Pitt HexAI Mini Summer Camp 2023

Lecture #1: Introduction to Computer Vision

Instructors:
- Ahmad P. Tafti, PhD, FAMIA
- Nickolas Littlefield (PhD Student at Pitt)
- Kyle Buettner (PhD Student at Pitt)

Learning Objectives

- Understand and explain a big picture of AI

- Understand and explain computer vision

- Explain computer vision applications

- Understand and explain different computer vision algorithms

Introduction to Computer Vision

Computer Science

Machine Intelligence

Statistical Learning

Speech Recognition

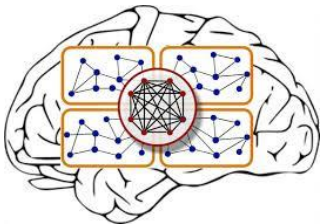Machine Learning

Natural Language Processing

Computer Vision

Image Processing
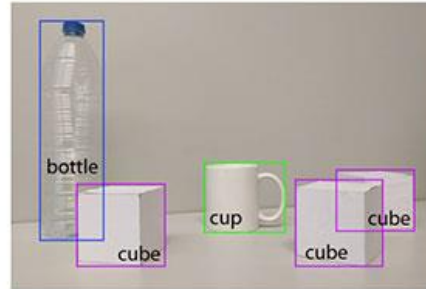
Robotics

Pattern Recognition

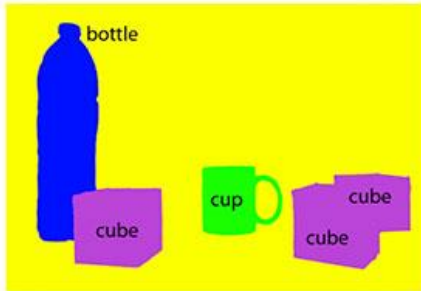Neural Networks

"Computer Vision"

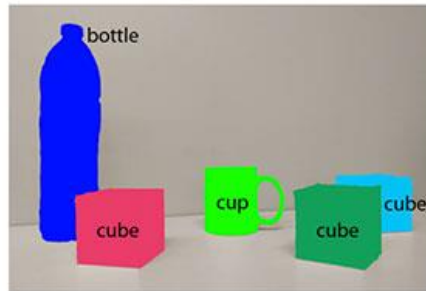- Computer vision deals with how computers can understand from digital images and video sequences.

(a) Image classification
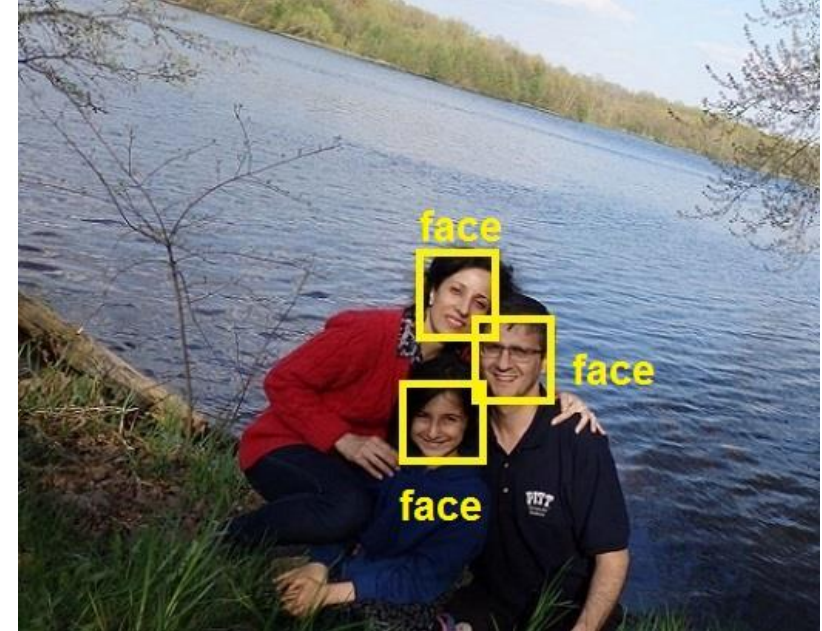(b) Object localization
(c) Semantic segmentation
(d) Instance segmentation

