Written report
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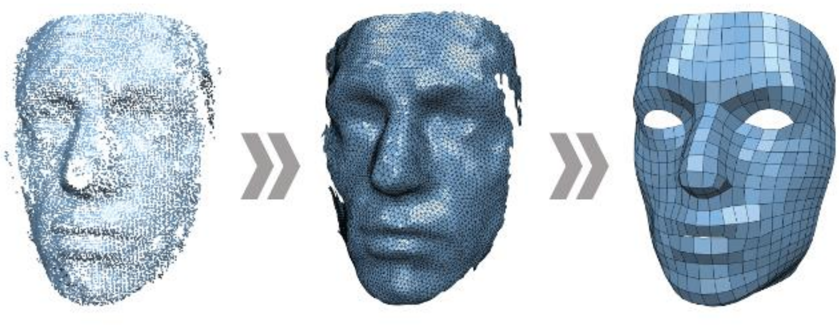
Image processing
-Big secret behind what we see-

Reporter : B06401078 許育綸



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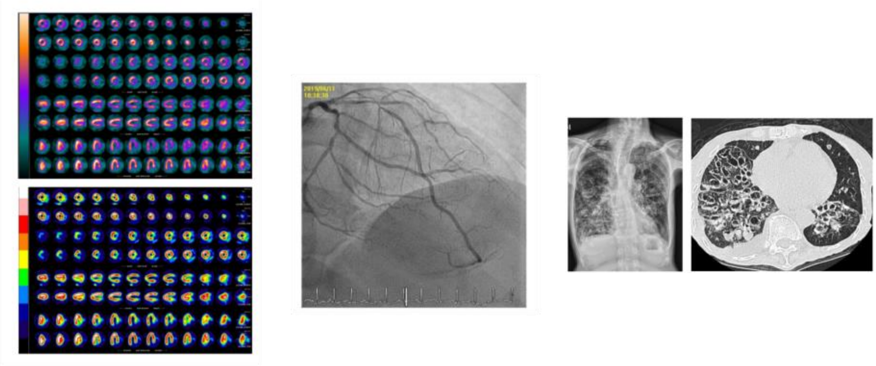
Introduction:

We have mentioned many Medical imaging in this semester.(Fig.1)



myocardial perfusion imaging coronary angiography X-ray and CT

Fig1：medical images discussed in this semester

In chapter 3, we discussed myocardial perfusion imaging and coronary angiography. In chapter 4, we spent much time searching for signet-ring sign.

We have been taught that **"Seeing is believing"** since we were young, especially in Histology and Gross anatomy. However, as for digital images, images are just combinations of numbers. We could easily modify it according to our need.

If images are easily changeable, should we believe what we see from images? If we become doctors, could we rely on these images?

Hence, in this report, I would reveal some secret behind what we see in medical digital images Explore the wolrd of computer science and medicine. With the knowledge of image processing, we could carefully interprete the medical images and **benefit from it.**

TOPIC1: Filter and Enhance.

The main targets of filters are reducing noise or highlighting edges.We first construct a kernel, a window with weighted numbers on it. We place the window on each pixel, and calculate the weighted average according to the position. (Fig. 2)

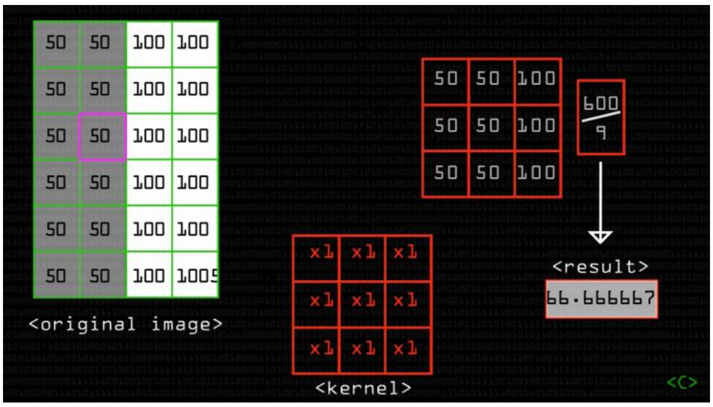


Fig.2：Implementation of the filter is based on the kernel, a window with weighted numbers on it

After implementing filters on each pixels, what result can we see?

