Computer Vision

(Introduction)

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Outline

- Introduction
  - Motivation
    - Visual pattern recognition
  - Applications
  - Illusion
  - Image formation
    - Perspective projection
    - Photometric model

Motivation

- Introduction of digital computer in mid-20th century
- The machine turns out to be superior to human being in number crunching.
- If it can mimic the ability of human being in pattern recognition and decision making.
- Birth of new subjects like *computational intelligence*, *machine intelligence*.

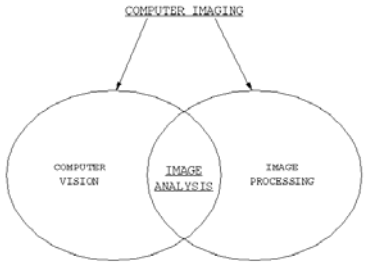
Visual pattern recognition

- In real life, human beings perform the pattern recognition tasks based on the information acquired from the ***environment*** through sensors like ears, eyes, nose, tongue and skin.
- Most of the ***information*** is acquired through ***eyes***.
- ***Visual pattern recognition***, thus, turns out to be most important activity in this context.
- This leads to development of ***Computer vision and scene understanding***.

Visual data processing

- Visual or pictorial data processing by digital computer may be grouped into three categories:
  - **Input:** textual description; **Output:** an image
    Computer Graphics
  - **Input:** an image; **Output:** an image
    Image Processing
  - **Input:** an image; **Output:** textual description
    Image analysis and recognition \ Computer Vision

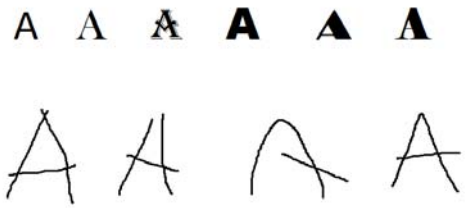
Visual data analysis



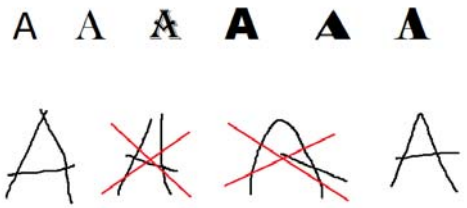
Pattern recognition: Learning

Pattern recognition: Learning

Pattern recognition: Learning



Learning



Natural images: examples

Outdoor scene

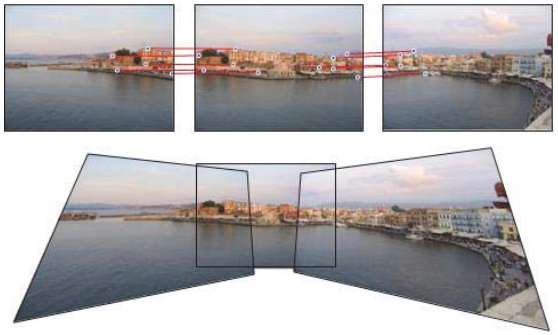
Indoor scene

Micrograph

Applications

- Intelligent machines (AI)
- Industrial inspection
- Automobile
- Security / biometric
- Image/video retrieval / Digital Library
- Robot navigation
- Activity analysis and so on ….

Panorama



Face Detection

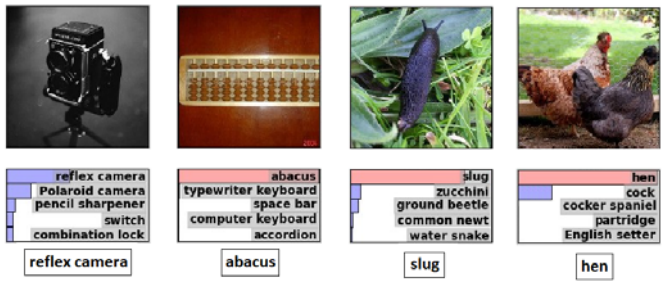
- Real-time face detection on most phones /cameras now
  - Use to set exposure
  - Also input for face *recognition* system

Object recognition

- Referred to by three tasks:
- Image classification
  - Assigning a class label to an image.
  - May be multiple labels with confidence levels.
- Object localization
  - Drawing a bounding box around the targeted object.
- Object detection
  - Drawing a bounding box around each object of interest and assigning class label to those.

