DSP Homework 02

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Contents

Abstract

In this article I write a summary of two videos saw in class, one is about chip production and the other is about taking a picture of black hole. After watching this two video, I have a deep acknowledge of chip industry and I learned a way that the EHT team used to replace a telescope which is as big as the earth. To know how many colors our eyes can distinguish, I write a program using opencv-python to generate two pictures and let the RGB components of two differ by only one latitude more and more each time until I can distinguish them to get the minimum color interval that our eyes can distinguish. Then I use the way that volumes are equal (more detail please go to section 2.2) to calculate how many color our eyes can distinguish. And it was while working on this problem that I first came across the opencv, which brings the idea of my first project. What's more, I read some article and find the time to build our mood need, and through the **Nyquist Sampling Theory**, I get the sampling rate of mood, which can rebuild our mood in a day virtually without information lost. As for my first project, I want to make a program based opecv-python to achieve identify my classmates who are in front of my computer camera.

1 Talks About Videos

1.1 Problem Description

Write a summary of this week's videos and your further thoughts on the content.

1.2 Summary of Two Videos

In this week, we saw two videos in class, one is about chip manufacturing, and the other is about the black hole.

The first video talks about how a chip get out of a pile sand. Sand is mainly consist of silicon dioxide, first we mix sand with carbon and oxygen heated to high temperatures to get silicon ingot, and then we cut the ingot to get very very thin wafer. Silicon is a semiconductor, can act as conductors and insulators. But it does not conduct electricity at room temperature, so that we need to mix some other elements that similar to silicon to make it conductive. The most commonly used is phosphorus and boron, producing corresponding n-conductive and p-conductive, respectively. This two conductive can constitute the transistors in chip, which are the smallest micro controller in the chip that control voltage and current. Developers use specific EDA tools to design and blueprint, then it is transferred to a photomask, which is a template for subsequent chip production. At the time of production, the wafer is first oxidized in a high temperature furnace to get insulating layer, and then apply the photoresist evenly, and expose carving in an exposure machine using the mask we mentioned, and after it we need to clean wafer using special way. After a few repetitions, we doping the wafer to enhance it conductive ability. Next, we lithography and clean the wafer again. Repeat two to three times, we finally get chips in the wafer. Then we need to cutting wafer to get single chip and package it. Finally, we get the chip we can use directly. What's more, all those chips making process need to be done at a dust-free environment, even employees have special requirements for work wear.

The second is about black hole, the EHT team published their second photo of balck hole in May, 2022. Taking a picture of a black hole is not simple in principle, because we need a telescope which is as big as our earth. Three hundred astronomers from nearly 80 institutes around the world have joined forces to find a way to make a telescope as big as our planet without using new mirrors, screws or steel. In fact EHT is not a real telescope but a virtual one. They used eight powerful radio telescopes that already existed to collect pick up radio signals from the hot gas around the black hole and image the shadow cast on it by the black hole, combined the observation results and the technique of ultra-long baseline interferometry. They use a special algorithm to fill in the blanks and reconstruct the image. After years of their hard work, the second picture of black hole in the Milky Way come out.

1.3 Further Thoughts After Watching

We all know that lithography machines is the most important part in chip production, there is little mention of the lithography machine in vedio we watched. So I looked it up after class and have a deeper cognition of chip industry and further thoughts about development of Chinese chip.

There is a global shortage of chips nowadays, chip imports are the biggest drain on China's foreign exchange reserves. The chip industry chain is divided into two parts: design and manufacturing. In section of design, we need to determine the purpose of chip, usually chips serve three purposes: logic, storage and power. The logic chips are most widely used, our phones, graphics card and cars are all used this chip. After determine what purpose it is, we need to use VHDL to describe the hardware structure and behavior of the system, then we get HDL code, we use this code to get logic circuit diagram, and finally use it to get physical circuit diagram. This is all about the design section, as for manufacturing part, the video we saw in class is very detailed about this. But what I want to talk about is lithography machine. The development of lithography machines revolves around three theories, the first is Moore's law, it says that after two years, a chip of the same size can have twice the number and performance of transistors integrated inside it, and at a certain stage, the gap between the transistors inside the chip reaches the nanometer scale, ordinary mechanical methods could not achieve such high accuracy, so people thought of light. This leads to the second theory–Rayleigh criterion. It says that the smaller the wavelength of light, the smaller the size it can resolve, so that when the chip size reaches 7nm, the light we use also transitions from DUV(Deep ultraviolet light) to EUV(Extreme ultraviolet light). But the EUV is easily absorbed, so it comes th third theory about absorption, the shorter the wavelength, the easier it is to absorb. To reduce absorption, the mirrors used in lithography machines are very flat, which is been called the smoothest thing

in the world produced by ZEISS SMT in German. Even we used this high tech mirrors, 98% EUV is still absorbed due to its short wavelength. To enhance the ability of photoetching we need to use a light pulse to hit the same drop of liquid tin twice, the first time flattening the tin, the second time actually excites the EUV with enough energy. This is the most difficult part. The Figure1 is a lithography machine use EUV made by ASML.

