Who am I

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Research Interest :

Computer vision, image/video processing, pattern recognition, machine learning

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(You can download lecture notes in my homepage)

EE Experiments (Computer Vision)
(Lecture Note 1)

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Introduction to Computer Vision

2019. 9. 2

Prof. Wonjun Kim

School of Electrical and Electronics Engineering

Introduction (1/2)

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- **Look at the following pictorial examples**
  - **Are they same ? How can you recognize it ?**

* Tell me the sources yielding the "difference" in a given scene

* Can computers (or other devices) get such difference easily ?

  ➔ We need to construct "algorithm" to address these issues

※ Images from CS231n of Stanford Univ.

Introduction (2/2)

- **Challenge issues in computer vision**
  - **Still, there are many hurdles to be resolved by you**

Viewpoint variations

Scale variations

Deformation

Occlusion

Illumination conditions

Background clutters

Intra-class variation

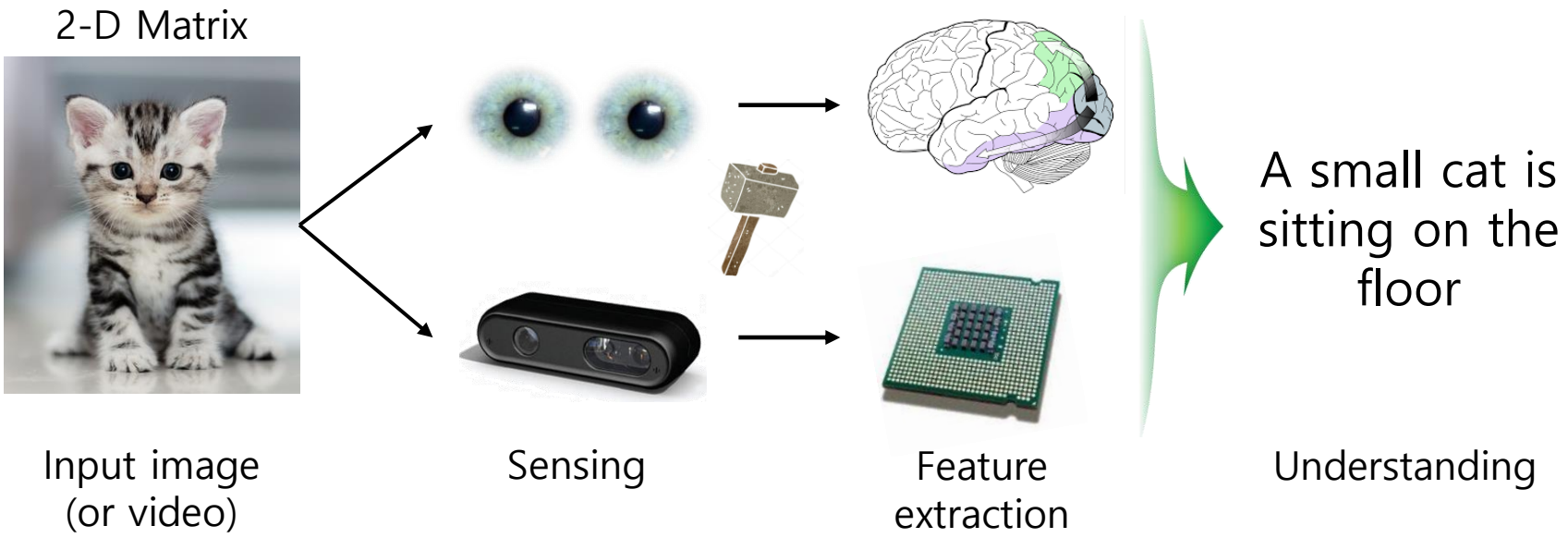
* Each topic is very hard to be solved completely …

: However, many researches need to be conducted such conditions

※ Images from CS231n of Stanford Univ.

Definition (1/2)

- **What is computer vision ?**
  - **Understanding a given image (video) via visual information**



* Raw data is generally pre-processed for better understanding

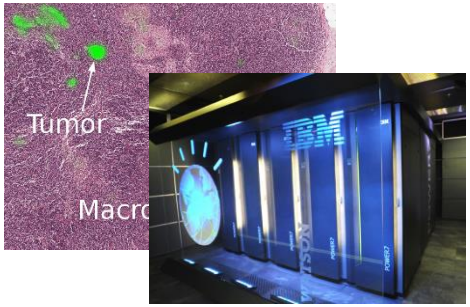
* To extract "features", strong backgrounds for math are highly required !

