1 Matlab correction

1.1 Morphological center

The noisy image is obtained with the function imnoise.

```
A=double(imread('lena512.bmp'));
A=255*imnoise(A/255,'salt & pepper', 0.04);
```

Following the definition, the morphological center is obtained with the following code, and illustrated in Fig.1:

```
n=1;
se=strel('disk',n);
coc=imclose(imopen(imclose(A,se),se),se);
oco=imopen(imclose(imopen(A,se),se),se);
cMin=min(oco,coc);
cMax=max(oco,coc);
B=min(max(A,cMin),cMax);
```

(a) Noisy image. (b) Median filter of size 5×5. (c) Morphological center.

Figure 1: Morphological center compared to the classical median filter.

1.2 Alternate sequential filters

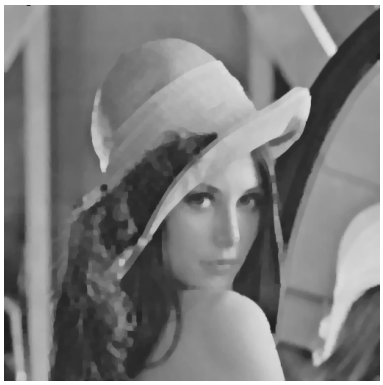
The order of these filters are often chosen empirically. The results are illustrated in Fig.2.

```
function F = asf_n(I, order)
% Alternate Sequential Filter beginning by a closing
% I: original image
```

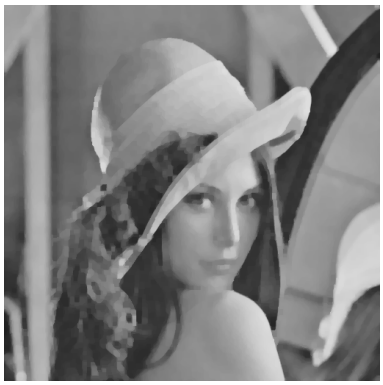
```
% order: order of the filter (number of loops)
F = I;
for i=1:order
    se = strel('disk', i);
    F = imclose(imopen(F, se), se);
end
```

```
function F = asf_m(I, order)
% Alternate Sequential Filter beginning by an opening
% I: original image
% order: order of the filter (number of loops)
F = I;
for i=1:order
    se = strel('disk', i);
    F = imopen(imclose(F, se), se);
end
```

(a) Original image.



(b) ASF of order 3, starting with a closing operation (denoted N).



(c) ASF of order 3, starting with an opening operation (denoted M).

Figure 2: Alternate Sequential Filters compared to original image.

1.3 Geodesic reconstruction filters

These two functions are simply implemented using erosion and reconstruction operators. Notice the duality property, that is used to code closerec. In this example, 8 bits images (unsigned) are considered, and the results are illustrated in Fig.3.

```
function D=openrec(A,n)
B=imerode(A,strel('disk',n));
D=reconstruct(A,B);
```

```
function D=closerec(A,n)
% closerec and openrec are dual operators
D = 255-openrec(255-A, n);
```

(a) Original image. (b) Opening by reconstruction. (c) Closing by reconstruction.

Figure 3: Opening and closing by reconstruction.

1.4 ASF by reconstruction

This is an example of a 3rd order alternate sequential filter, illustrated in Fig.4.

```
n1=1;
n2=2;
n3=3;
co1=closerec(openrec(A,n1),n1);
co2=closerec(openrec(co1,n2),n2);
co3=closerec(openrec(co2,n3),n3);
```

1.5 Morphological center by reconstruction

Morphological center by reconstruction replaces the opening and closing operations by their equivalent by reconstruction (see Fig.5).


(a) Original image.


(b) ASF by reconstruction.


(c) Noisy image.

Figure 4: Alternate Sequential Filtering by reconstruction.

```
n=1;
coc=closerec(openrec(closerec(A,n),n),n);
oco=openrec(closerec(openrec(A,n),n),n);
cMin=min(oco,coc);
cMax=max(oco,coc);
B=min(max(A,cMin),cMax);
```


(a) Original image.


(b) Center by reconstruction.


(c) Noisy image.

Figure 5: Morphological center by reconstruction.