電腦視覺與深度學習
(Computer Vision and Deep Learning)
Homework 1

TA:

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Office Hour: 17:00~19:00, Mon.

10:00~12:00, Wed.

At CSIE 9F Robotics Lab.

Notices (1/2)

❑ Copying homework is strictly prohibited!! Penalty: Grade will be zero for both persons!!

❑ If the code can't run, you can come to our Lab within one week and show that your programming can work. Otherwise you will get zero!!

❑ Due date =>??
  ▪ No delay. If you submit homework after deadline, you will get 0.

❑ Upload to => 140.116.154.1 -> Upload/Homework/Hw1
  ▪ User ID: cvdl2020   Password: cvdl2020

❑ Format
  ▪ Filename: Hw1_StudentID_Name_Version.rar
    • Ex: Hw1_F71234567_ 林小明 _V1.rar
    • If you want to update your file, you should update your version to be V2, ex: Hw1_F71234567_ 林小明 _V2.rar
  ▪ Content: project folder*(including the pictures)
            *note: remove your "Debug" folder to reduce file size

Notices (2/2)

- ❑ Python
  - ▪ Python 3.7 (https://www.python.org/downloads/)
  - ▪ opencv-contrib-python (3.4.2.17)
  - ▪ Matplotlib 3.1.1
  - ▪ UI framework: pyqt5 (5.15.1)

- ❑ C++ (check MFC guide in ftp)
  - ▪ OpenCV 3.3.1 (https://opencv.org/release.html)
  - ▪ Visual Studio 2015 (download from http://www.cc.ncku.edu.tw/download/)
  - ▪ UI framework: MFC