Definition (2/2)

- **Applications of computer vision**

Self-driving car

Smart devices

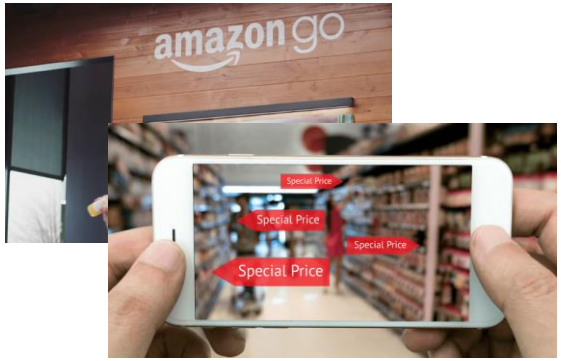


Medical engineering

Computer Vision

Robotics

Smart surveillance



Distribution systems

Goal of Computer Vision

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- **Mimicking a human vision system (HVS)**
  - **Bridging the gap between pixels and "meaning"**

What we see

CV finds meaning in a set of pixels (spatially close)

100	105	102	106	107	• • •
97	103	100	100		
105	100	99	98		
112	110	119			
117					
⋮					

What computers see

Why Do We Study CV ?

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- **Vast amount of images are generated (day by day)**
  - **Images (or videos) are everywhere !**

※ Slide credit : fei-fei Li.

Information from Images (1/2)

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- **Plentiful semantic information**
  - **Vision as a source of semantic information**

※ Images from Google image search

Information from Images (2/2)

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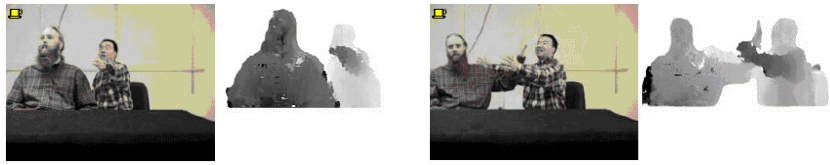
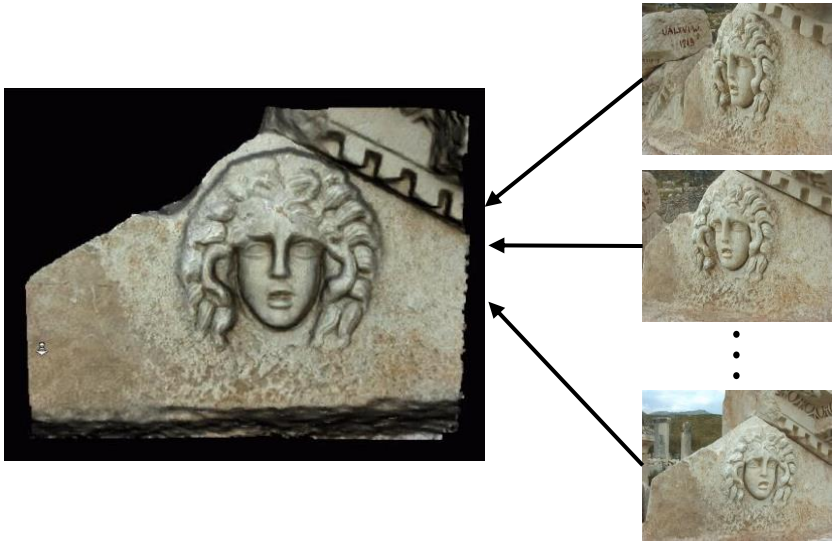
- **Metric 3D information**
  - **Vision as measurement devices**