Image (object) recognition

Pixels to class-label:



Optical character recognition (OCR)

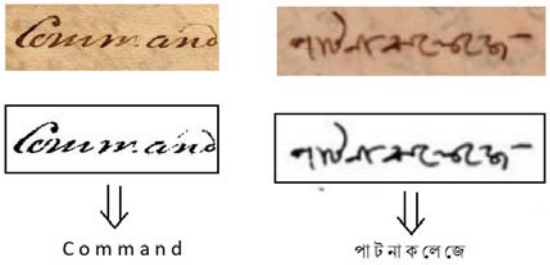
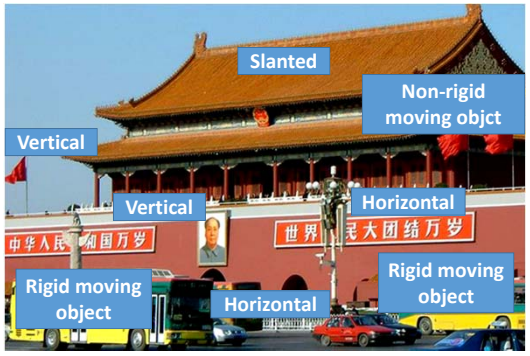


Image to semantic information

Qualitative information

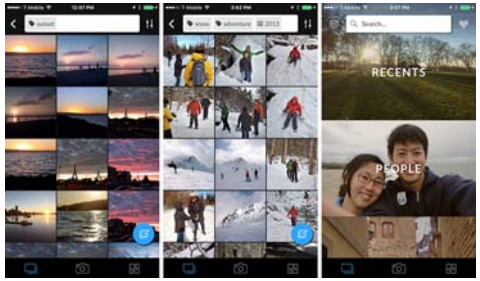


Object categorization

Scene and context categorization

Advanced Photo Search

- Content-based image search
  - that actually looks at image

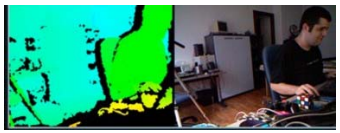


http://clarifai-blog.s3.amazonaws.com/wp-content/uploads/2015/12/pic1.jpg

Data sources

Vision-based interaction (and games)

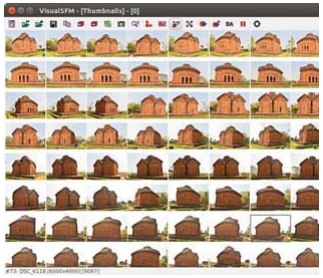
Microsoft Kinect



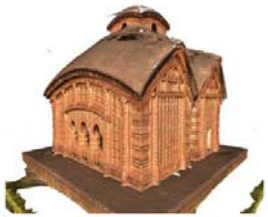
Virtual/Augmented Reality

- Tracking of user head with high accuracy
- Rendering realistic 3D scene in real-time
- Oculus / HTC / Hololens

Geometry: 3D reconstruction (cond.)

