數位影像處理

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National Yunlin University of Science and Technology

課程內容

- Introduction
- BMP format
- Image Capture
- Image Display
- Point Processing
- Neighborhood Processing
- Image Geometry
- Image Segmentation
- Hough
- Mathematical Morphology
- Image Topology
- Shapes and Boundaries
- Color Model
- Transform
- Applications
- Camera Calibration

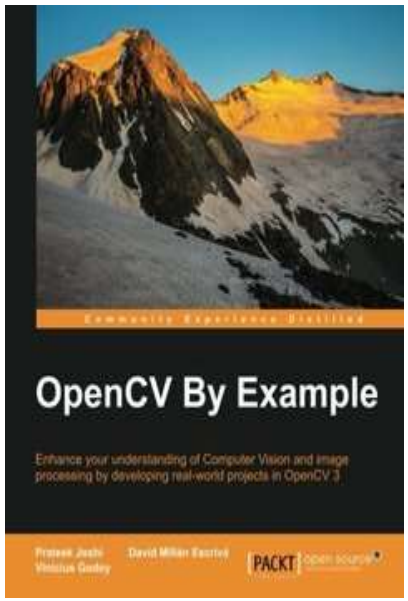
Reference

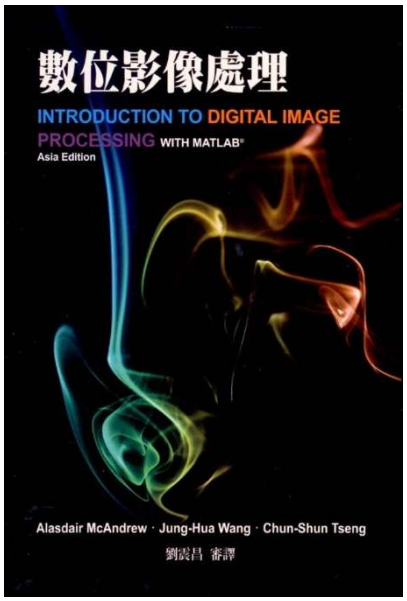
- **OpenCV-3-x-with-Python-By-Example**
  - https://github.com/PacktPublishing/OpenCV-3-x-with-Python-By-Example
- **Geeksforgeeks**
  - https://www.geeksforgeeks.org/opencv-python-tutorial/
  - https://www.geeksforgeeks.org/introduction-to-opencv/
- **Learn DIP**
  - https://www.tutorialspoint.com/dip/index.htm

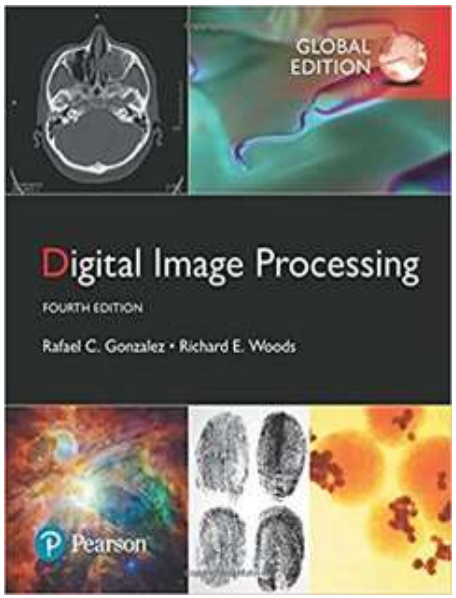
課程目標

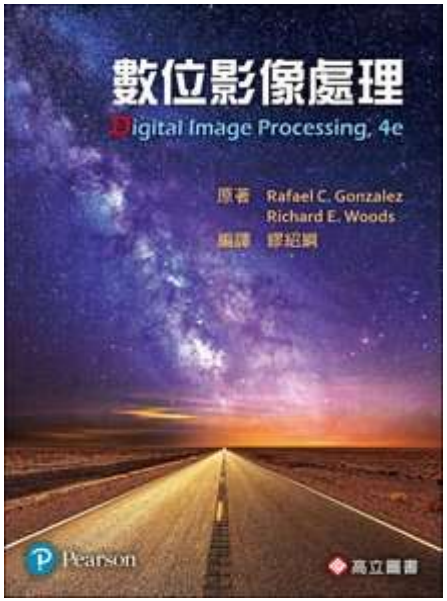
- 基礎影像處理
  - 理論及演算法介紹
  - 實作與專案軟體開發

Books


OpenCV By Example
Enhance your understanding of Computer Vision and image processing by developing real-world projects in OpenCV 3
PACKT


數位影像處理
INTRODUCTION TO DIGITAL IMAGE PROCESSING WITH MATLAB
Asia Edition
Alasdair McAndrew · Jung-Hua Wang · Chun-Shun Tseng
劉震昌 審譯


GLOBAL EDITION
Digital Image Processing
FOURTH EDITION
Rafael C. Gonzalez • Richard E. Woods
Pearson


數位影像處理
Digital Image Processing, 4e
原著 Rafael C. Gonzalez
Richard E. Woods
Pearson
高立圖書

評分標準

- 平時成績(點名、課後練習) 30%
- 期中考 40%
- 期末專案軟體開發 30% (一分組3-4人)
  - 第五週後每週一組作業報告
  - 期末報告全部作業盤點報告

課程專題

- 作業一 讀取影像/顯示座標的素點/彩色轉灰階/儲存檔案
- 作業二 上下翻轉/左右翻轉/90度翻轉/270度翻轉
- 作業三 亮度轉換(線性)/直方圖統計/直方圖等化
- 作業四 任意倍率的放大縮小
- 作業五 平均濾波器/Sobel濾波器/Prewitt濾波器/高斯濾波器/
  拉普拉斯濾波器
- 作業六 中位數濾波器
- 作業七 任意倍率的旋轉
- 作業八 影像銳化
- 作業九 Otsu's 分割
- 作業十 連通標記
- 作業十一 Canny 邊緣偵測
- ……

Dynamic Link Library

- VC 2017 C++ Call ANSI C
- VC 2017 C# Call ANSI C
- BCC Call ANSI C
- Python Call C

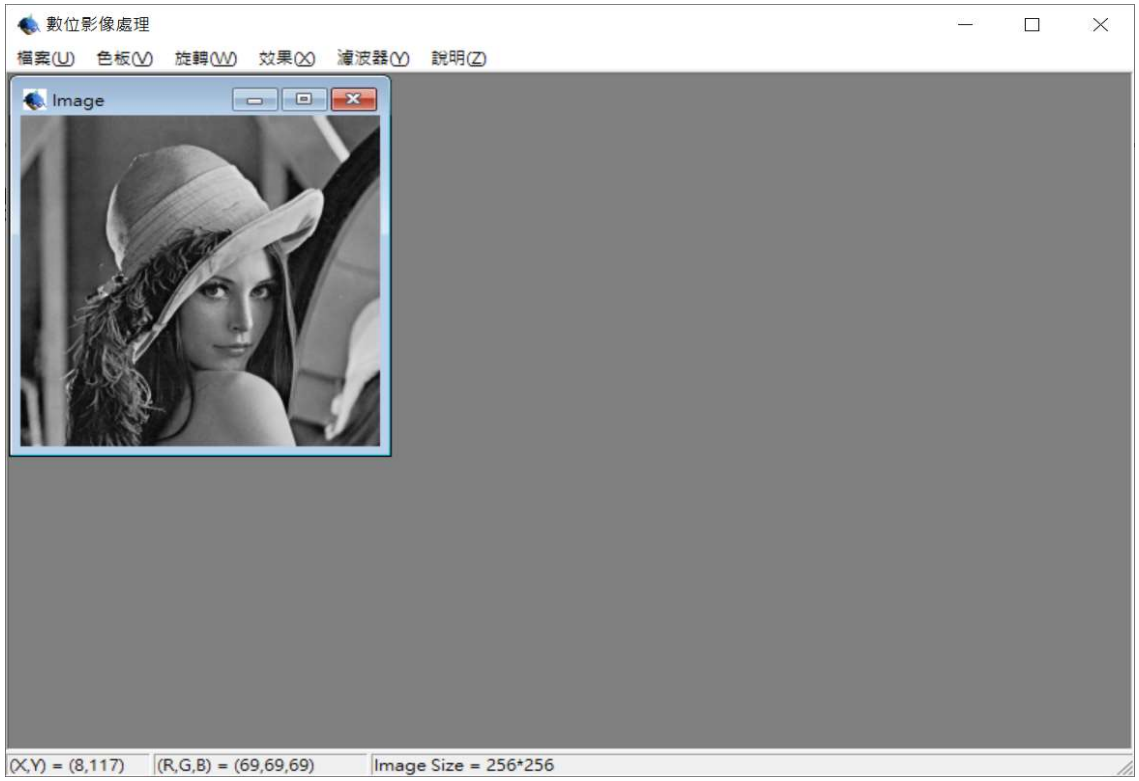
DIP

- bmp_dip() (show)
- bmp2array() (to printer f)
- array2bmp() (from printer g)
- bmp_write() (save)