3D reconstruction from urban scenes



Interactions from depth information

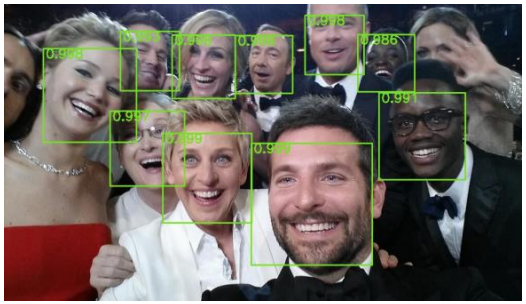


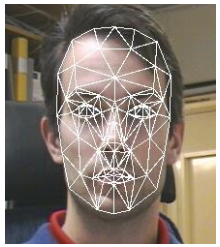
3D reconstruction from video

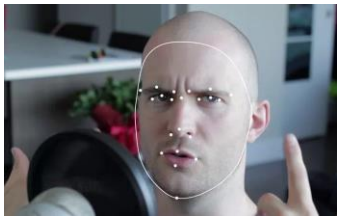
※ Images from Marc Pollefey's homepage

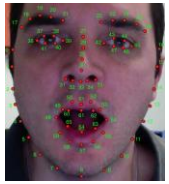
Main Topics in CV (1/8)

- **Face detection, recognition, and attributes (expressions)**
  - **Such techniques are already deployed into mobile devices**



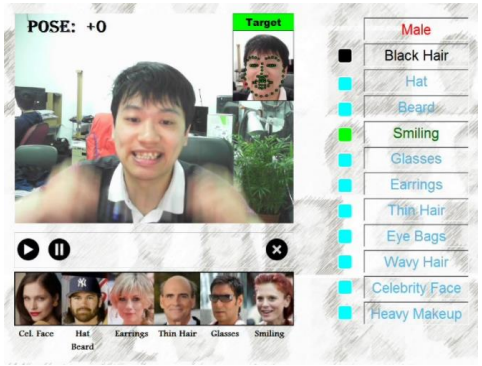






Face detection & tracking

Face recognition
(in the smartphone)



Attribute detection

Smile detection

Main Topics in CV (2/8)

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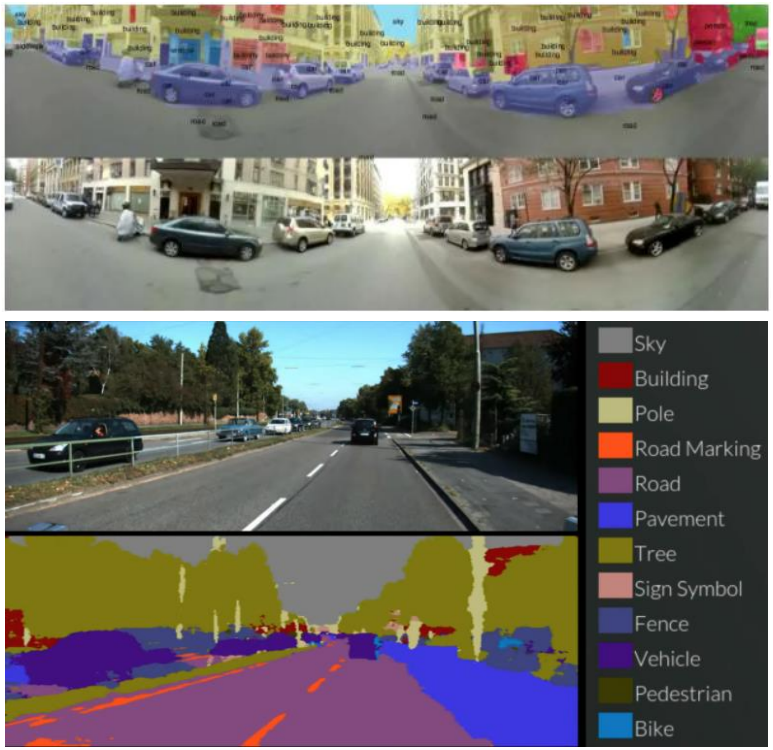
- **Scene understanding**
  - **This is a key task for autonomous driving systems**

    * Many companies attempt to achieve this using only a single camera !

Scene parsing (segmentation & recog.)



