B31SE Image Processing: Assignment 2

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B31SE: Image Processing
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---Task 1 : Image deblurring by the Wiener filter---

Our code is composed of two main parts :

- The process for blurring the image
- The process for deblurring the image

The process for blurring the image has two components : the blur and the noise.

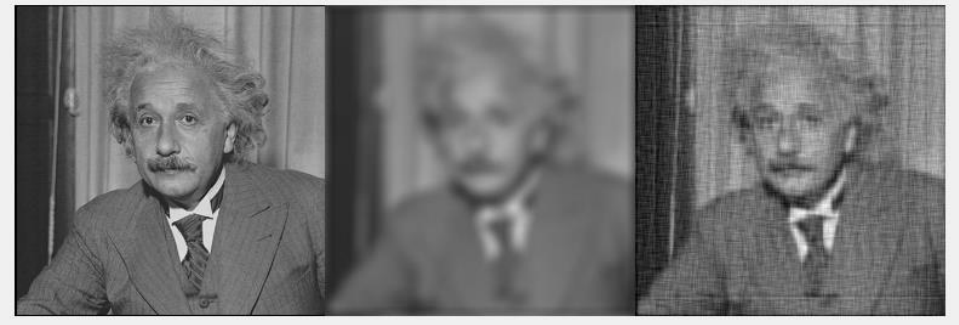
The process for deblurring the image uses the Wiener filter formula :

$$F(u,v) = \left[\frac{1}{H(u,v)}\frac{|H(u,v)|^2}{|H(u,v)|^2 + K}\right]G(u,v) = \frac{\bar{H}(u,v)}{|H(u,v)|^2 + K}G(u,v)$$

We can see the results by comparing the 3 key images (original, blurred, deblurred) with the two types of blur (Motion blur and Gaussion blur):

Motion blur :

Gaussian blur :



Of course, as we apply operations in the frequency domain with the Fourier transform, the deblurred image possesses some noise that is unavoidable, but overall, the deblurred image has a good sharpness. We can also note that the type of resulting noise is different with the type of blurred applied : with motion blur the result blur resembles a salt and pepper noise while with the gaussian blur it takes the shapes of little crosses that gives an “old paper” feel.

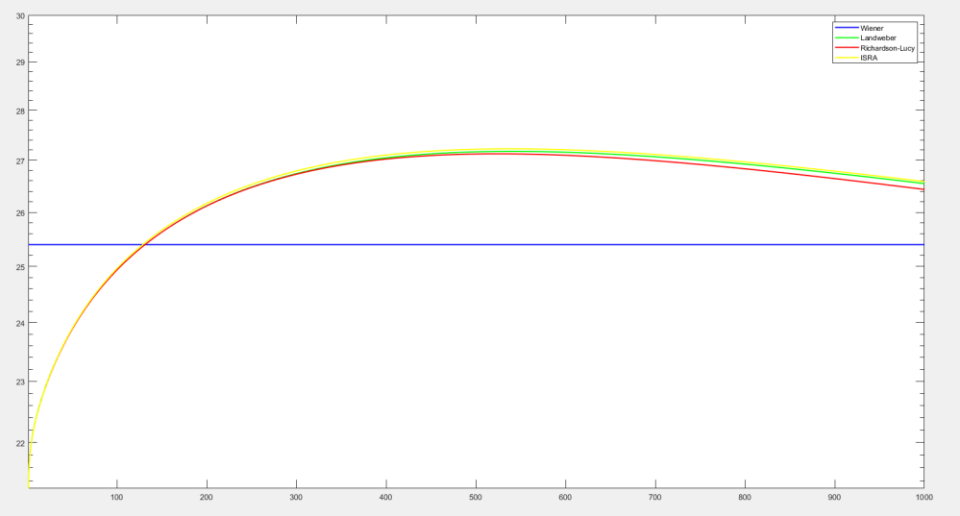
---Task 2 : Image deblurring by ISRA---

We implemented the ISRA filter in MATLAB from the mathematic formula:

```
ISRA = ISRA.*ifft2(conj(H).*G)./ifft2(conj(H).*fft2(blur(ISRA)));
```