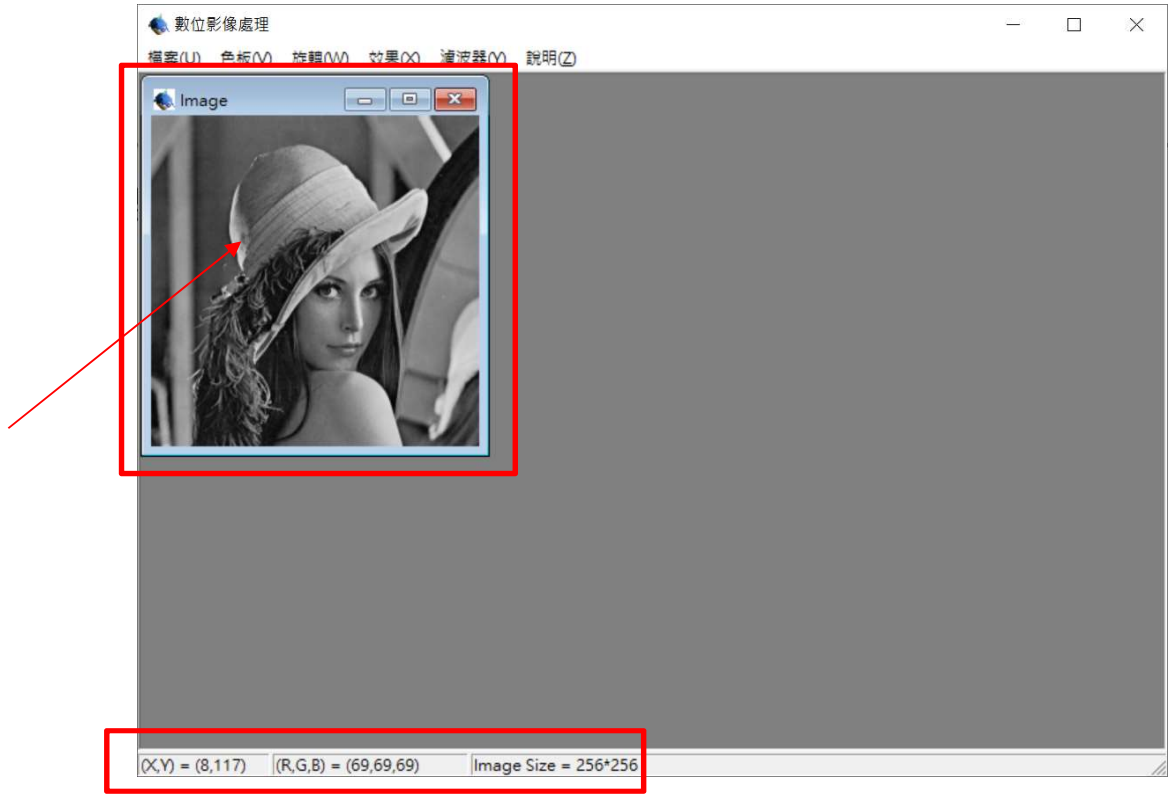
Python 程式下載

- https://drive.google.com/drive/folders/1pFHi6Rk1DimaE2Fl4S6uElCmuIIAoWwi?usp=sharing

Project


數位影像處理
檔案(U) 色板(V) 旋轉(W) 效果(X) 濾波器(Y) 說明(Z)
Image
(X,Y) = (8,117)
(R,G,B) = (69,69,69)
Image Size = 256*256

Homework

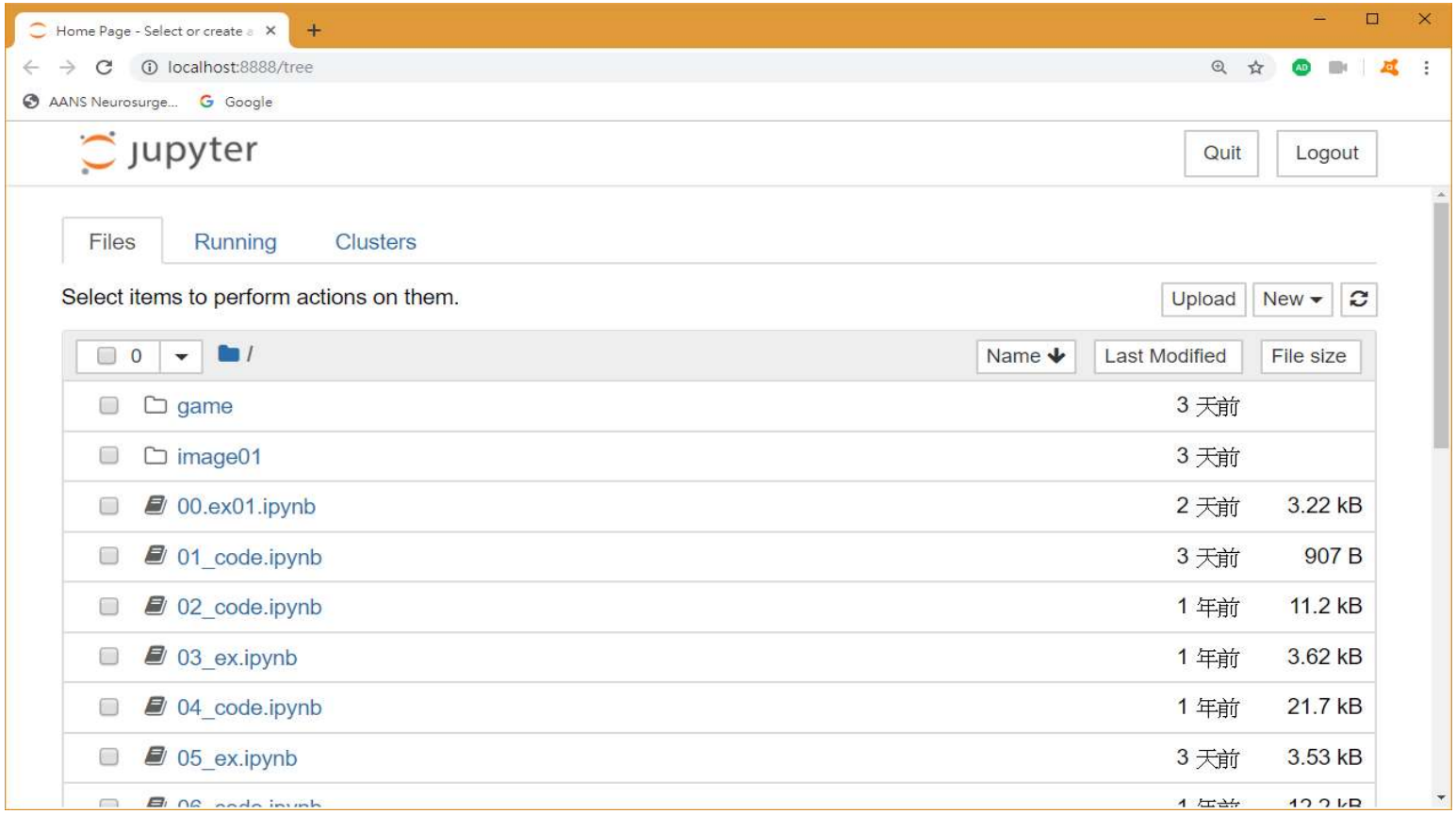

數位影像處理
檔案(U) 色板(V) 旋轉(W) 效果(X) 濾波器(Y) 說明(Z)
Image
(X,Y) = (8,117)
(R,G,B) = (69,69,69)
Image Size = 256*256

