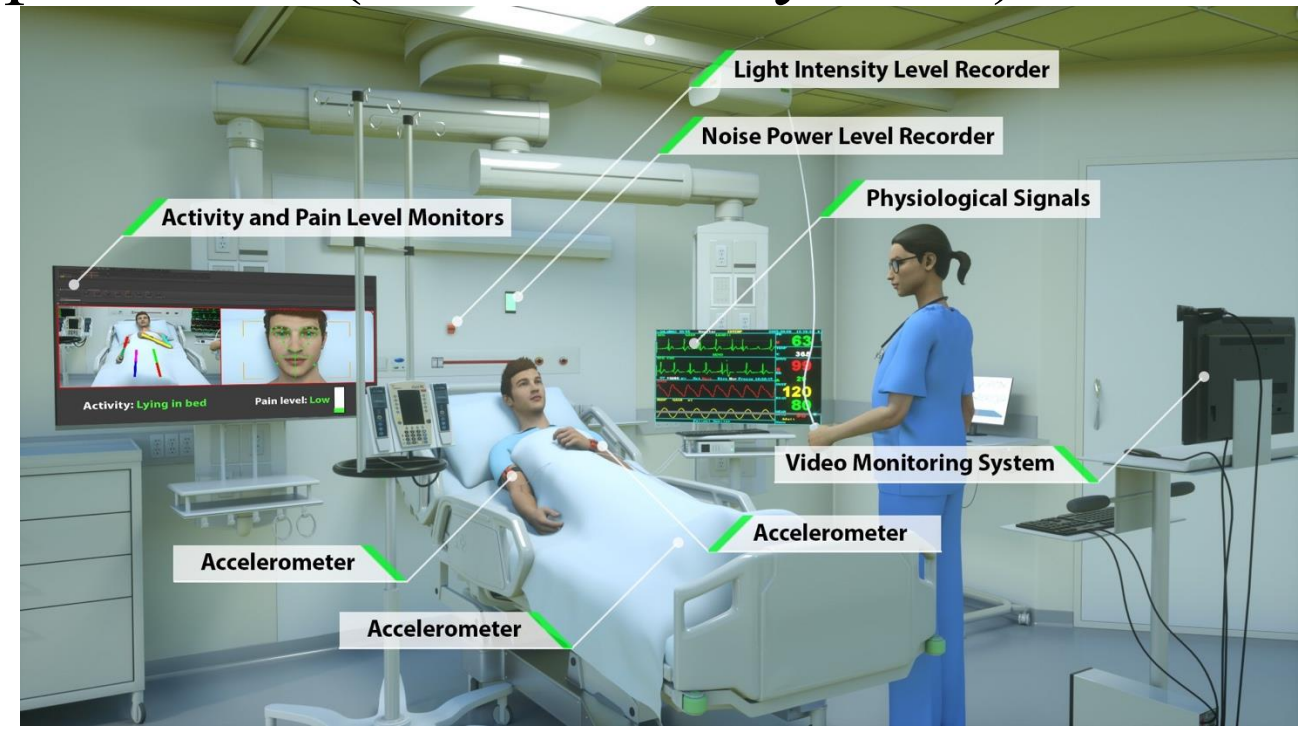
Citation: Application of sEMG and Posturography as Tools in the Analysis of Biosignals of Aging Process of Subjects in the Post-production Age

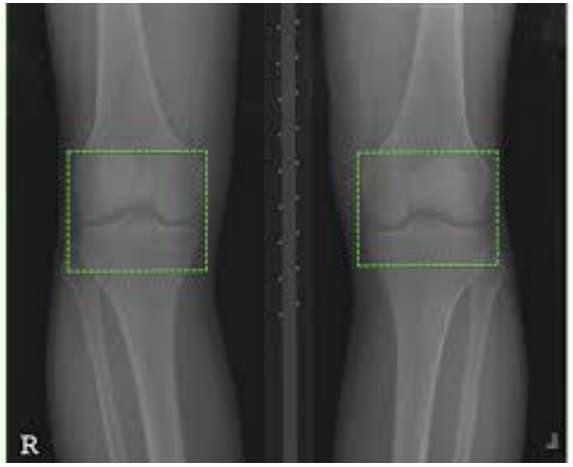
Motivation: Computer Vision Applications (Surveillance Systems)



Motivation: Computer Vision Applications (Healthcare Systems)





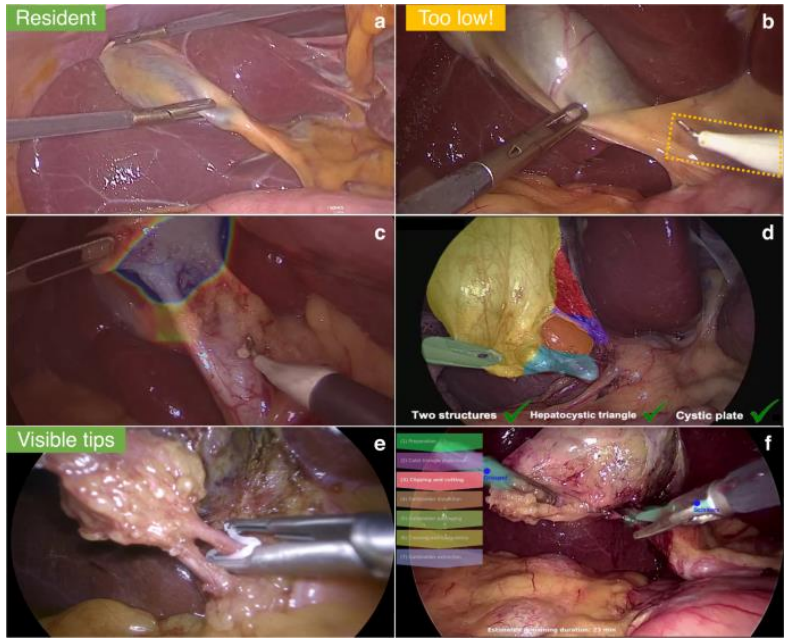


Motivation: Computer Vision Applications (QA/QC Systems)

