Applications of Computer Vision and AI in Robotics

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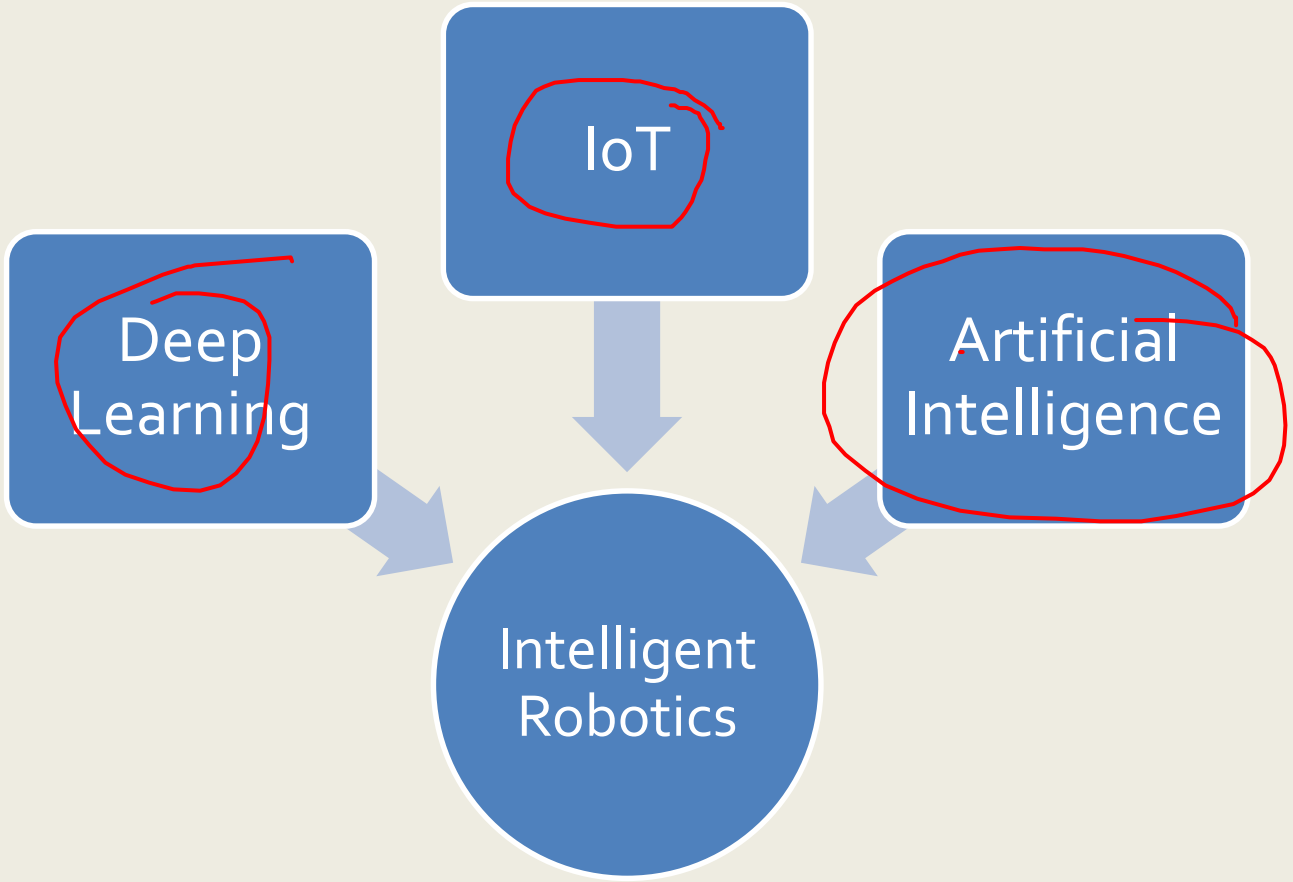
