ITI517 Computer Vision

Introduction

Chang-Su Kim

Some figures are excerpted from the book "Computer Vision Algorithms and Applications" by R. Szeliski

Course Outline

- Pre-requisites
  - Signals and Systems
  - High School Math
  - or **Common Sense**
- Course Homepage
  - Homepage: http://mcl.korea.ac.kr
- Questions
  - You are welcome to come to my office (Engineering Bldg, Rm 508) and ask any questions any time
  - Tel: 02-3290-3217
  - Email: changsukim@korea.ac.kr
- Teaching Assistant
  - 최환
  - Email: hwanc@mcl.korea.ac.kr
  - Tel: 02-3290-3806

Course Outline

- Assessment Methods
  - Assignments & Attendance: 30%
    - Small coding projects
    - Problem solving assignments
  - Mid-term Exam: 30%
  - Final Exam: 40%

- Textbook and References
  - Richard Szeliski, *Computer Vision: Algorithms and Applications*, Springer, 2011. (http://szeliski.org/Book/)
  - David A. Forsyth and Jean Ponce, *Computer Vision: A Modern Approach*, Prentice Hall, 2003.
  - Linda G. Shapiro and George C. Stockman, *Computer Vision*, Prentice Hall, 2001.

Tentative Course Outline

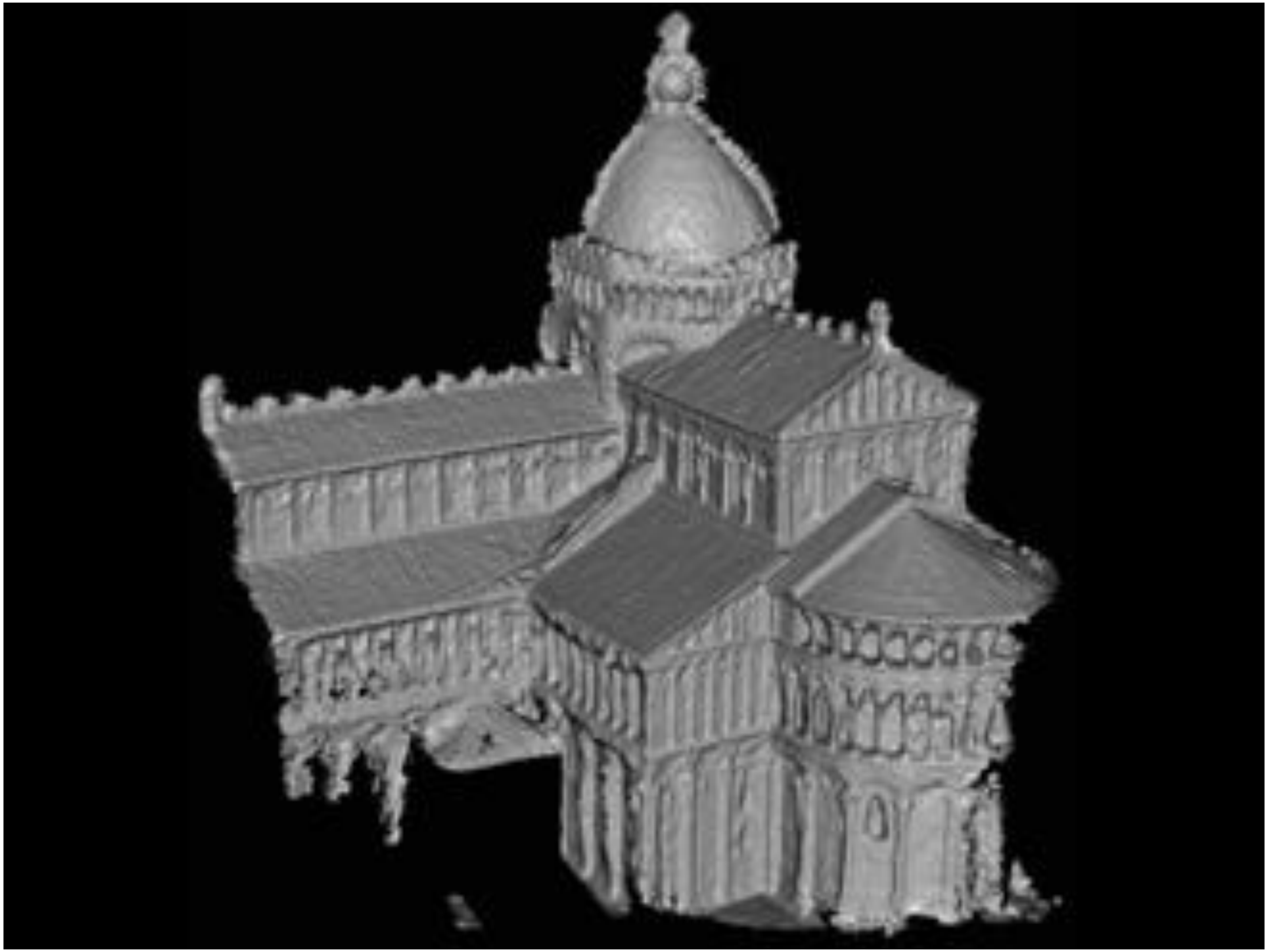
Week	Topics	Events
1	Introduction, Binary Image Analysis	
2	Binary Image Analysis	
3	Machine Learning Basics	
4	Machine Learning Basics	
5	Machine Learning Basics	
6	Machine Learning Basics	
7	Filtering	
8	**Mid Exam**	18 April 2023
9	Edge Detection	
10	Segmentation	
11	Segmentation	
12	Pyramidal Image Representation	
13	Texture	
14	Stereo	
15	Motion	
16	**Final exam**	15 June 2023

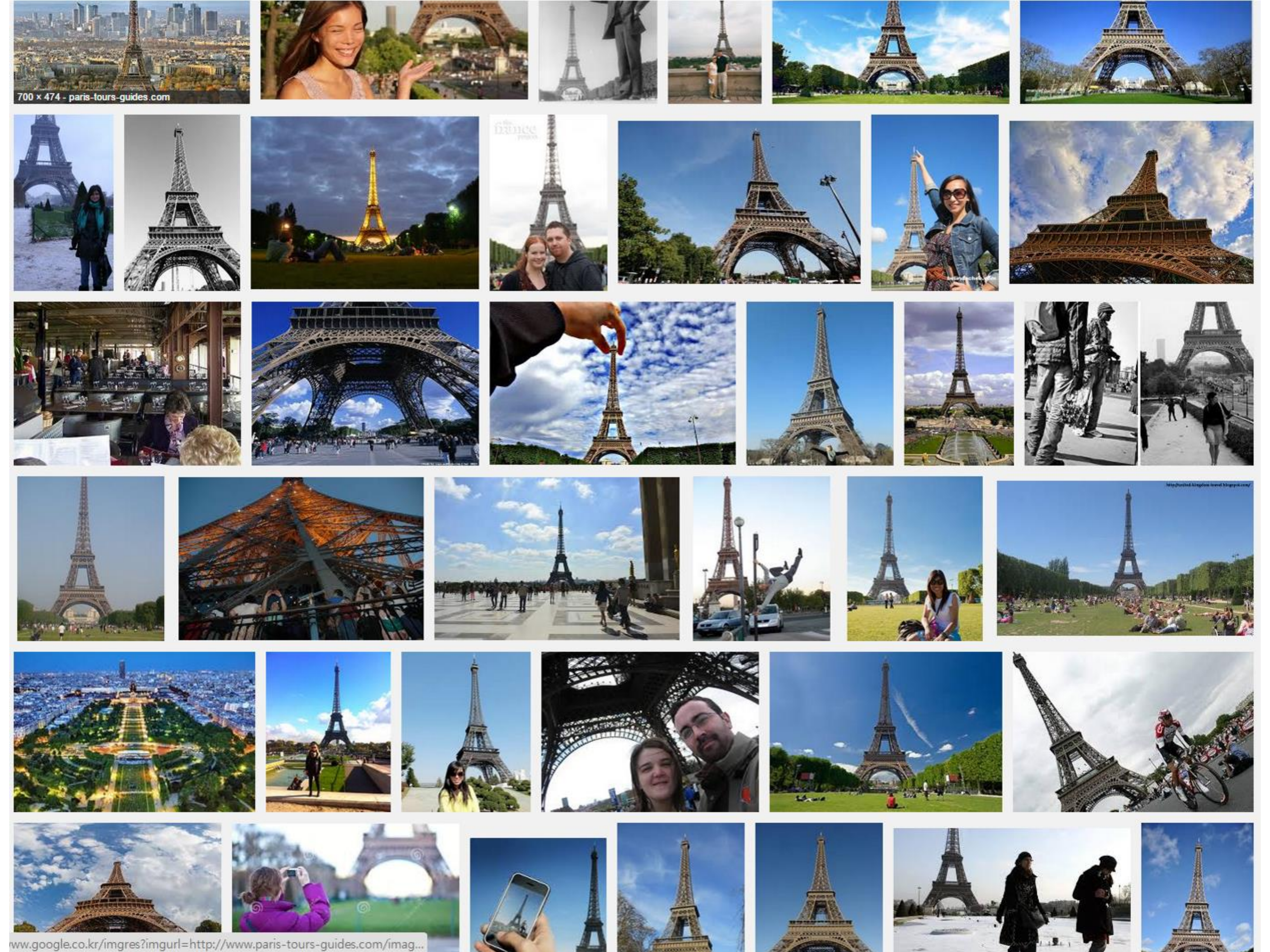
What is computer vision?