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

Object Detection

3D Surface Modeling

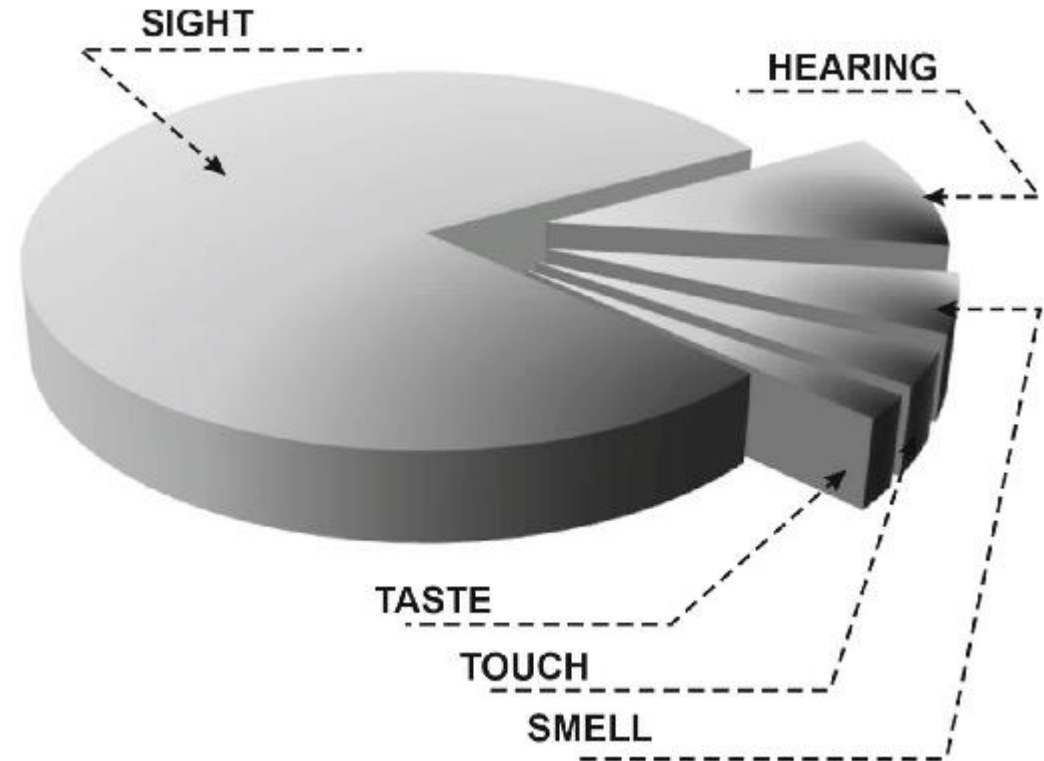# **Motivation:** Sight (Vision), Sound (Hearing), Smell, Taste, and Touch