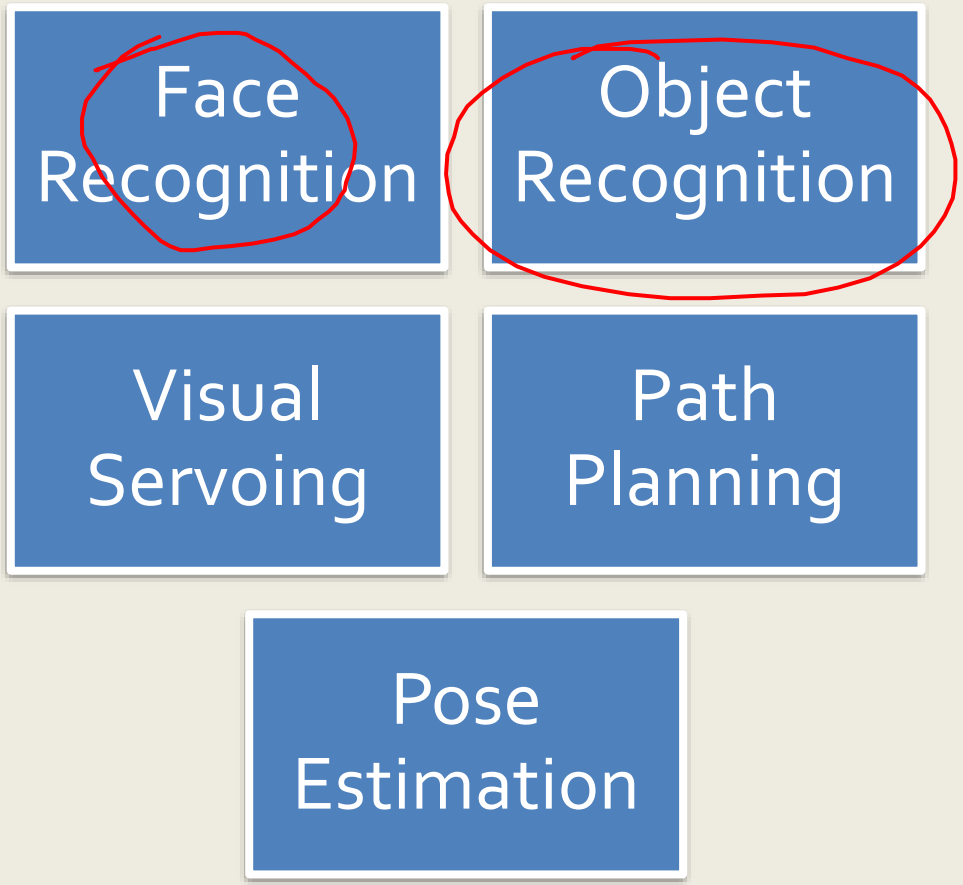
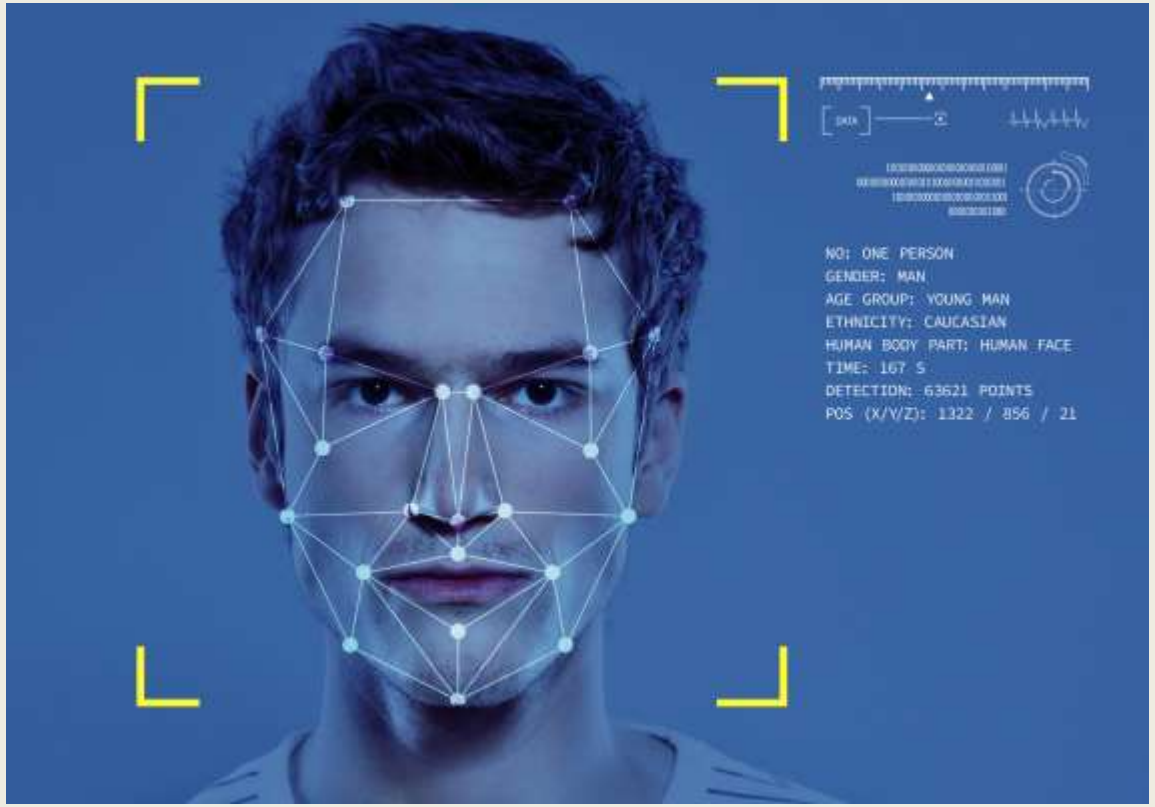
What is being used to make machines intelligent