Grading

1. (20%) Camera Calibration   (出題： Max)
   1.1 Corner detection (5%)
   1.2 Find the intrinsic matrix (5%)
   1.3 Find the extrinsic matrix (5%)
   1.4 Find the distortion matrix (5%)
2. (20%) Augmented Reality   (出題： Oran)
3. (20%) Stereo Disparity Map   (出題： Mark)
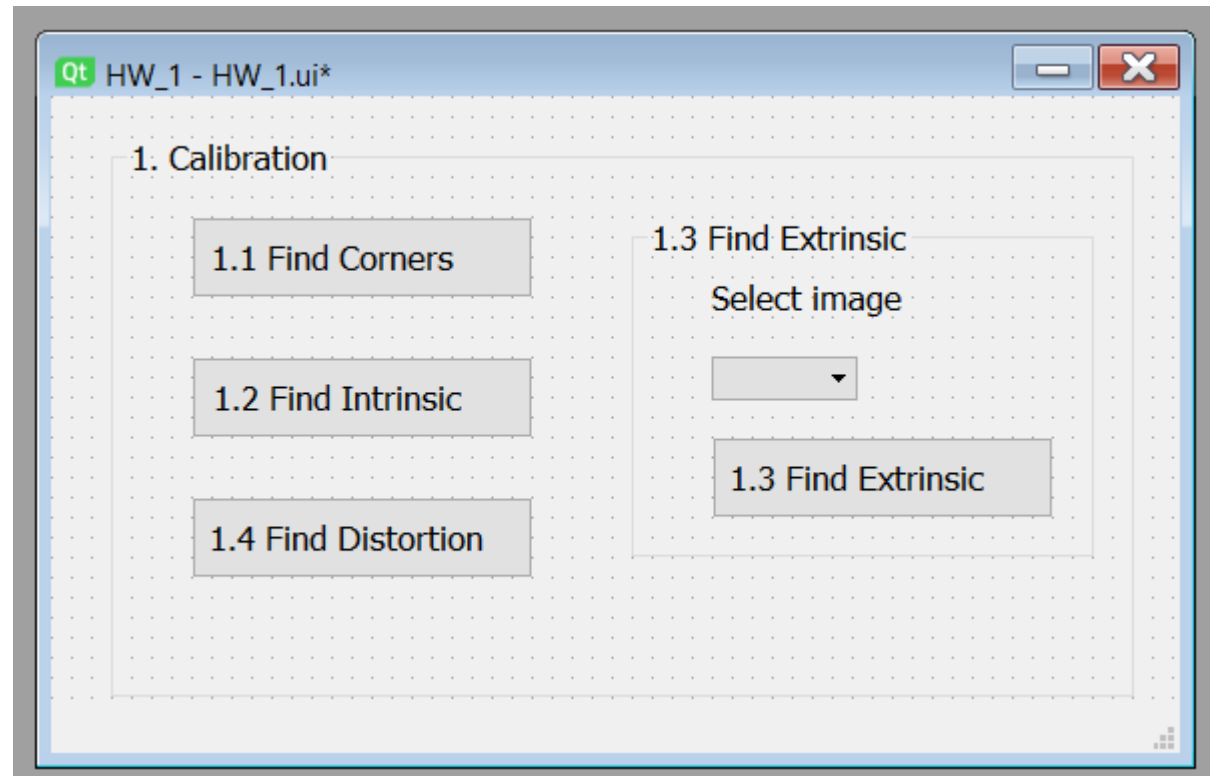
1. (20%) Camera Calibration　　（出題： Max)
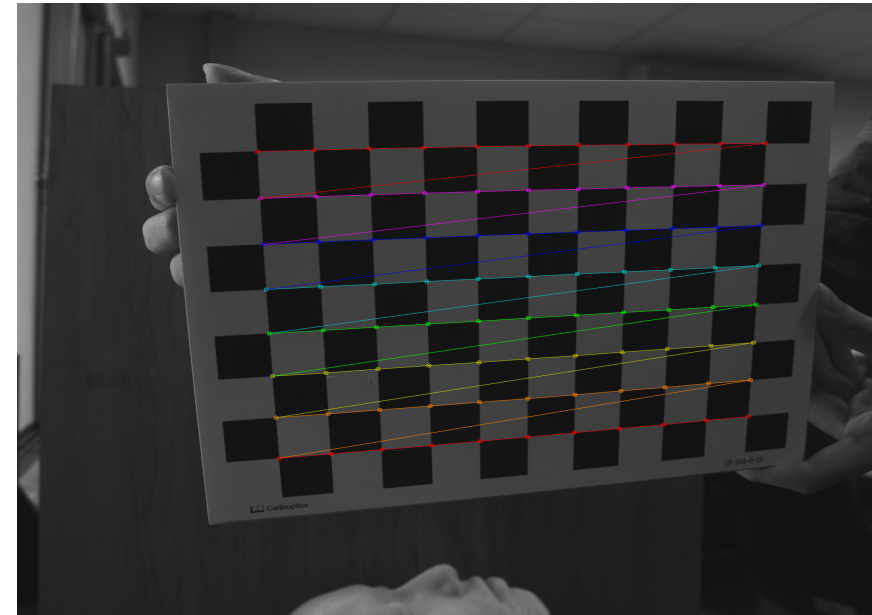
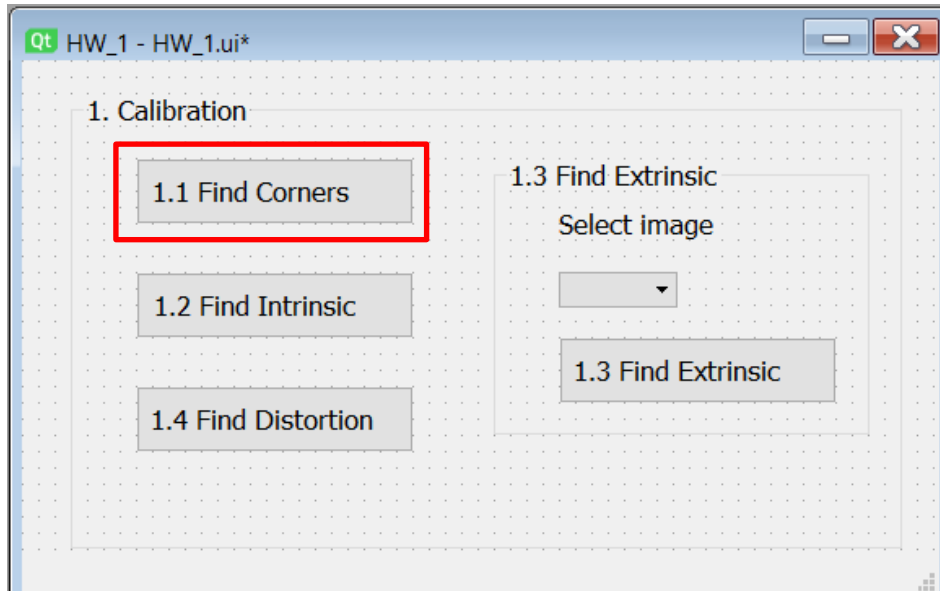1.1 (5%) Corner detection
1.2 (5%) Find the intrinsic matrix
1.3 (5%) Find the extrinsic matrix
1.4 (5%) Find the distortion matrix

1.1 Corner Detection

❑ Given: 15 images, 1.bmp ~ 15.bmp

❑ Q: 1) Find and draw the corners on the chessboard for each image.