Scene parsing on the road

Main Topics in CV (3/8)

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- **Quality enhancement**
  - **Make a clear image for better understanding**

Image dehazing (from Kaiming he's results) [left: input, right : result]

Contrast enhancement (from Zhetong Liang's results) [left: input, right : result]

Main Topics in CV (4/8)

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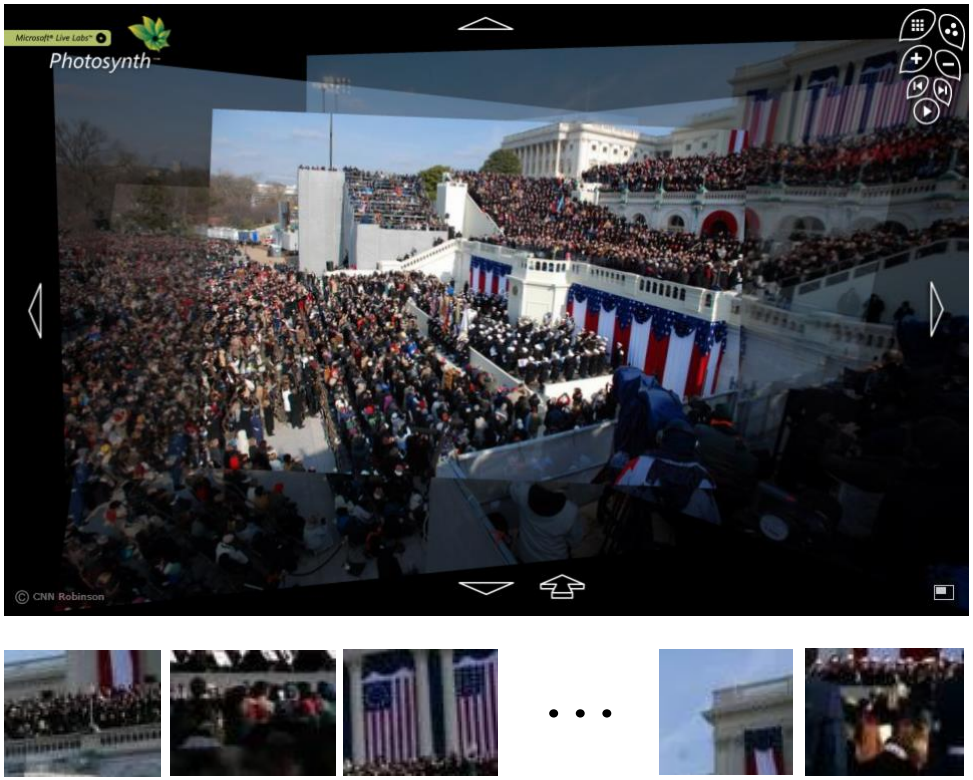
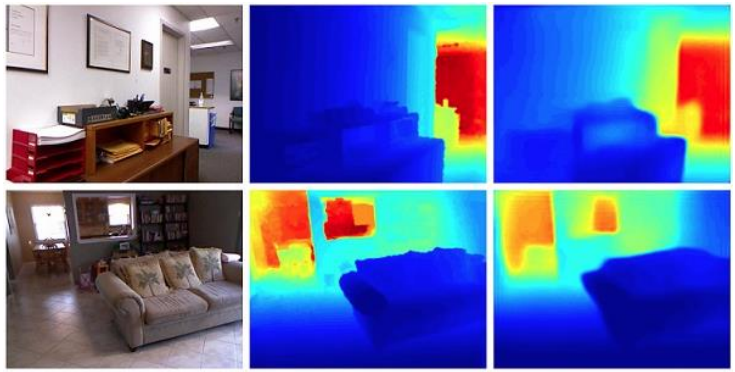
- **3D image processing**
  - **This is a key task for autonomous driving systems**



3D reconstruction (Microsoft Photosynth)

Geometry analysis



Depth estimation

Main Topics in CV (5/8)