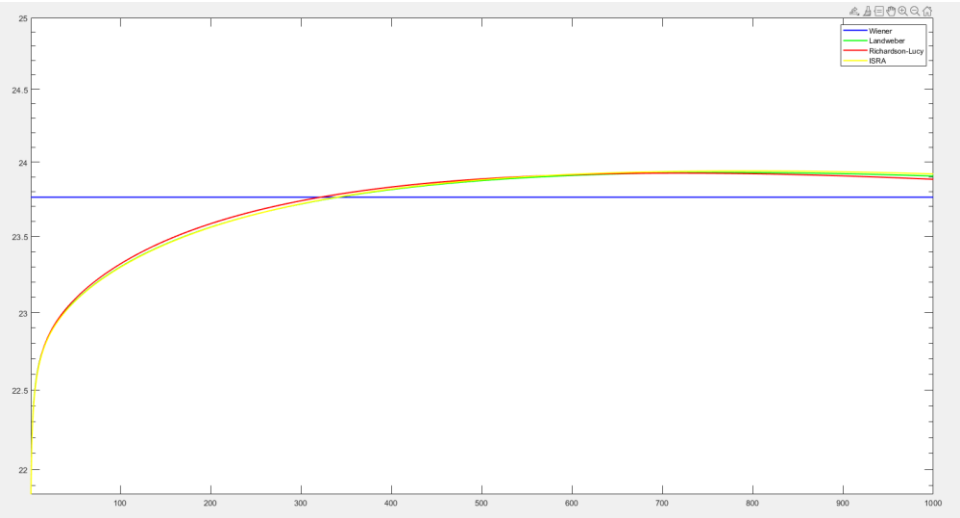
We can compare its performance with the Landweber and Richardson-Lucy filters:

Motion blur



For the motion blur, the ISRA filter is slightly better on the PSNR, which means the deblurred image contains less noise relative to the original image comparing to the other filters, but its quantitative advantage is very small and therefore does not make an evident noticeable difference.

Gaussian blur

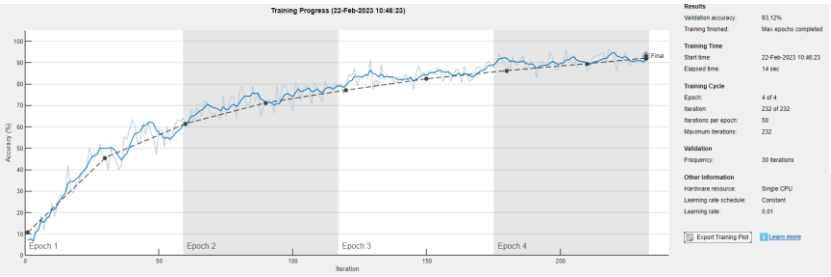


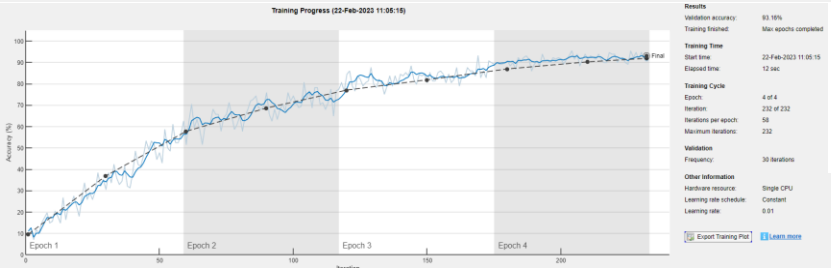
The comparison between ISRA and the other filters is similar to the motion blur, they all give approximately equal results relative to one another. However, we can notice that all algorithms are less efficient to deblur gaussian blur: while all algorithms achieve a PSNR of 27 for the motion blur, here none of them goes beyond 23.

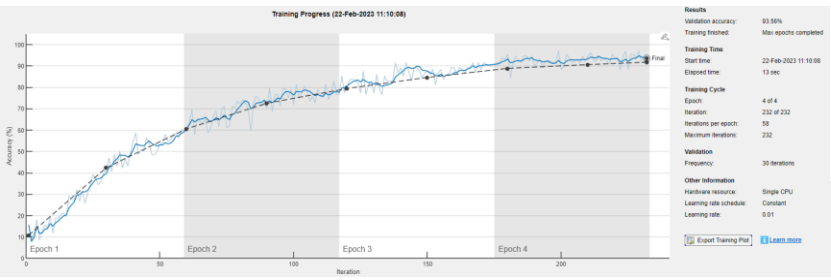
---Task 3 : Digit recognition by ANN---

By a process of tuning the 3 parameters, being the number of neurons in each hidden layer, one of the solutions that resulted for an accuracy higher than 93% is to even the distribution of neurons : 34 in the first layer, 33 in the second and third layer.

On three different runs, we achieve an accuracy higher than 93% :







A more advanced technique for Neural Network parameter tuning is to use an Evolutionary Algorithm. The algorithm initializes a set of numerous random parameters and processes several iterations with algorithms steps that mimic evolution process in nature that improve the value of each parameter towards the desired goal, here the highest possible accuracy. At the end, we keep the best set of parameters, that is our solution.