      2) Click button "1.1" to show the result.

❑ Hint :

OpenCV Textbook Chapter 11 (p. 398 ~ p. 399)

cvShowImage(…);

❑ Ex:

1.2 Find the Intrinsic Matrix

❑ Given: 15 images, 1.bmp ~ 15.bmp

❑ Q: 1) Find the intrinsic matrix ():

$$\begin{bmatrix} \alpha & \gamma & u_0 \\ 0 & \beta & v_0 \\ 0 & 0 & 1 \end{bmatrix}$$
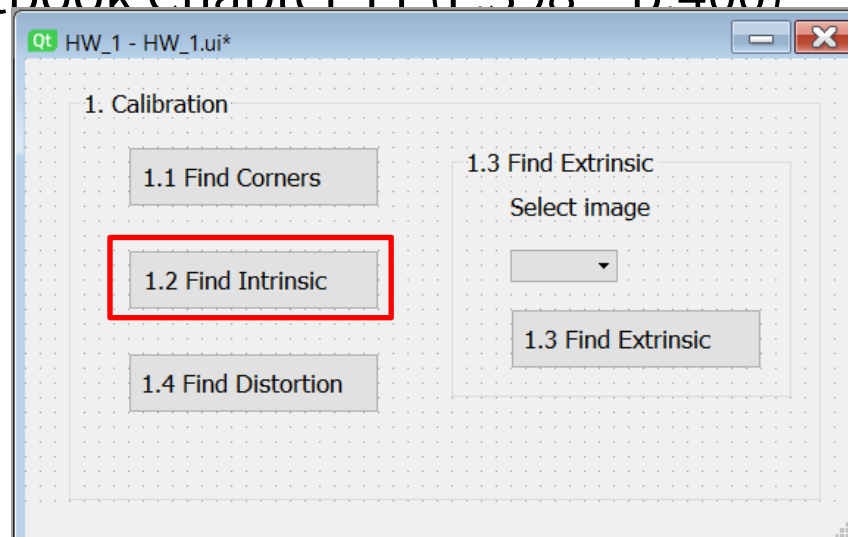
      2) Click button "1.2" and then show the result on the console window.

❑ Output format:

```
[2227.333008, 0.000000, 384.186066;
0.000000, 2226.654541, 299.351746;
0.000000, 0.000000, 1.000000]
```

(Just an example)

❑ Hint: OpenCV Textbook Chapter 11 (P.398 ~ p.400)

1.3 Find the Extrinsic Matrix

❑ Given: intrinsic parameters, distortion coefficients, and the list of 15 images
❑ Q: 1) Find the extrinsic matrix of the chessboard for each of the 15 images, respectively:

$$\begin{bmatrix} R_{11} & R_{12} & R_{13} & T_1 \\ R_{21} & R_{22} & R_{23} & T_2 \\ R_{31} & R_{32} & R_{33} & T_3 \end{bmatrix}$$

2) Click button "1.3" and then show the result on the console window.
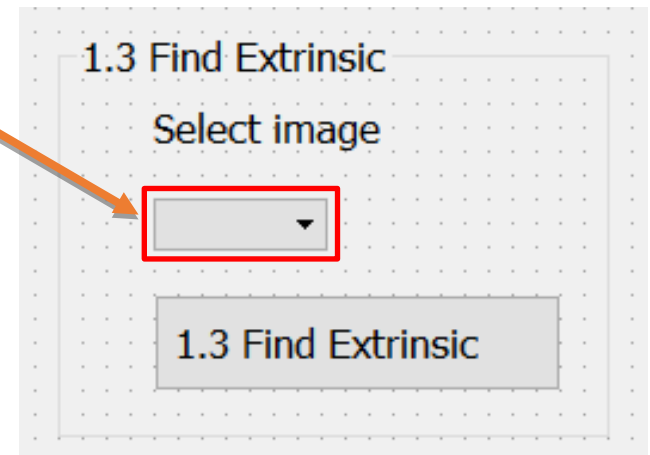
❑ Output format:
```
[-0.128827 ,0.991169 ,-0.031426 ,-1.969988 ;
0.983549 ,0.131755 ,0.123583 ,-1.105037 ;
0.126632 ,-0.014988 ,-0.991836 ,49.121323 ; ]
```
(Just an example)

