

Computer Vision Course Lecture 01

Introduction

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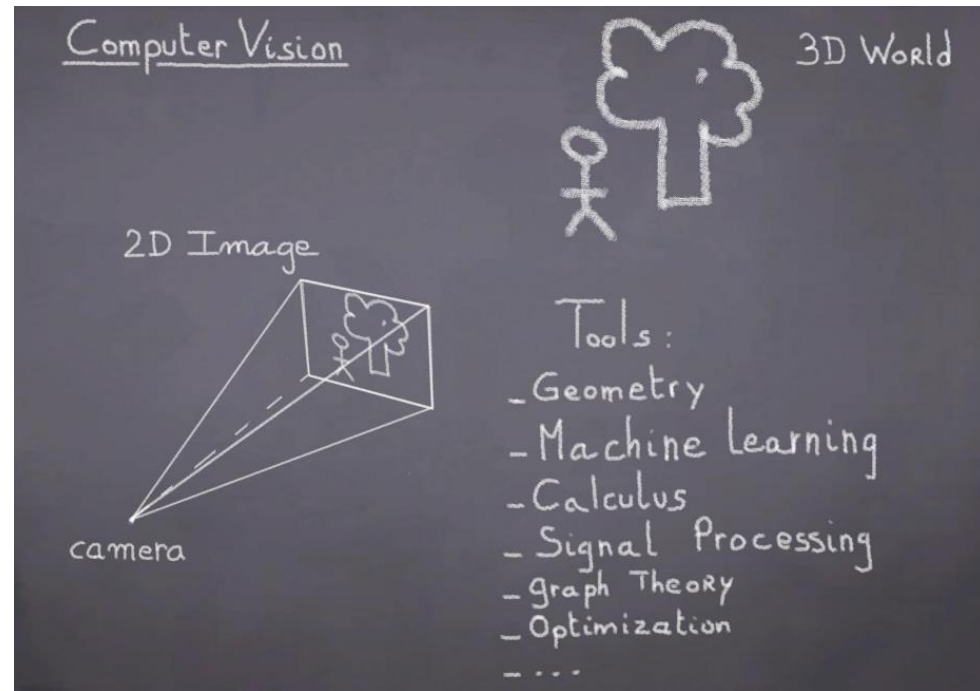


Photo credit: Olivier Teboul
vision.mas.ecp.fr/Personnel/teboul

About Me

- 2002 – 2004** **MS in EE, Boğaziçi Univ. EE Dept.**
Analysis of Functional Near Infrared Spectroscopy Signals
- 2004 – 2007** **PhD in Computer Vision, Télécom ParisTech & Boğaziçi Univ. EE Dept.**
Density-Based Shape Descriptors and Similarity Learning for 3D Object Retrieval
- 2008 – 2009** **Marie Curie Postdoctoral Researcher, Philips Research**
IRonDB Project: Content-based Indexing and Retrieval in MR Image Databases, Image-based Methods for Diagnosing Alzheimer's Disease
- 2010 – 2011** **Senior Research Scientist, Vistek ISRA Vision – Istanbul**
Machine Vision for Industrial Inspection Systems, Human-centric Computer Vision Face and Body Analysis, Behavior analysis, Object Tracking and Recognition
- 2011 – 2013** **R&D Director, Vistek ISRA Vision – Istanbul**
Machine Vision for Industrial Inspection Systems, Human-Centric Computer Vision Face and Body Analysis, Behavior analysis, Object Tracking and Recognition
- 2014 →** **Founder and CTO, Vispera Information Technologies – Istanbul**
Visual Recognition Solutions for the Retail Industry | vispera.co
- 2010 →** **Adjunct Faculty, Boğaziçi Univ. EE Dept.**
Data Mining for Visual Media, Image Analysis, MS and PhD Student Supervision

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What Is Computer Vision?

In 1966, Minsky hired a first-year undergraduate student and assigned him a problem to solve over the summer...

