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ECG782: Multidimensional Digital Signal Processing

Lecture 01
Introduction

http://www.ee.unlv.edu/~b1morris/ecg782/

Outline

- Computer Vision Overview

What is Computer Vision?

- Given an image, want to answer questions about what we see

- Hanauma Bay, Hawaii

What is Computer Vision?

- Goal is to develop algorithms and programs that can interpret and understand images
  - Image can be a single image or come from a video
- Must bridge the gap between what we see and what a computer “sees”

Why is Computer Vision Difficult II

- Humans are very skilled with vision
  - We are designed with vision as our primary sensory input
  - It comes naturally
- Computers operate on numbers and do not have contextual clues we have wired in our brains

What we see

0	3	2	5	4	7	6	9	8
3	0	1	2	3	4	5	6	7
2	1	0	3	2	5	4	7	6
5	2	3	0	1	2	3	4	5
4	3	2	1	0	3	2	5	4
7	4	5	2	3	0	1	2	3
6	5	4	3	2	1	0	3	2
9	6	7	4	5	2	3	0	1
8	7	6	5	4	3	2	1	0

What a computer sees

Why is Computer Vision Difficult II

- Loss of information in 3D → 2D
  - The world is 3D but an image is only 2D
    - Loss of information from perspective imaging
- Interpretation
  - Many different interpretations of the same image
  - `interpretation: image data → model`
  - How to develop a meaningful model
- Noise
- Big data
  - High resolution imagery, HD video, lots of training data
- Brightness measurement
  - Complicated physical process that is hard to determine from an image
- Local window vs. need for global view
  - Processing done locally but must make inference globally

Humans vs. Computers

- Computers can't currently "beat" humans
  - Humans are much better at "hard" things
  - Computers can be better at "easy" things

- Computers are computational device so must be given memory and learn
- If the task requires lots of attention it may be better suited for a computer
  - Surveillance
  - Automotive blind spot detection
  - Searching for a face in a crowd

CV as Intelligent Systems

- Intelligence
  - The capacity to acquire knowledge
  - The faculty of thought and reason
- System
  - A group of interacting, interrelated or interdependent elements forming a complex whole

- This class uses computer vision to give a system intelligence
- The systems should perceive, reason, learn, and act intelligently