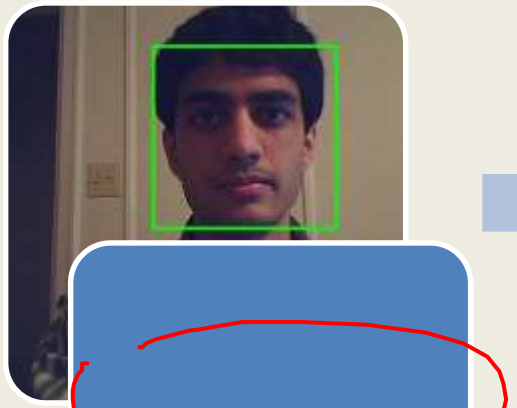
Systems requiring intelligence



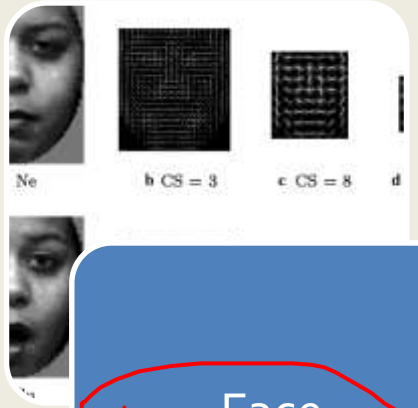


Face Recognition

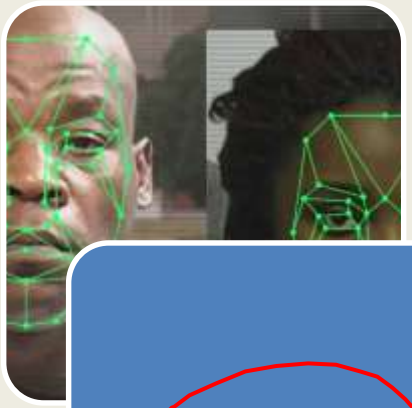
Process of Face Recognition(FR)