HVS and Computer

Examples

Examples




700 × 474 - paris-tours-guides.com
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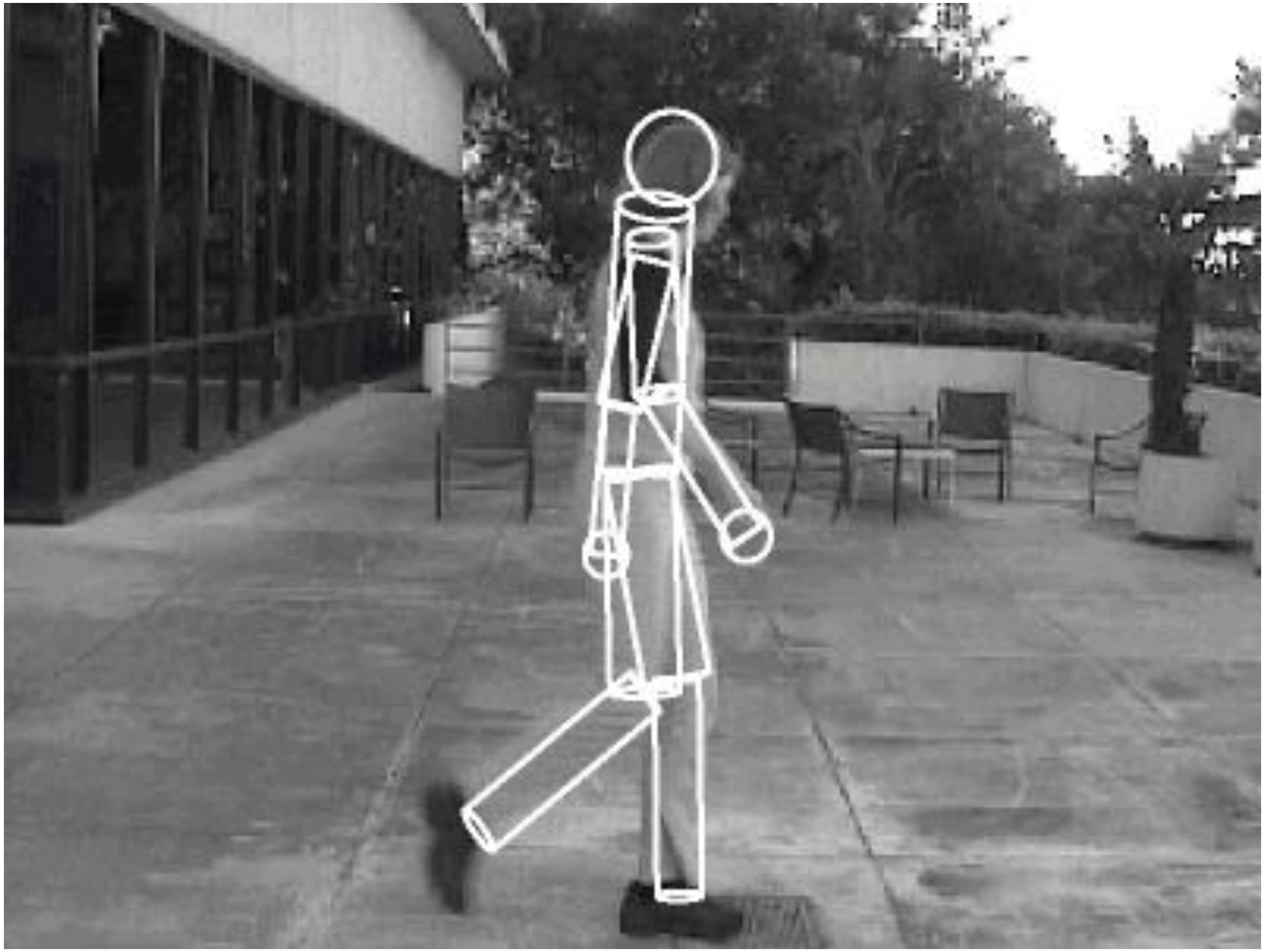
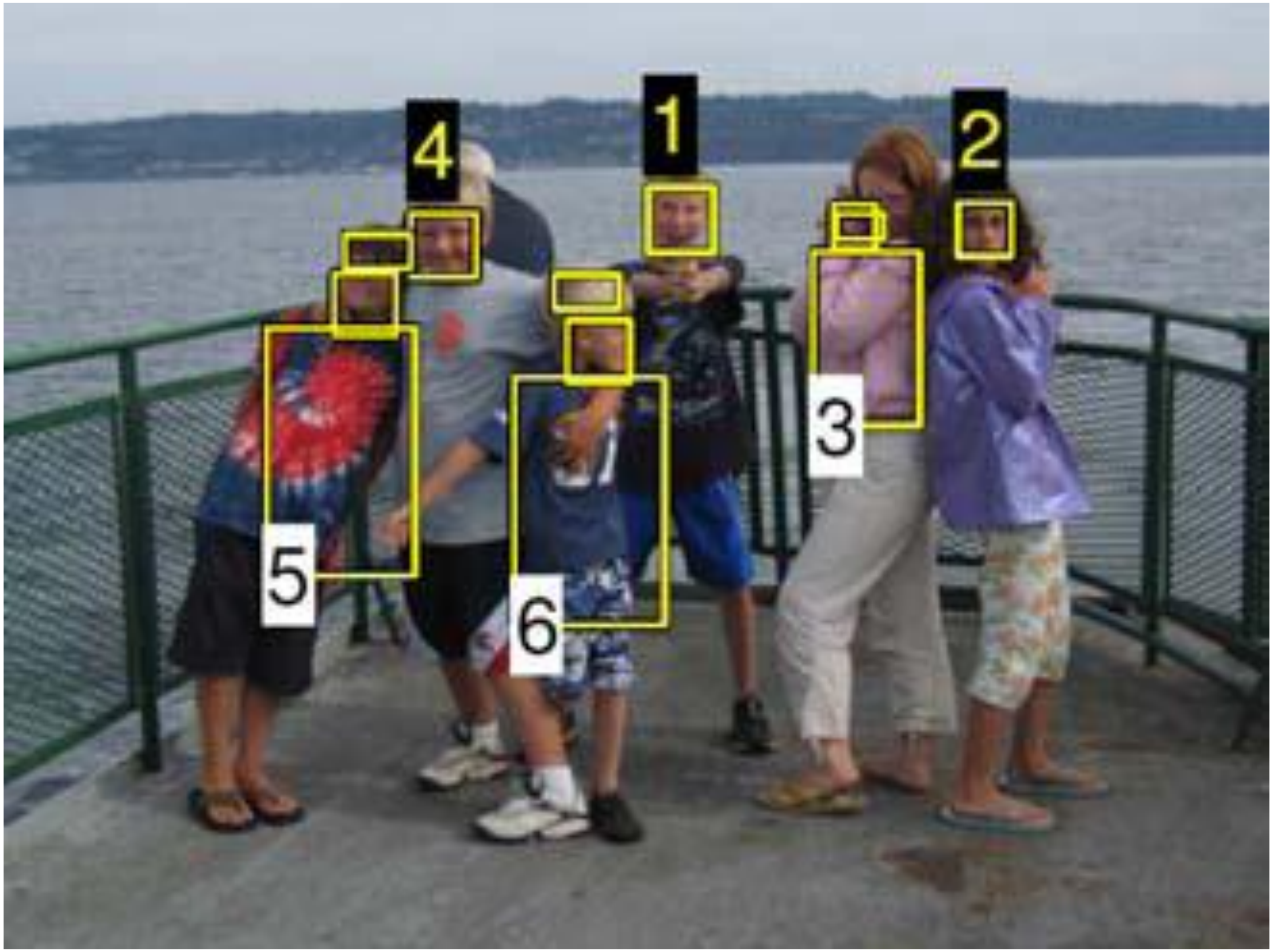
Examples



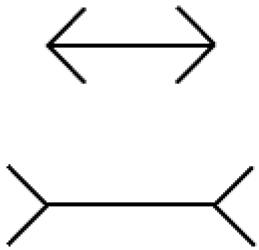
Examples

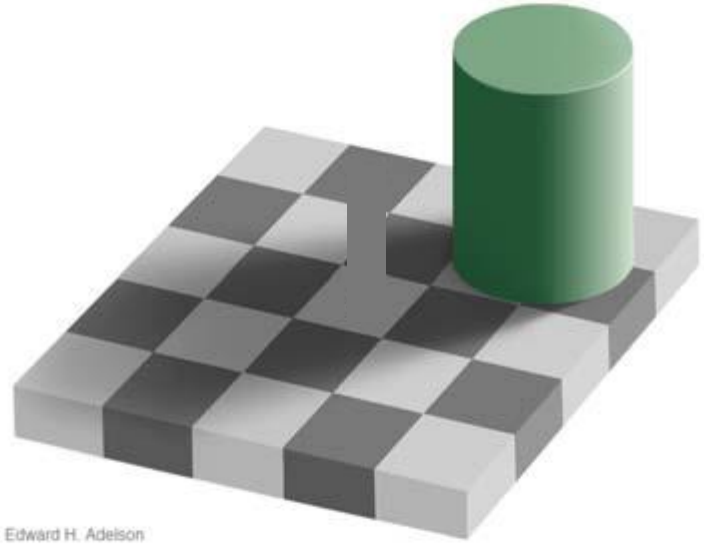


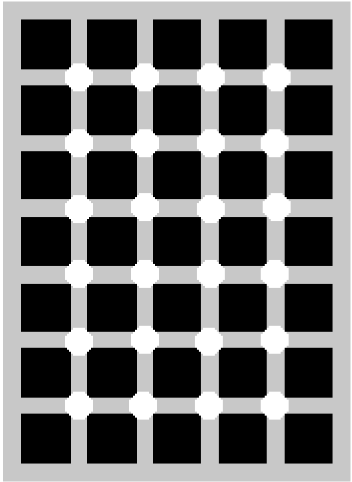
How many are there?