Vision

- Signal to symbol transformation

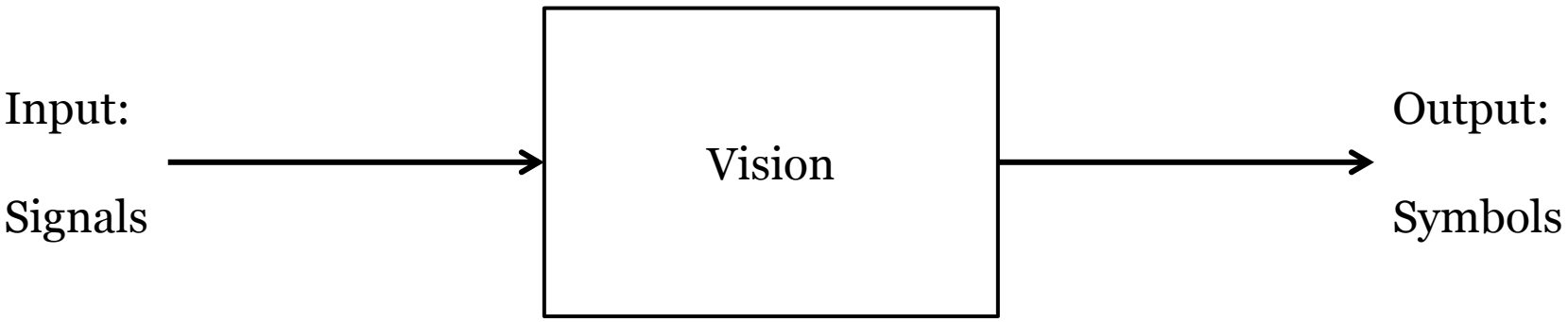


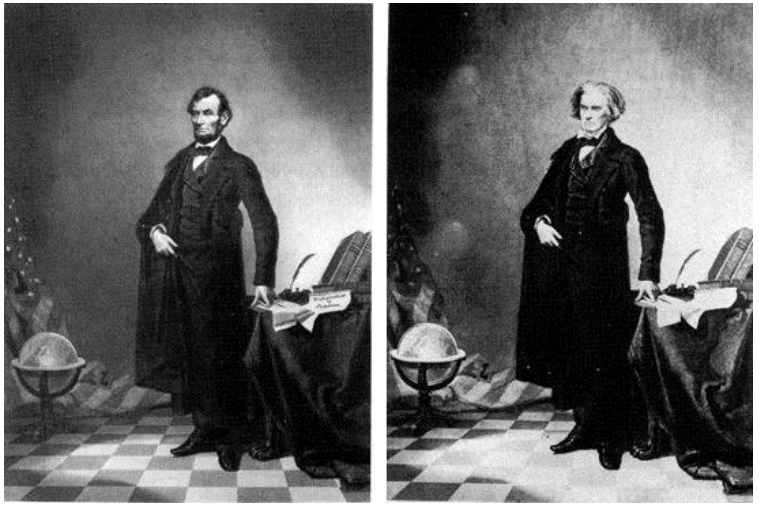
Image Processing

- Manipulation of images

Examples:

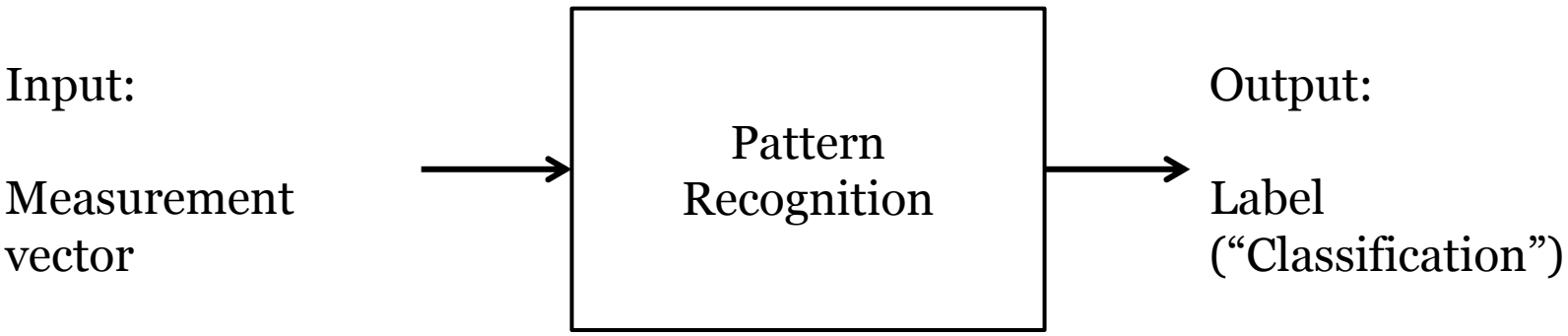
- “Photoshopping”
- Image enhancement
- Noise filtering
- Image compression