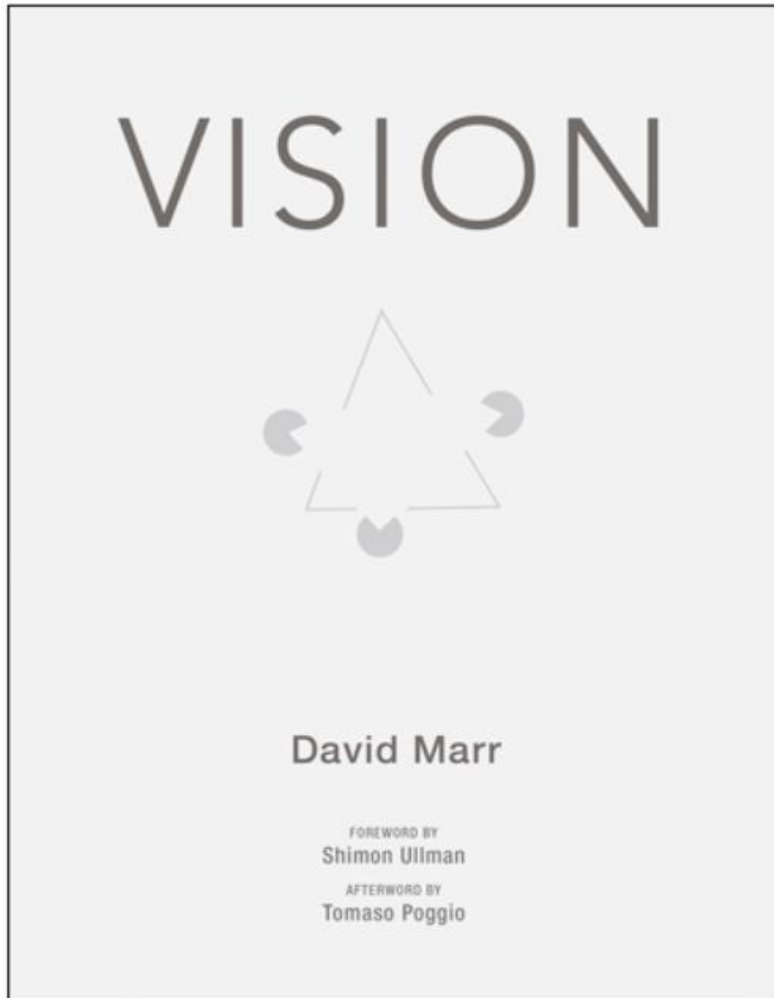


Marvin Minsky
MIT Media Lab

Connect a television camera to a computer and get the machine to describe what it sees!

... And the story started!

What Is Computer Vision?



David Marr on Vision:

“To tell what is where by looking”

Goals of Computer Vision

Estimate the shapes and properties of things

Recognize objects

Recognize people

Recognize other structures

Recognize places

Understand A Visual Scene

What Is Computer Vision?



What humans see in this scene

What Is Computer Vision?



What computers get from the camera

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 Is Computer Vision?



What modern computers vision programs are able to «understand» from this image

What Is Computer Vision?



And what if the image is this one?

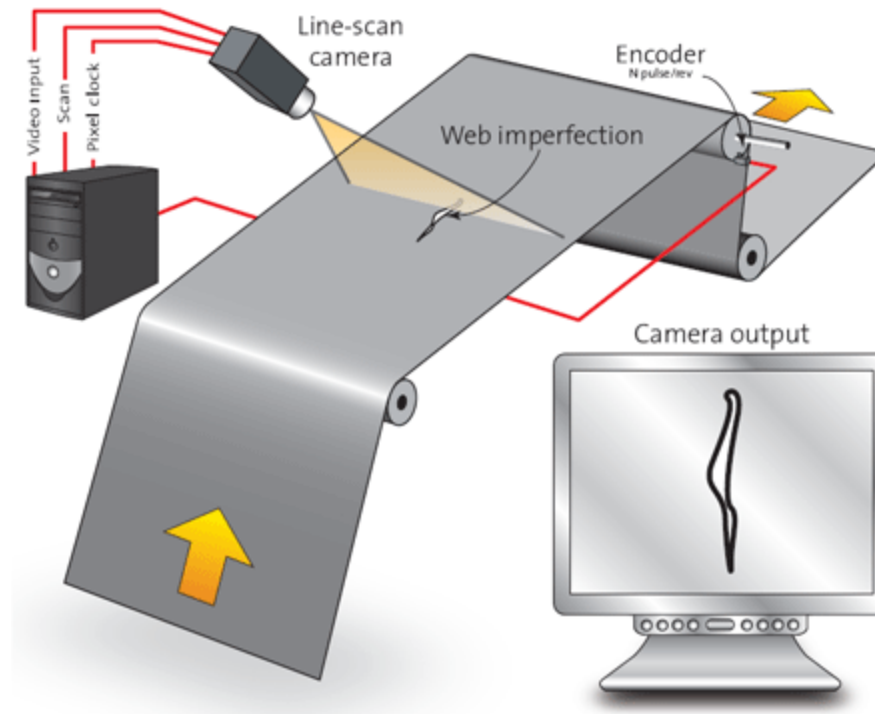
How To Capture The Visual World?