Lesson 01: Tools

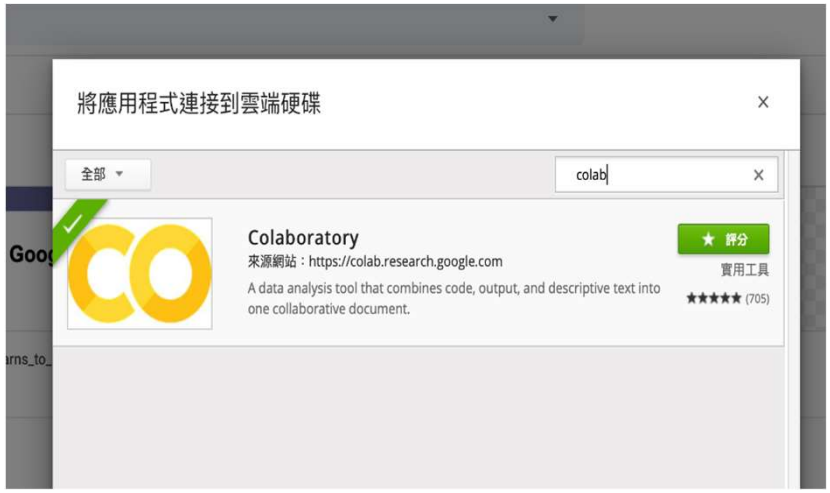
Tools

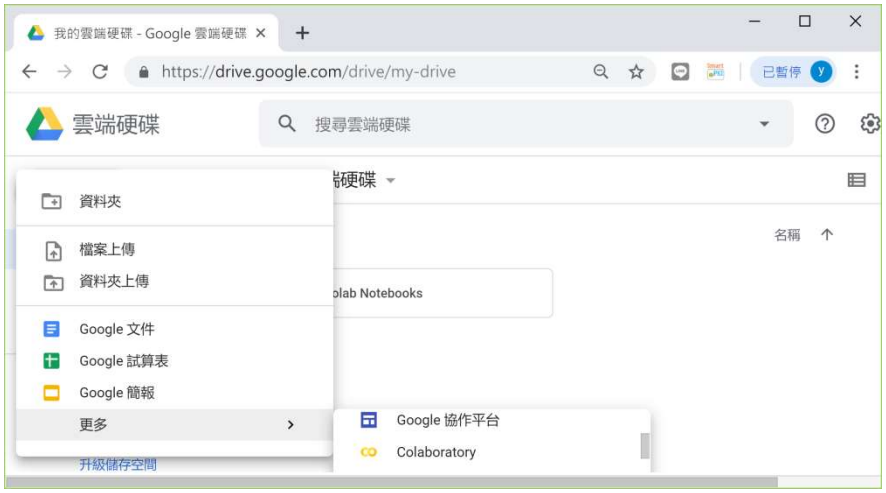
- Colab
- VS Code
- Visual Studio C#

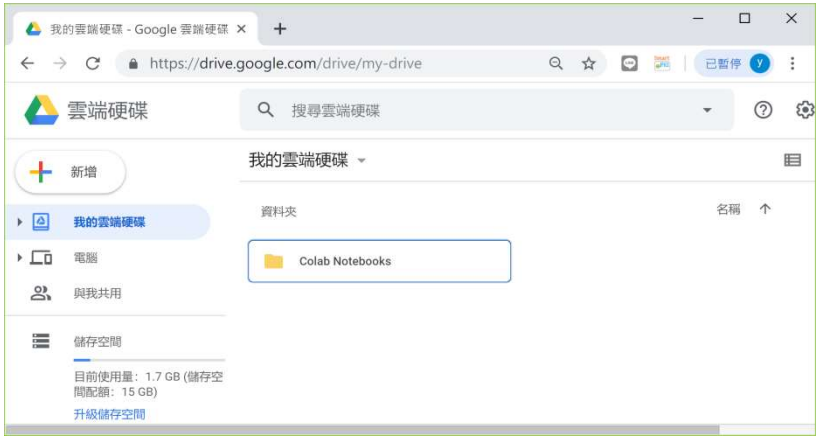
Jupyter Notebook

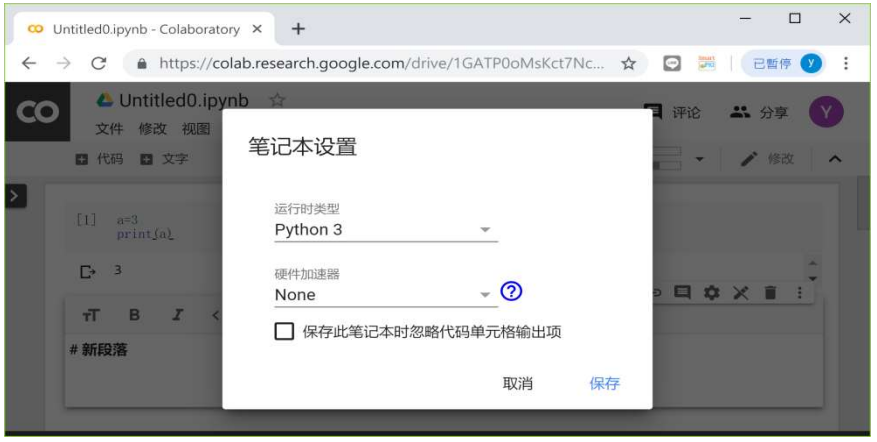


Google Colab





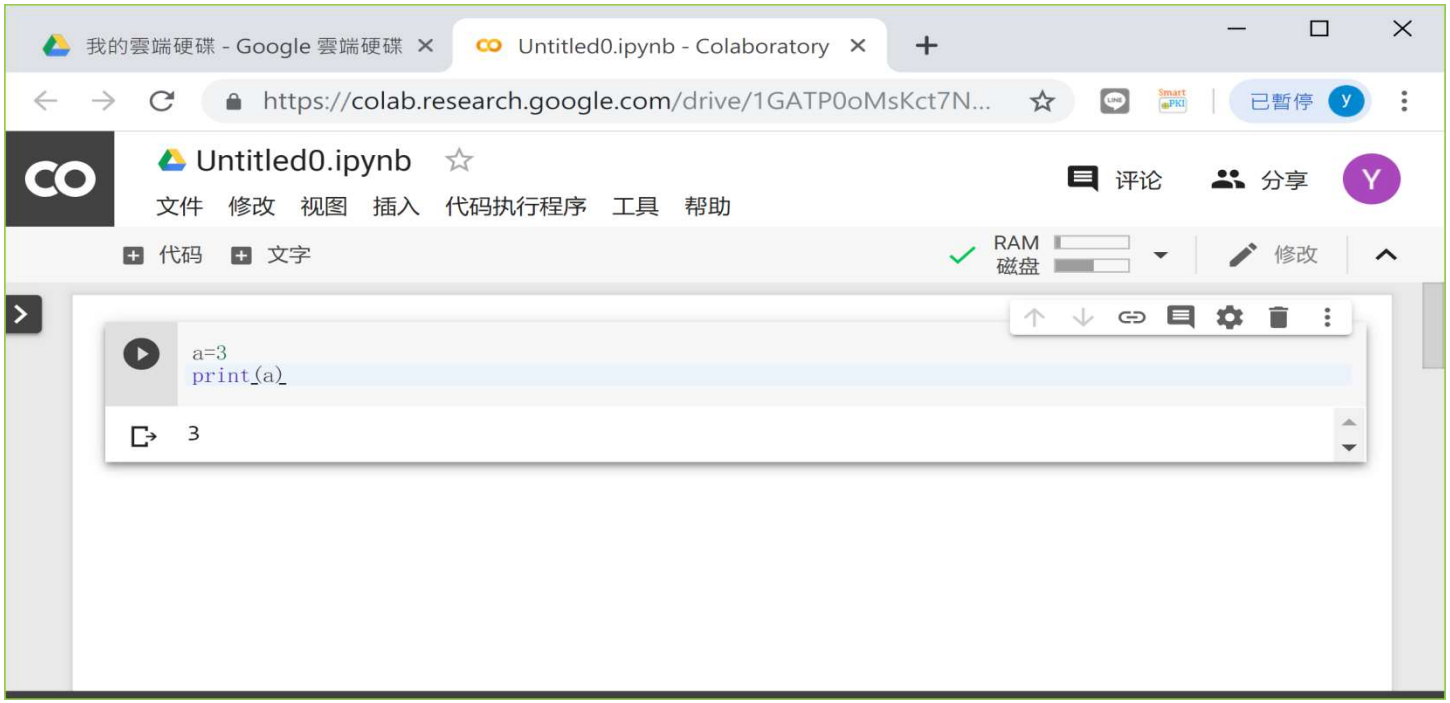




https://zhuanlan.zhihu.com/p/33466657

Google Colaboratory

- Google Drive/Colab Notebooks

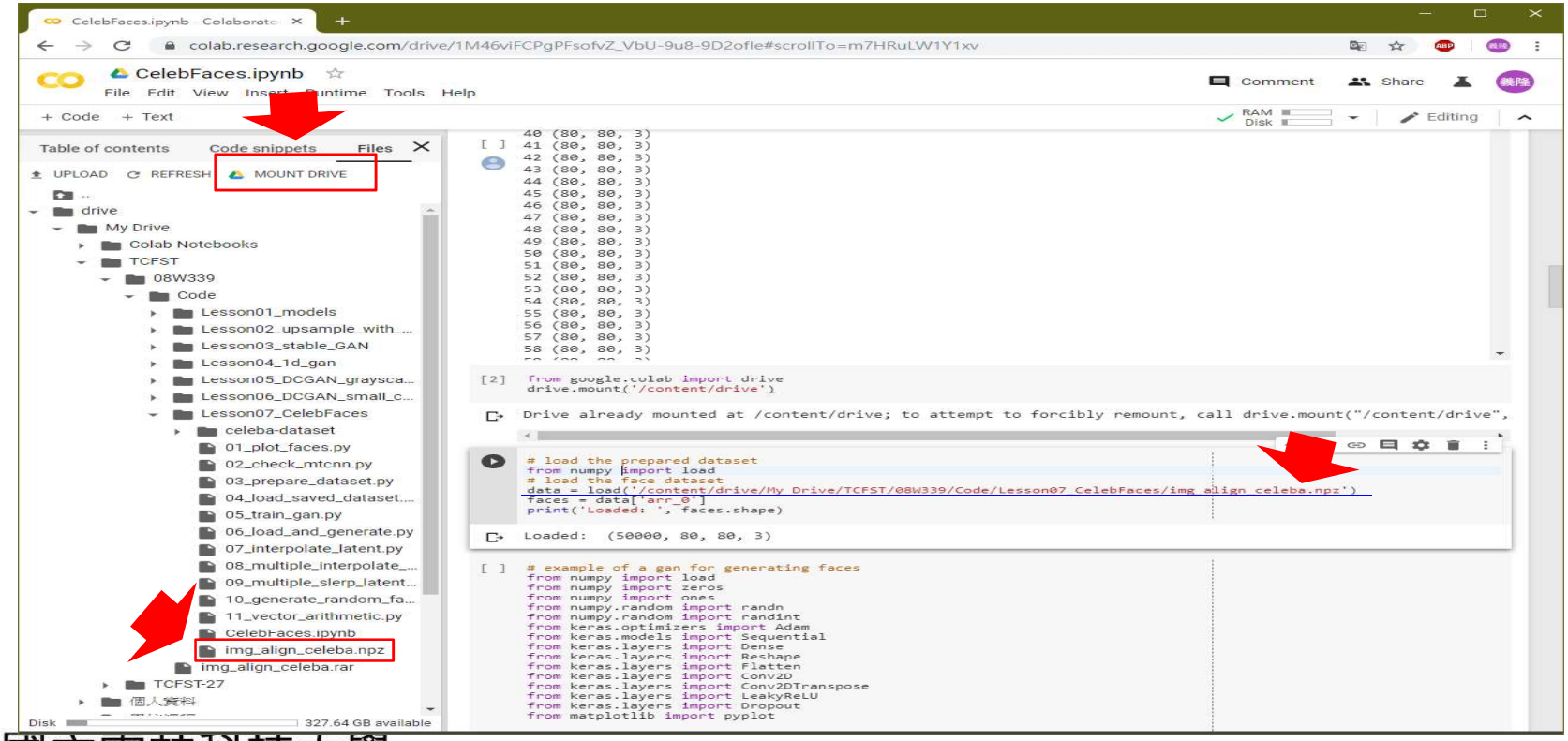


Control+Enter

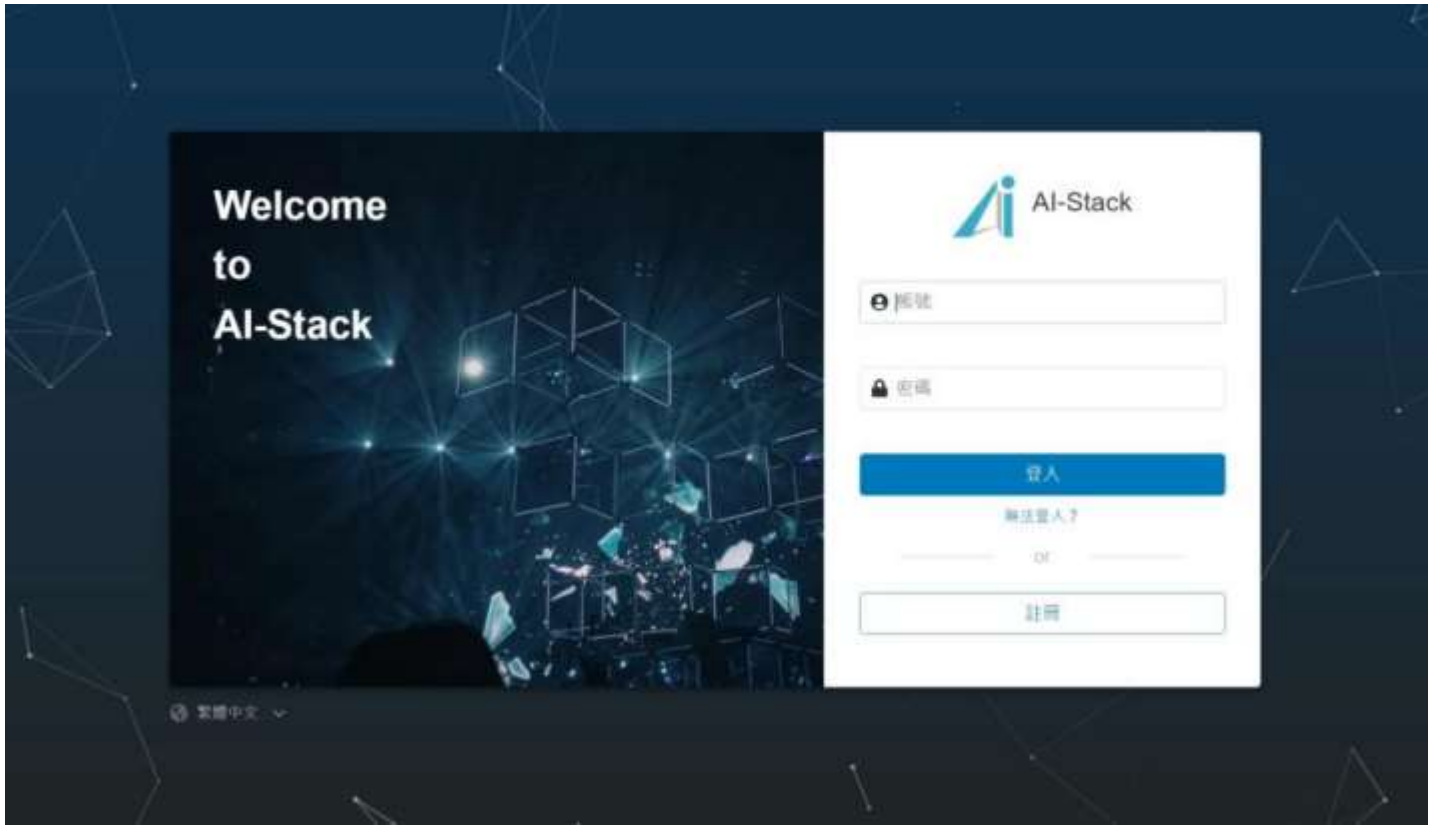
Mount Drive

from google.colab import drive

drive.mount('/content/drive')

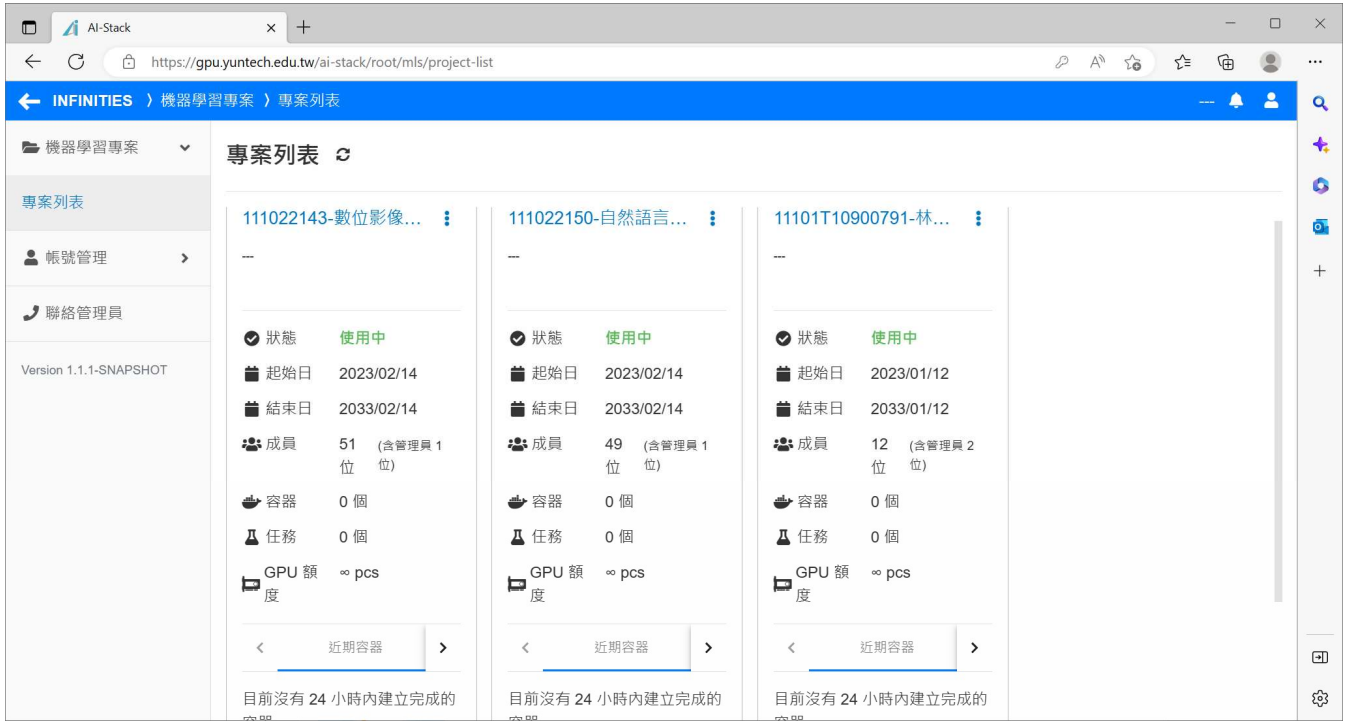


AI Stack



https://gpu.yuntech.edu.tw/ai-stack/account/login

AI Stack


AI-Stack
https://gpu.yuntech.edu.tw/ai-stack/root/mls/project-list
INFINITIES 〉機器學習專案 〉專案列表