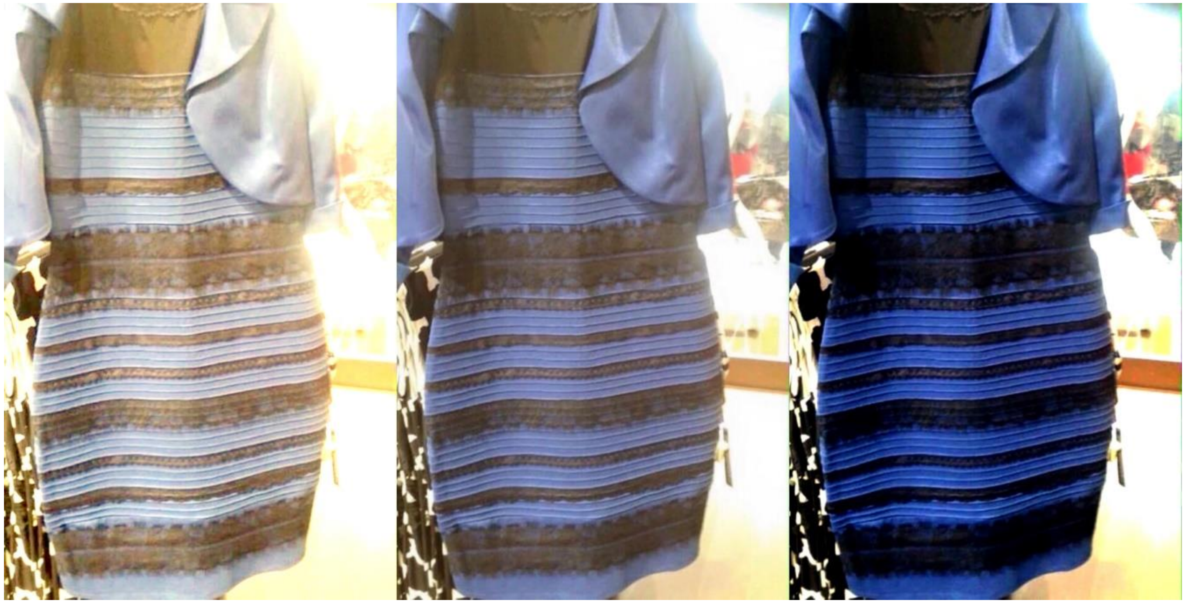
HVS

- Side results

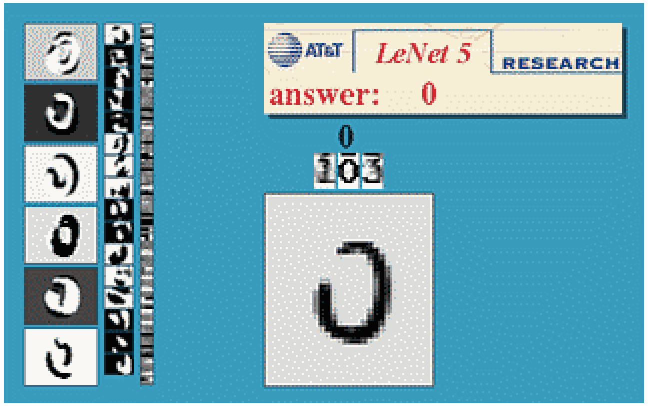


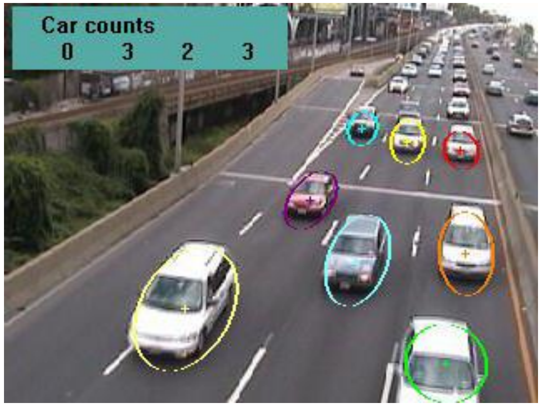






Applications



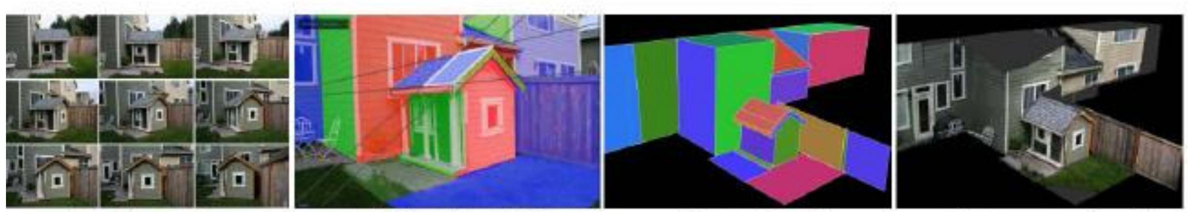


Applications

(a)

(b)

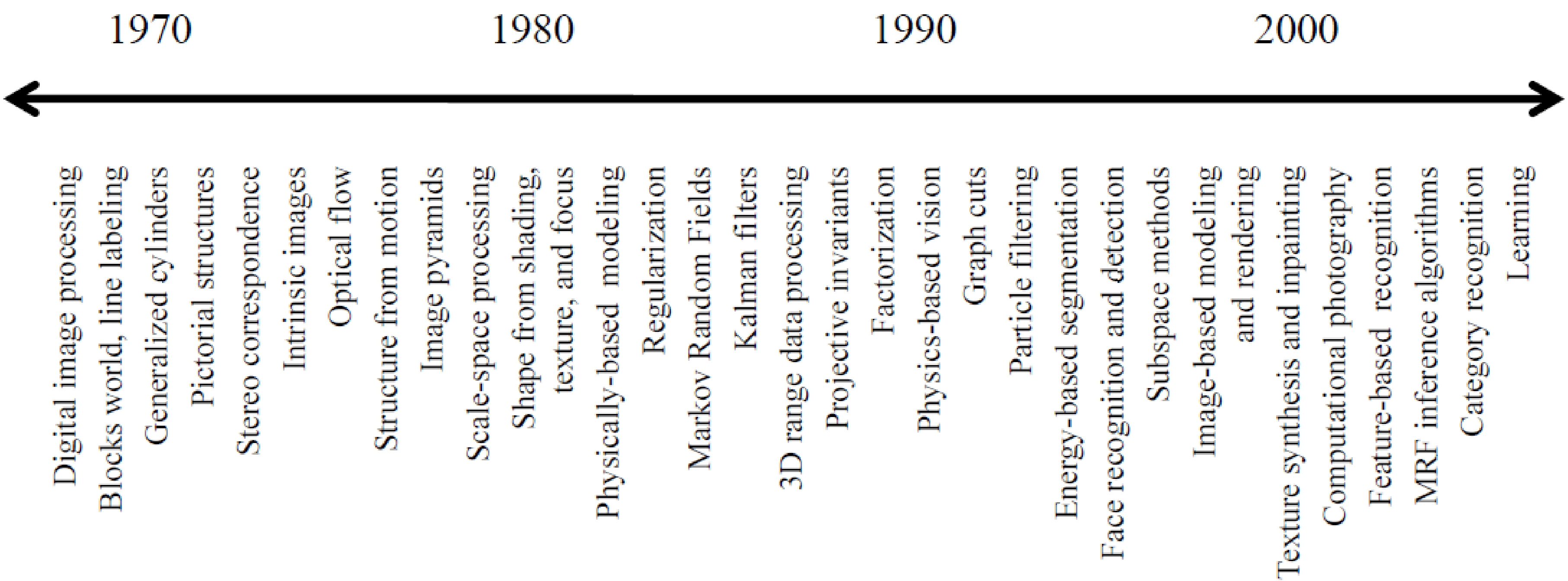
(c)



Input Photographs | 2D Sketching Interface | Geometric Model | Texture-mapped model

(d)

A Brief History



- Short history
- Recent big bang

Hot! 2018

- English
  - Business, Economics & Management
  - Chemical & Material Sciences
  - Engineering & Computer Science
  - Health & Medical Sciences
  - Humanities, Literature & Arts
  - Life Sciences & Earth Sciences
  - Physics & Mathematics
  - Social Sciences
- Chinese
- Portuguese
- Spanish
- German
- Russian

Top publications - English   Learn more

	Publication	h5-index	h5-median
1.	Nature	379	560
2.	The New England Journal of Medicine	342	548
3.	Science	312	464
4.	The Lancet	259	418
5.	Cell	224	339
6.	Chemical Society reviews	224	329
7.	Journal of the American Chemical Society	218	293
8.	Proceedings of the National Academy of Sciences	215	286
9.	Advanced Materials	201	301
10.	Angewandte Chemie International Edition	198	276
11.	Journal of Clinical Oncology	197	265
12.	Physical Review Letters	196	282
13.	Chemical Reviews	194	332
14.	Nano Letters	192	270

45.	IEEE Conference on Computer Vision and Pattern Recognition, CVPR	140	214

Hot! 2023

	Publication	h5-index	h5-median
1.	Nature	444	667
2.	The New England Journal of Medicine	432	780
3.	Science	401	614
4.	IEEE/CVF Conference on Computer Vision and Pattern Recognition	389	627
5.	The Lancet	354	635
6.	Advanced Materials	312	418
7.	Nature Communications	307	428
8.	Cell	300	505
9.	International Conference on Learning Representations	286	533
10.	Neural Information Processing Systems	278	436

Supplementary Video

Moving Window Regression:
A Novel Approach to Ordinal Regression

Anonymous CVPR 2022 submission
Paper ID 6920

Supplementary Video

Eigenlanes: Data-Driven Lane Descriptors for Structurally Diverse Lanes

Anonymous CVPR 2022 submission

Paper ID 6918

Supplemental Video on

DPICT: Deep Progressive Image Compression Using Trit-Planes

What is Computer Vision?

- Develop computational algorithms to mimic or replace the functionality of human visual system