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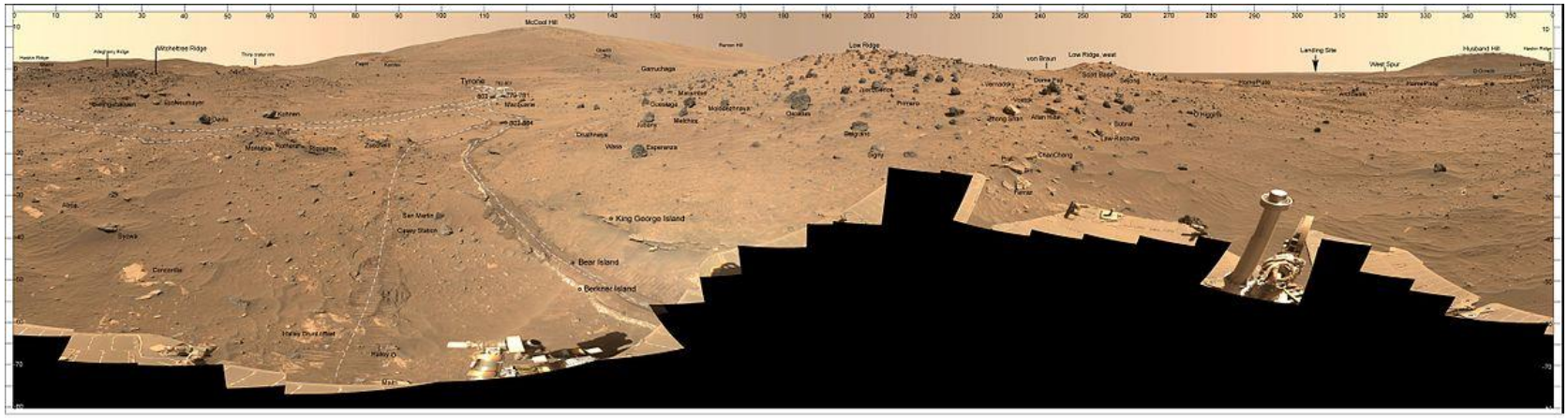
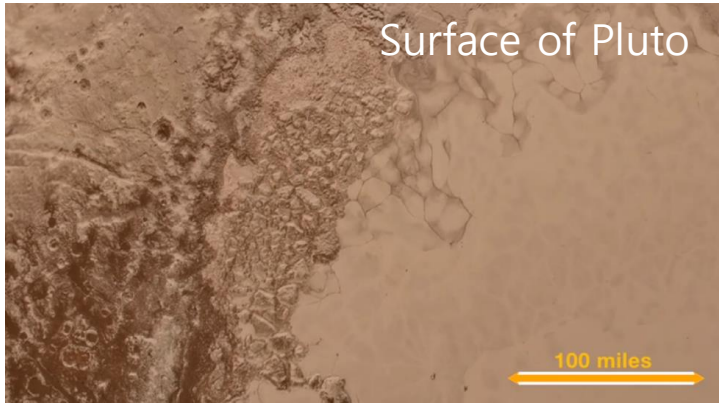
- **Vision for robotics and space exploration**
  - **This is a key task for autonomous driving systems**



Color panorama on Mars

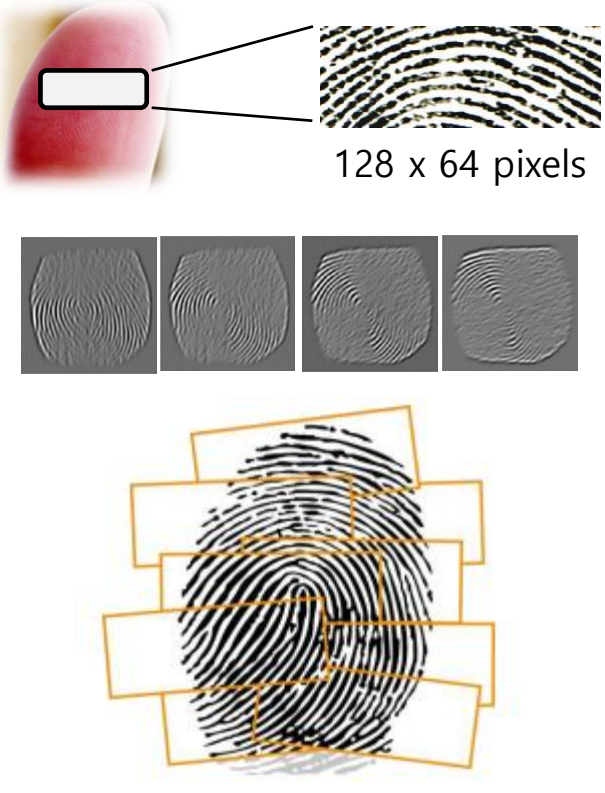


* Panorama stitching
* 3D terrain modeling
* Obstacle detection and position tracking

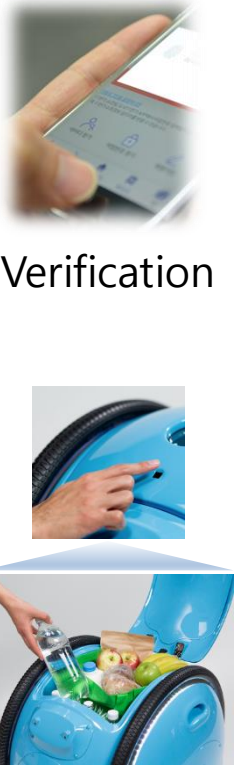
※ Computer vision on Mars (by Matthies et al.)