Face Detection

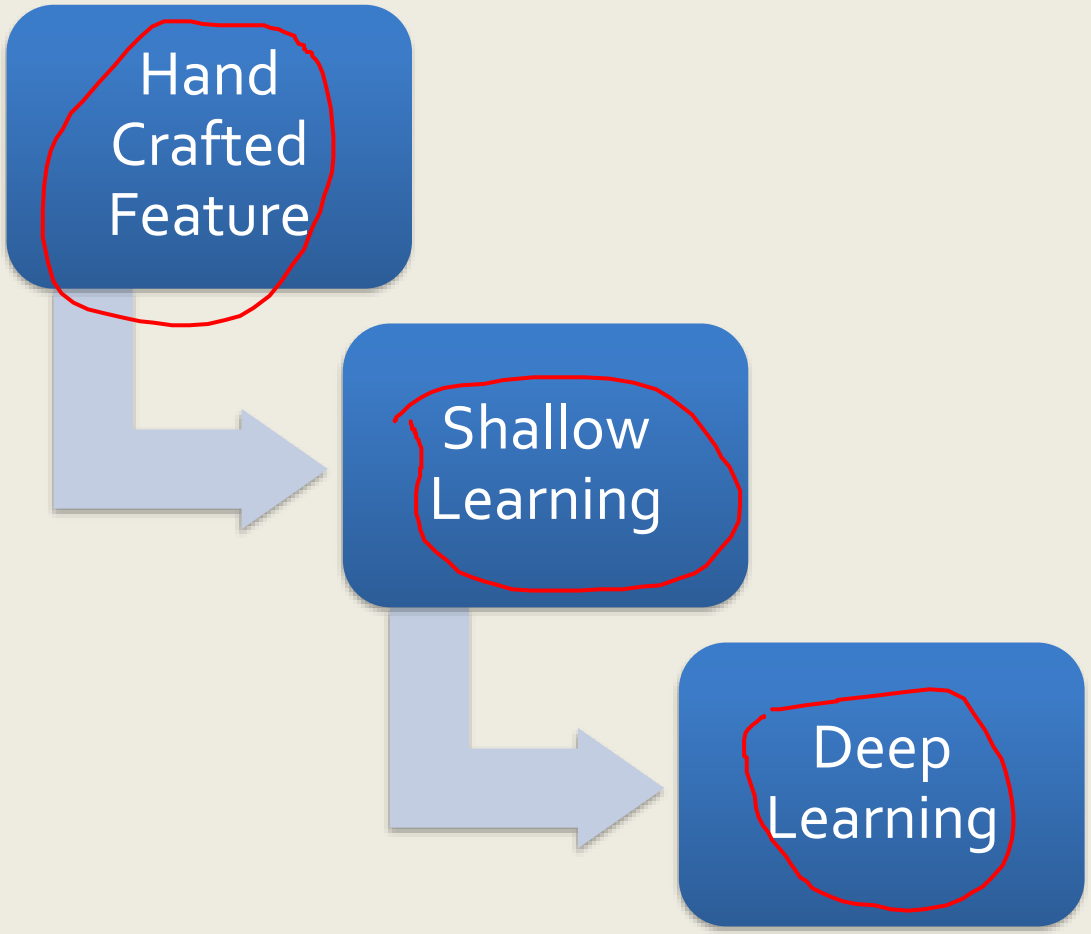


Face Representation

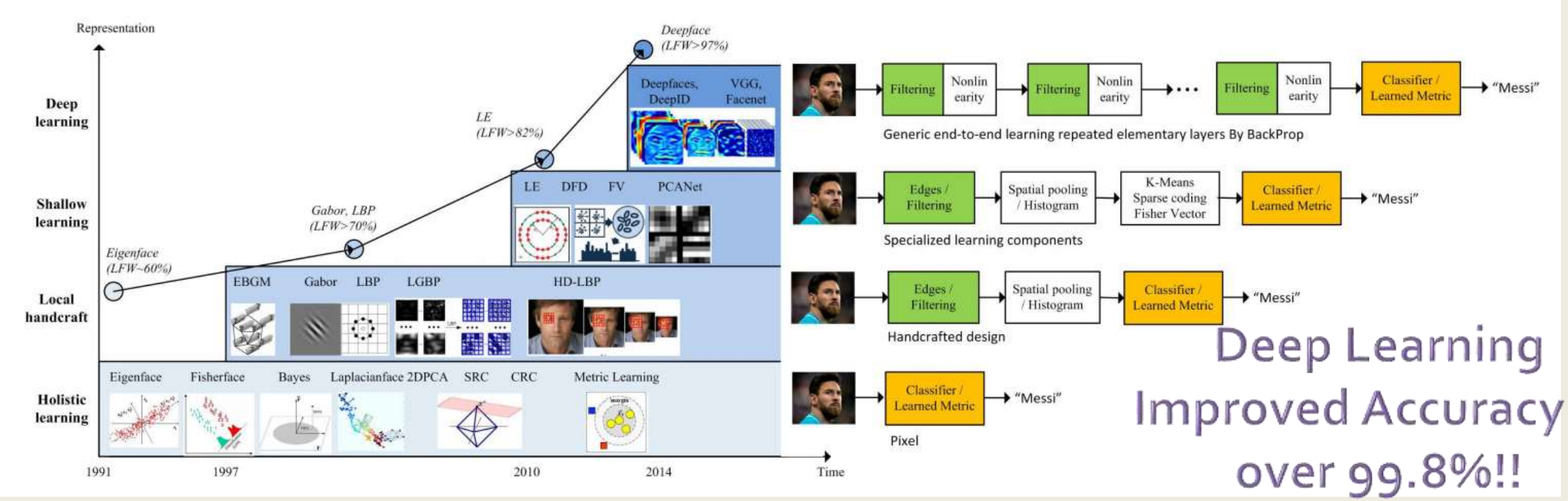


Matching

Methods of Face Recognition (FR)