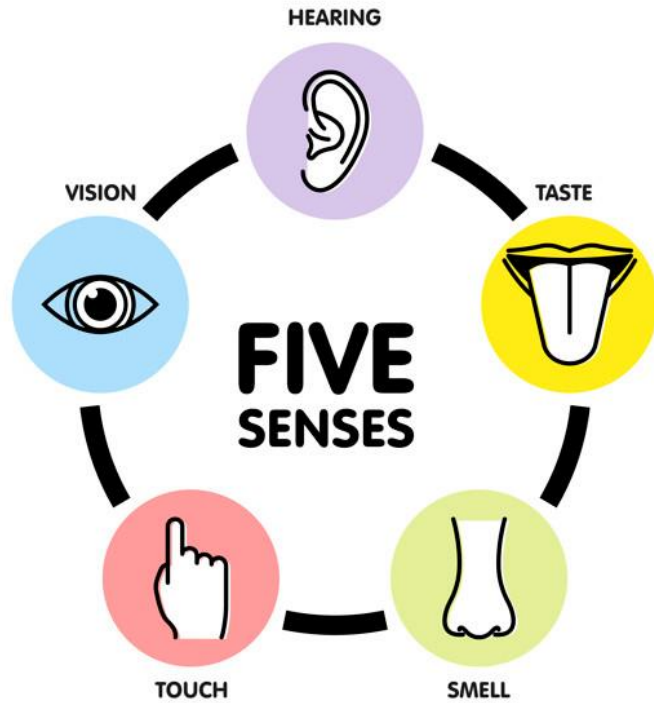
Image from: https://www.freepik.com
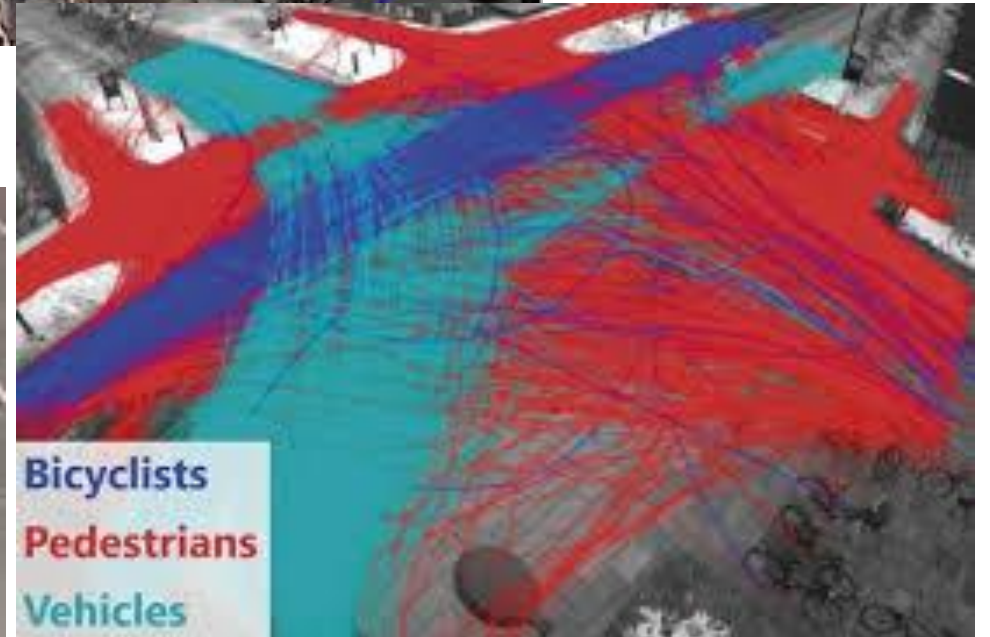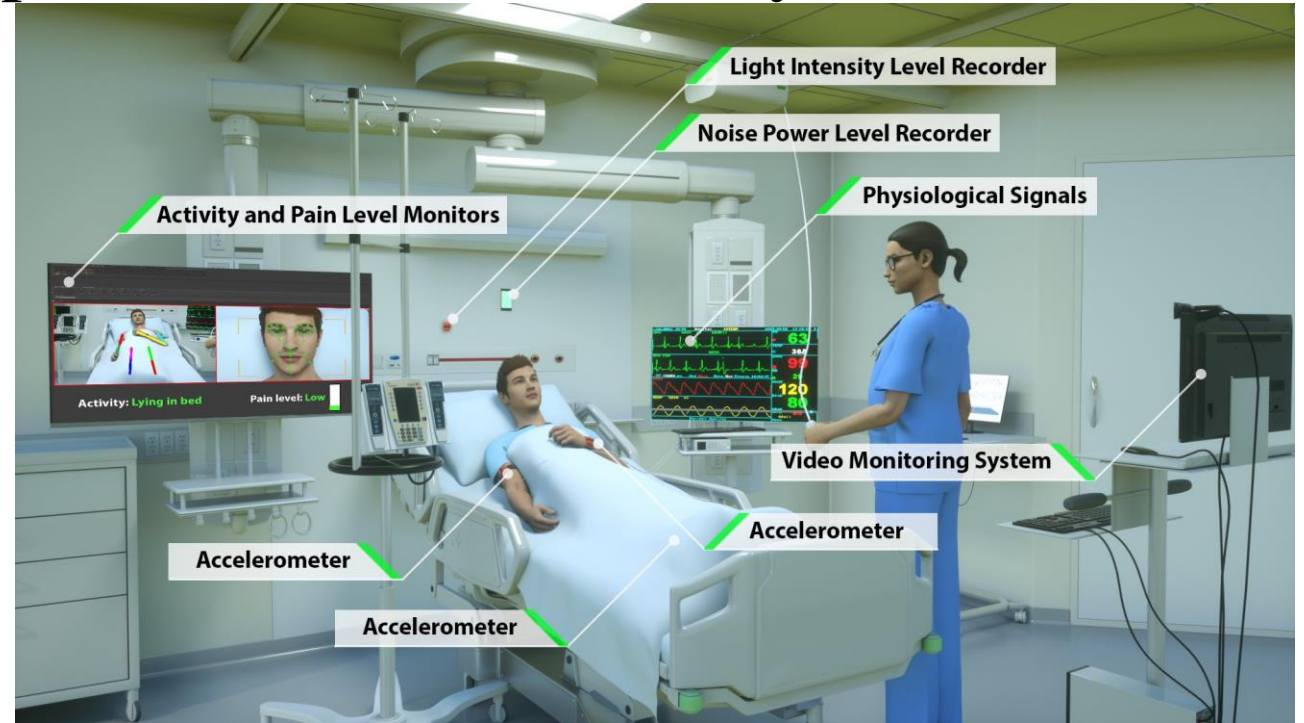