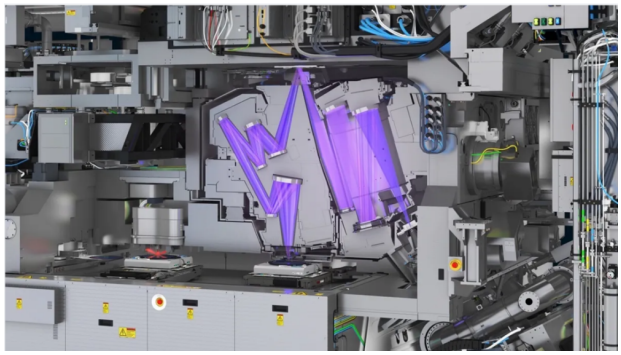


Figure 1: EUV lithography machine

At present, the most advanced company in making lithography is ASML in Netherlands, which has more than 5,000 suppliers, and employee comes from 118 countries, even through ASML holds the most advanced and core lithography machine production technology, it still collaborate with other company. So far, our China are too far behind in the chip manufacturing industry. We should not build our own business behind closed doors. We should actively strengthen exchanges and cooperation with other countries, just like every student, and cultivate our own teamwork ability.

Through the video about black hole, I find that they used a way to construct a telescope which is as big as the earth is a little like sampling. Many things in our lives are not perfect, like our umbrella, there are actually small gaps in the surface of the umbrella, but because of the surface tension of water, water droplets do not fall directly off the surface of the umbrella. Also when we sample a signal, we don't sample it all, it's so amazing for our computer, we sample it at a frequency, which have little impact on rebuilding it. So next time, when we deal with problems, we should grasp the principal contradiction in the matter. Once it is solved, the secondary contradiction will be readily solved. In the video we know that the center of our solar system is the sun, and at the center of the Milky Way is black hole. The Milky Way belongs to the Virgo super cluster, what will be in the center of that and what will be in the center of our universe? It seems so exciting!!!

What's more, in this two video, we can see the importance of teamwork, so we should pay attention to develop our ability of teamwork in our daily life, so as to lay the foundation for our future development.

2 How Many Color Our Eyes Can Distinguish

2.1 Problem description

Find a way to determine how many different colors your eyes can see.

2.2 Idea of solving this problem

Good

We know that computer's screen is RGB mode, it use red, green and blue with different proportions to show different color, the RGB component of each pixel in image is an intensity value ranging from 0 to 255, so the computer can display $256^3 = 16777216$ kind color. But our eyes can only distinguish millions of colors according to Wikipeida, so I write a program to randomly produce different color to fill picture1 and picture2, they are same at first, and based on them, I let one value of picture2's RGB components add one each time, and after doing this, if we can distinguish it with the picture1, we can then stop, else we circle on this process until we can distinguish them. Also the sensitivity to different colors of our eyes varies, so I use a big circle to do several times to avoid coincidence, and get the average value, and at the first we should input how many times we want to circle. This a single circle can be show as Figure2.