Preview

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7	Filtering	
8		Mid exam
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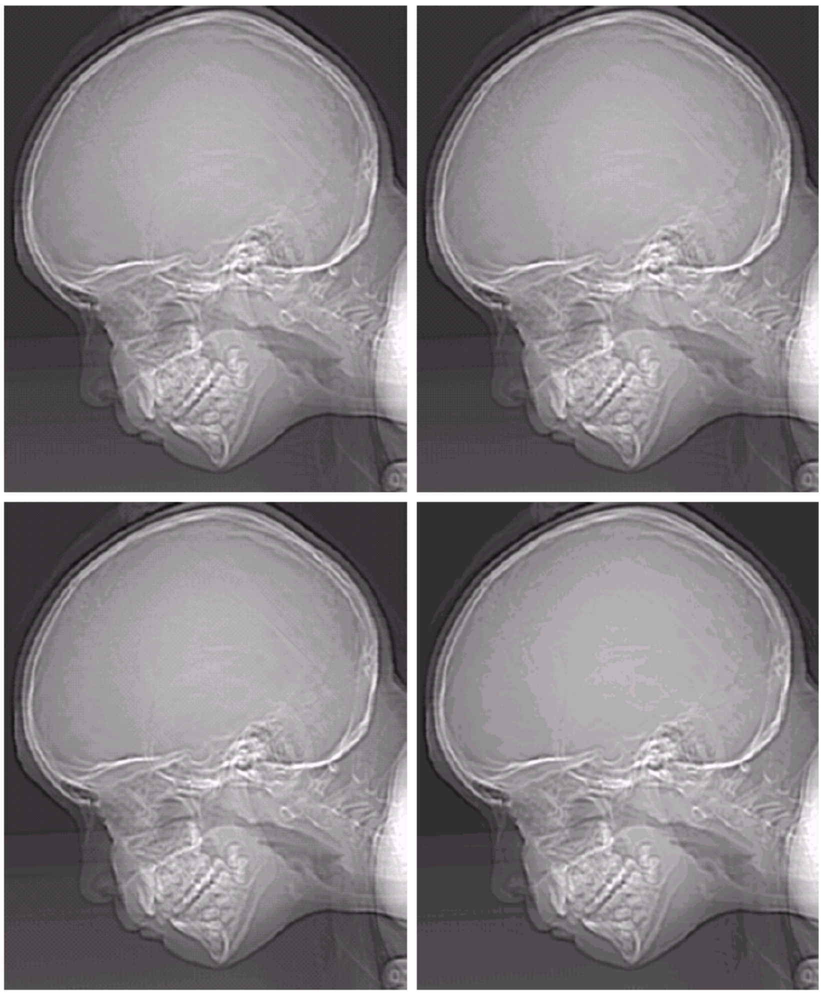
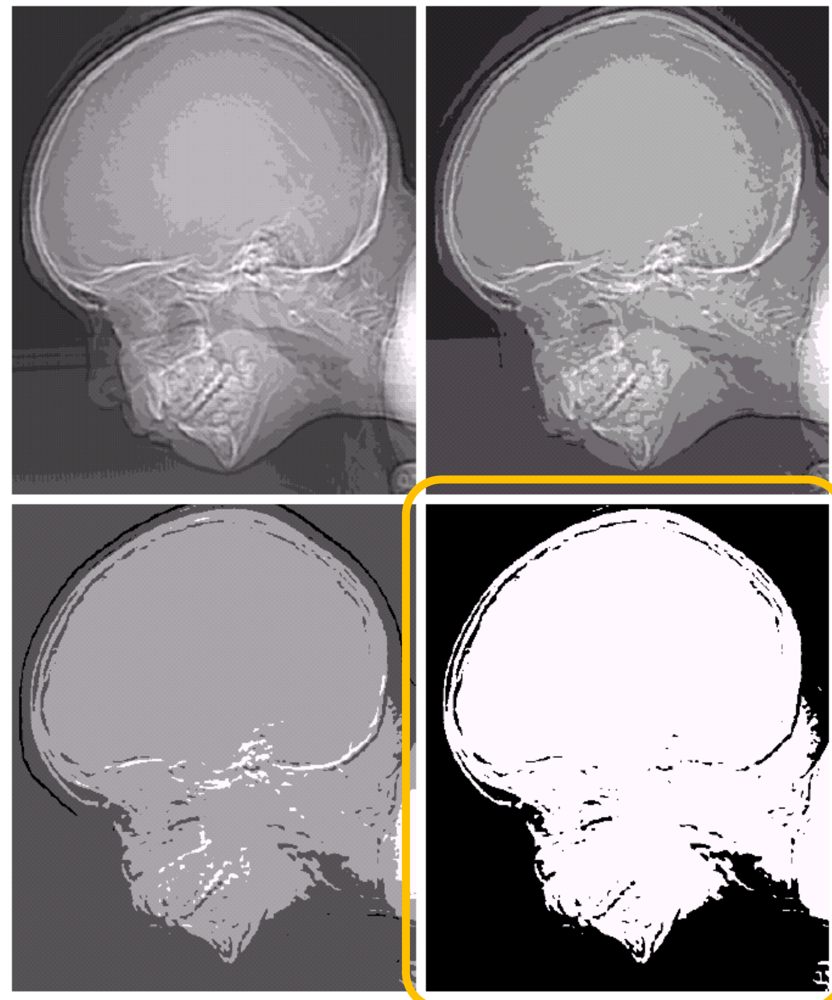
13	Texture	
14	Stereo	
15	Motion	
16		Final exam

Binary Image Analysis

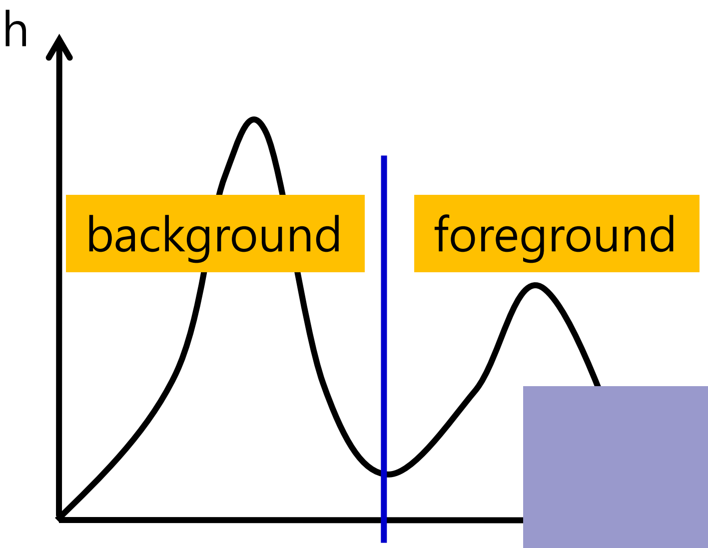


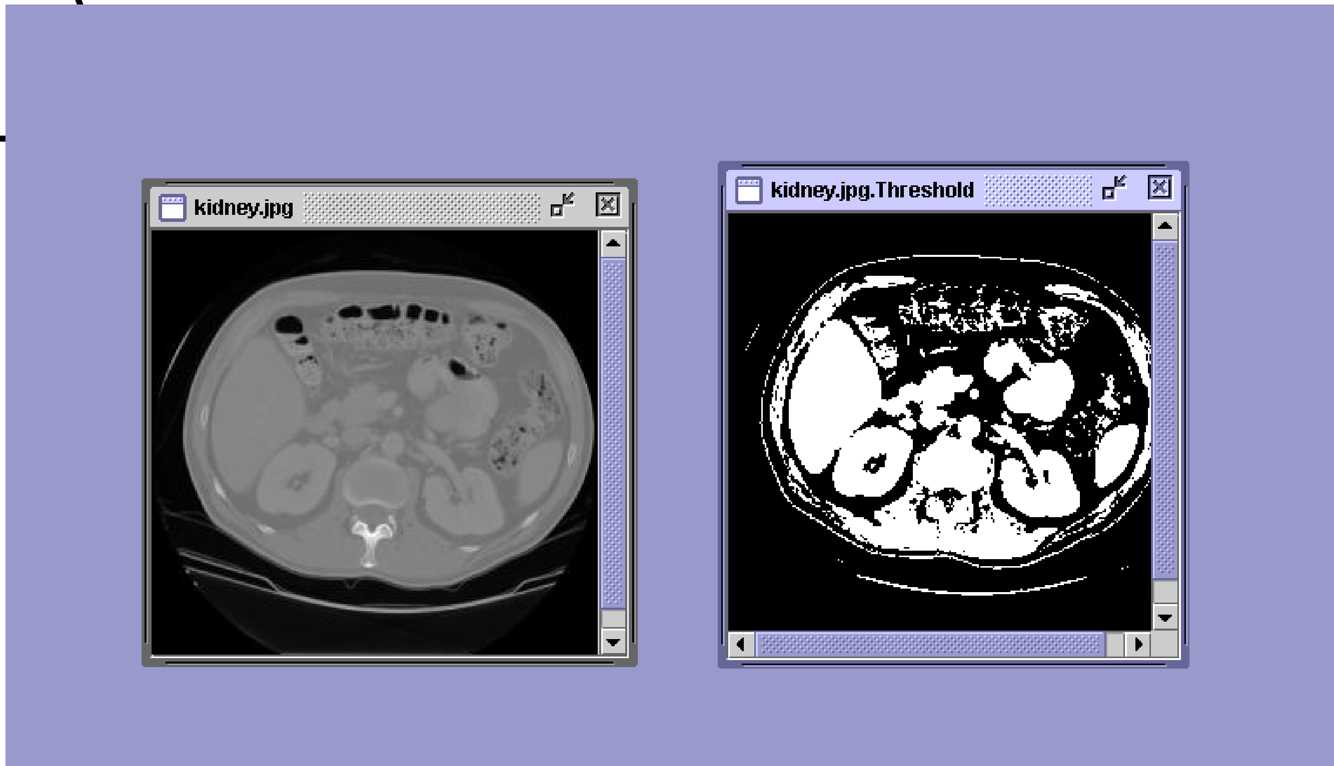
a b
c d

FIGURE 2.21 (a) 452 × 374, 256-level image. (b)–(d) Image displayed in 128, 64, and 32 gray levels, while keeping the spatial resolution constant.

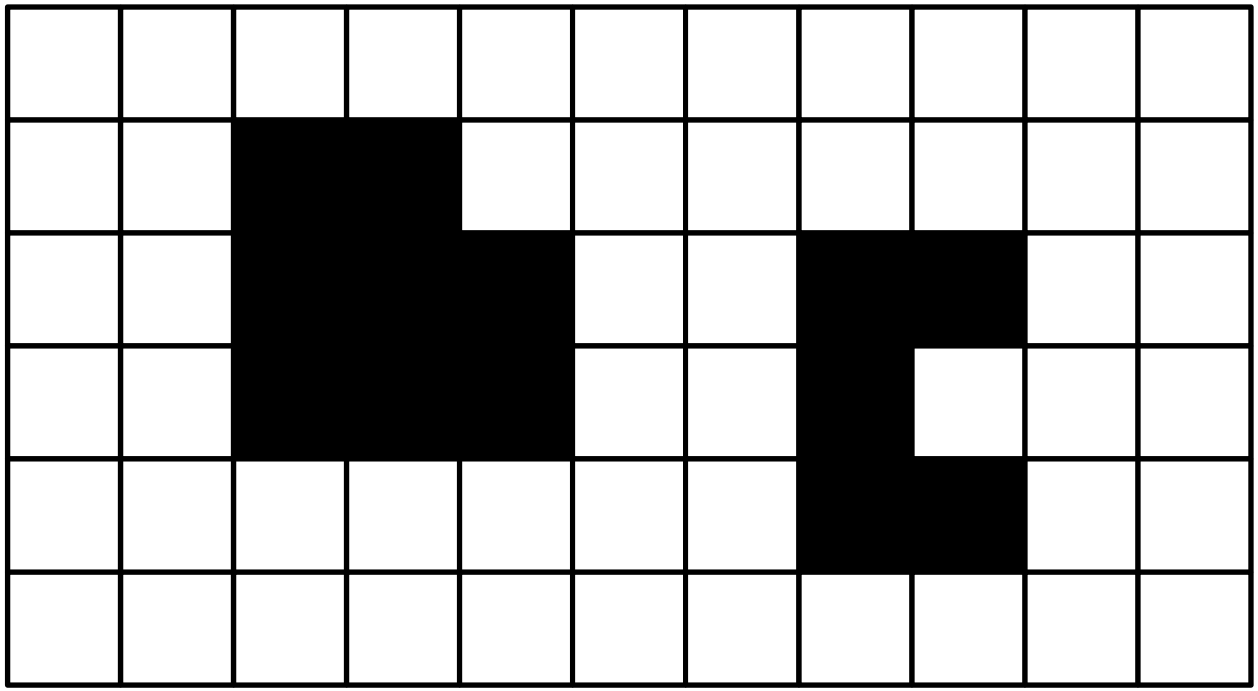


Binary Image Analysis





Binary Image Analysis



How many objects are there?