❑ Hint: OpenCV Textbook Chapter 11, p.370~402

(1) List of numbers: 1~15
(2) Select 1, then 1.bmp will be applied, and so on

1.3 Find Extrinsic

Select image

1.3 Find Extrinsic

1.4 Find the Distortion Matrix

❑ Given: 15 images

❑ Q: 1) Find the distortion matrix: $[k_1, k_2, p_1, p_2, k_3]$

   2) Click button "1.4" to show the result on the console window.

❑ Output format:

`[-0.072230, -0.261944, -0.000024, -0.003354, 4.228090]`

(Just an example)

❑ Hint:

   ▪Distortion coefficients can be obtained simultaneously with intrinsic parameters

   ▪OpenCV Textbook Chapter 11 (P.398 ~ p.400)
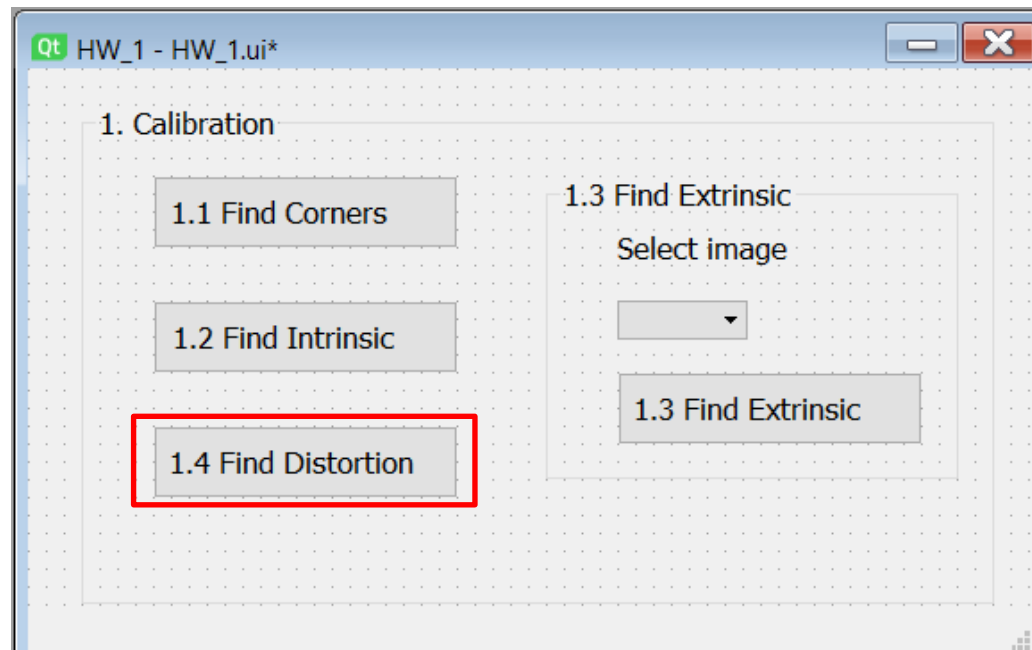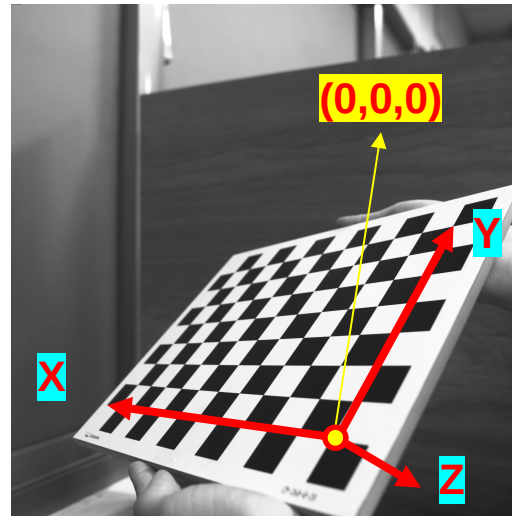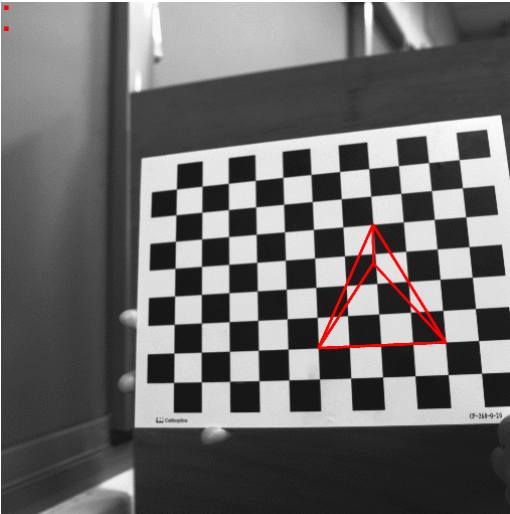
2. (20%) Augmented Reality　　　　（出題：Oran)