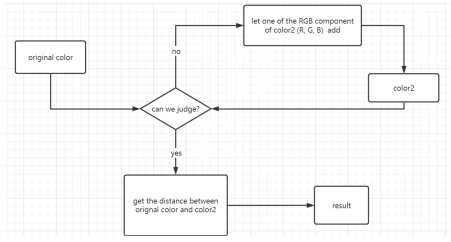


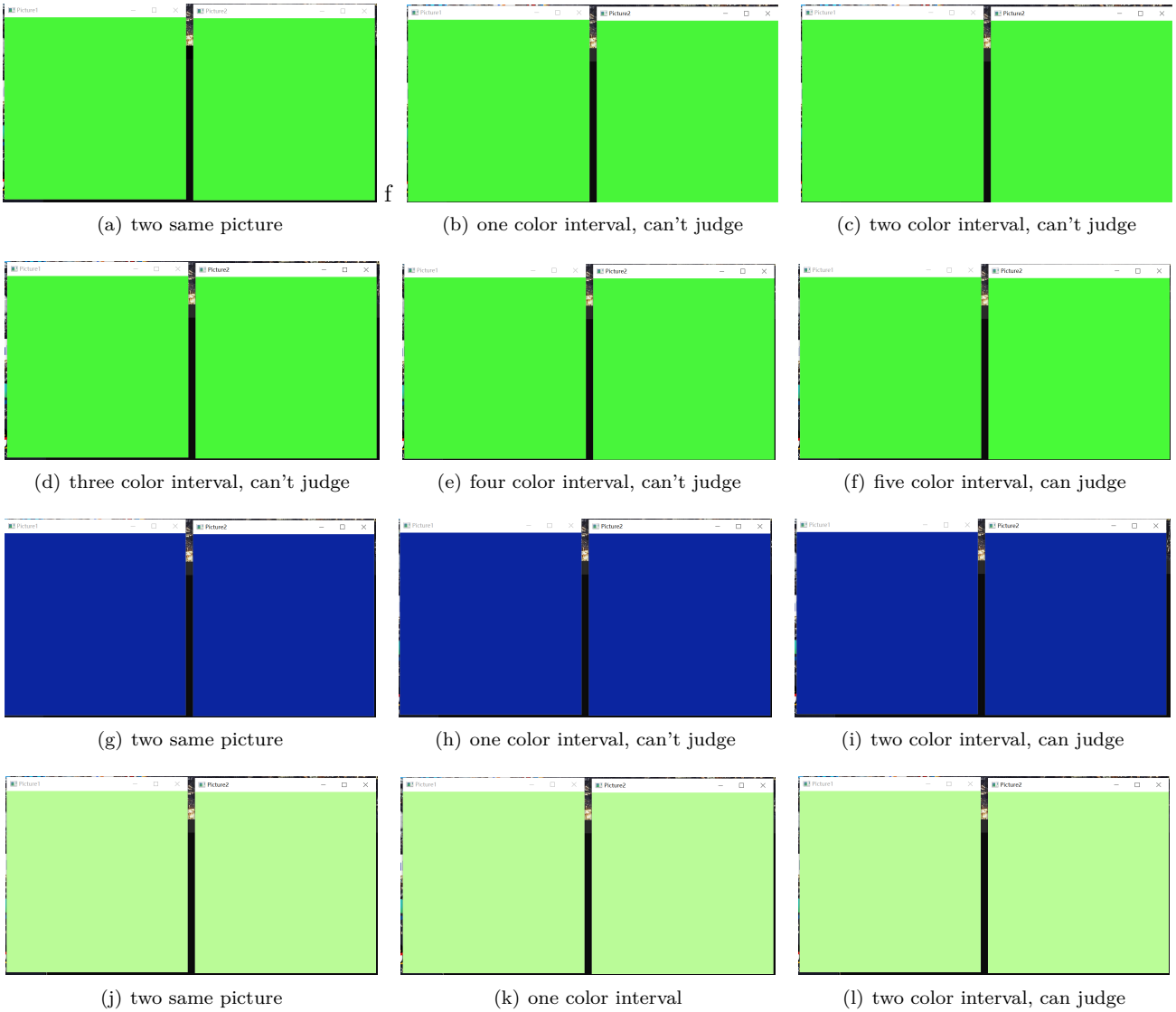
Figure 2: way to distinguish smallest color interval people can distinguish

Through this program we can get the smallest color interval that our eyes can distinguish. When we find the smallest color interval, we can compute how many color we can see using $256^3/(4/3 \times pi \times (r/2)^3)$, where r is smallest color interval. We can understand it as the volumes are equal that all color forms a 256^3 cube of boxes, a color our eyes can distinguish is like a water ball, which its radius is half of the smallest color interval. To fill that cube boxes, we add this water ball, how many water ball we can add is how many color we can distinguish.

Good thought.