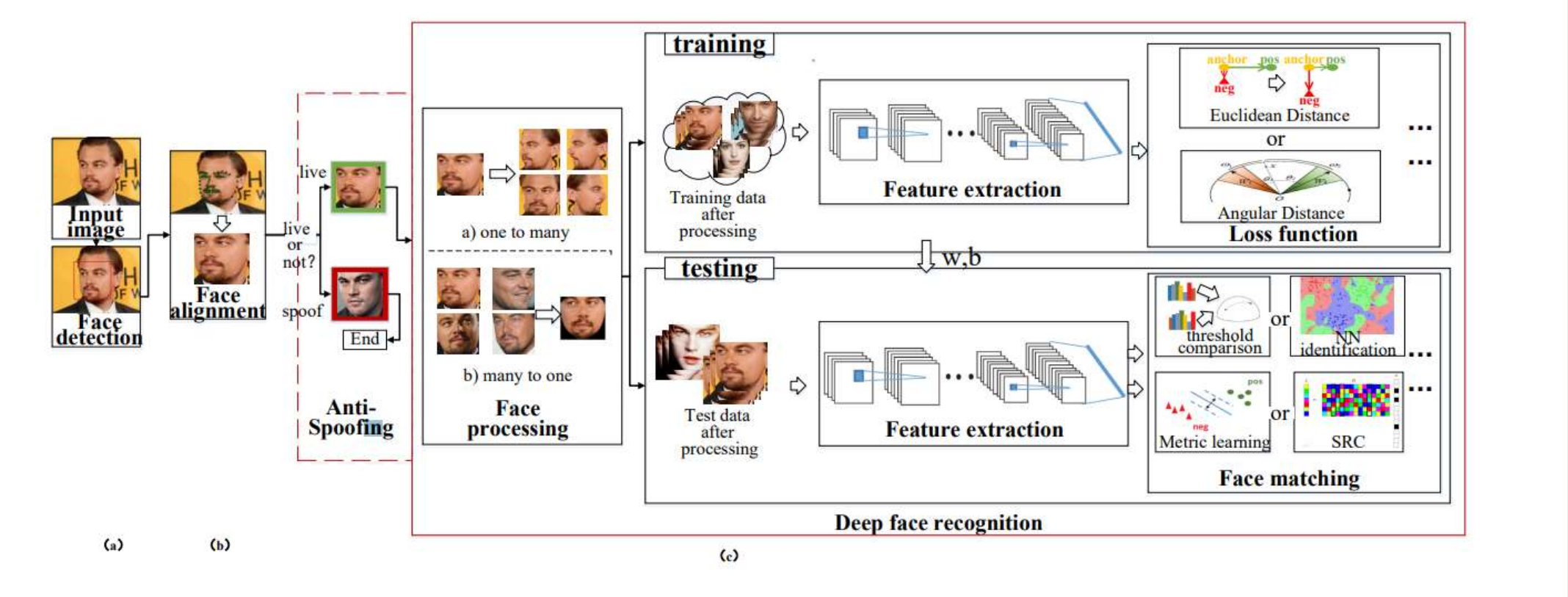


Face Recognition in the ages



Wang, M., & Deng, W. Deep face recognition: A survey. arXiv 2018. *arXiv preprint arXiv:1804.06655*.