機器學習專案
專案列表
帳號管理
聯絡管理員
Version 1.1.1-SNAPSHOT
專案列表
111022143-數位影像...
111022150-自然語言...
11101T10900791-林...
狀態 使用中
起始日 2023/02/14
結束日 2033/02/14
成員 51 位 (含管理員 1 位)
容器 0 個
任務 0 個
GPU 額度 ∞ pcs
近期容器
目前沒有 24 小時內建立完成的
狀態 使用中
起始日 2023/02/14
結束日 2033/02/14
成員 49 位 (含管理員 1 位)
容器 0 個
任務 0 個
GPU 額度 ∞ pcs
近期容器
目前沒有 24 小時內建立完成的
狀態 使用中
起始日 2023/01/12
結束日 2033/01/12
成員 12 位 (含管理員 2 位)
容器 0 個
任務 0 個
GPU 額度 ∞ pcs
近期容器
目前沒有 24 小時內建立完成的

Code Sample

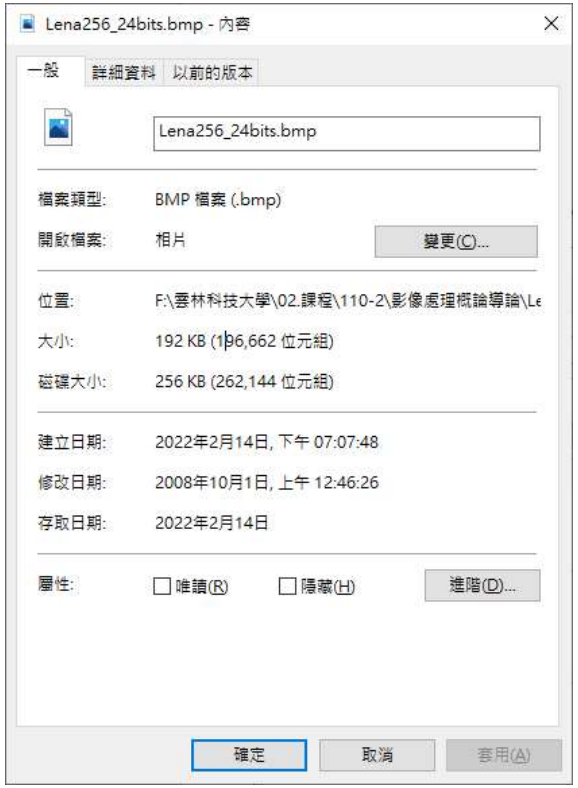
- **User Interface (UI)**
- **Algorithm**
- **User Interface (UI) + Algorithm**
  - **C++ Pointer *f***
  - **C++ Pointer *g***

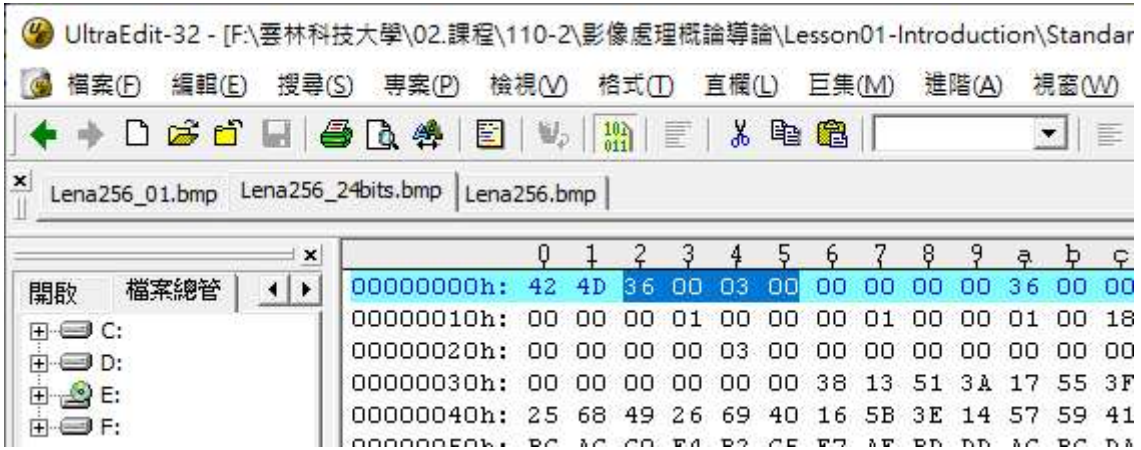
Lesson 02: Introduction

DIP-Single Form

- OpenFileDialog 物件(UI) -> Bitmap 物件 (C#)
  - pictureBox 物件(UI)
  - int(f)