RGB Camera: Still and Motion (Video)



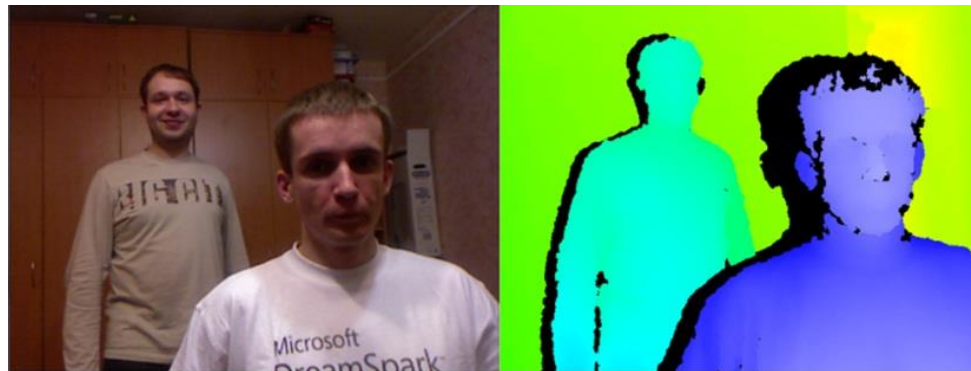
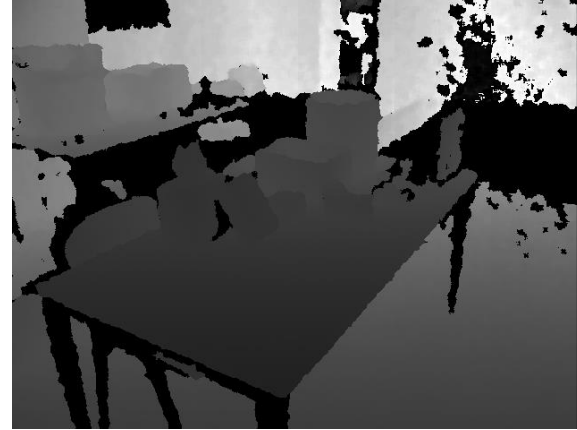
How To Capture The Visual World?

Linescan Camera: A sensor with a single line of CCDs



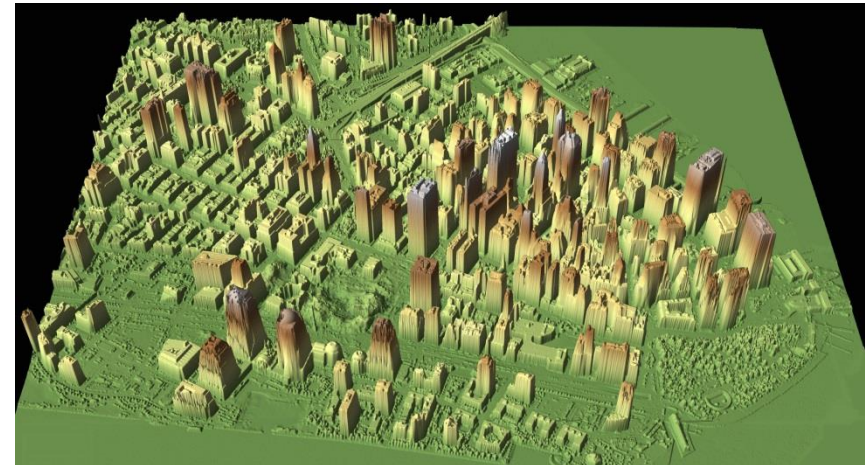
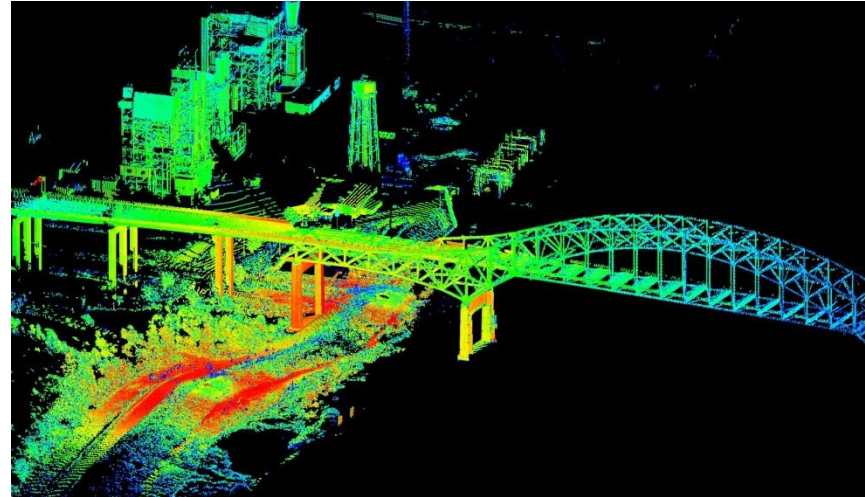
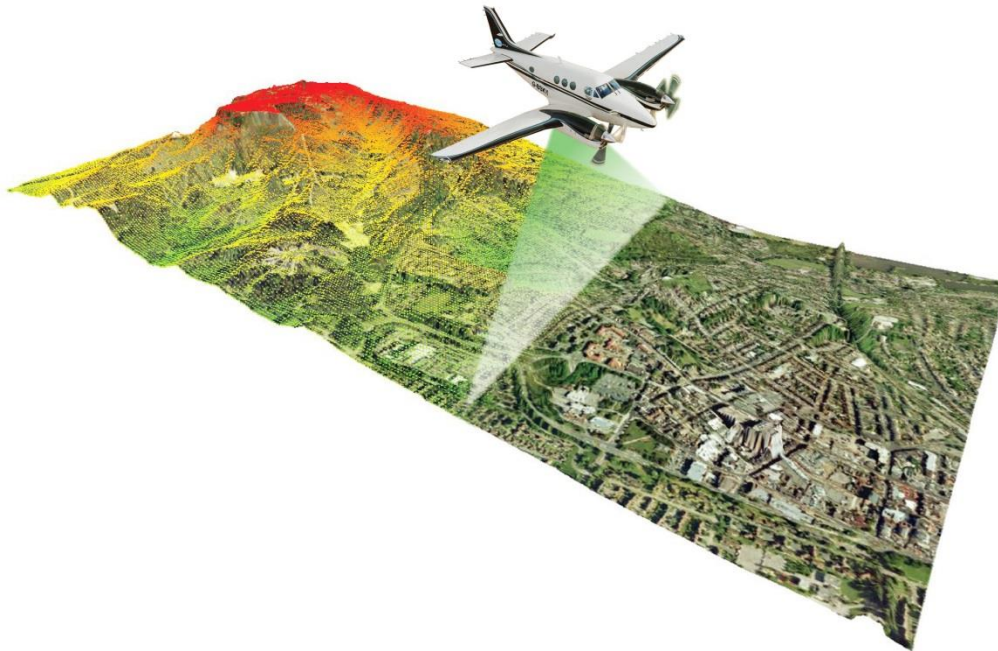
How To Capture The Visual World?

