10 September 2020

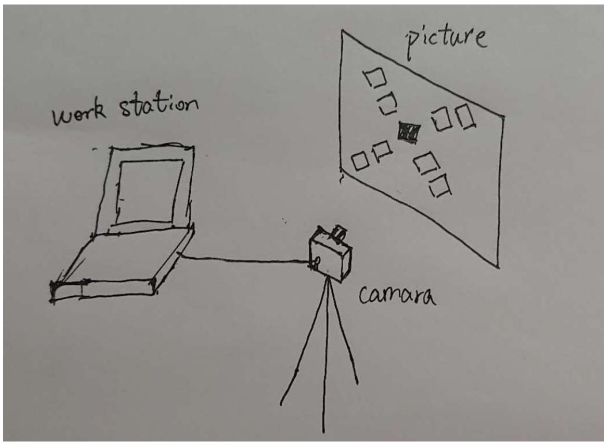
Image Processing

First prelab:

- Introduction:
  In this experiment, together with corresponding teaching assistant and teammates, I will learn the basic concepts about digital camara that how such stuffs work to capture and to store the picture. Then we will compose a program with Python or Matlab to scan the patterns and extract some information hiding in the image, meaningful for scientific research, to analyze data for results and conclusions.
- Background Information:
  The digital camara is a filmless camara that, with a sensor, converts lights into electric charges. By reading the charges of each cells, the analog-to-digital converter will translate the data of each pixel to binary code. In this lab session, the CCD type sensor is applied to the digital camara. Compare to CMOS sensor, the CCD sensor will offer more accurate image with little noise, because of the sensitivity difference of these two chips. The sensitivity is determined by the method how photons hit the sensor's electric components. However, the CCD sensor is more energy consuming.
  Image's resolution is described by the total number of the pixels in an image. An image with higher resolution, i.e. more pixels used to store the information about the original figure, is easier for people to recognize the details.
  To make the picture colored, some digital camaras use beam splitter to separate original light beam into 3, and 3 beams will be detected by 3 sensors that correspond to calculate the values of red, green and blue. With such 3 values, the chip can reverse the calculation to obtain the original colors.
  Dynamic range (DR) for digital camara is the scale that distinct grey level of the colors. With greater DR, we can find small difference of grey, with which we will obtain more visible pattern in extreme dark or bright environment.
  Being different from traditional film camara, sensor in digital camara can be reset electrically. By adjusting the size of aperture, automatically or manually, appropriate amount of light will hit sensor in shutter time, just like hitting real film, to finish exposure.
  There are 4 ways of focusing, fixed-focus, optical-zoom focus, digital-zoom focus and lens replacing. For fixed-focus, the system is economical but limited. Optical-zoom is like rotating the lens of those film camara, but the digit camara can adjust the lens group automatically. Digital-zoom is to pick the pixels at the center of the sensor and enlarge the pattern, and the clearness is determined by

the resolution of the sensor. Some other type digital camara, like SLR camara, the lens can be changed by users for different propose.
If image moving, like things in TV, we need methods to refresh screen. When TV was huge and heavy, the pattern was created by electrons hitting screen, one pixel by one pixel. Due to the limitation of bandwidth, the CRT display would scan the odd number array first, and then scan the even number array repeatedly. As old pattern will remain in human's sight, people would not recognize the flash of the image. This scanning method is called interlace. The old TV station delivered signals with NTSC encoding system, which was widely used in north America and east Asia. NTSC had 525 scan lines totally, i.e. 480*640 resolution in pixels, and 29.97 frames per second (due to interlace, the scan frequency is 60Hz). As NTSC is an outdate encoding system, a German innovated PAL system which was firstly applied by BBC in 1964. PAL has higher resolution: 625 scan lines, 576*720 in pixels and different refresh frequency: 25 frame per second. Recently, on computer screen, the progressive scanning is applied and the refresh frequency is 60Hz to 85Hz, if the screen is used for video games, like esports, the refresh frequency will reach 144Hz, even 300Hz. Meanwhile, the aspect-ratio changed from 4:3, for old TV, to 16:9.

- Equipment setting:



- Tasks:

1, Learning the working procedure of digital camara.
2, Learning the basic knowledge of digital image.
3, Learning how to use Edmund Resolving Power Chart and the formula:

$$resolution(in\ second\ of\ arc) = \frac{8121}{D(dis\ in\ inch) * LPMchart}$$

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In the first lab session, we will finish the task: measuring the resolution of the digital camara (with CCD sensor) by using Edmund Resolving Power Chart. There are 3 different patterns to be used, and for each pattern, the calculated result of the digital camara would be closed to each other.

In-Lab (12:00 pm, 10-Sept-2020):

Procedure:

- TA hung the picture on board and set the camara in front of the picture.
- TA capture the photos of the picture with different distance.
- TA send us the photos with the guideline of Edmund Resolving Power Chart.

Data and calculation:

Photo 1: D=82cm=32.2834inch

LPM(group 0, element 4)=1.41

Resolution=178.41”

Phtoto 2: D=58cm=22.8346inch

LPM(group 1, element 1)=2.00

Resolution=177.82”

Photo 3: D=56.5cm=22.2441inch

LPM(group 1, element 1)=2.00

Resolution=182.54”

Mean R = 179.59”

SD = 2.10

Possible error source:

- For Photo 1, the angle of the shooting might reduce the resolution as relating to camara, the bars of patterns are more closed.
- For Photo 2, yellow pattern is too light to be distinguished with background very clearly, which might cause a reduction of resolution.
- For Photo 3, BLACK color is composed by RED, YELLOW and BLUE. When these 3 colors are printed, there will be fuzzy edge. Then the fuzzy edge influences resolution result.

Summary:

In this lab session, TA taught us about the digital camara and demonstrated some digital image with different filter. Then TA sent the photos to us and we practiced to calculate the resolution of the digital camara showing in the lab. As this lab focus more on code and programming, we now is starting compose different filters.