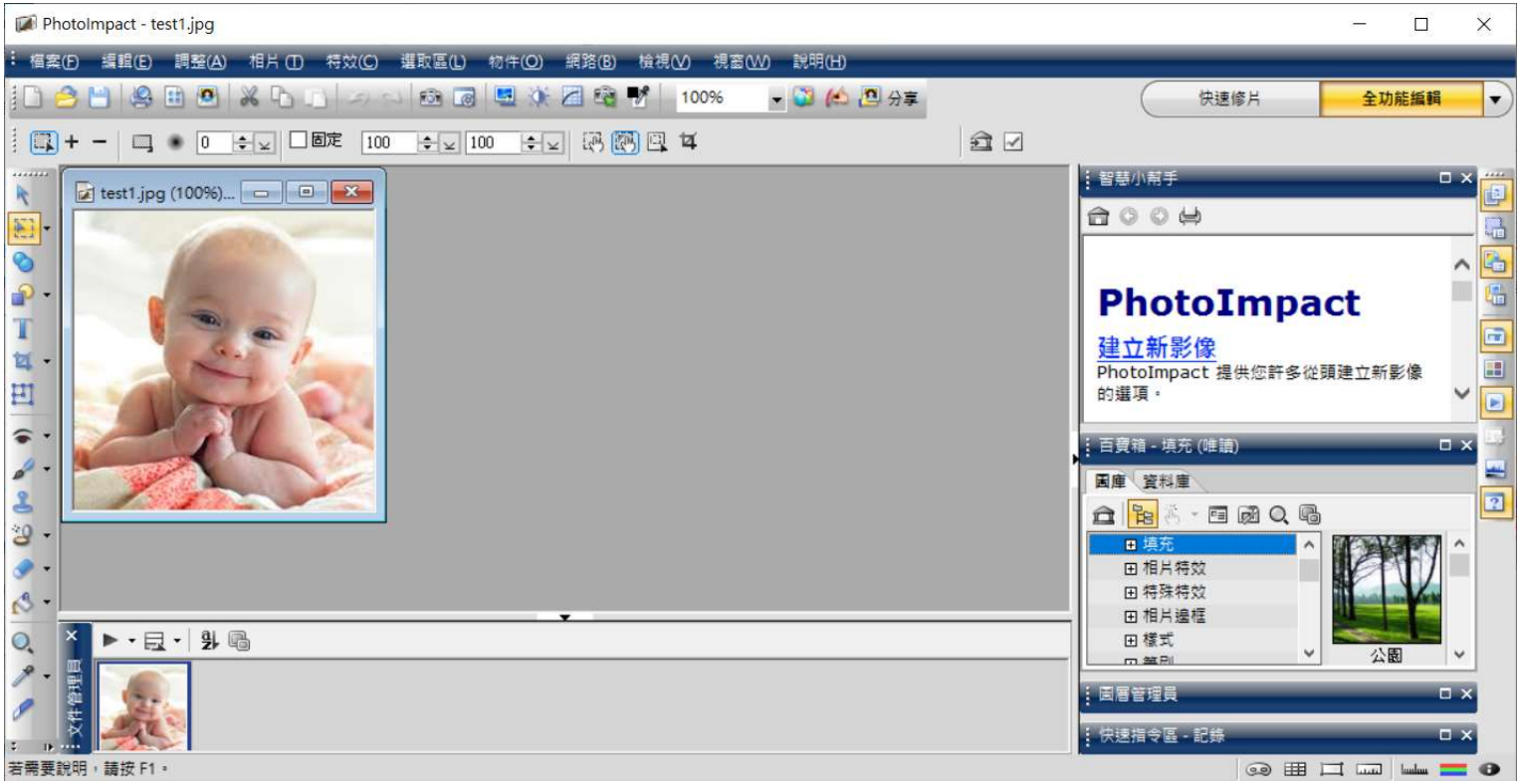
BMP Format



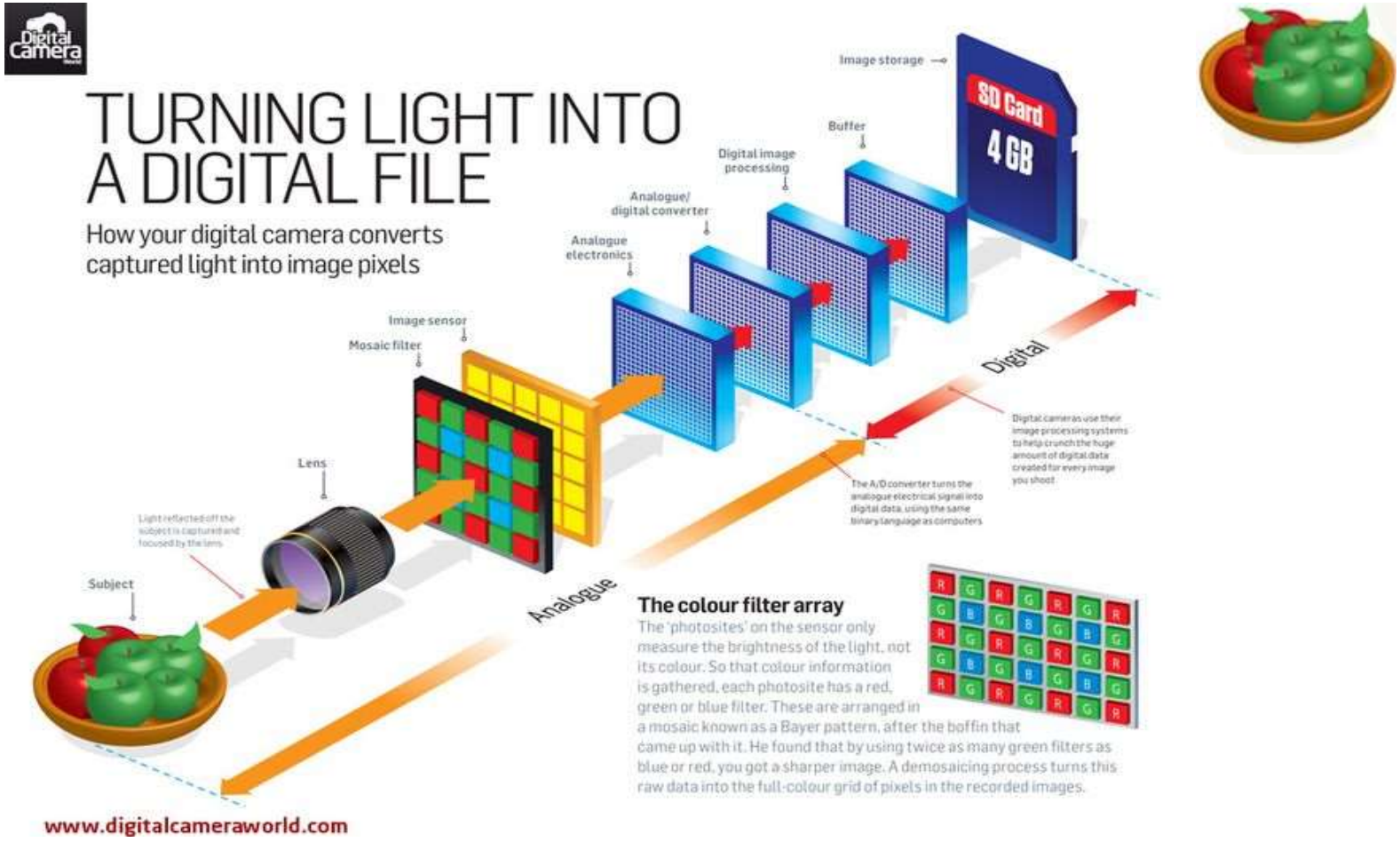


https://www.itread01.com/content/1549504280.html

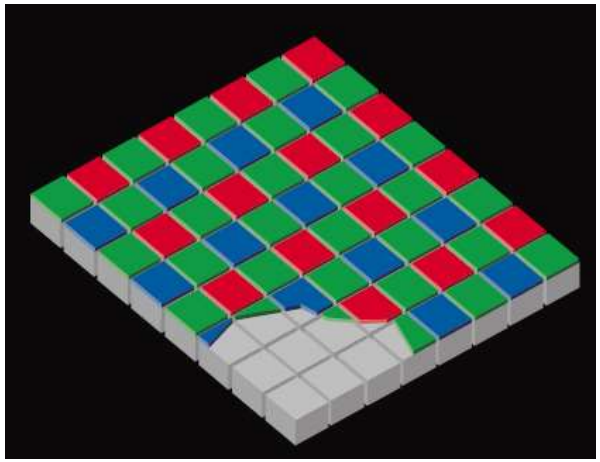
Photo Impact

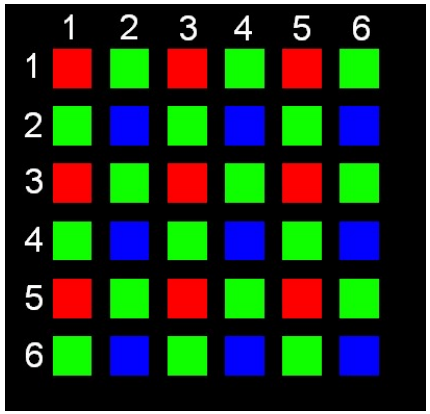


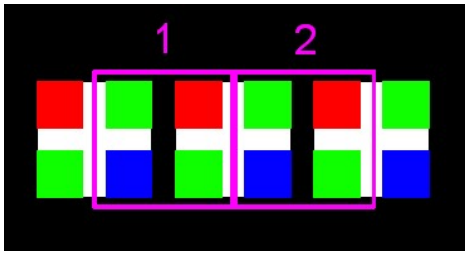
Camera Module

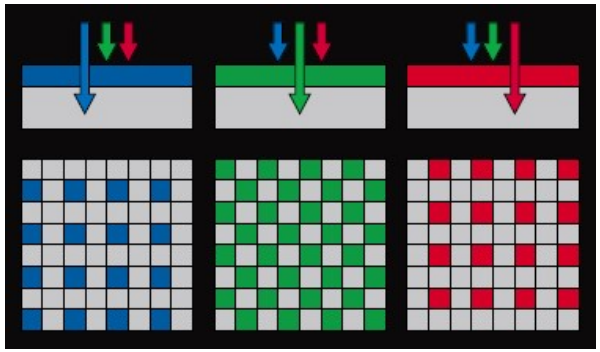


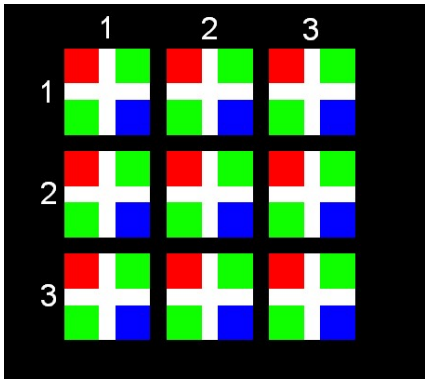
1R2G1B

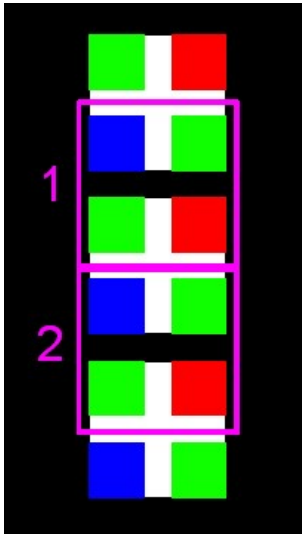






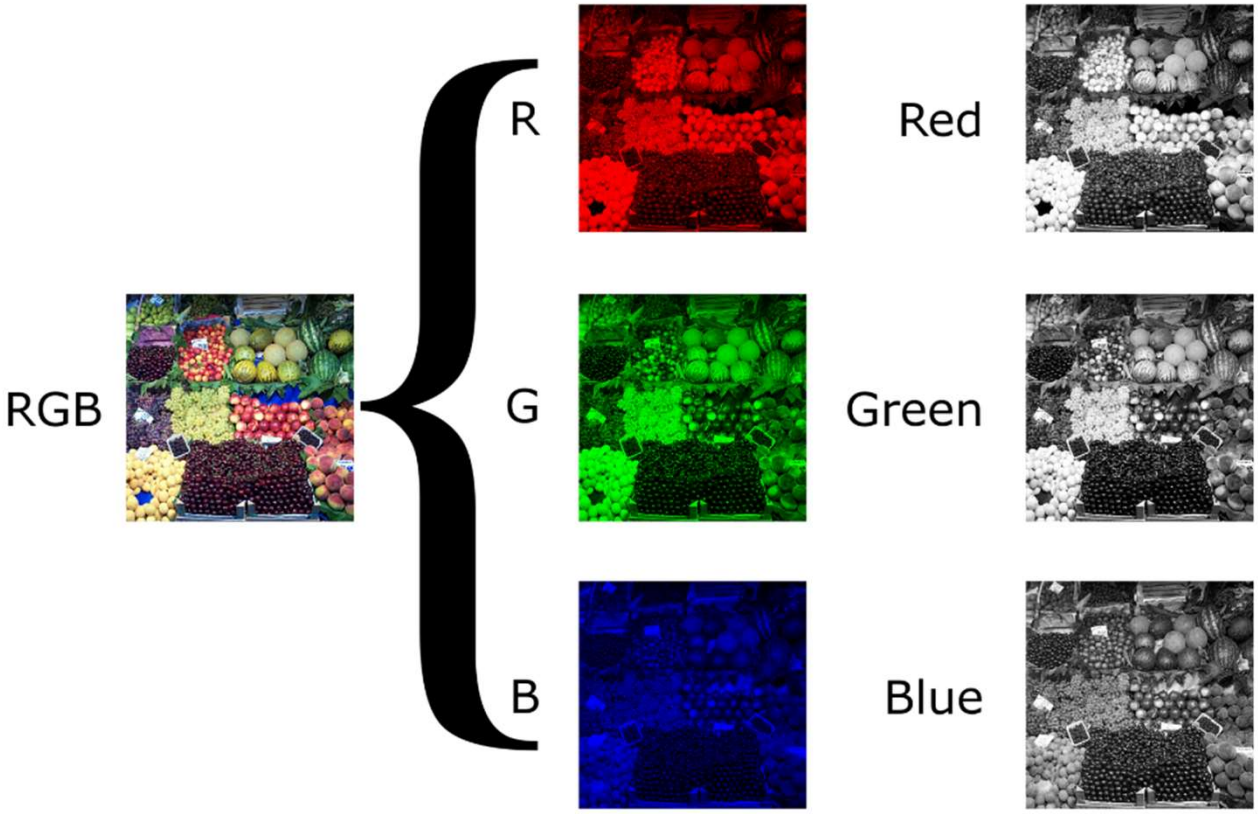