Main Topics in CV (6/8)

- **Biometrics**
  - **Fingerprint and iris recognition are now deployed**



Fingerprint recognition



Verification

FR-based

How the Afghan girl was identified ?

Iris recognition

Main Topics in CV (7/8)

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- **Vision in supermarkets**
  - **More complicated scenarios can be possible !**

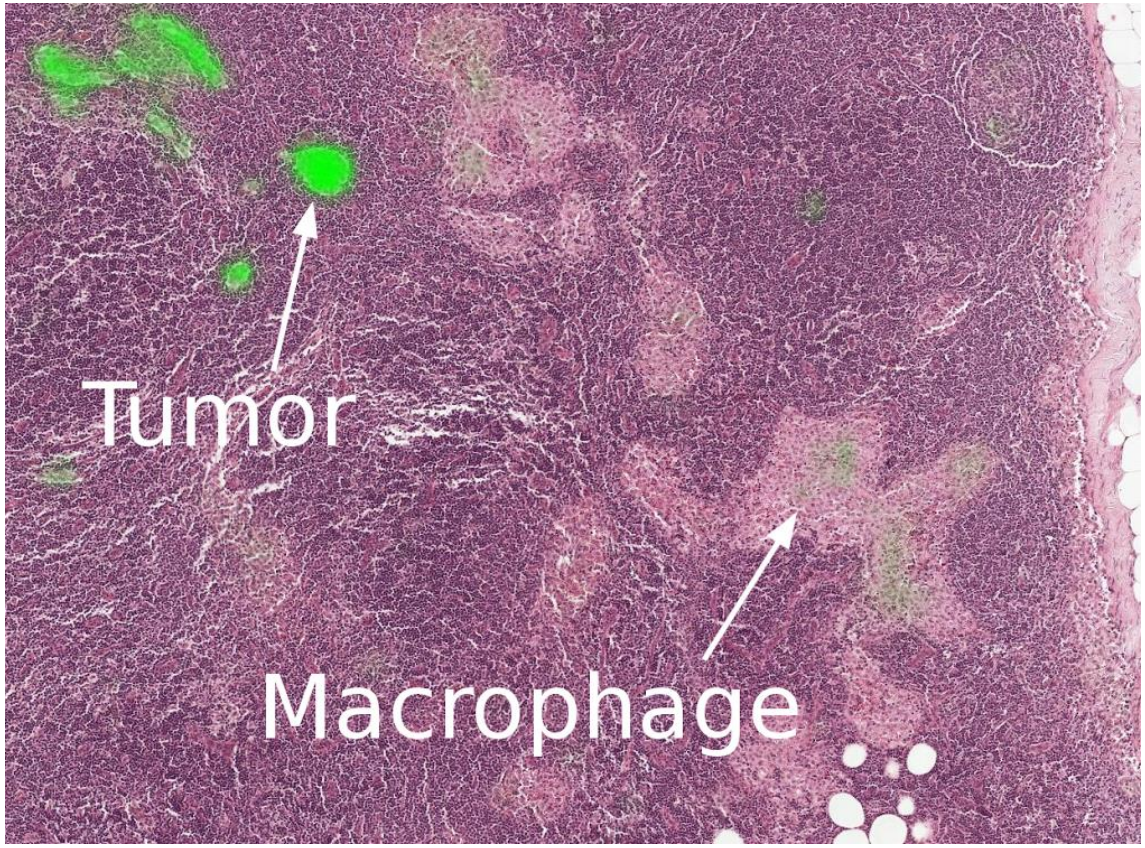
    * Items can be recognized by using computer vision techniques

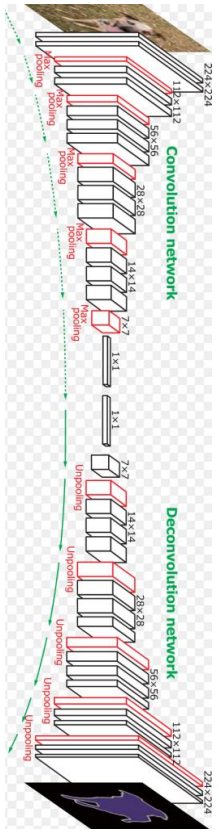
[Unmanned mart]
(https://www.youtube.com/watch?v=NrmMk1Myrxc)

CV is a key technique !