Kernels like average kernel or gaussian kernel could smoothing and reducing noise of an image. Smoothing means the difference between pixels become smaller. Also, it could eliminate the extreme value. Take Fig3 for example, we found zero and 90 as an extreme value on the left, and the boundary of white and black is obvious. After average kernel, we could see a smooth and slowly changing image like right one.

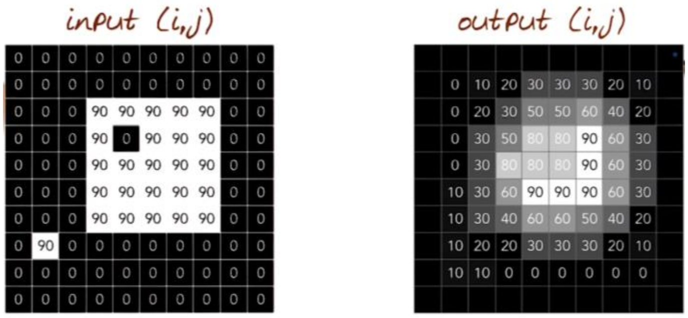


Fig.3：The left image is orginal one, and the right one is a filtered image.

The results of gaussian kernel on real images are like Fig4. Bigger sigma get a more smooth and blurrier image. Although this kind of kernel reduces the noise, it also makes the images more blurry. So we could call this kind of implementation blur. Not only blur. We could get differnet results from different kernels. But gaussian kernel is most useful.

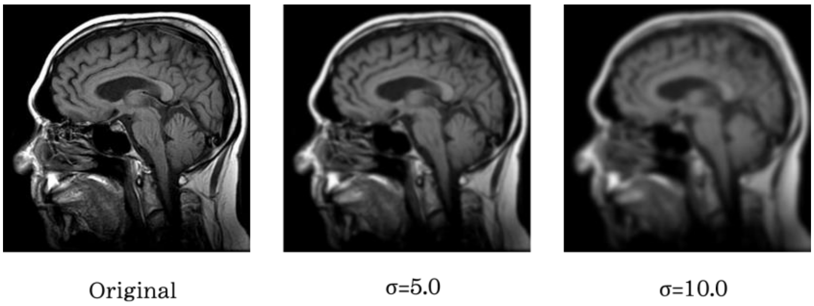


Fig.4：examples of gaussian filter(kernel).

If we use different kernels on the same images, we could get different results. Each result gives us some information of the image. If we combine these images together, we could get a better image. This kind of implementation is “enhance”.(Fig.5)

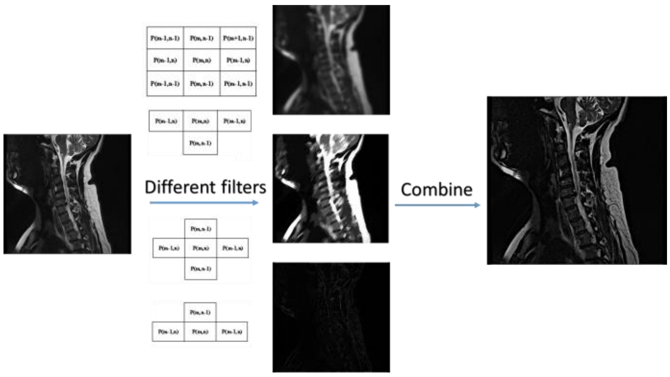


Fig.5：Procedure of the enhace is based on the combination of filtered images

For example, we use different kernel to decompose the photos into low-frequency images and high frequency images.(Fig. 6) You could take low-pass filter as a gaussian filter. Why we need to distinguish this two kinds of images is based on one assumption : Low-frequency image contains large scale information. It mainly preserve the intensity of the image. That is, how bright a pixel is.And high-frequency image contains more details, It mainly preserve where is the edges on an image.