3D Structure Sensor: «Kinect-like» sensing



How To Capture The Visual World?

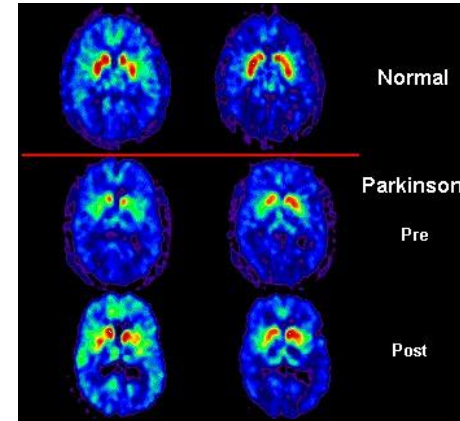
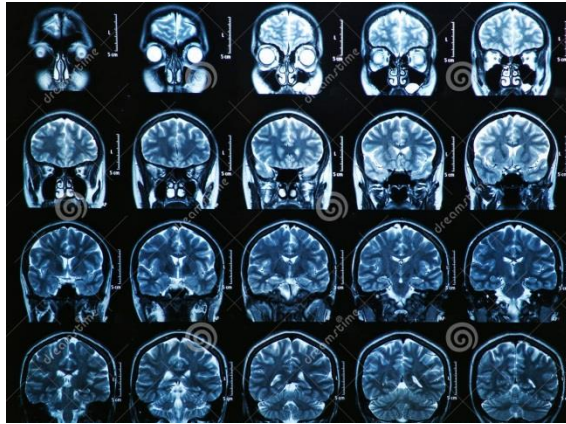
LIDAR*: Sensing the Earth



* LIDAR: Light Detection and Ranging

How To Capture The Visual World?

Medical Imaging: Looking inside



Computer Vision In The Real World

Optical Character Recognition



Digit recognition, *AT&T Labs*



License plate readers, *Elsag*



Automatic
check processing

Computer Vision In The Real World

Face Detection and Recognition



Many new digital cameras now detect faces

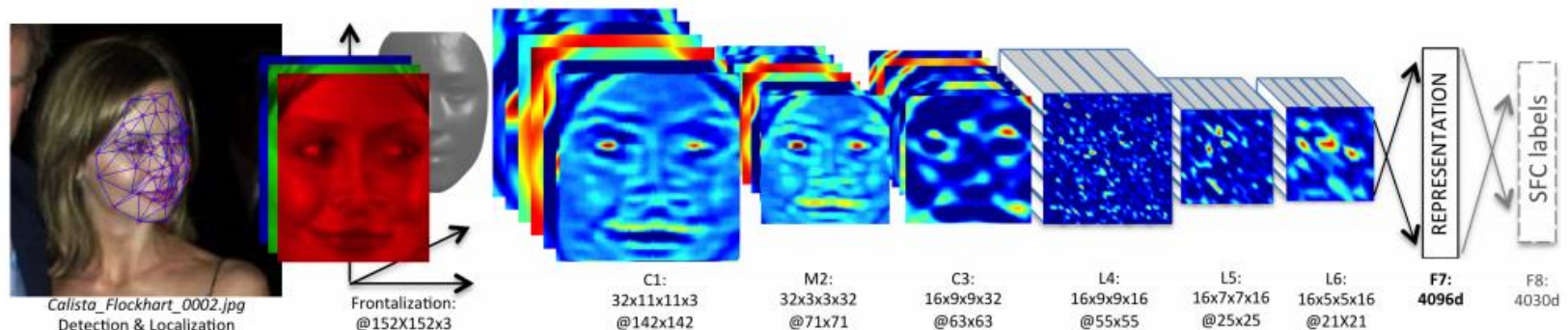
With Facebook's New Tech, You'll Never Need to Know Friends' Faces Again