Components of FR Systems



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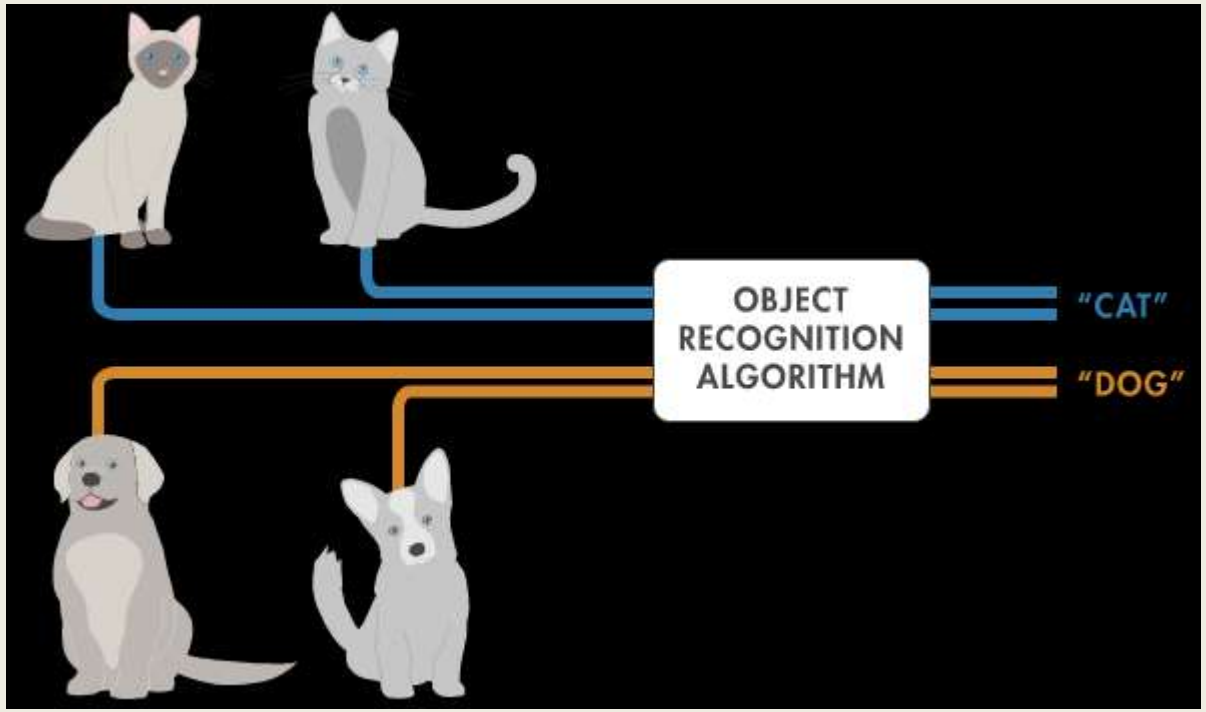
Major Deep Learning-Based FR Algorithms

