Project 1 Report

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Introduction

This report mainly cover how to implement a "Einstein-Marilyn" (or a "dog-cat") picture, by image filtering and hybrid images. In this task we abandon the matlab's *imfilter* function but to rewrite our own *my_filter* function.

Procedure

The most important task is to implement a filter that does convolution.
But... What is a convolution?

- Read image and filter information first.
- Pad the image to a larger size for convolution.
- Rotate 180° and place the filter at the origin.
- Do convolution, the current pixel's value is the sum of all neighbours and filter's dot product, in each color channel.
- Move the filter row by row, column by column, s.t. its center covers every pixel.
- Ok, got the new image!

If you want a math explanation of what I have done, here it comes:

$$g = f * h \tag{1}$$

$$g(i,j) = \sum_{k,l} f(i-k, j-l)h(k,l) = \sum_{k,l} f(k,l)h(i-k, j-l) \tag{2}$$

:)

Interesting Implementation Detail

(a) **What is the upper bond and the lower bond?**
Boundary handling can be tricky as the filter can't be centered on pixels. So we implement a new function called *fil* to help us read the surrounding pixel's value of a pixel with the size of filter and do dot product.

```
1
2  function new_pixel_val = fil(data, input_image,
       filter)
3  filter_height = size(filter,1);
4  filter_width = size(filter,2);
5
6  colors = data(3);
7
8  row_low = data(1) - floor(filter_height/2);
9  col_low = data(2) - floor(filter_width/2);
10 row_upp = data(1) + floor(filter_height/2);
11 col_upp = data(2) + floor(filter_width/2);
12
13 sub_mat = input_image(row_low:row_upp, col_low:
       col_upp, colors);
14
15 new_pixel_val = sum(sum(sub_mat.*filter));
16 end
```

In this we do not touch the original picture, but to copy the values we need to **sub_mat**, and do dot product.

(b) **What's the difference between convolution and correlation filter?**
First, their names are different.
Second, their equation are different.

$$g = f \otimes h \tag{3}$$

i.e.

$$g(i,j) = \sum_{k,l} f(i+k, j+l)h(k,l) \tag{4}$$

Third, their final result may be different.

Result

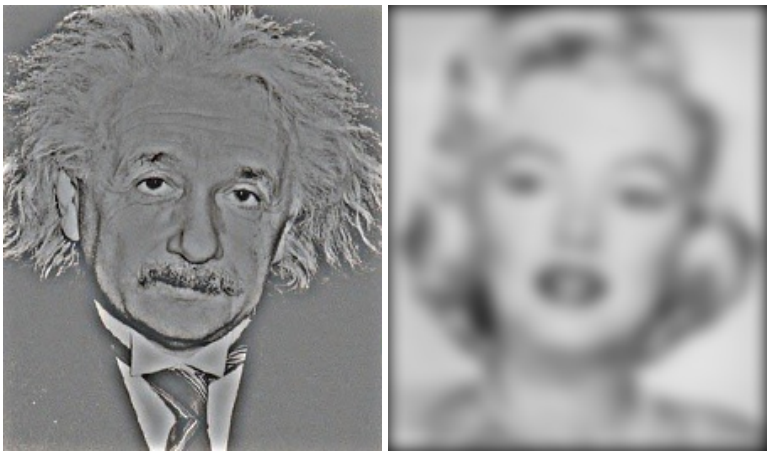

Figure 1: *Left:* Detail of Einstein. *Right:* Smooth content of Marilyn.

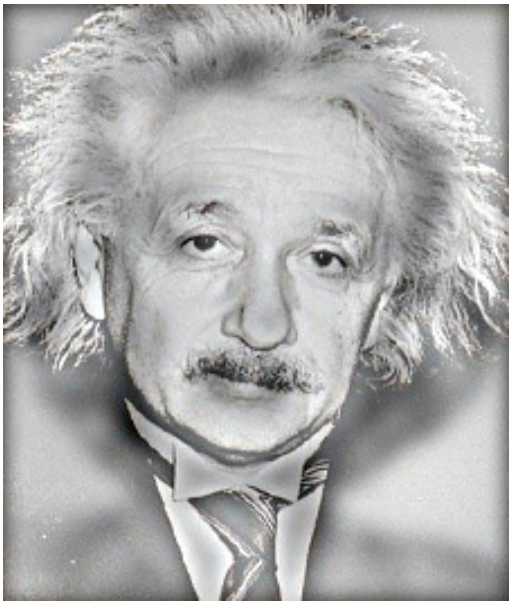

Figure 2: Combination.

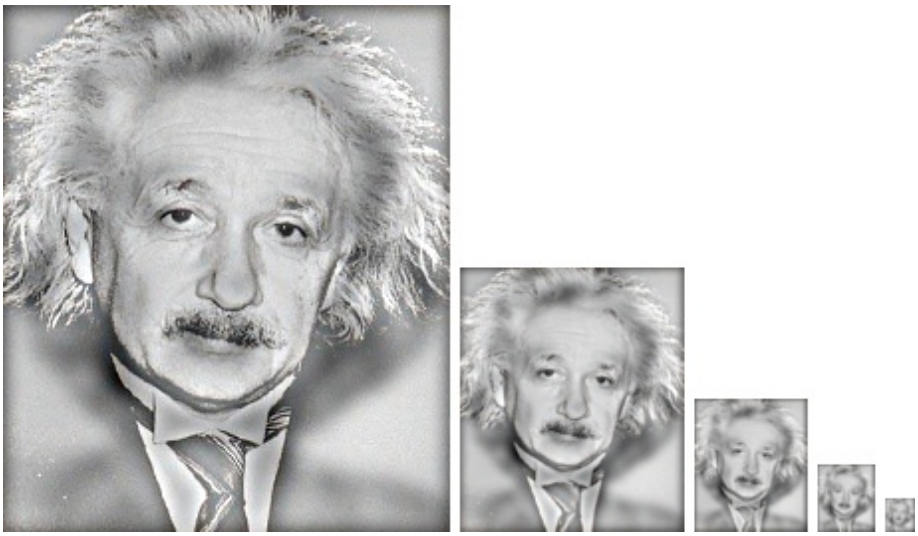

Figure 3: Left is Einstein, right is Marilyn.