2.3 Final Result

Using this program several times, I find that the result have to do with fatigue level of our eyes, reflection of screen and brightness of environment. So to get the relatively precise result, I relaxed my eyes for about 2 hours and did the test in a dark environment to decrease the brightness and avoid reflection of screen. I used three times circle and get the result. The Figure3 shows the testing process and the Figure4 shows the result. **I got answer that we can distinguish about 1186745 kind color!**



(a) two same picture (b) one color interval, can't judge (c) two color interval, can't judge

(d) three color interval, can't judge (e) four color interval, can't judge (f) five color interval, can judge

(g) two same picture (h) one color interval, can't judge (i) two color interval, can judge

(j) two same picture (k) one color interval (l) two color interval, can judge

Figure 3: Three test round

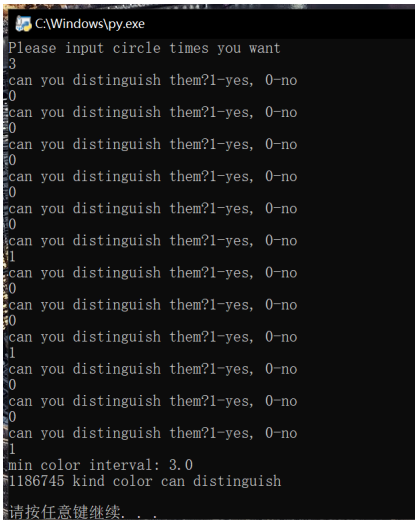


Figure 4: Final result

2.4 Result Analysis

Our result is that human can distinguish about 1 million color, but it is not accurate in fact. Because the visual power differs according to different people, some people are nearsighted, some are farsighted and some also have flashing eyes..... Also I am a nearsighted too, so that it is a approximate value for reference only.

3 An Low-distorted Mood Sampling Way

3.1 Two ways about Production of Moods

In our homework of week 1, we write an article about our brain, through it I know that all human nervous system activity is inseparable from the reflex, reflex is the most basic neural activity, the current theory is to divide the reflex into two kinds, unconditioned reflex and conditioned reflex. The emotional response pathway is also based on a large number of reflexes. As for the generation mechanism of emotional response, research believes that there are two pathways. One is long pathway: stimulation -> thalamus -> cerebral cortex (rational brain) -> amygdala (producing fear) -> hypothalamus (regulating the activity of plant nerves and viscera), the other is short pathways: stimulation -> thalamus -> amygdala (producing fear) -> hypothalamus (regulating the activity of plant nerves and viscera). These two ways can shows as the Figure5.

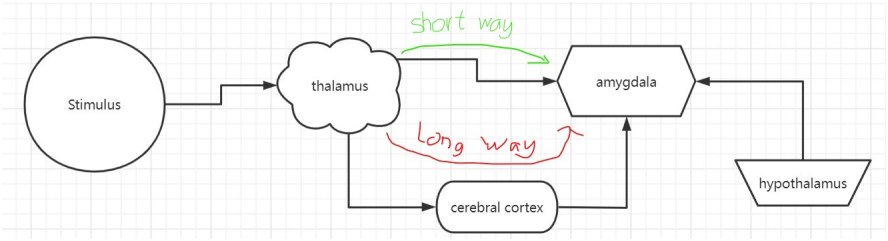


Figure 5: Two ways our mood comes

The stimulus signal is transmitted to the thalamus for processing, and this signal can be divided into two paths. The short path quickly transmits the signal to the amygdala, which determines the emotional response to the event based on the emotional memory information in the subconscious memory, and communicates with other structures of the limbic system through neurotransmitters, generating a series of emotional responses. The other long path, the thalamus sends signals to the cerebral cortex and the prefrontal lobe of the brain analyzes the message and says, such as "Is this something to be angry about?" After the judgment, the amygdala further informed the judgment result, and further regulated the degree of emotional response.

In general: long path of stimulus information after the cerebral cortex (rational brain) of fine processing, to control and take the appropriate response to the mood, short channel stimulus information without the fine processing of the cerebral cortex, faster and ensure respond rapidly to fear stimulus, thus it can be seen, the main function of the amygdala to directly produce accords with the feature of stimulation with the outside world, and produce emotions that are appropriate to the various external information that has been sent to the neocortex.

3.2 Mood Sampling Rate

According to the two mechanisms by which our moods are produced, it takes a certain time for our mood to be produced. So I come out an idea that if our sampling rate is faster than rate of our mood's change, then we can achieve virtually no information lost after sampling. But the problem comes, how can we know how long it takes to product a mood? I searched and read some related articles, and finally I got this data. The average arousal time of the emotional response is 2100ms(SD = 674ms) [1] according to M.M.Bradley and P.J.Lang. Also according to Nyquist sampling theorem, when $f_s >= 2f_m$ we can rebuild the signal without distortion, where f_s is sampling frequency and f_m is the max frequency of signal. So that we can set our sampling rate **once per second**.