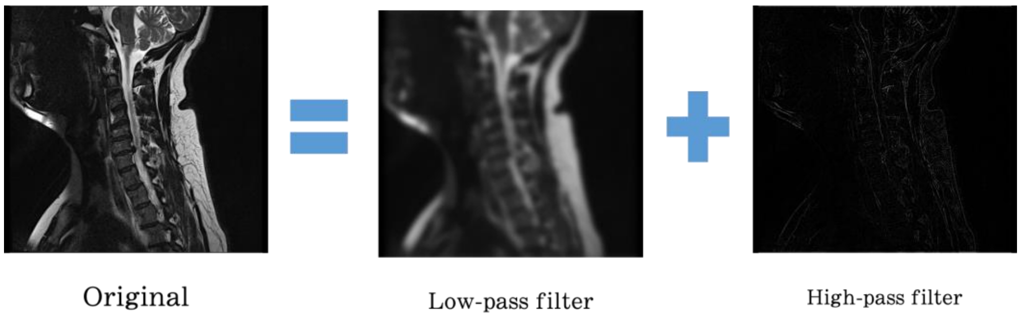
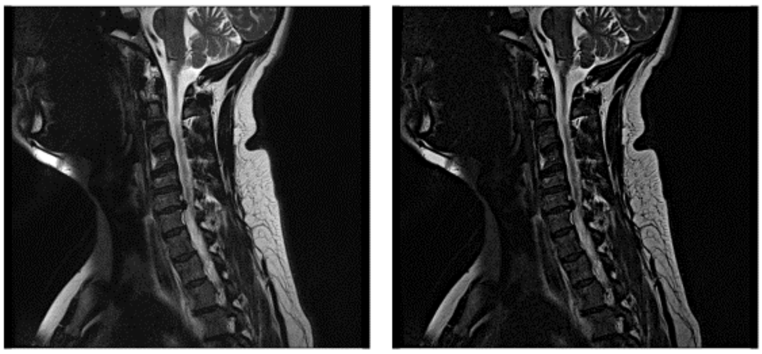


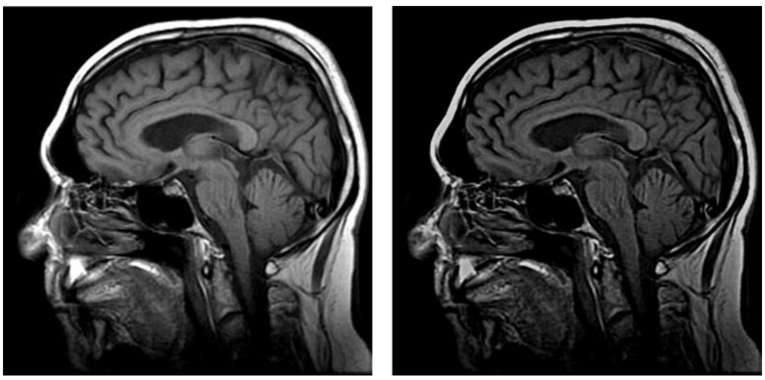
Fig.6：Low-frequency image tells us how bright a pixel is. High-frequency image tells us where is the edges on an image.

If we boost high-freqeuncy image, and keep low-frequency one the same. We could have a sharper image. Because it is easier for us to judge the edges.

Here are some results from my codes(actually, **all the mri images in this report are produced by my code**), which is based on implementation above.



Result1：We could see more details on right enhanced image



Result2：Edges of nose and brain are more clear on right enhanced image

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TOPIC2: feature detection.

After we have a good image. How could we interpret it by computers? Hence, the second part of my report is feature detection. I would explain how could computer “see” these images.

Features are some pixels that could represent an image. They are special enough for us to find and compare in different images.In this simple image(Fig7), there are three candidates. In your opinion, which one is better as a feature? Could you explain your reasons?

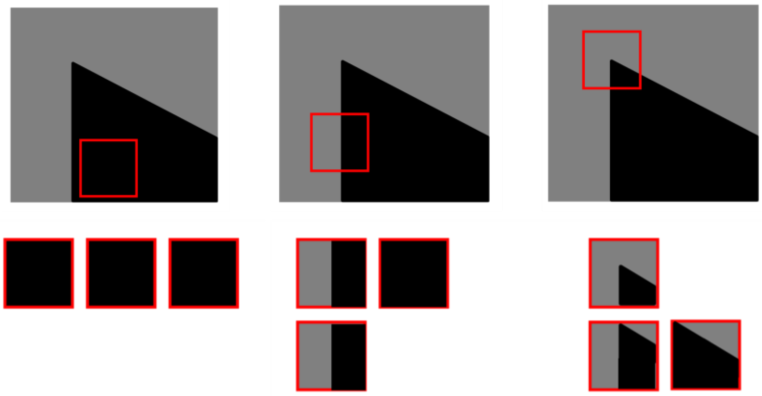

Fig.7：Feature candidates

We could place a window on each candidate to examine which one is better. Move this window up down left and right to see whether informaion in the window is the same. For the right candidate, different implementations lead to different results, And we realize: this kind of features are what we looking for. We call this kind of features “corners”.