DeepFace, *Facebook API*

3.9k
SHARES

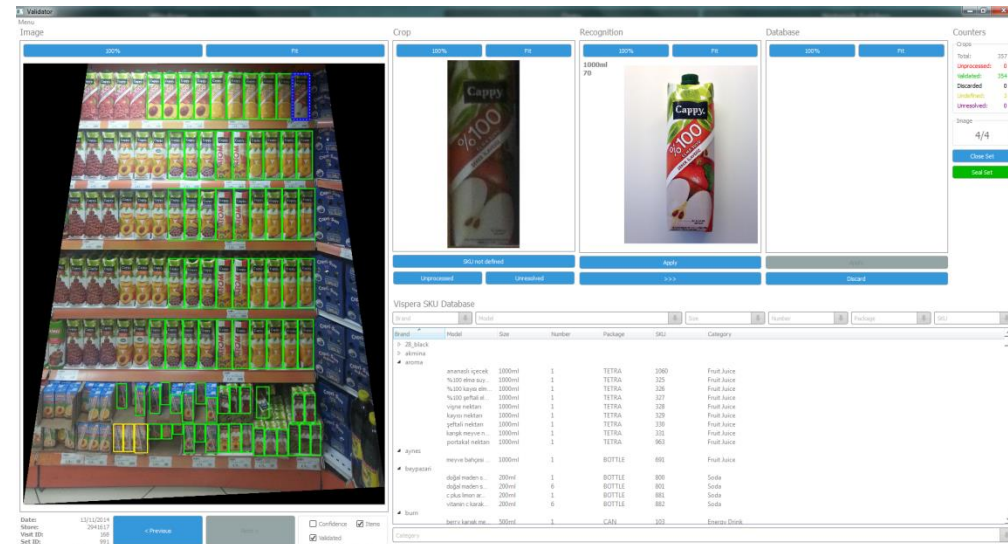
Share on Facebook

Share on Twitter



Computer Vision In The Real World

Object Recognition



Localize and count products in supermarket shelves
Vispera Information Technologies | vispera.co

LaneHawk prevents thefts in supermarkets
DataLogic

Computer Vision In The Real World

Object Recognition



Recognize places and get related web content



MOBILE IMAGE RECOGNITION?
TRY IT OUT NOW!!!



[Show another poster](#)

Movie data provided by: **OutKout-CH**

1. POINT
YOUR MOBILE
PHONE CAMERA TO
THE MOVIE
POSTER.

2. SNAP A
PICTURE AND SEND
IT:

IN SWITZERLAND:
MMS TO 5555 (OR
079 394 57 00
FOR ORANGE
CUSTOMERS)