Pattern Recognition Concepts

- Recognition
  - To know that  is an apple from our knowledge

rec·og·nize

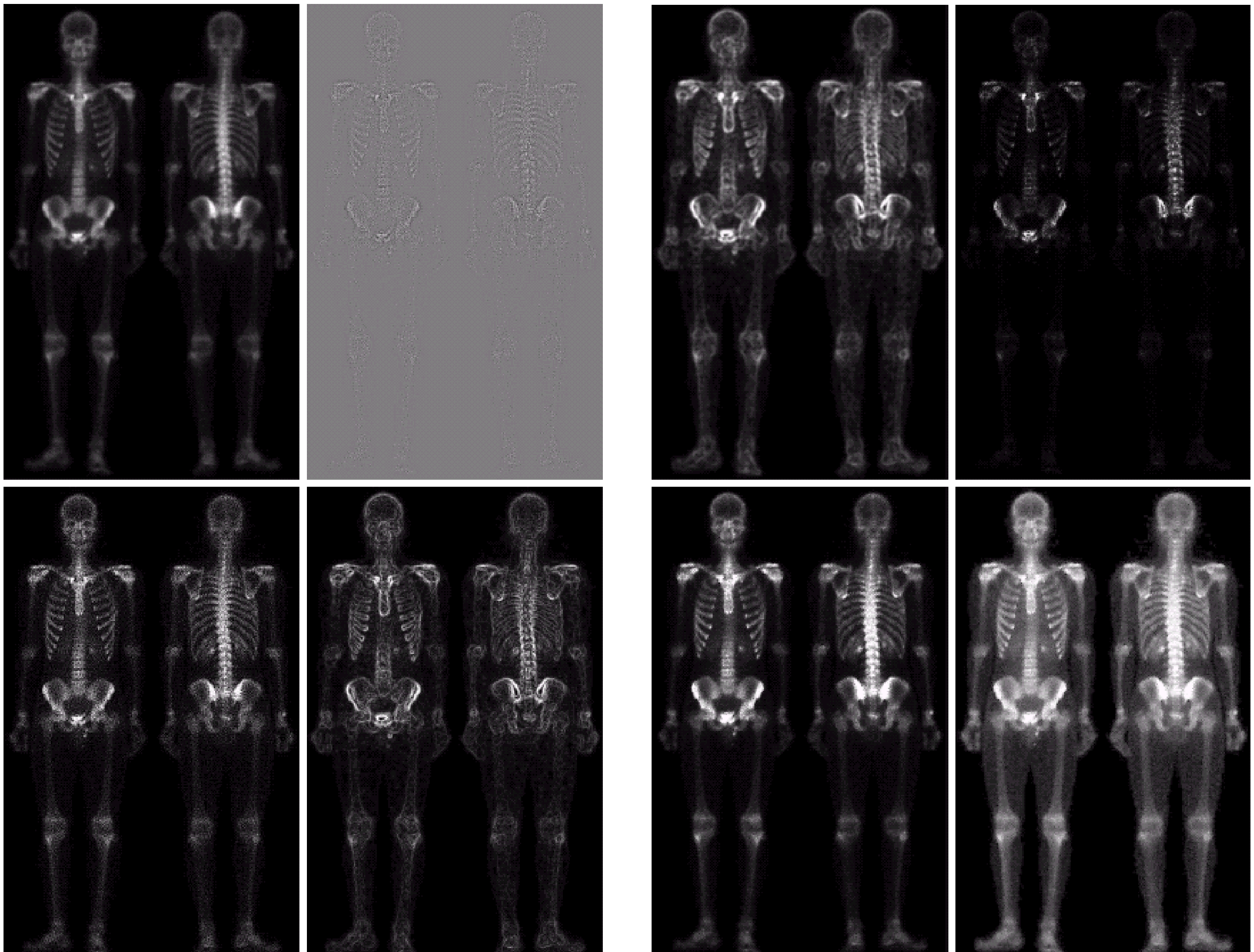
rec·og·nize (rĕk′əg-nīz′) *verb, transitive*
rec·og·nized, rec·og·niz·ing, rec·og·niz·es

1. To know to be something that has been perceived before: *recognize a face.*
2. To know or identify from past experience or knowledge: *recognize hostility.*
3. To perceive or show acceptance of the validity

- Computer vision
  - To make useful decision based on sensed images
  - It includes visual pattern recognition

Image Filtering and Enhancement

(a) original (b) Laplacian of (a) (e) smoothed (a) (f) = (c)x(e)

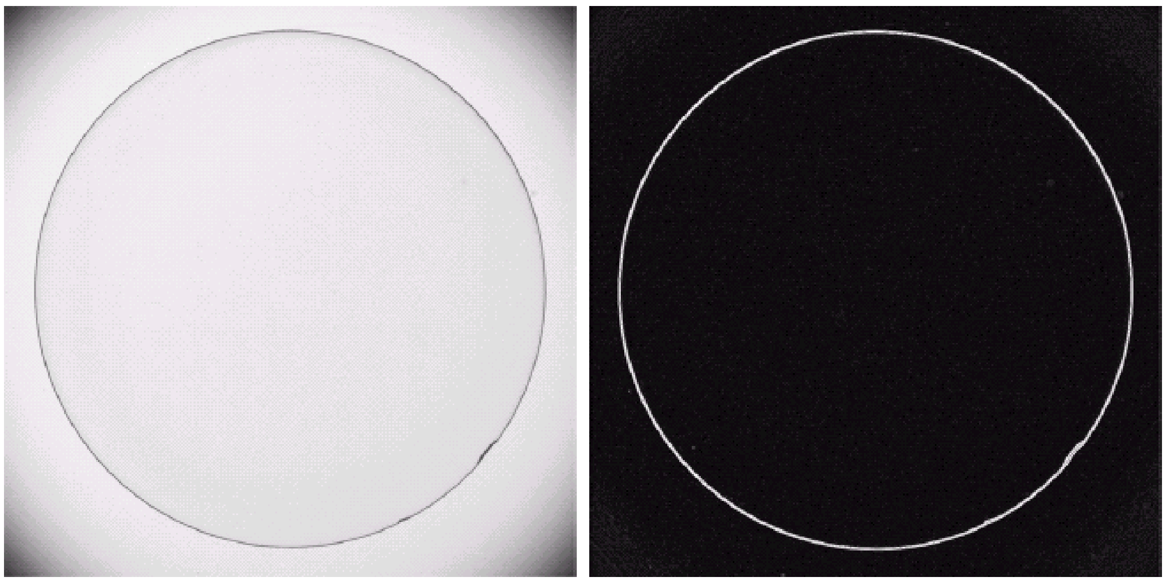


(c) = (a)+(b) (d) gradient of (a) (g) = (a)+(f) (h) power-law transform of (g)

Image Filtering and Enhancement

Input image

Gradient image



a b

FIGURE 3.45 Optical image of contact lens (note defects on the boundary at 4 and 5 o'clock). (b) Sobel gradient. (Original image courtesy of Mr. Pete Sites, Perceptics Corporation.)

Edge Detection

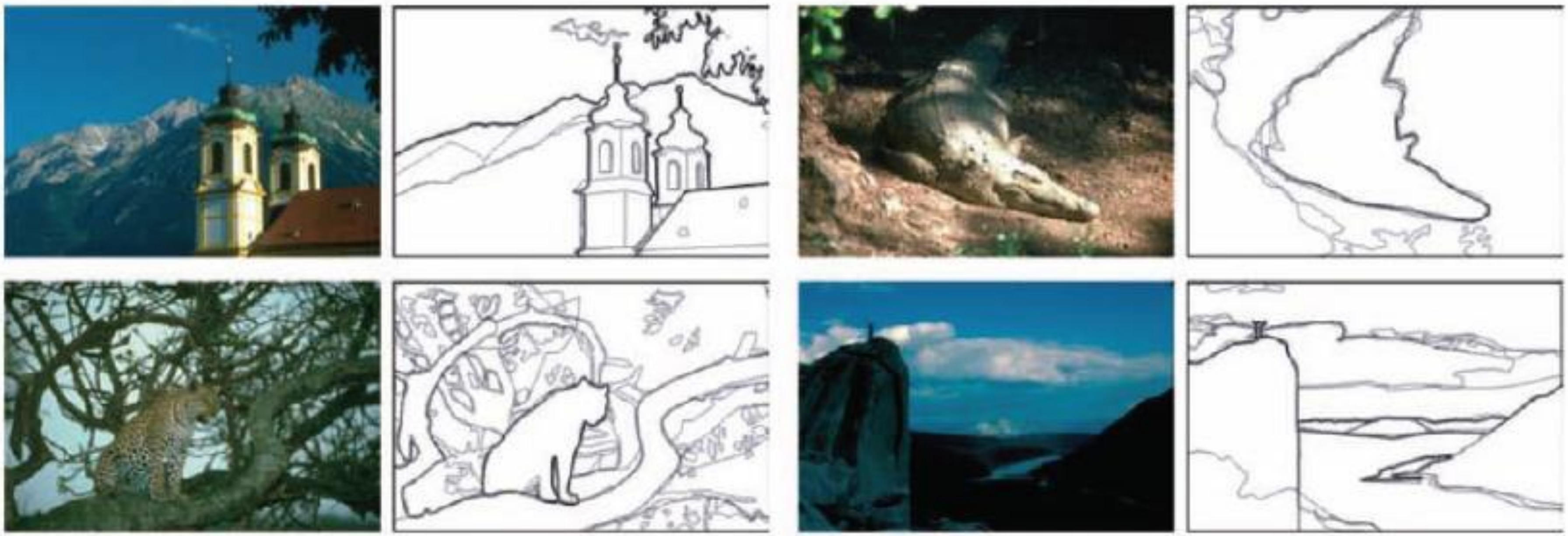


Figure 4.31 Human boundary detection (Martin, Fowlkes, and Malik 2004) © 2004 IEEE. The darkness of the edges corresponds to how many human subjects marked an object boundary at that location.