In Matthew Brown’s research, we could easily find corners on the image. First, we caculate the corner strength according to the formula. Sigma in this formula is the parameter of a gaussian filter. And we pick the top 500 biggest features. (Fig.8)

$$\mathbf{H}_l(x,y) = \nabla_{\sigma_d} P_l(x,y) \nabla_{\sigma_d} P_l(x,y)^T * g_{\sigma_i}(x,y)$$

$$f_{HM}(x,y) = \frac{\det \mathbf{H}_l(x,y)}{\operatorname{tr} \mathbf{H}_l(x,y)} = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$$

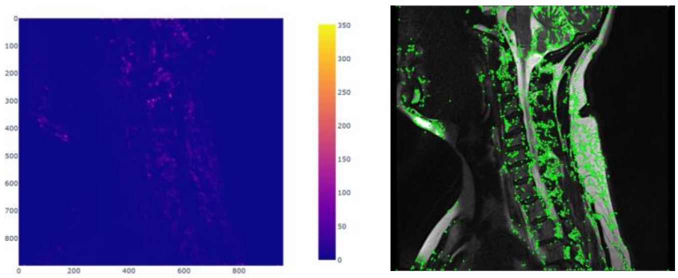

Fig.8：On the middle is corner strength of each pixel. The righr images shows 500 features.

With knowledge of features, we could use it on various field. Let’s see some applications of features. In deep learning neural network. What computers do is actually finding different features of an image. It simultanuously identify edges, combinationes and features. With complicated network, computers help us identify the image. Is this man George? Or, is there cancer cells in this image?

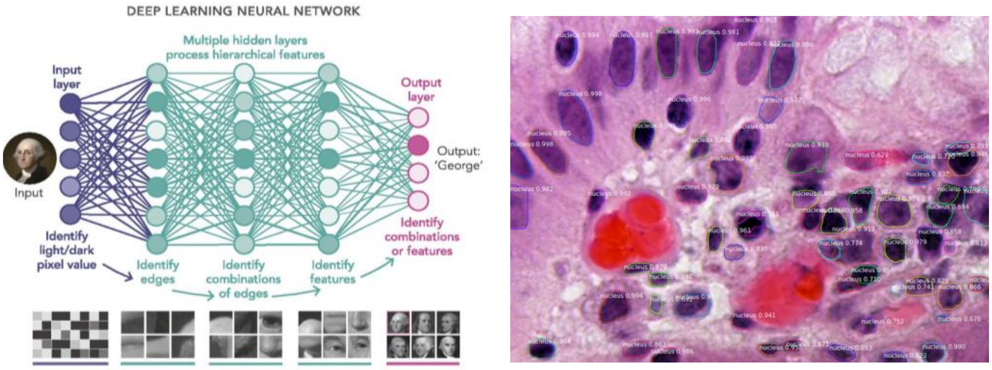

Fig.9：Left image shows the framwork of Deep Learning CNN. Right image shows computers could help us idendify cells in medical use.

Also, what I have shown you before an application of features. We compare two images and find correspondent position. And then combine and blend it.

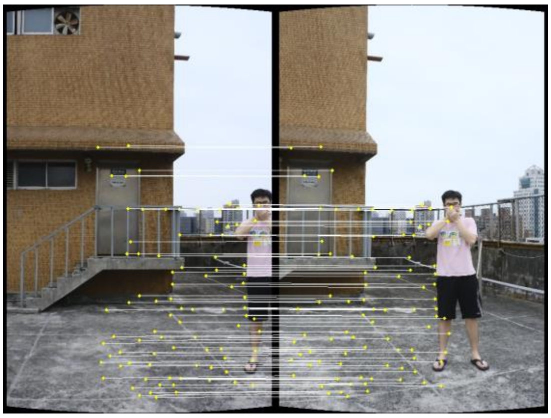

Fig.10：Stitching with features

Take home message

Last but not least, please take some message home. In gaussain filters, it helps us reducing noise. What we learn from it is **we should ignore others' shortcomings.** And corner is one of useful feature to represent an image. We realize, **the start in the cornet shine the most.**

Reference:

Multi-Image Matching using Multi-Scale Oriented Patches
How blurs and filters work: https://bit.ly/3dwGLJ9
Smoothing Process Over an Image Using Average:https://bit.ly/307RAxa
VFX class: https://bit.ly/2ABVofC
image processing: https://bit.ly/2U6vGqc
opencv: https://bit.ly/3gTPwPi
mask-RCNN: https://github.com/matterport/Mask_RCNN.git