IN GERMANY:
MMS TO 84000

EVERYWHERE:
EMAIL TO
M@KOOABA.COM

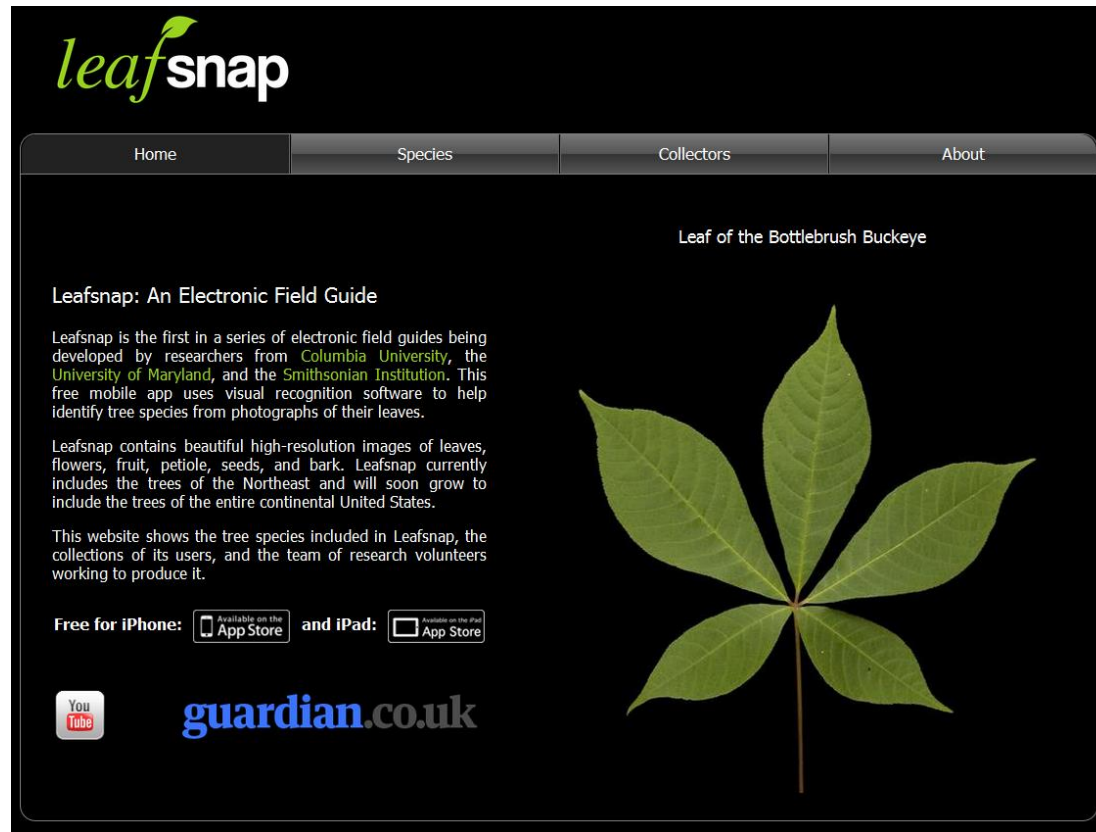
3. FIND ALL
RELEVANT INFOR-
MATION ABOUT THE
MOVIE ON YOUR
MOBILE PHONE

Recognize movie posters, newspapers and the like
Kooba API (acquired by Qualcomm)

Recognize CD covers, books, barcodes, and the like
FireFly Technology built-in FirePhone by Amazon