https://en.wikipedia.org/wiki/Bayer_filter

RGB



https://en.wikipedia.org/wiki/Grayscale

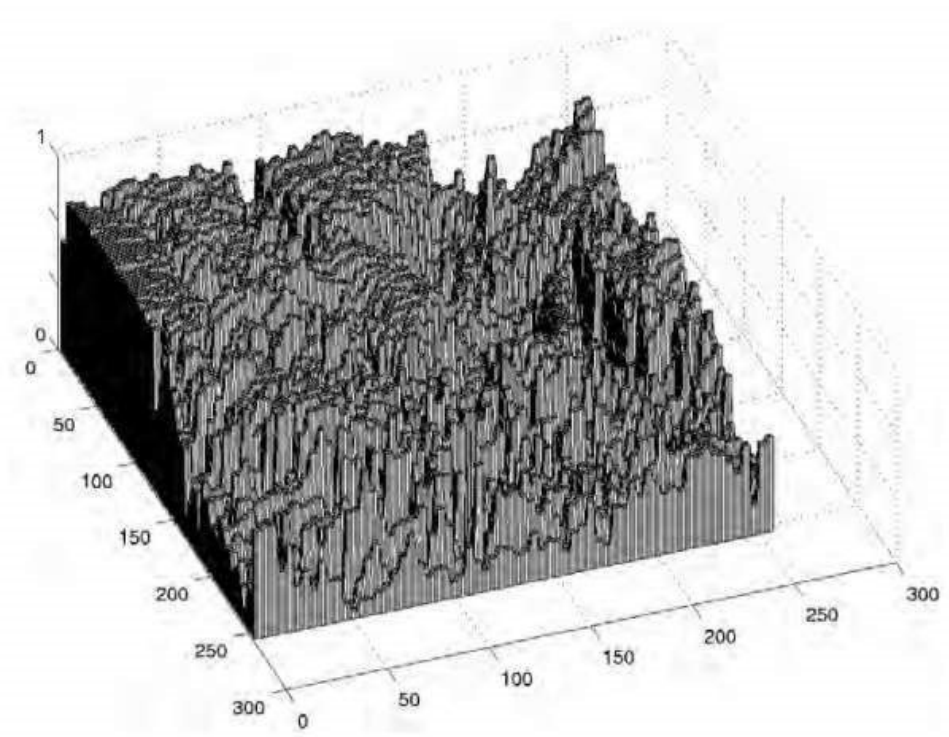
Image Representation in 2-Dim

20	23	12	5	7	9	22	30
22	32	16	5	8	12	11	23
29	32	16	11	70	30	20	20
100	142	3	45	44	200	50	22
103	120	33	41	200	50	22	70
120	210	22	123	23	70	69	160
12	222	24	126	90	20	6	60
212	252	243	26	149	221	61	90

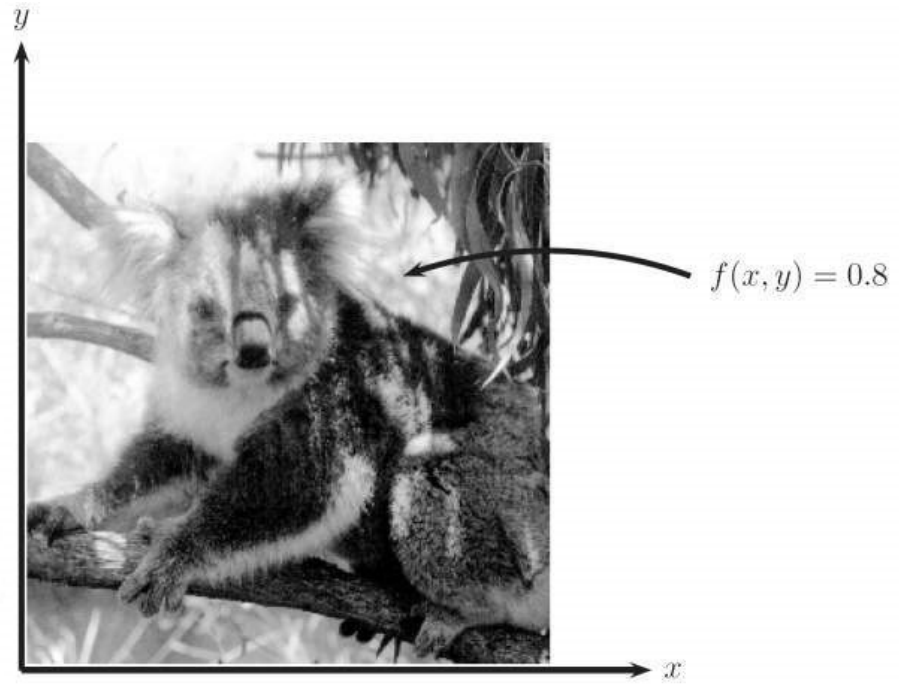
- $f(0,0)$: 20
- $f(1,0)$: 23
- $f(2,0)$: 12
- $f(0,7)$: 212