IP Examples



Pattern Recognition

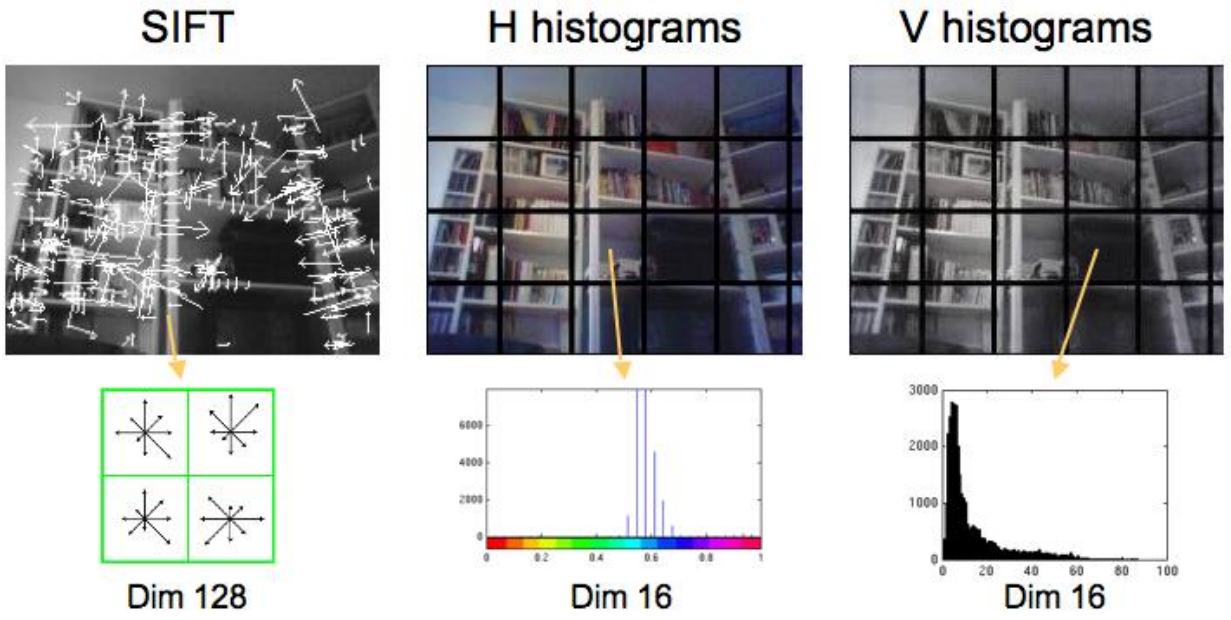
- Assignment of a label to input value

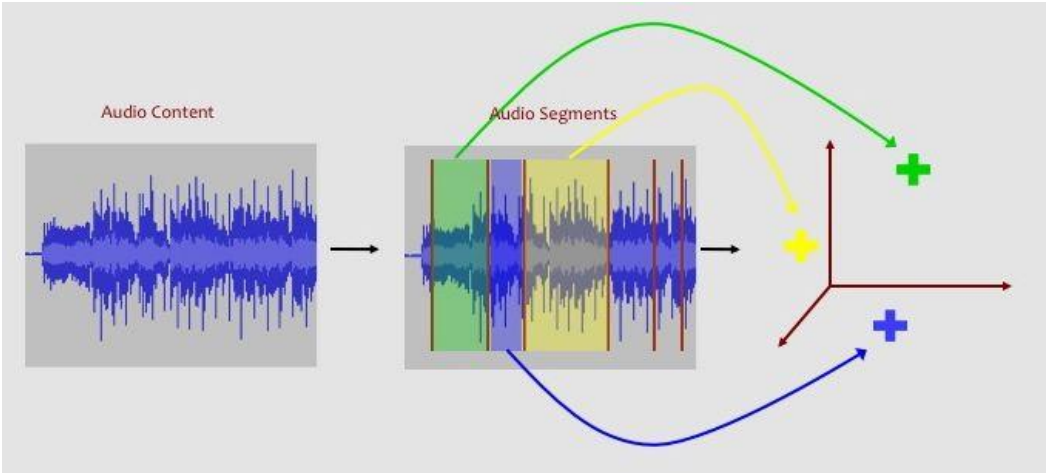


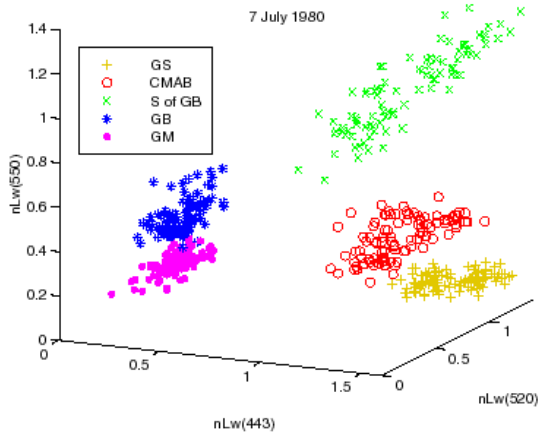
Examples:

- Classification (1/0)
- Regression (real valued)
- Labeling (multi label)