Edge Detection

Edge Detection

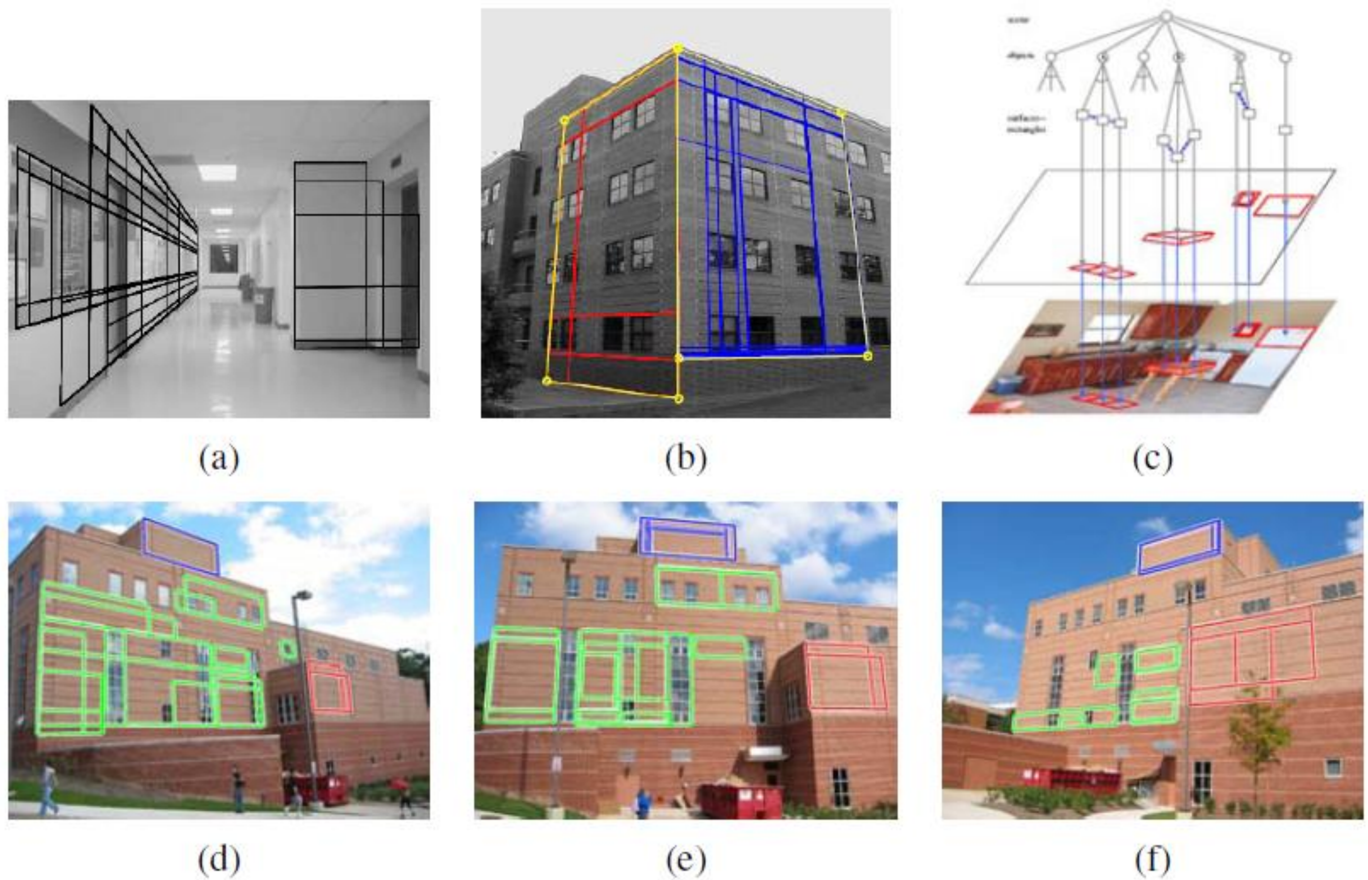


Figure 4.47 Rectangle detection: (a) indoor corridor and (b) building exterior with grouped facades (Košecká and Zhang 2005) © 2005 Elsevier; (c) grammar-based recognition (Han and Zhu 2005) © 2005 IEEE; (d–f) rectangle matching using a plane sweep algorithm (Mičušìk, Wildenauer, and Košecká 2008) © 2008 IEEE.

Segmentation

Original image

2 clusters

5 clusters

10 clusters

20 clusters

50 clusters

Segmentation

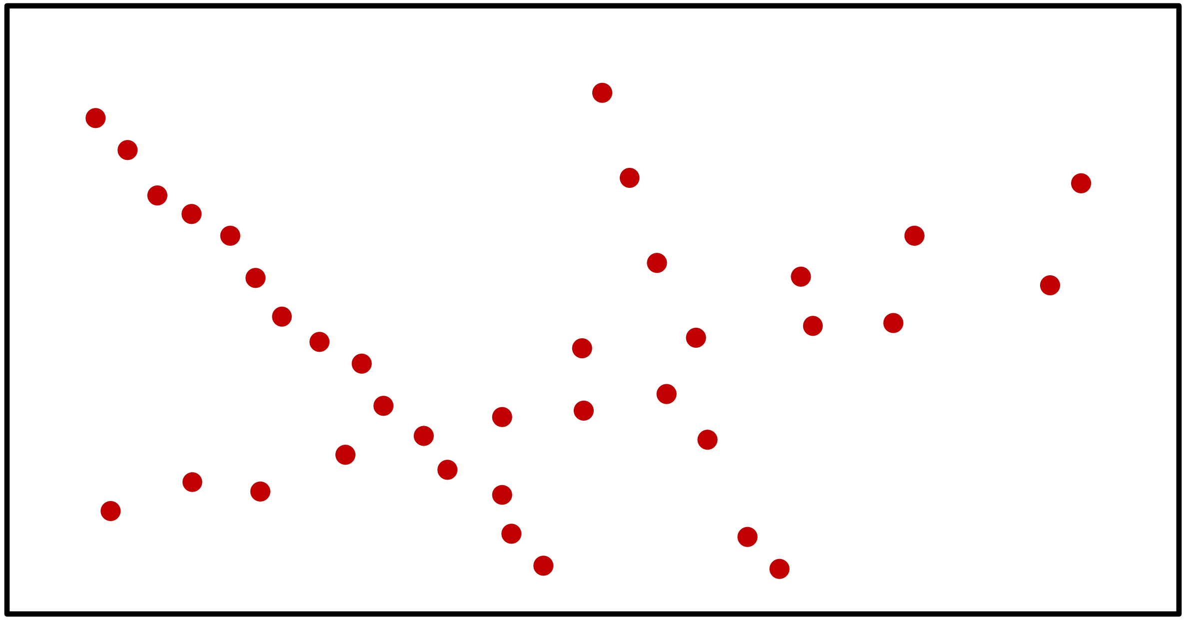
Image

Clusters on intensity

Clusters on color

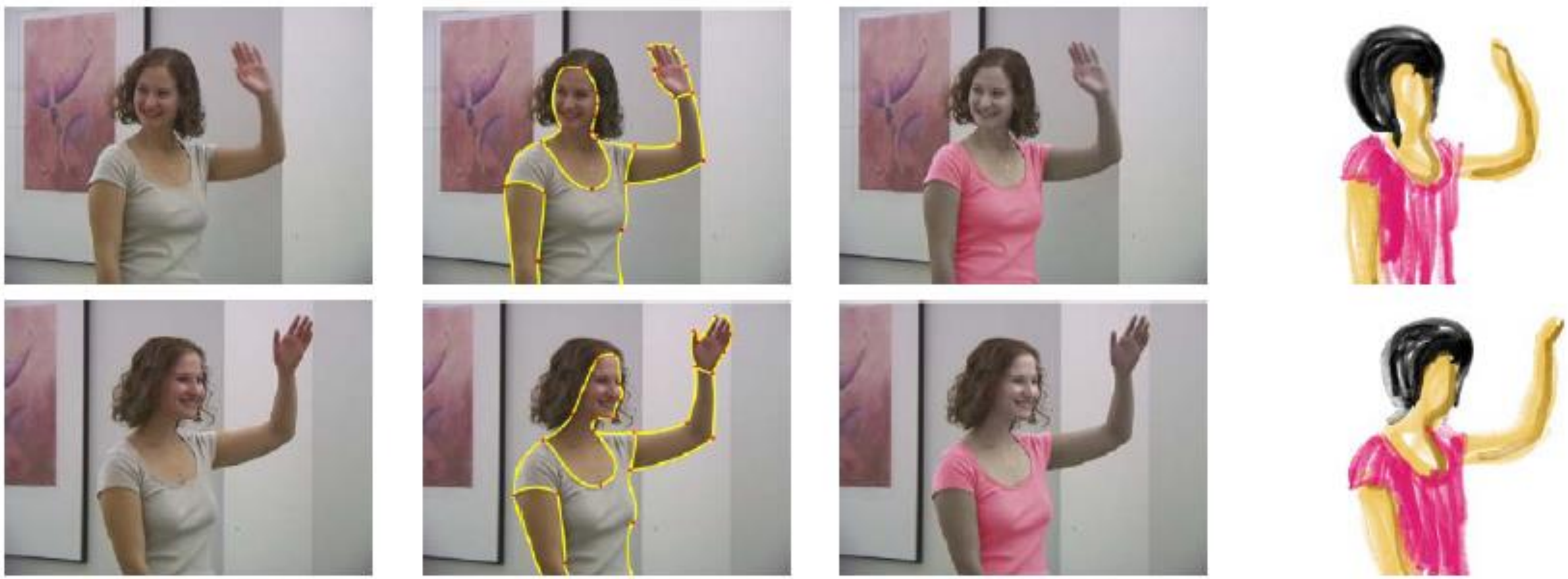
K-means clustering using intensity alone and color alone
(5 clusters in each case)

Segmentation



- Three main questions
  - What line represents this set of points best?
  - Which lines gets which points?
  - How many lines are there?