$$z=f(i,j)$$

Magnitude vs Light



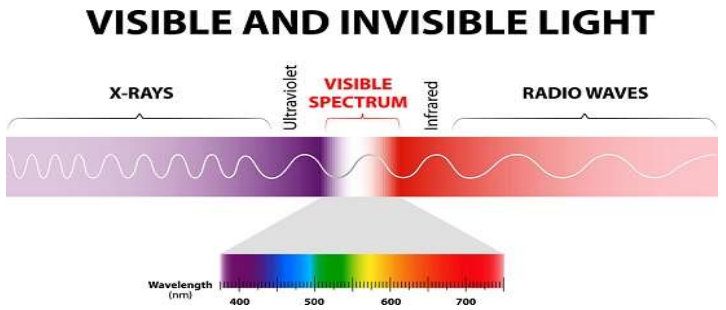
z: *z*-axis magnitude

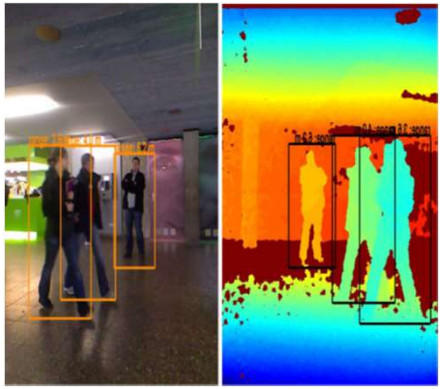


z: brightness of lights

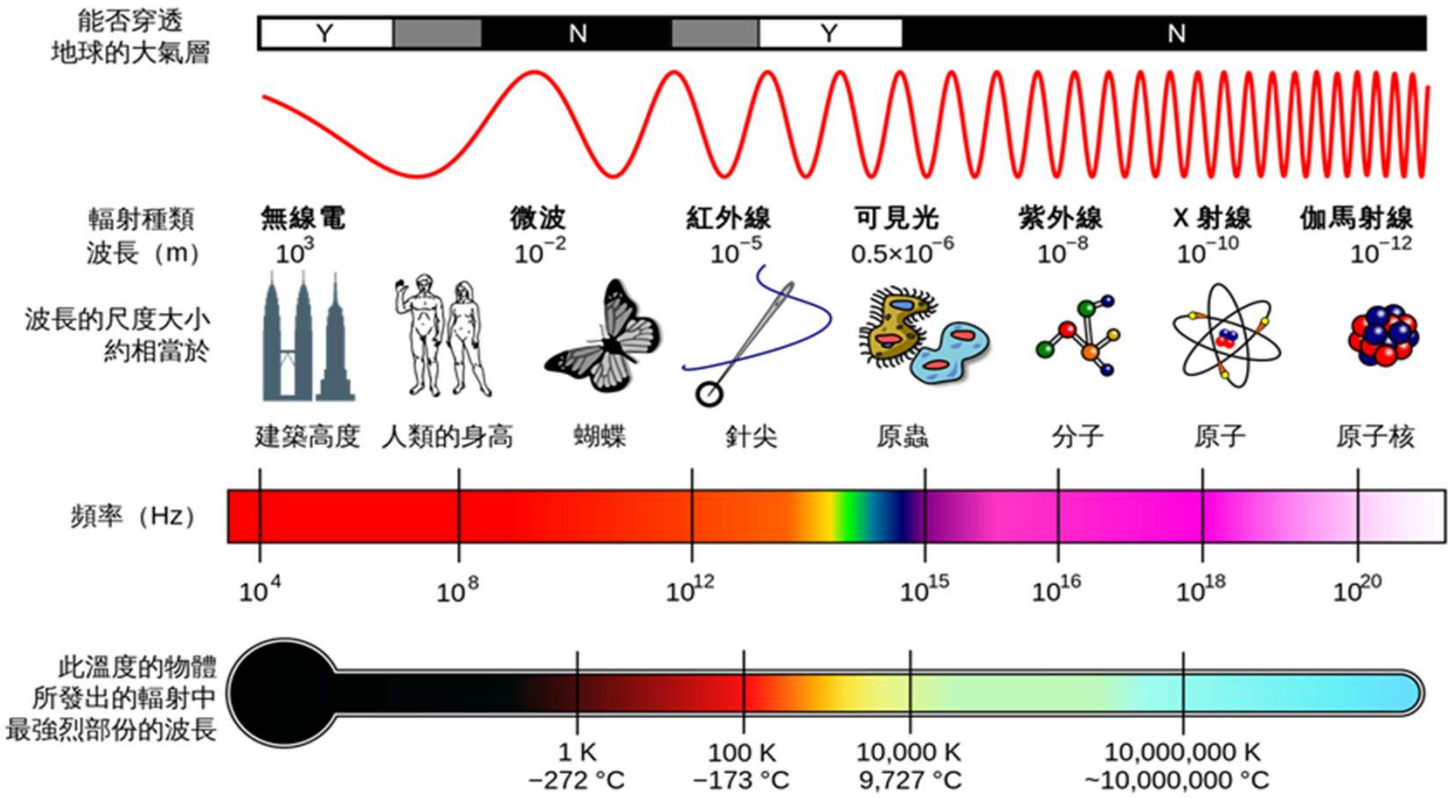
Any Possible Signal *z*

- Visible light, Infrared (IR)
- Ultrasonic
- Medical (CT and MRI)
- Microwave (SAR)
- Alpha ray
- Earthquake, Weather
- …
- Everything



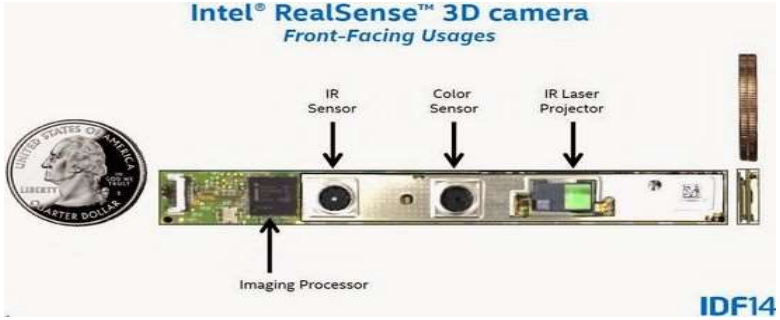


Spectral Characteristics

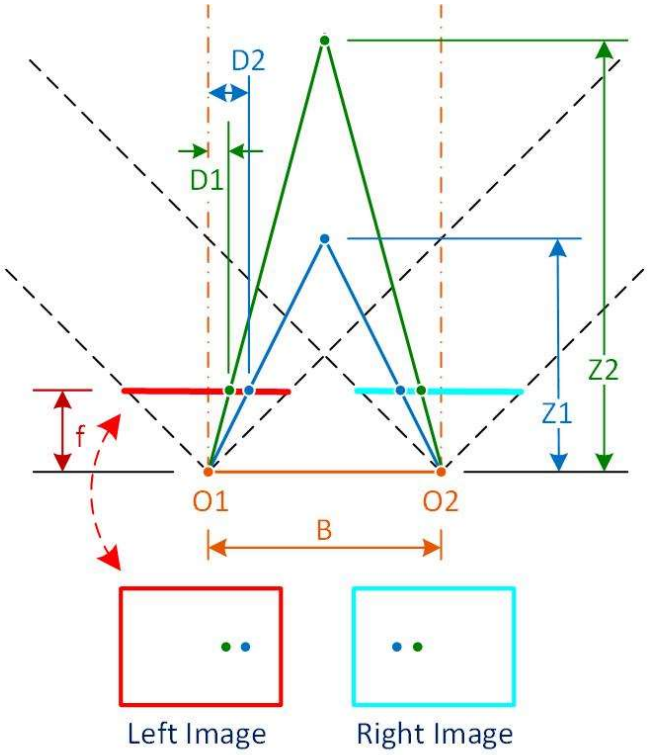


https://www.narlabs.org.tw/xcscience/cont?xsmsid=0I148638629329404252&sid=0J009494851141638603