Computer Vision In The Real World

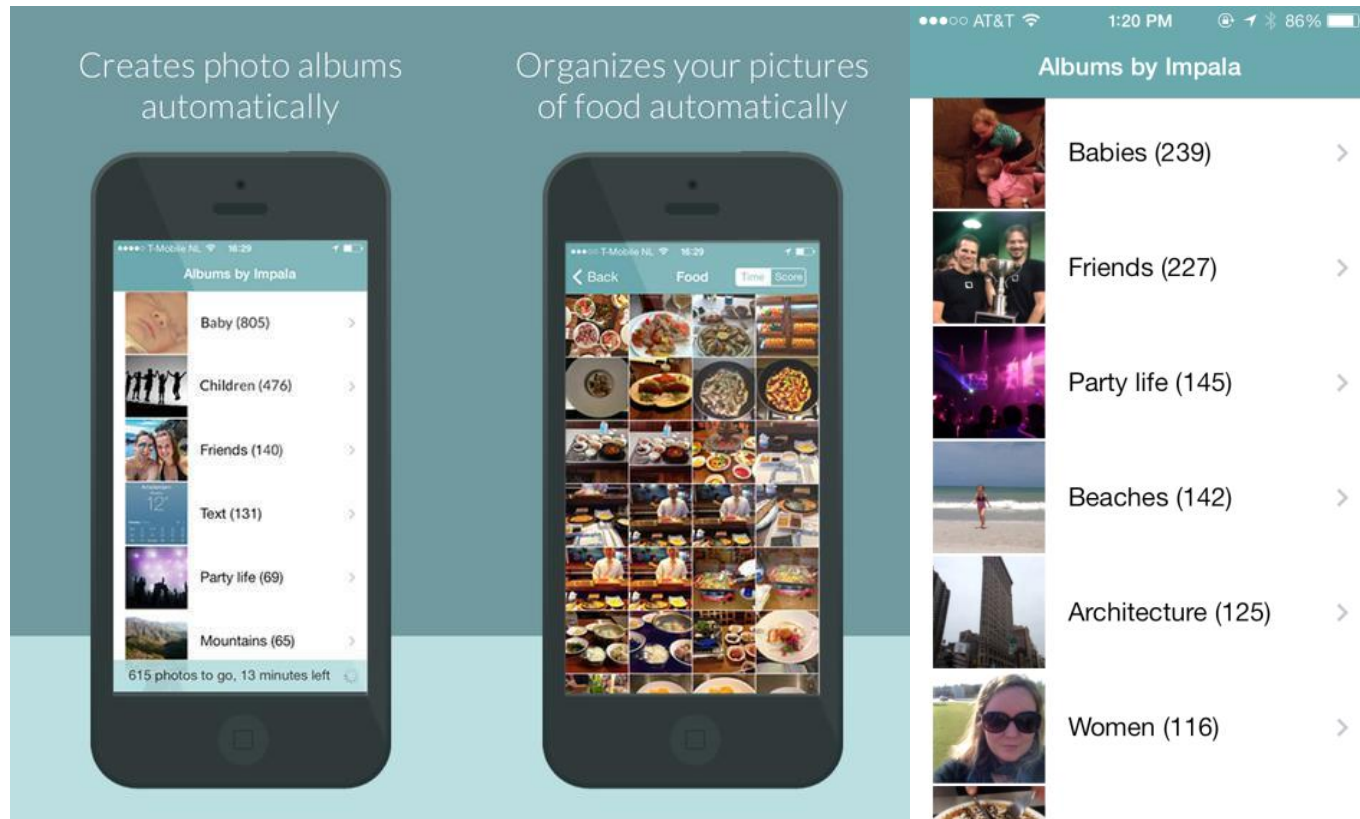
Object Recognition



LeafSnap recognizes trees by the pictures of their leaves

Computer Vision In The Real World

Visual Concept Detection



Impala mobile app automatically organizes photos into albums
EUVision (acquired by Qualcomm)

Computer Vision In The Real World

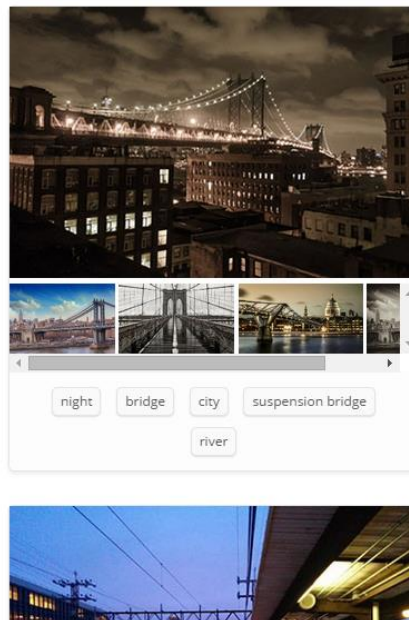
Image/Video Search and Annotation

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Recognize thousands of concepts

Classify, Localize & Search by Similarity

Our algorithms enable fine grained classification, localization of objects in images and similarity search based on the combination of semantic and visual properties.



Clarifai

Computer Vision In The Real World

3D Reconstruction/View Synthesis



Photosynth reconstructs the world in 3D from 2D pictures taken from arbitrary views and synthesizes new views / *Microsoft Research*