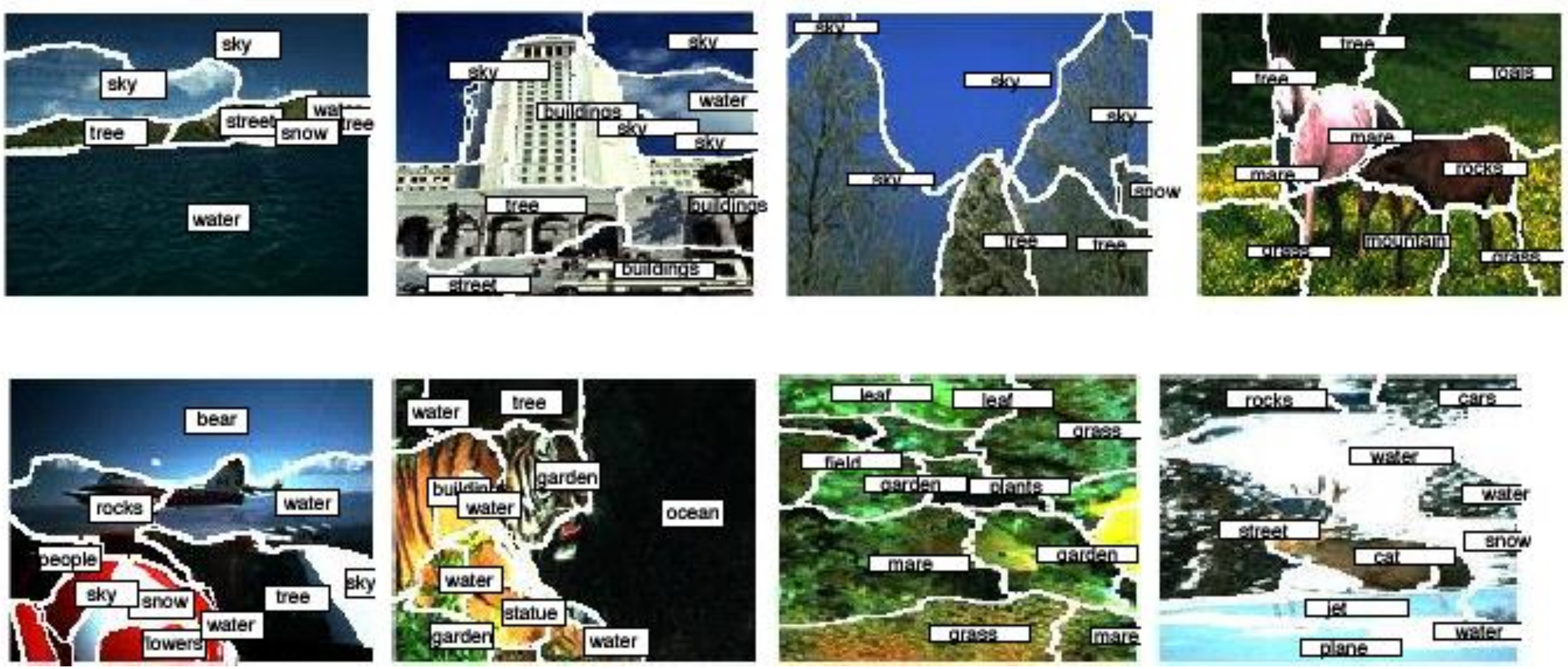
Segmentation



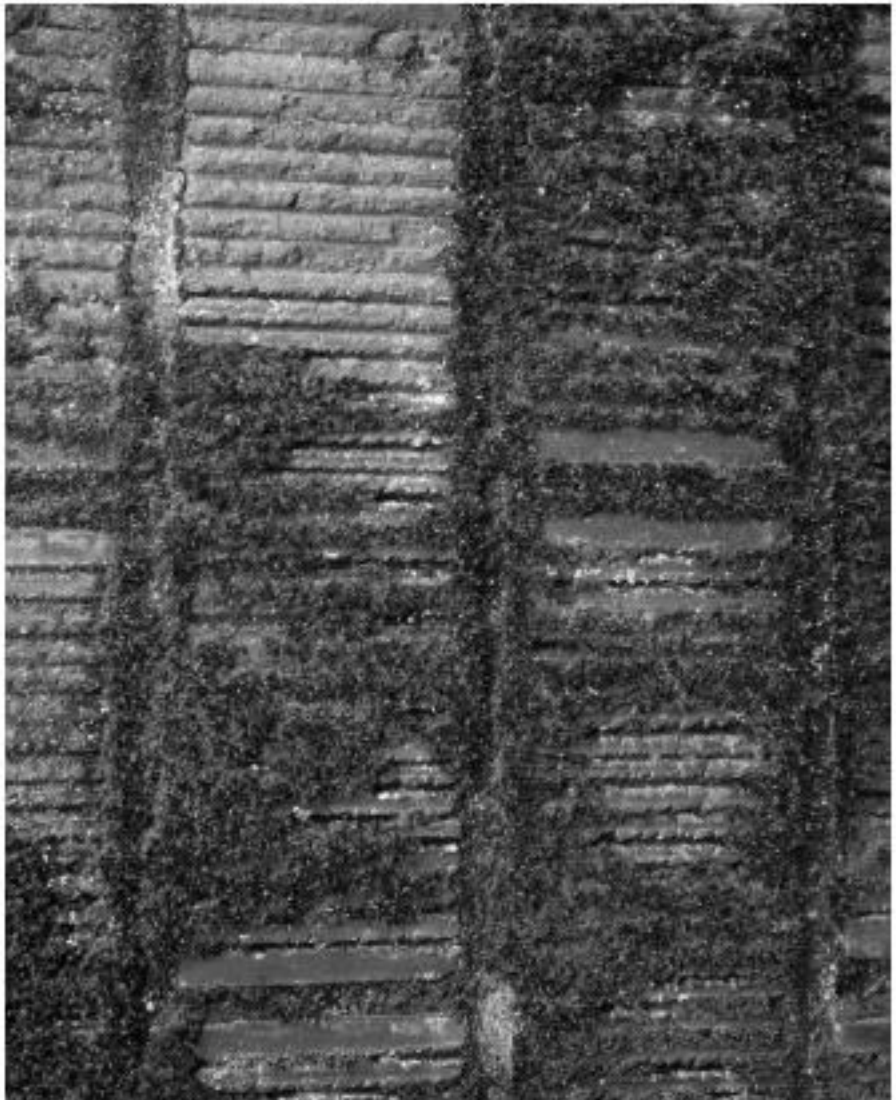
(a) (b) (c) (d)

Figure 5.12 Keyframe-based rotoscoping (Agarwala, Hertzmann, Seitz *et al.* 2004) © 2004 ACM: (a) original frames; (b) rotoscoped contours; (c) re-colored blouse; (d) rotoscoped hand-drawn animation.