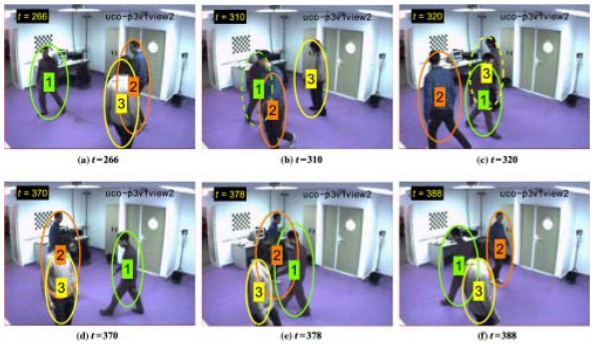


Geometry: 3D reconstruction

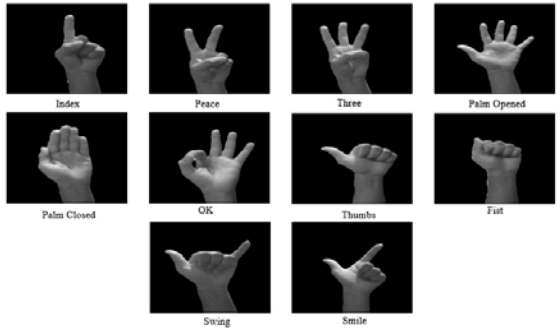


Motion detection and tracking

Activity analysis: tracking



Activity analysis: hand gesture



Activity analysis: events

Other applications with DL

Image classification

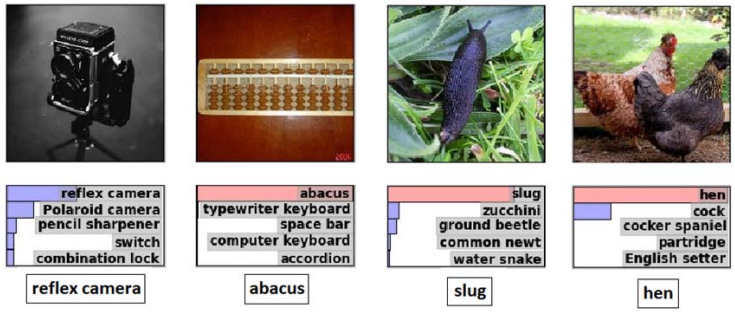


Image generation

Image generation: Progress

Aging face image

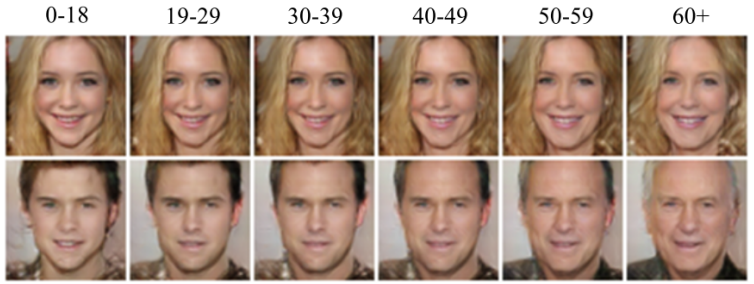
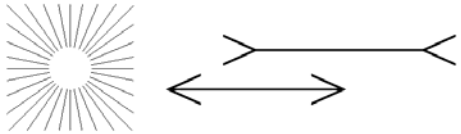


Image colorization

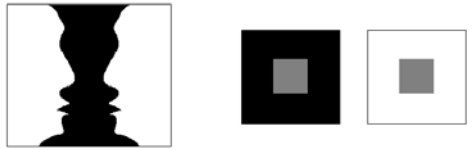
Style transfer

Illusion: Examples



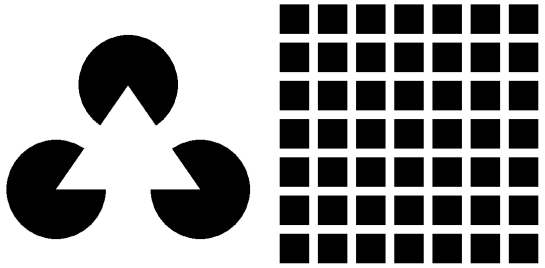
(a) (b)

Illusion: Examples



(c) (d)

Illusion: Examples



(e) (f)

Illusion: Examples

Illusion: Examples

Illusion: Examples

Scene types

Scenes are of two types:
- **3-D**, example: usual outdoor and indoor scenes
- **2-D**, example: document page, micrograph, satellite image, x-ray image, etc.

Types of **images**:
- Static image (single frame)
  - Black and white, colour
- Sequence of images (video/movies)

Types of digital image

Black-and-white image
- Binary (two-tone) image
- Gray level (gray-tone) image

Color image

Another way of classifying images:
- Static image (single image)
- Image sequence (movie)

Thank you!

Any question?