Computer Vision In The Real World

3D Reconstruction/View Synthesis



Computer Vision In The Real World

Smart Cars



Google Self-Driving Car

MobileEye

Vision systems in high-end BMW, GM, Volvo models



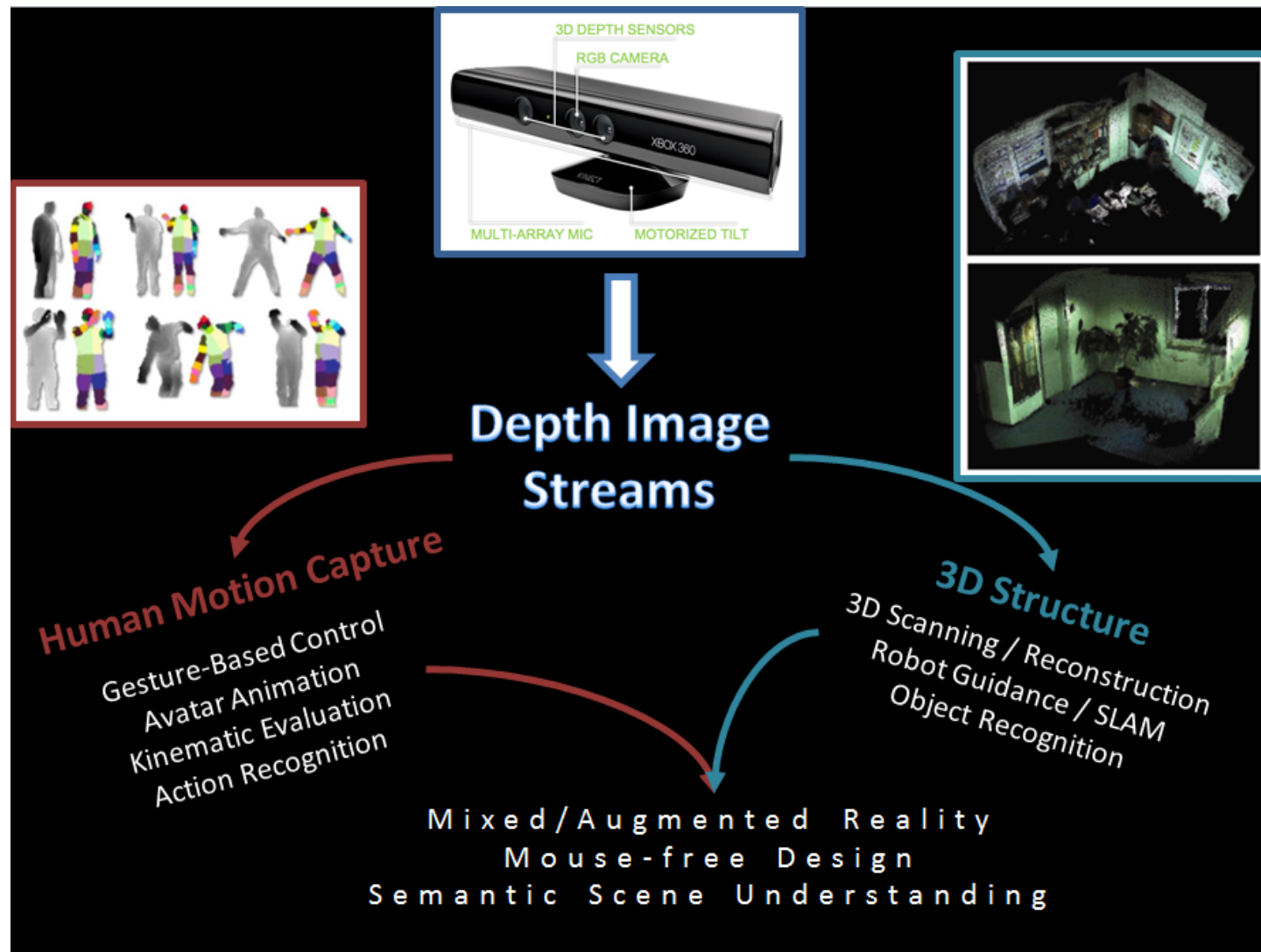
Computer Vision In The Real World

Sports Analytics



Computer Vision In The Real World

Kinect: A Phenomenon on its own



Course Outline

Image Formation and Processing

Light, Shape and Color

The Pin-hole Camera Model, The Digital Camera

Linear filtering, Filter banks, Multiresolution

Feature Detection and Matching

Edge Detection, Interest Points: Corners and Blobs

Local Image Descriptors

Feature Matching and Hough Transform

Multiple Views and Motion

Geometric Transformations, Camera Calibration

Feature Tracking , Stereo Vision

Segmentation and Grouping

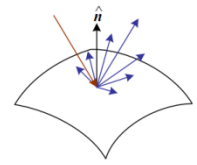
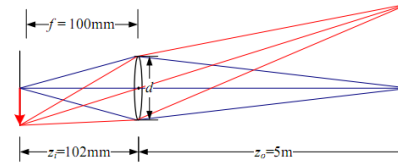
Segmentation by Clustering, Region Merging and Growing

Advanced Methods Overview: Active Contours, Level-Sets, Graph-Theoretic Methods

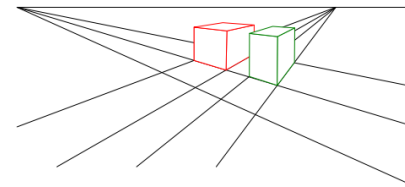
Detection and Recognition

Problems and Architectures Overview

Statistical Classifiers, Bag-of-Words Model, Detection by Sliding Windows



G	R	G	R
B	G	B	G
G	R	G	R
B	G	B	G



Resources

Books

R. Szeliski, Computer Vision: Algorithms and Applications, 2010 – *available online*

D. A. Forsyth and J. Ponce, Computer Vision: A Modern Approach, 2003

L. G. Shapiro and G. C. Stockman, Computer Vision, 2001

Web

CVonline: The Evolving, Distributed, Non-Proprietary, On-Line Compendium of Computer Vision

<http://homepages.inf.ed.ac.uk/rbf/CVonline/>

Dictionary of Computer Vision and Image Processing

<http://homepages.inf.ed.ac.uk/rbf/CVDICT/>

Computer Vision Online

<http://www.computervisiononline.com/>

Programming

Development environments/languages: Matlab, Python and C/C++

Toolboxes and APIs: OpenCV, VLFeat Matlab Toolbox, Piotr's Computer Vision Matlab Toolbox, EasyCamCalib Software, FLANN, Point Cloud Library PCL, LibSVM, Camera Calibration Toolbox for Matlab

Course Evaluation

4 Small Projects (60% in Total)

1 Paper Reading and Presentation Assignment (20%)

1 Semester Project (20%)

Project Deliverables

Code: *Inline-commented and I/O documented*

Data: *Dataset and Outputs*

Full Presentation: *Describe the problem, report the state-of-the-art, describe the approach taken, report the experimental results, discuss and conclude*