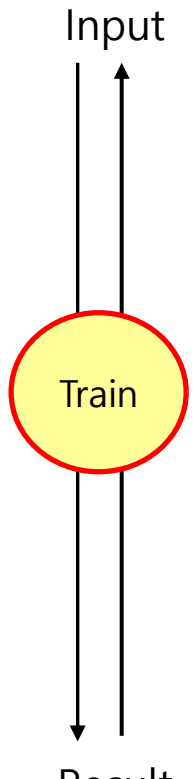
Main Topics in CV (8/8)

- **Vision in medical imaging**
  - **More complicated scenarios can be possible !**





Deconvolution
(POSTECH)



※ Images from DeepMind's homepage

Before Starting …

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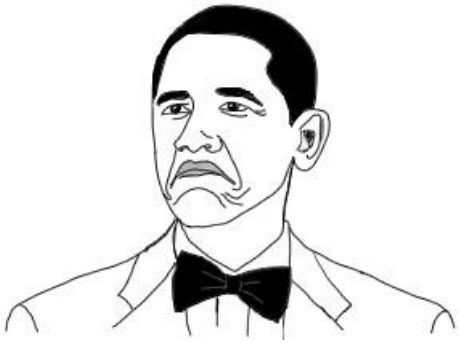
- **C, C, and C !**
  - We only use C and C++ language
    - * Students should be familiar with programming by C (or C++)
  - Particularly, pointer and object will be our main tool
    - * Memory handling is very important since images are loaded via pointers
  - It will be very good chance to you for experiencing SOTA techniques
    - * Students should be faithful to devising algorithms and coding it

Are you ready ?



Introduction to OpenCV (1/2)

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- **Open library for computer vision**
  - **Many useful algorithms are included in OpenCV**

OpenCV (Open Source Computer Vision Library) is released under a BSD license and hence it's free for both academic and commercial use. It has C++, C, Python and Java interfaces and supports Windows, Linux, Mac OS, iOS and Android. OpenCV was designed for computational efficiency and with a strong focus on real-time applications. Written in optimized C/C++, the library can take advantage of multi-core processing. Enabled with OpenCL, it can take advantage of the hardware acceleration of the underlying heterogeneous compute platform.

Adopted all around the world, OpenCV has more than 47 thousand people of user community and estimated number of downloads exceeding 14 million. Usage ranges from interactive art, to mines inspection, stitching maps on the web or through advanced robotics.

Introduction to OpenCV (2/2)

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▪ Structure overview

- **Basically, it is constructed based on "classes"**

  * Therefore, there are a lot of **member functions** for each class

    → Our main class is "**Mat**" , which can be regarded as a matrix

    ※ Think about the form of an image (it is a large matrix) !

- **Name of member (functions) are straightforward and intuitive**

  * Although you meet some functions first time, you can understand it

    → For example, "imread" function is for reading a target image

- **Many algorithms in computer vision are included as classes**

  * We can easily implement the state-of-the-art methods

    → For example, face detection can be implemented with ~30 lines

First Task : Install OpenCV (1/3)

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▪ Download OpenCV library

- **Visit http://opencv.org/releases.html**

  * We use the 3.4.5 (or 3.2.0) version

  * Pre-requisite : Visual Studio 2017

- **Execute the downloaded file**

  * Set the path for OpenCV library

➔ **Now, we are read to include Opencv library in our C++ project**

Action item : Read an image and show it using a pop-up window

1) Include OpenCV library in Win32 console project

2) After that, try to build the code in the next slide

First Task : Install OpenCV (2/3)