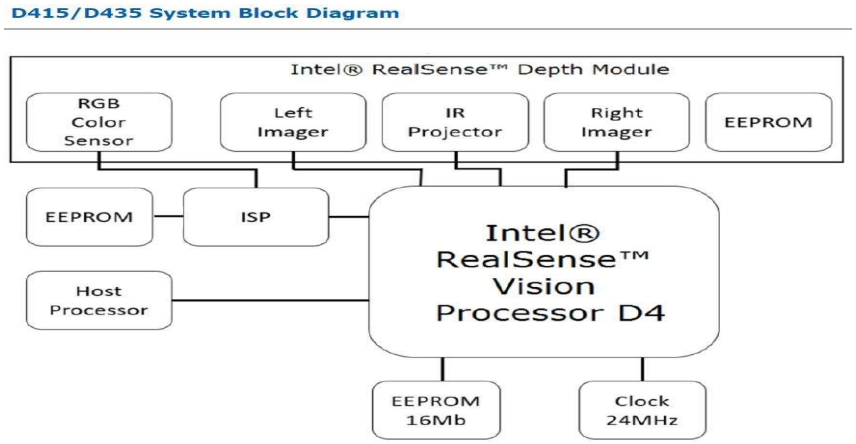
Intel RealSense 3D & ZED

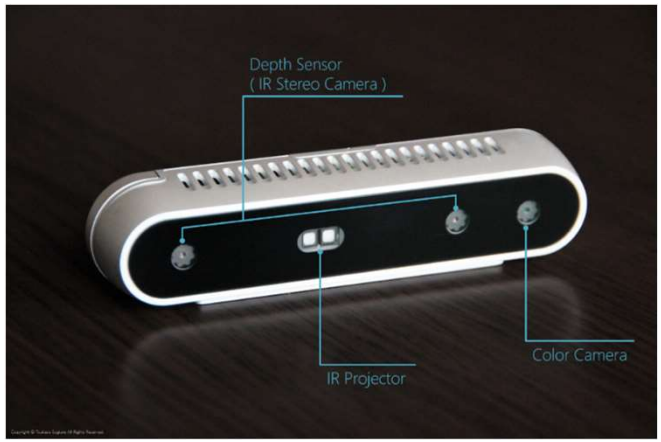


Intel RealSense 3D



Intel RealSense D435



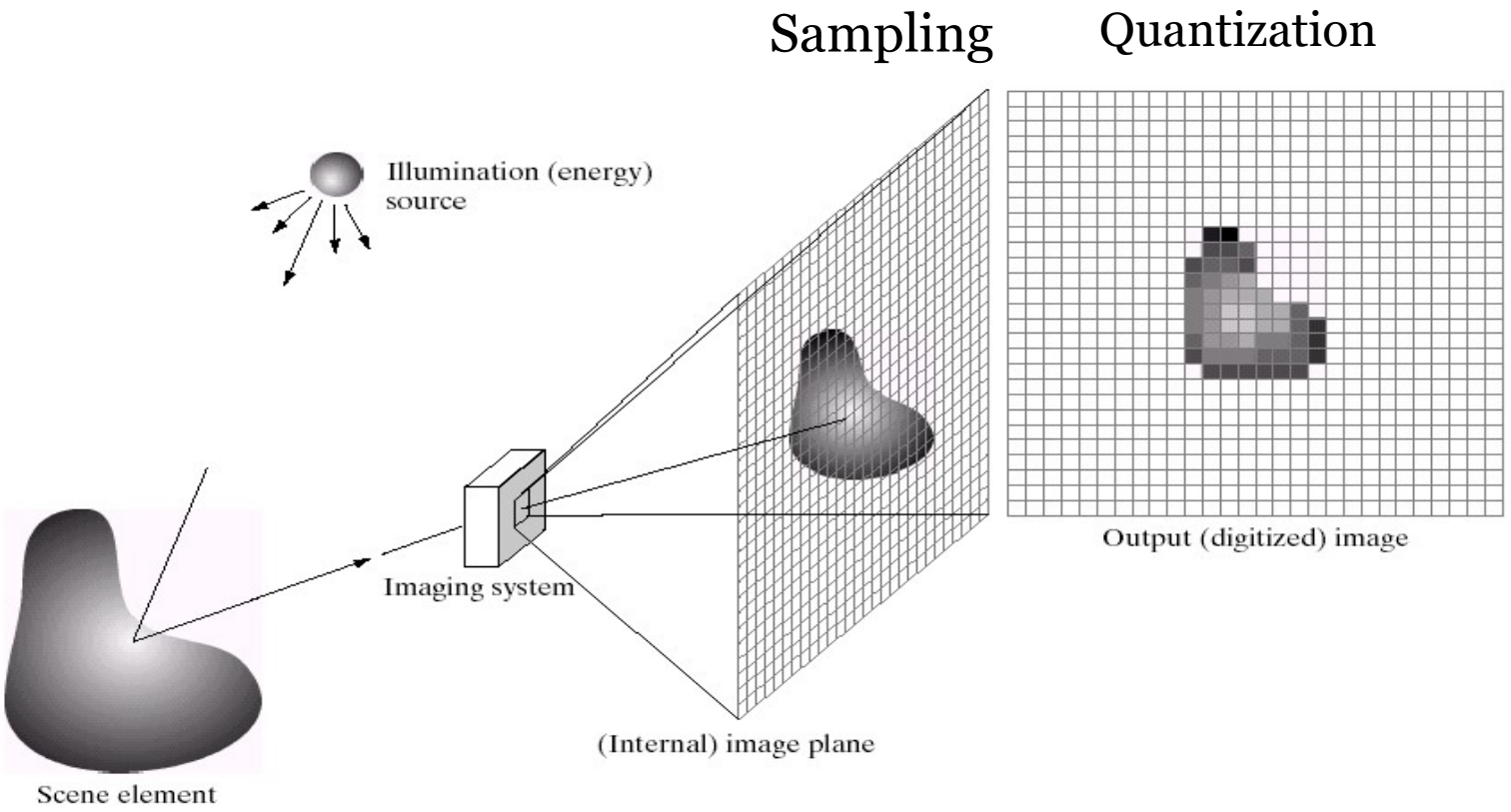


- Depth frame
- Color frame
- Infrared frame

Resolution

- Capture
- Representation
- Display & Printout
- Storage

Capture



a b c d e

FIGURE 2.15 An example of the digital image acquisition process. (a) Energy ("illumination") source. (b) An element of a scene. (c) Imaging system. (d) Projection of the scene onto the image plane. (e) Digitized image.

Representation

- Quantization: 8-bit, 256 levels


1(binary)-level

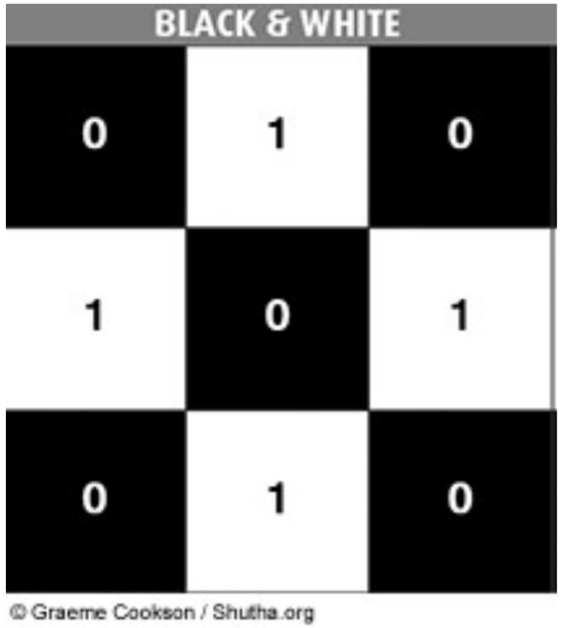

16(4 bits)-level


256(8 bits)-level


24 bits

- Sampling:
  3,456×2,304= 7,962,624 (8 Megapixel)
  5,184×3,456=17,915,904 (18 megapixels)

RGB, Gray & Binary



https://en.wikipedia.org/wiki/Grayscale

$0.2989 * R + 0.5870 * G + 0.1140 * B$

Size of Gray Level Image

- A 352 × 240 8-bit gray level image
  - 352 × 240 × 8/8=101,376 bytes (CIF video)

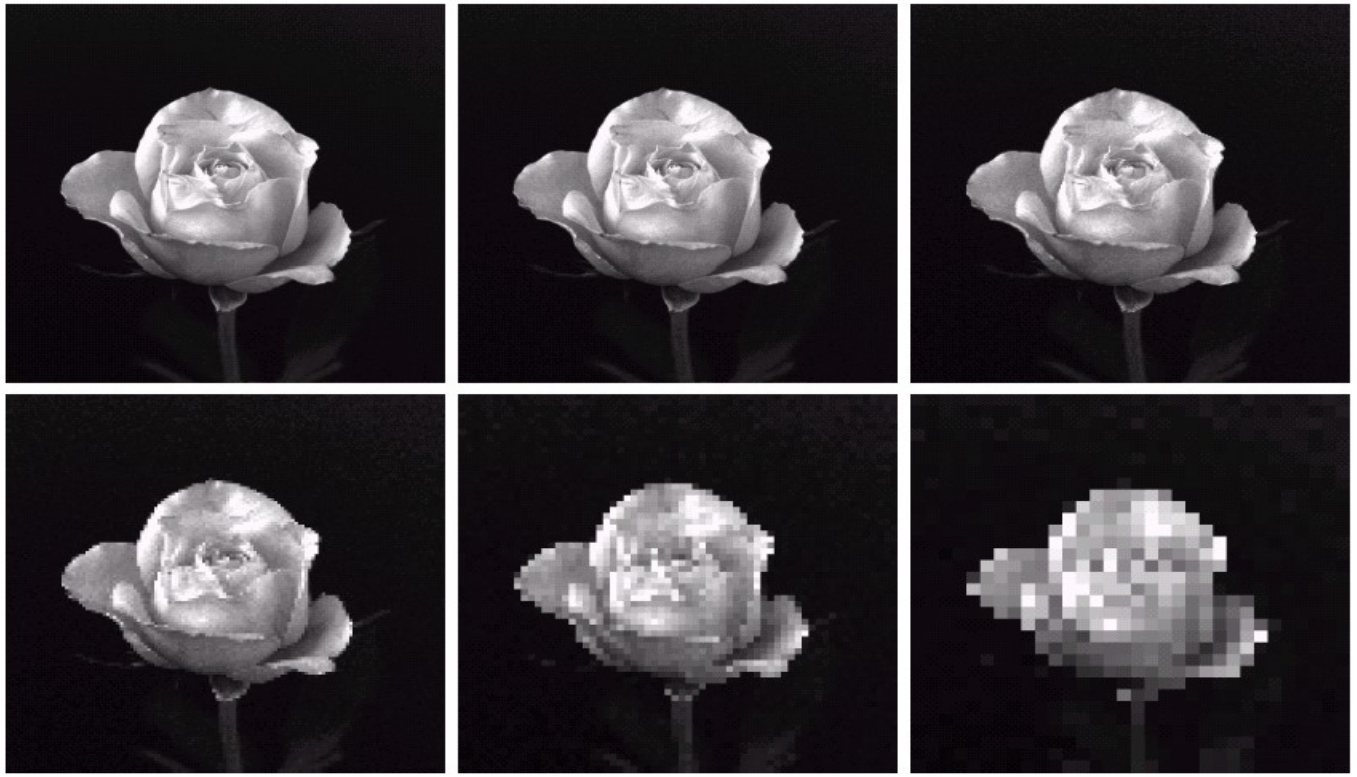
- 5,184×3,456×3=53,747,712 bytes

Subsampled down

FIGURE 2.19 A 1024 × 1024, 8-bit image subsampled down to size 32 × 32 pixels. The number of allowable gray levels was kept at 256.

Digital Image Processing (Gonzalez and Woods)

Subsampled down



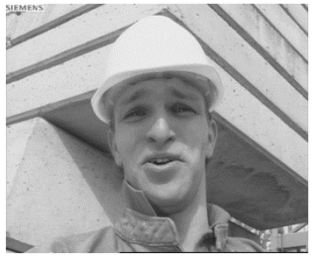
a b c
d e f

FIGURE 2.20 (a) 1024 × 1024, 8-bit image. (b) 512 × 512 image resampled into 1024 × 1024 pixels by row and column duplication. (c) through (f) 256 × 256, 128 × 128, 64 × 64, and 32 × 32 images resampled into 1024 × 1024 pixels.

Resolution Improvement

- Resolution in the **spatial direction**
  - Number of pixels in a ‘fixed” spatial range
  - Image super-resolution
- Resolution in the **intensity direction**
  - Number of levels from the darkest to the lightest
  - High dynamic range image (HDR)
- Resolution **in time** (audio, video)

Super-resolution on (x,y)



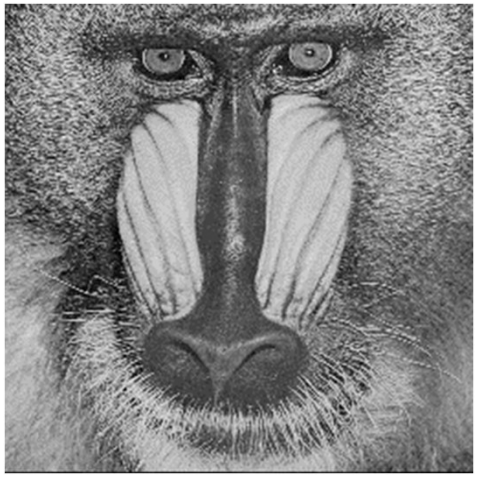
High Dynamic Range on Z

- Fixed camera, scene
- Various exposure settings




Fusion image

Exercise

0.5  + 0.5 

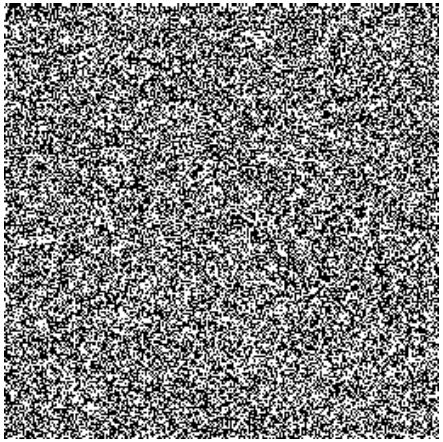
g f

Exercise






Bitplane



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