DeepFace

DeepID

VGGFace

FaceNet



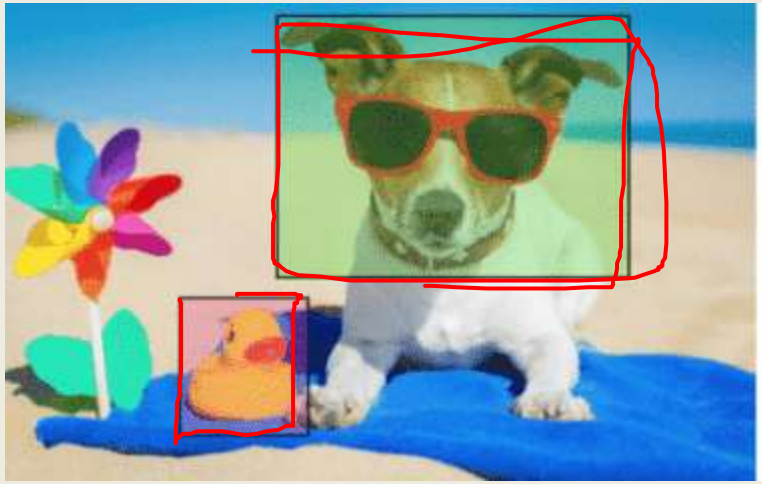
Object Recognition

Tasks in Object Recognition

Classification

Tagging

Tasks in Object Recognition



Detection

Segmentation

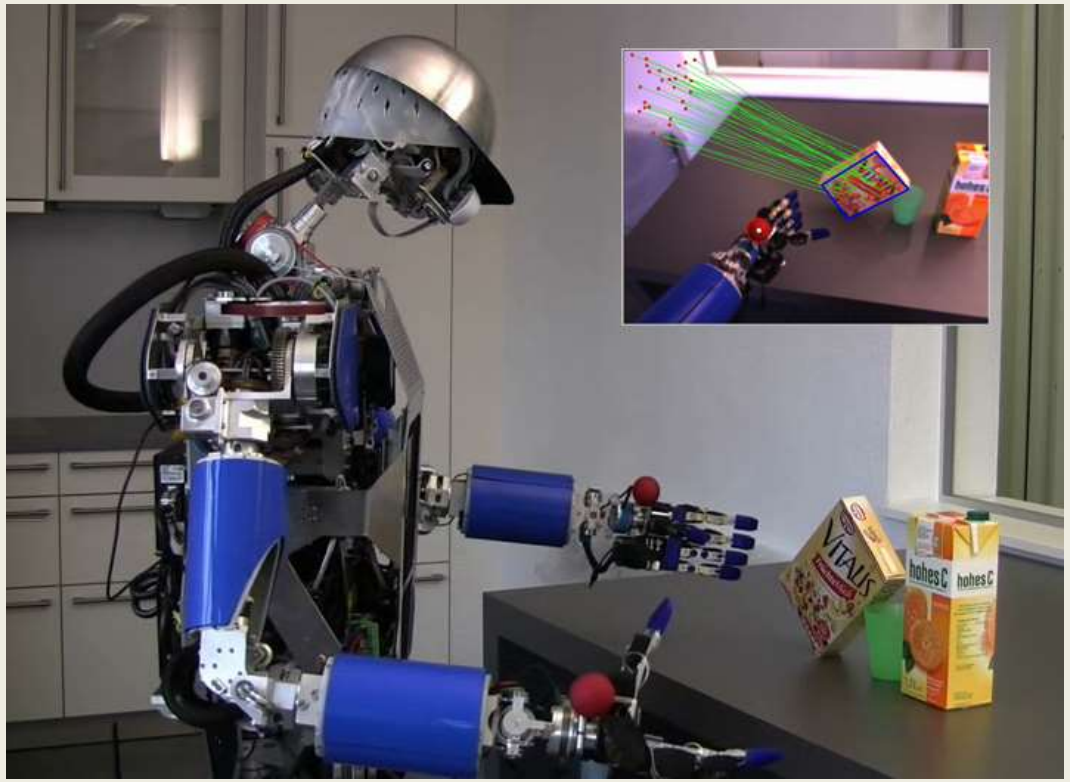
Pedestrian Tagging in Self Driving Cars

Source: https://tinyurl.com/y2hy6whv

Object Localization and Detection

For Performance

For Real-Time Usage



Visual Servoing

What is Visual Servoing?

- Controlling the motion of a robot using the visual feedback received from the camera sensors to execute tasks
- Image processing algorithms can be used to determine the position of objects in the robot's environment
- Then the robot can position itself to interact with the object
- The process depends on:
  - Camera Calibration
  - FK and IK solvers
  - Accurate Kinematic Model of robot
  - Good Camera Performance

https://control.com/technical-articles/an-overview-of-visual-servoing-for-robot-manipulators/

An Example

Types of Visual Servoing

Position/Pose-Based

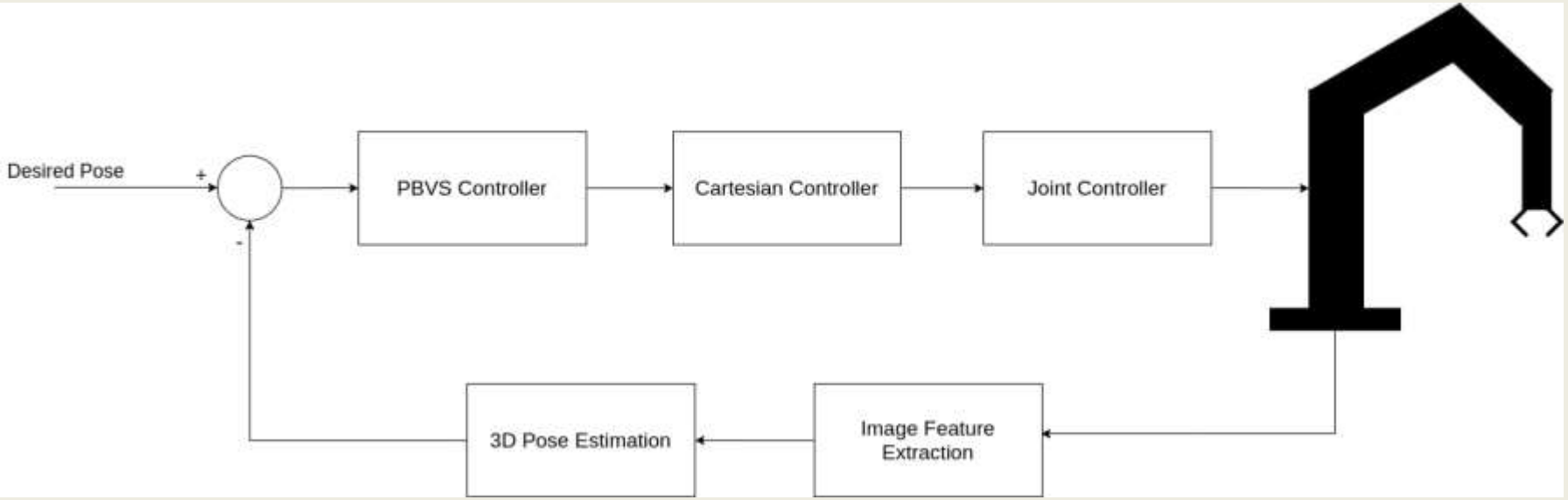
Uses 3d range finders or RGB-D cameras to retrieve the pose data of the object of interest. Pose data includes: 3d coordinates and orientation