PR Examples

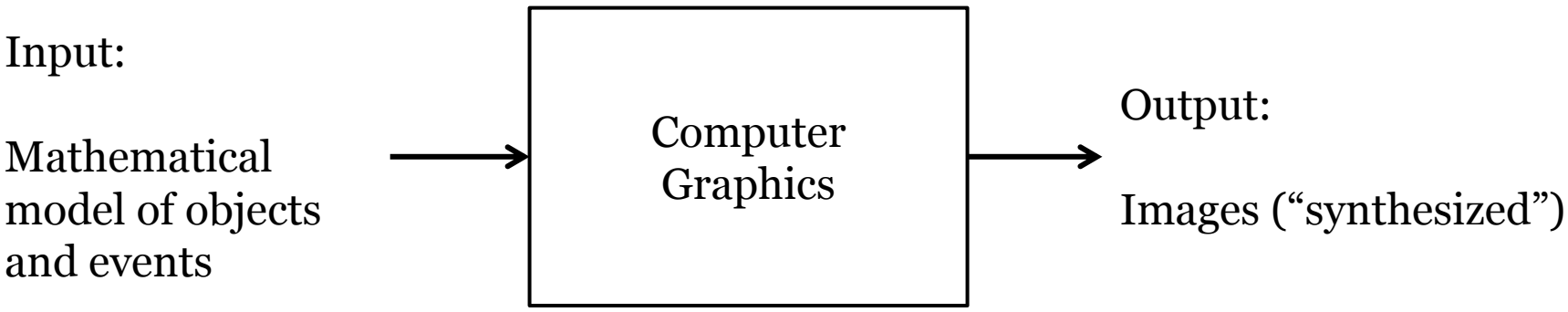

SIFT
H histograms
V histograms
Dim 128
Dim 16
Dim 16


Audio Content
Audio Segments


7 July 1980
GS
CMAB
S of GB
GB
GM
nLw(550)
nLw(443)
nLw(520)

Computer Graphics

- Create realistic images ("forward problem")



Examples:

- Simulation (flight, driving)
- Virtual tours
- Video games
- Movies

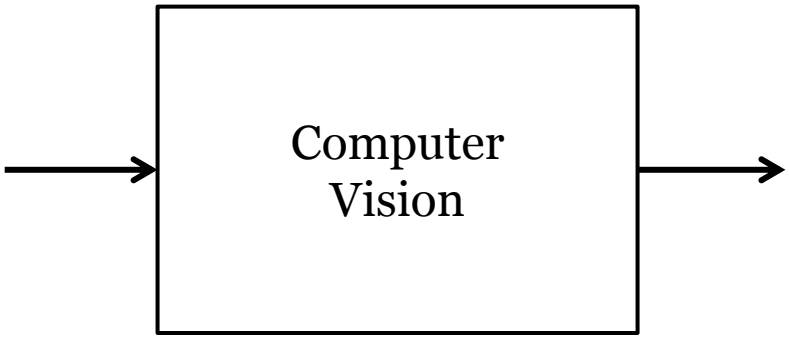
CG Examples

Computer Vision

- Interpretation and understanding of images

Input:

1. Image derived measurements
2. Models (prior knowledge)



Output:

Recognition of objects and events embedded in images and video

("Semantic" level classification)

Examples:

- Object recognition
- Face recognition
- Lane detection
- Activity analysis

Scope of Computer Vision

- Very broad
- Cfp for the Computer Vision and Pattern Recognition (CVPR) conference:

• Motion and Tracking • Stereo and Structure from Motion • Shape-from-X • Color and Texture • Segmentation and Grouping • Image-Based Modeling • Illumination and Reflectance Modeling • Shape Representation and Matching • Sensors • Early and Biologically-Inspired Vision • Computational Photography and Video	• Object Recognition • Object Detection and Categorization • Video Analysis and Event Recognition • Face and Gesture Analysis • Statistical Methods and Learning • Performance Evaluation • Medical Image Analysis • Image and Video Retrieval • Vision for Graphics • Vision for Robotics • Applications of Computer Vision