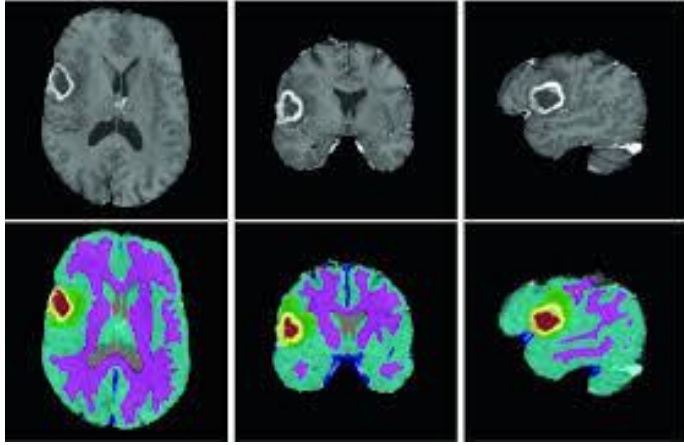Citation: Application of sEMG and Posturography as Tools in the Analysis of Biosignals of Aging Process of Subjects in the Post-production Age

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 (Robot Assisted Surgery)

Motivation: Computer Vision Applications (Self Driving Cars)

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

- Image Understanding

- Digital Image Processing

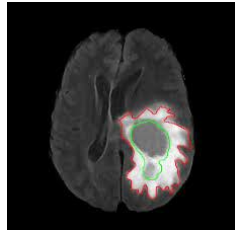Video Analysis/Video Understanding

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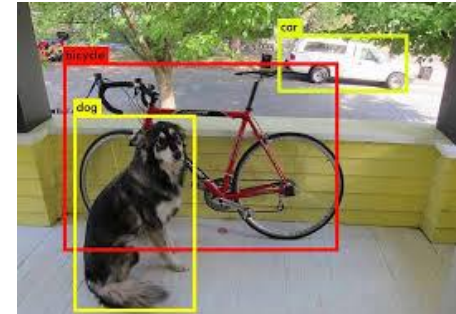
- **Facial recognition:** it is an advanced type of object detection that not only recognizes a human face in an image but can also identify a specific individual.
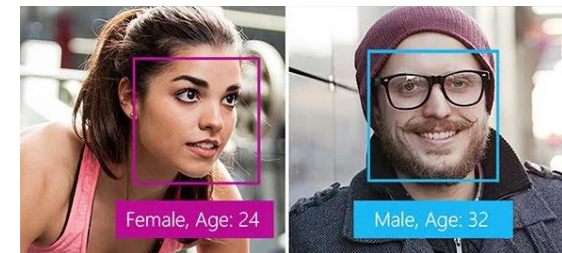

Image from: https://techbusinessguide.com

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.

(a)   (b)   (c)   (d)   (e)
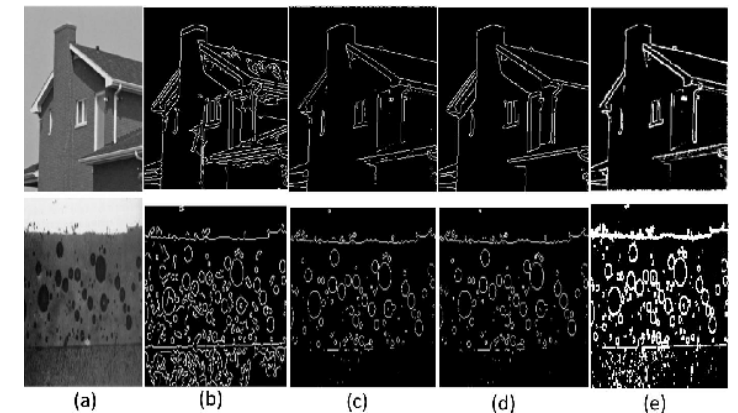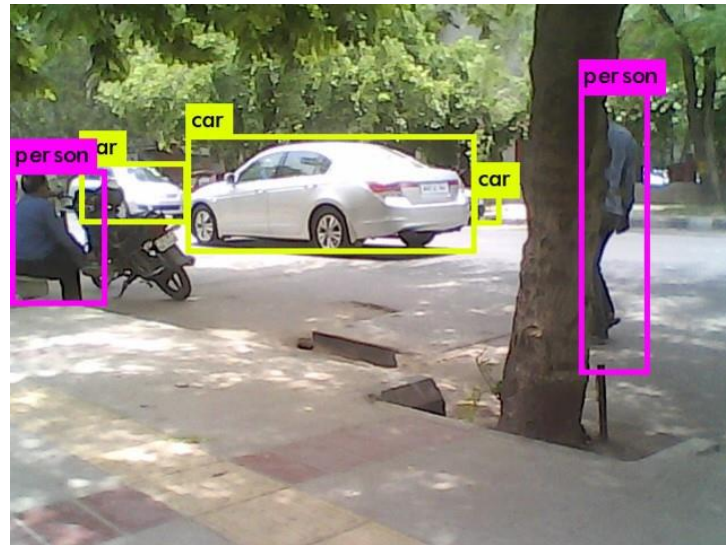
Low-Level, Mid-Level, and High-Level Image Processing

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!

Ahmad P. Tafti: tafti.ahmad@pitt.edu
Nickolas Littlefield: ngl18@pitt.edu
Kyle Buettner: buettnerk@pitt.edu