Then compares the pose of the object with the pose of the robot's end effector

The controller then calculates the error between two poses and moves the robot to the correct pose

https://control.com/technical-articles/an-overview-of-visual-servoing-for-robot-manipulators/

Position/Pose-Based



https://control.com/technical-articles/an-overview-of-visual-servoing-for-robot-manipulators/

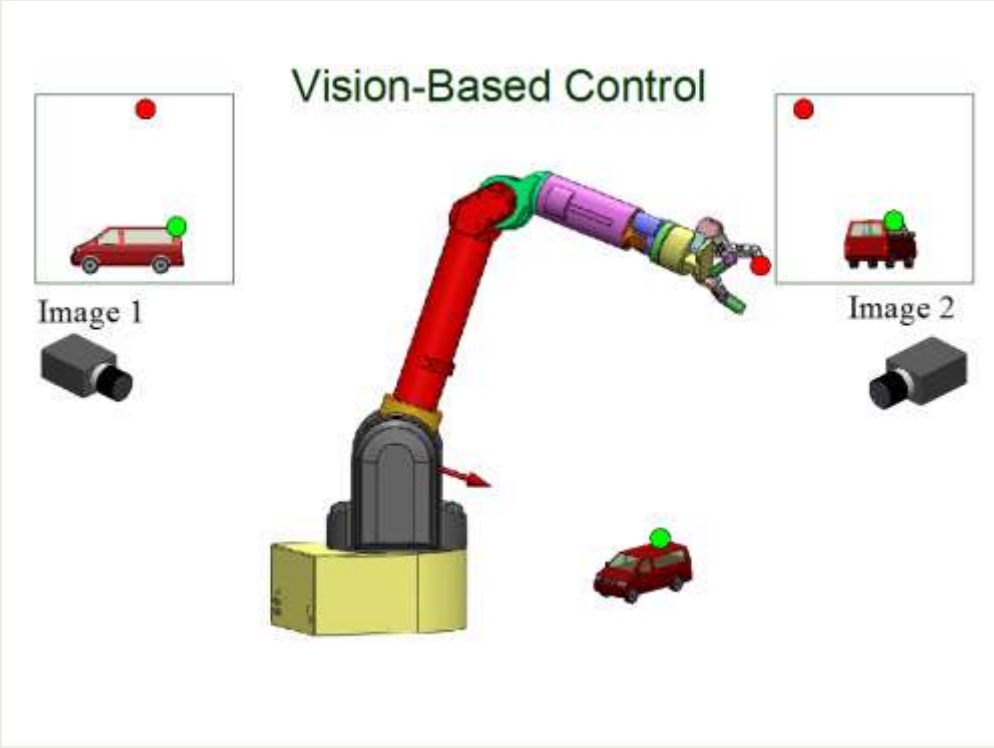
Image-Based

Project the 3D world image into 2D image → Extracts camera features and calculates the error in the image → Converts the error into robot motion

https://control.com/technical-articles/an-overview-of-visual-servoing-for-robot-manipulators/

Applications

- Moving workpiece or a moving robot,
- Conveyor belt sorting,
- Welding using a mobile manipulator,
- Garbage sorting
- Assistive Surgery



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More Applications!!

- Imitation Learning
- Self-supervised learning
- Multi-Agent Learning

Path Planning

- The problem of discovering the sequence of valid configurations that move the object from source to destination
- Can be used in mobile robots, industrial manipulators etc.
- Algorithms can differ based on the type of the robot
- Algorithms:
  - Djkstra's
  - BFS, DFS
  - A*
  - Rapidly Exploring Random Tree
  - Artificial Potential Field