4 Proposal of My First Project

4.1 Why Is It?

In this summer holiday, I watched a lot of action movies, of which some of them are about the spy, such as *Mission: Impossible* series, *Bourne Ultimatum* series and *007* series. In this movie, the backstage command center can directly identify a specific person through the monitor on street. I think it is so cool, also it has a strong application value. But due to lack of all people's face picture, I can't do a system to detect all the people in the front of the camera, so I want to do a face identification project about my classmates(22 students).

4.2 Project Describe

In my project, I want to achieve that identify each people in the front of our camera dynamically among my classmates. There is camera on our computer, so we can use this camera to identify each person and show their name on screen. Like the Figure6 shows.

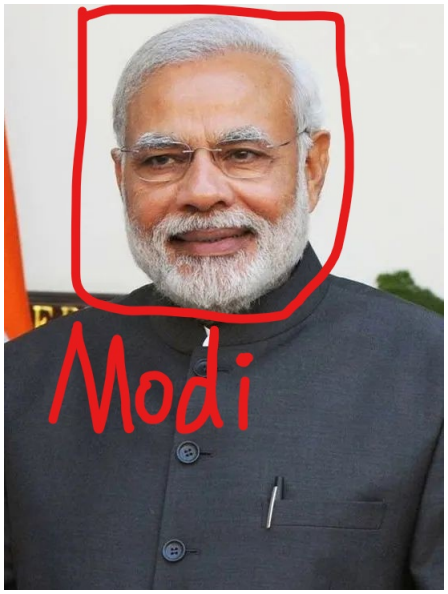


Figure 6: Effect of project

4.3 Further Application

4.3.1 Automatic class check-in

Nowadays, we usually use super-star to generate check-in code in class and then student sign in, but it has a bug. Namely, if student A is not in class, but his friend B is in class, when it comes to check-in, B send this check-in code to A, and then A check in successfully. Using this face identification project, maybe we can identify each student in class and check how many people came, then we can import this to teacher directly without any student knowing it.(*hoping homies who quit classes usually don't blame me, haha*)

4.3.2 Apply to Monitor System of Campus

We often use shared cycling, and occasionally forget things in the bike, we usually go back to the monitor room to see where the bike is to be parked, if the bike is rode away at this time we need to track the location of the bike, until the bike stopped.

But when we are in a search for the bike, it may be rode away again, it's so terrible. So we can apply the face recognition system to the monitoring system on campus, when we went to obtain monitoring and finding bike rode by others, it can identify who rode away the bike, if possible, we will import all the students' contact information in system, so that we can directly contact cycling students to avoid repeated tracking the bike position.

5 Conclusions

(1) Teamwork is becoming more and more important in solving human problems.

(2) Our eyes can distinguish about 1186745 kind color, and the mini color interval our eyes can distinguish is 3.

(3) A sampling rate of our mood that can rebuild our mood without distortion is **once per second**.

References

[1] M. M. Bradley and P. J. Lang. The international affective picture system (iaps) in the study of emotion and attention. 2007.

[2] 彭义升. 情绪反应时间动力性的参数研究. PhD thesis, 首都师范大学, 2012.

[3] 李改. 情绪反应的动力性及其影响因素的研究. PhD thesis, 首都师范大学, 2008.

Appendix A Code listings

```
import numpy as np
import os
import random
import cv2
'''
when you wang to continue, close the picture window first and input the answer,
just follow the order
'''
data=np.zeros((400,400,3),dtype=np.uint8) #a image at size of 400 * 400

res = 0;
times = eval(input('Please input circle times you want\n'))

for i in range(0, int(times)):
    dc = 0                  #dc is increasement at a time
    random_data = np.random.randint(0,246, 3) #not choose 0 to 256 because we need to add the RGB component
    while 1:
        data[:]=random_data #let image have color
        cv2.imshow("Picture1",data)
        pict2 = [random_data[0],random_data[1],random_data[2]]
        loc = random.randint(0,2) #R,G,B one of them add, it's random
        pict2[loc] += dc

        data[:]=(pict2)      #picture2 have difference with picture1
        cv2.imshow("Picture2",data)
        cv2.waitKey(0)
        cv2.destroyAllWindows()
        a = eval(input('can you distinguish them?1-yes, 0-no\n'))
        if(a):
            break
        else:
            dc += 1     #enlarge color interval
            continue

    res += dc
res = res / times                    #average color interval
res2 = int(256**3 / (1/6 * np.pi * res**3)) #calculate the result

print(f'min color interval: {res}\n{res2} kind color can distinguish\n')

os.system('pause') #waiting for click
```