Motivation: Computer Vision Applications (Robotics)

Motivation: Computer Vision Applications (Self Driving Cars)

Motivation: Computer Vision Applications (Robot Assisted Surgery)



Successes with Computer Vision

- Optical character recognition (OCR)
- Retail (e.g., automated checkouts)
- 3D model building (and 3D printing)
- Medical imaging
- Automotive safety
- Surveillance
- Fingerprint recognition and biometrics

“Computer Vision”

- Machine Vision
- Robot Vision
- Image Analysis
- Image Processing
- Digital Image Processing
- Imaging Informatics

Video Analysis

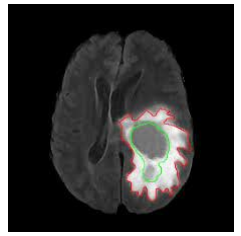
How Computer Vision Works?

1) Acquiring an image
2) Processing Image
3) Understanding Image

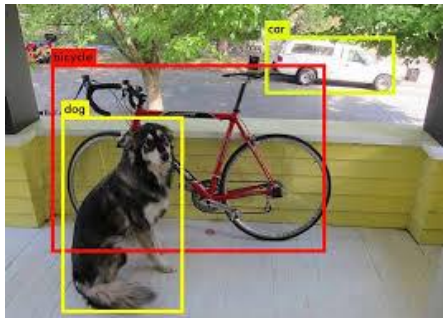
Computer Vision Mechanisms/Algorithms

There are **many types of computer vision algorithms** that are used in different ways:

- **Image segmentation:** partitions an image into multiple regions to be examined separately.



- **Object detection:** identifies a specific object in an image. Advanced object detection recognizes many objects in a single image



- **Facial recognition:** it is an advanced type of object detection that not only recognizes a human face in an image but can also identify a specific individual.

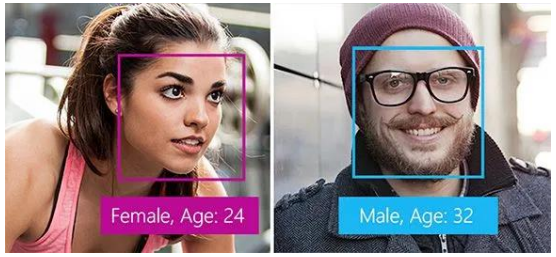
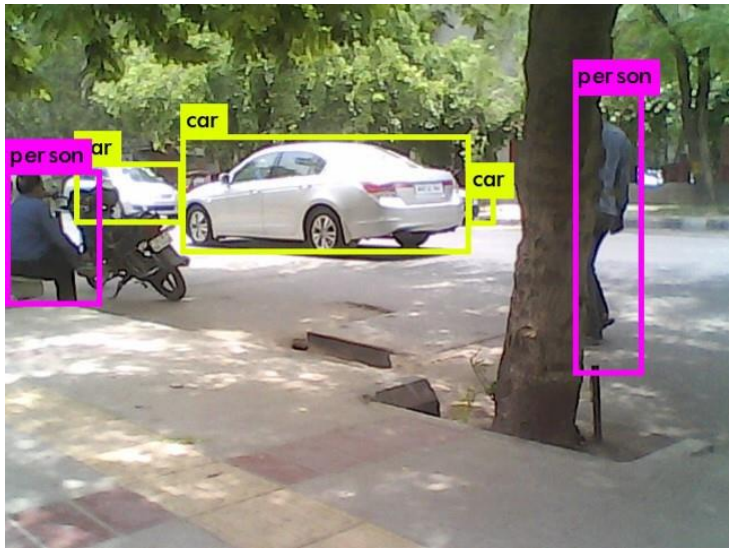
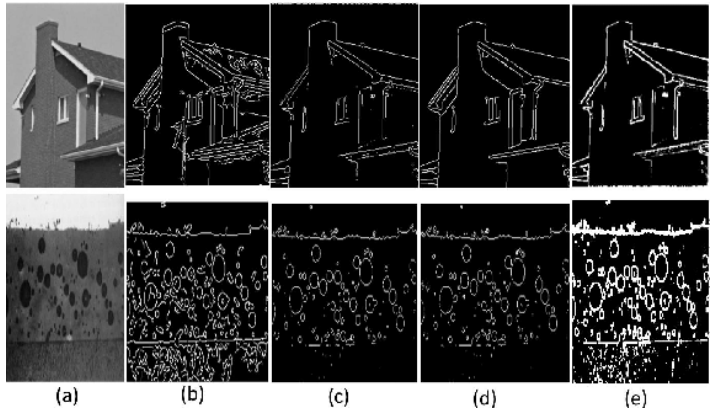


Image from: https://techbusinessguide.com

Computer Vision Mechanisms/Algorithms

- **Edge detection:** is a technique used to identify the outside edge of an object or landscape to better identify what is in the image.
- **Pattern detection:** is a process of recognizing repeated shapes, colors and other visual indicators in images.
- **Image classification:** groups images into different categories.
- **Feature matching:** is a type of pattern detection that matches similarities in images to help classify them.





Low-Level, Mid-Level, and High-Level Image Processing

Type	Input	Output	Examples
Low Level Process	Image	Image	Noise removal, image sharpening
Mid-Level Process	Image	Attributes	Object recognition, Segmentation
High Level Process	Attributes	Understanding	Scene understanding, autonomous navigation

Thank you!

Questions!