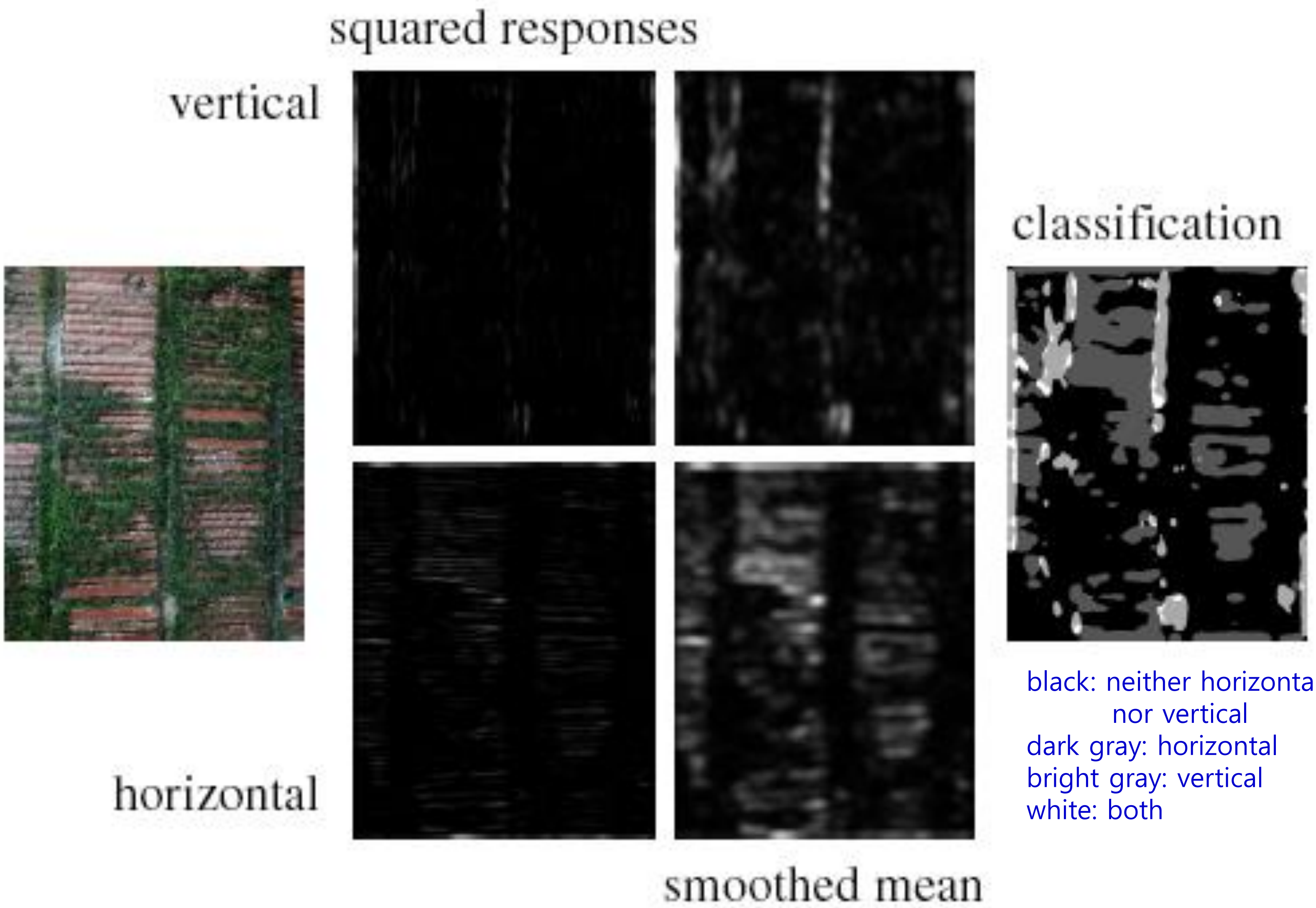
Segmentation



Texture



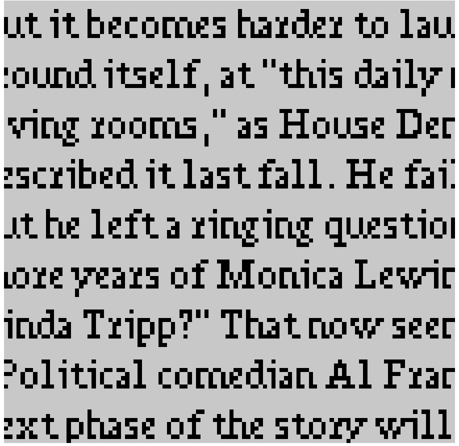
Texture



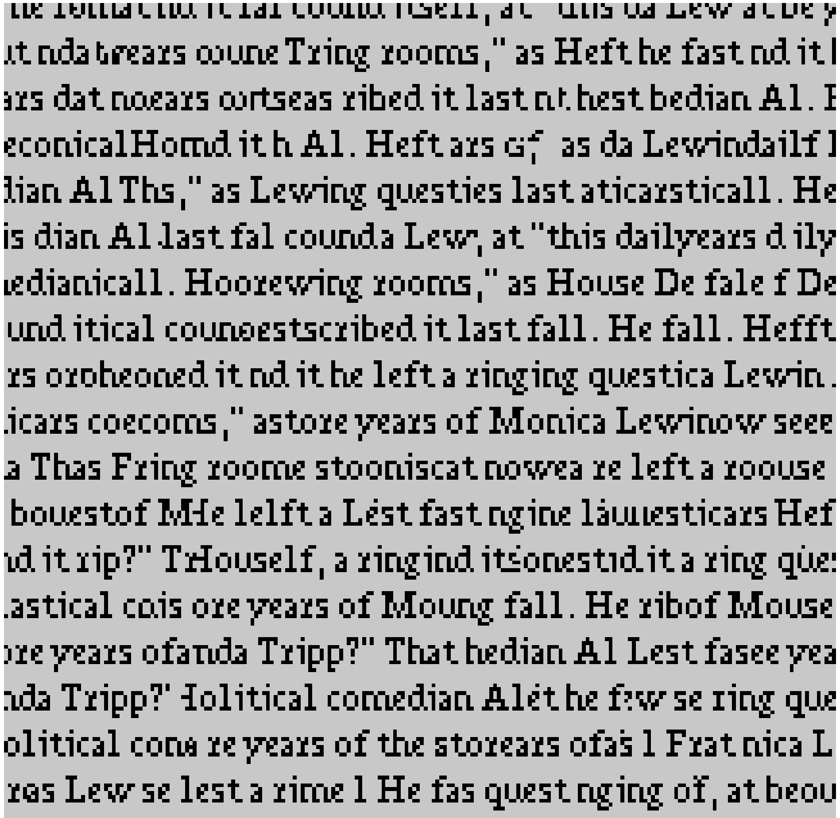
black: neither horizontal
nor vertical
dark gray: horizontal
bright gray: vertical
white: both

Texture

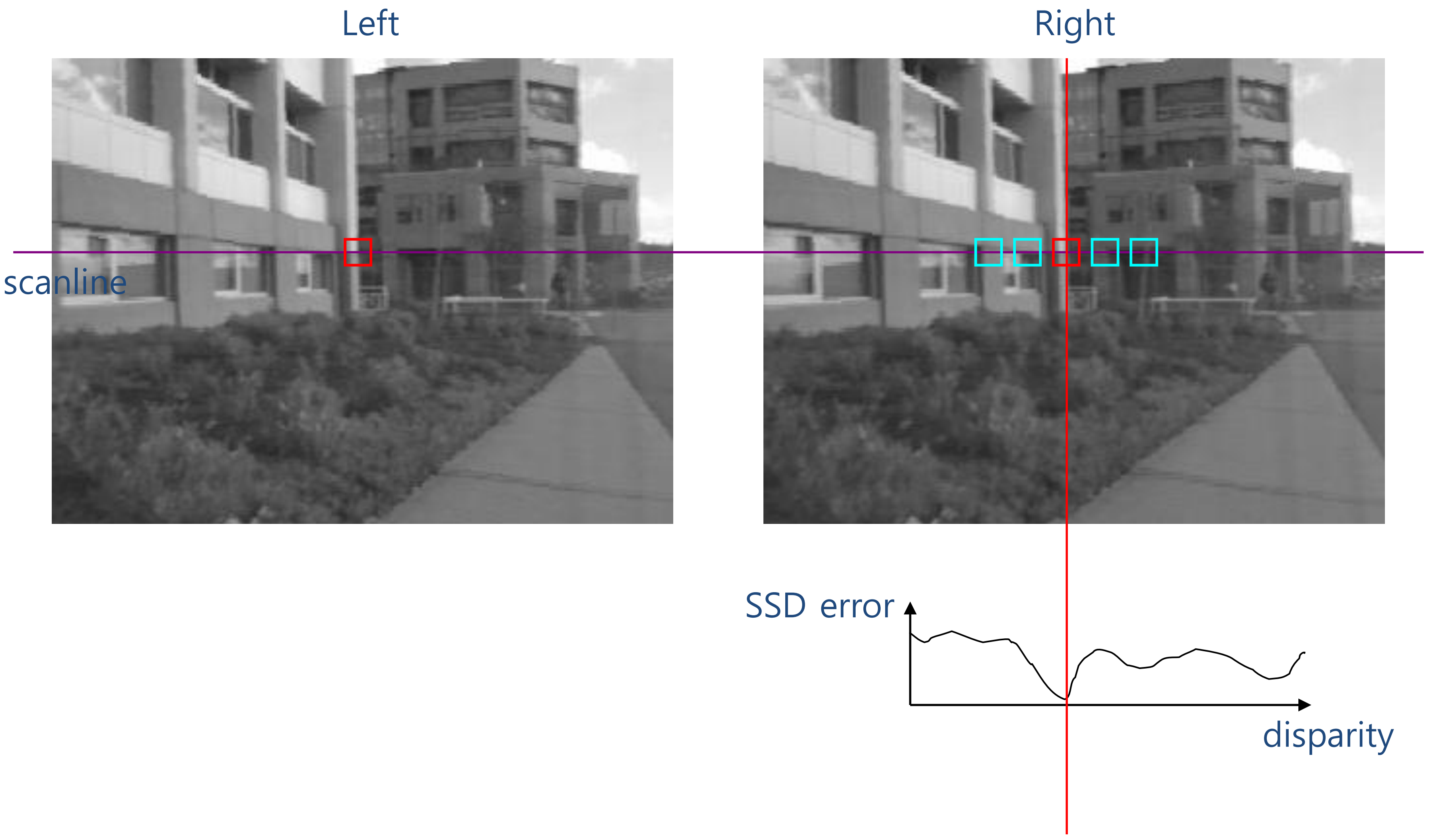
Example



Synthesized Texture



Stereo



Stereo

Disparity Map

Stereo

(a)

(b)

(c)

(d)

(e)

(f)

Motion

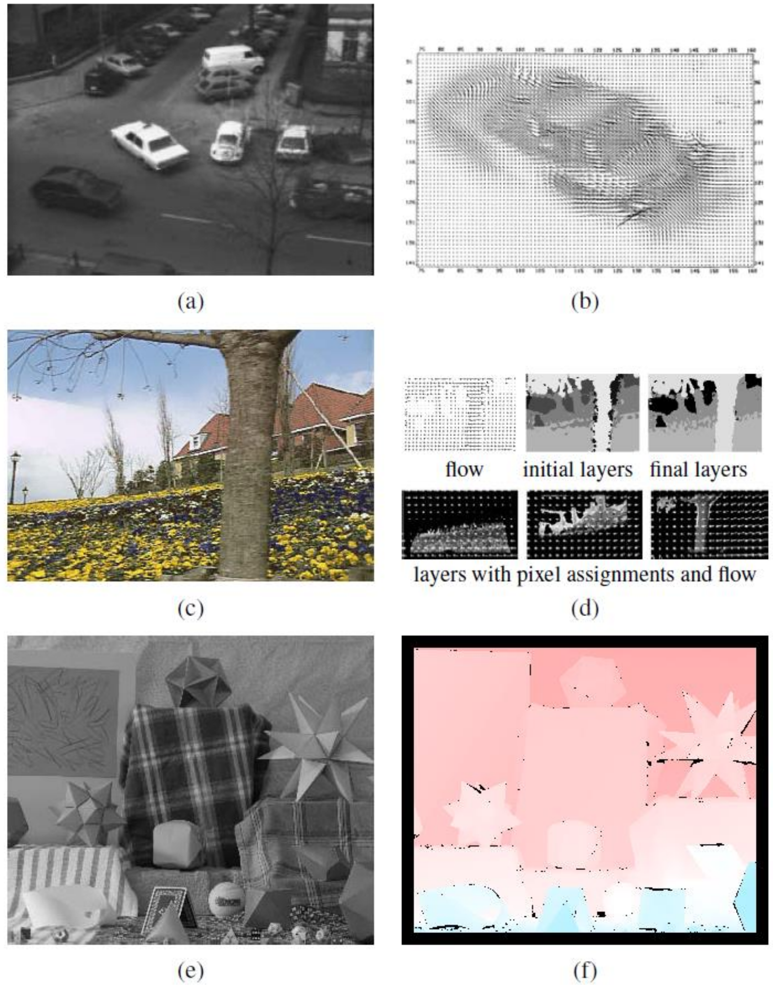


Figure 8.1 Motion estimation: (a–b) regularization-based optical flow (Nagel and Enkelmann 1986) © 1986 IEEE; (c–d) layered motion estimation (Wang and Adelson 1994) © 1994 IEEE; (e–f) sample image and ground truth flow from evaluation database (Baker, Black, Lewis *et al.* 2007) © 2007 IEEE.

Motion