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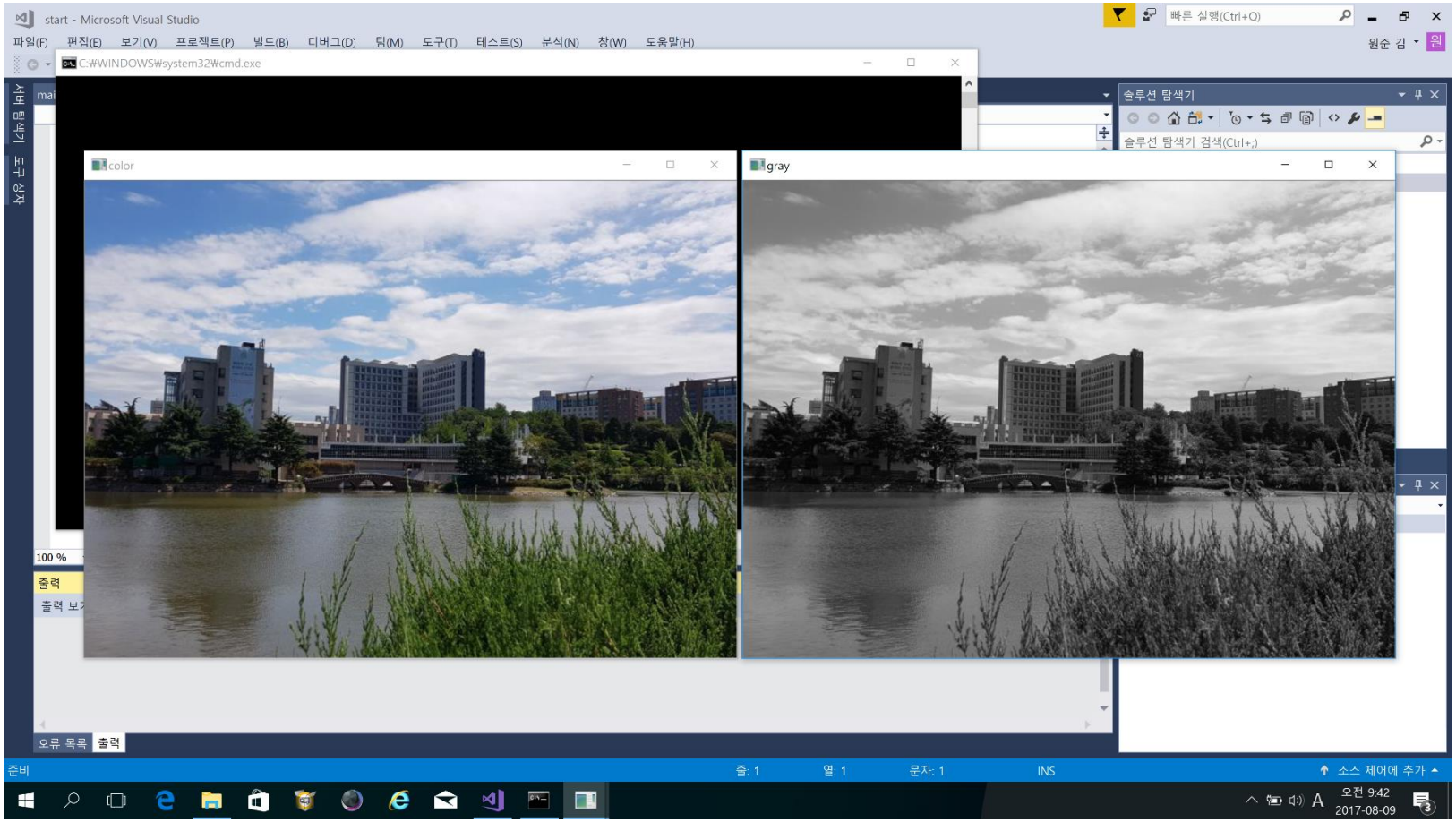
- **Code example : image read**
  - **Check the build result (two images are poped-up !)**

```
#include <opencv2/imgproc.h>
#include <opencv2/highgui.h>

using namespace cv;

void main()
{
   // You can set the path of an image file
   Mat imgColor = imread("test.jpg", CV_LOAD_IMAGE_COLOR);
   Mat imgGray = imread("test.jpg", CV_LOAD_IMAGE_GRAYSCALE);

   imshow("color", imgColor);
   imshow("gray", imgGray);

   waitKey(5000);
}
```

You can set your own path

First Task : Install OpenCV (3/3)

- **Code example : image read**
  - **This is the result**



Summary

- **Computer vision is a key technique in industry fields**
  - Most applications are based on computer vision
  - Find underlying meaning from a set of pixels
- **OpenCV provides a good starting point for CV**
  - You need to be familiar with handling C and C++
  - Complete our first task before the next class !