❑ Given: 5 images: 1~5.bmp
❑ Q:

　　1) Calibrate 5 images to get intrinsic, distortion and extrinsic parameters
　　2) Draw a "tetrahedron" on the chessboards images(1.bmp to 5.bmp)
　　3) Click the button to show the pyramid on the picture. Show each
　　　　picture 0.5 seconds (total 5 images)

❑ Hint : Textbook Chapter 11,　p.387~395 Calibration
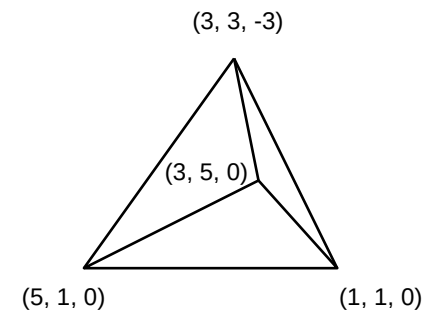　　　　　　　　　　　　　　　　 p.405~412 Projection

`cv::calibrateCamera()`

`cv::projectPoints()`

Demo

• 3D Object coordinates:
　　Vertex　(3, 3, -3)
　　Corners(1, 1, 0)(3, 5, 0)(5, 1, 0)

3. (20%) Stereo Disparity Map　　　（出題： Mark)

✈ Given: a pair of images, imL.png and imR.png (have been rectified)
✈ Q: Find the disparity map/image based on Left and Right stereo images.
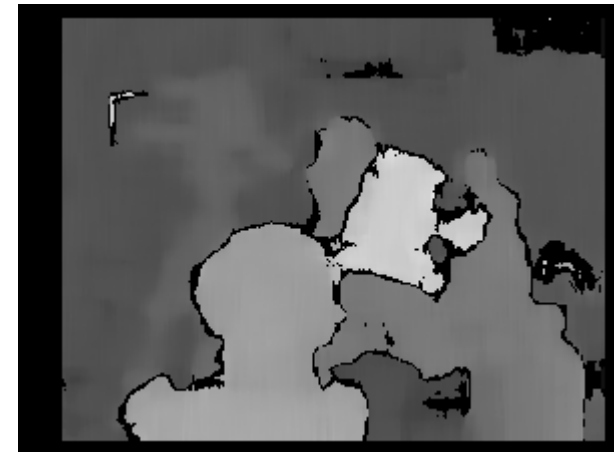

imL.png

Left Image (Reference Image)

imR.png

Right Image

3.1 Disparity Map

❑ Guides:
(1) Block/window Size: Must be odd like 5 (suggestion), can be [5, 255]
(2) Search range and direction:

  ▪ Disparity range:
    • Must be positive and divisible by 16.
    • Map disparity range to gray value range 0~255 for the purpose of visualization.

  ▪ If the left image is the reference image (the one used to cal. depth info for each pixel of that img), then the search direction at right image will go from the right to left direction.

✈ Hint: OpenCV Textbook Chapter 12 (P.451)
  StereoBM::create(64, 9);

Result