Digital image processing

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Homework 3

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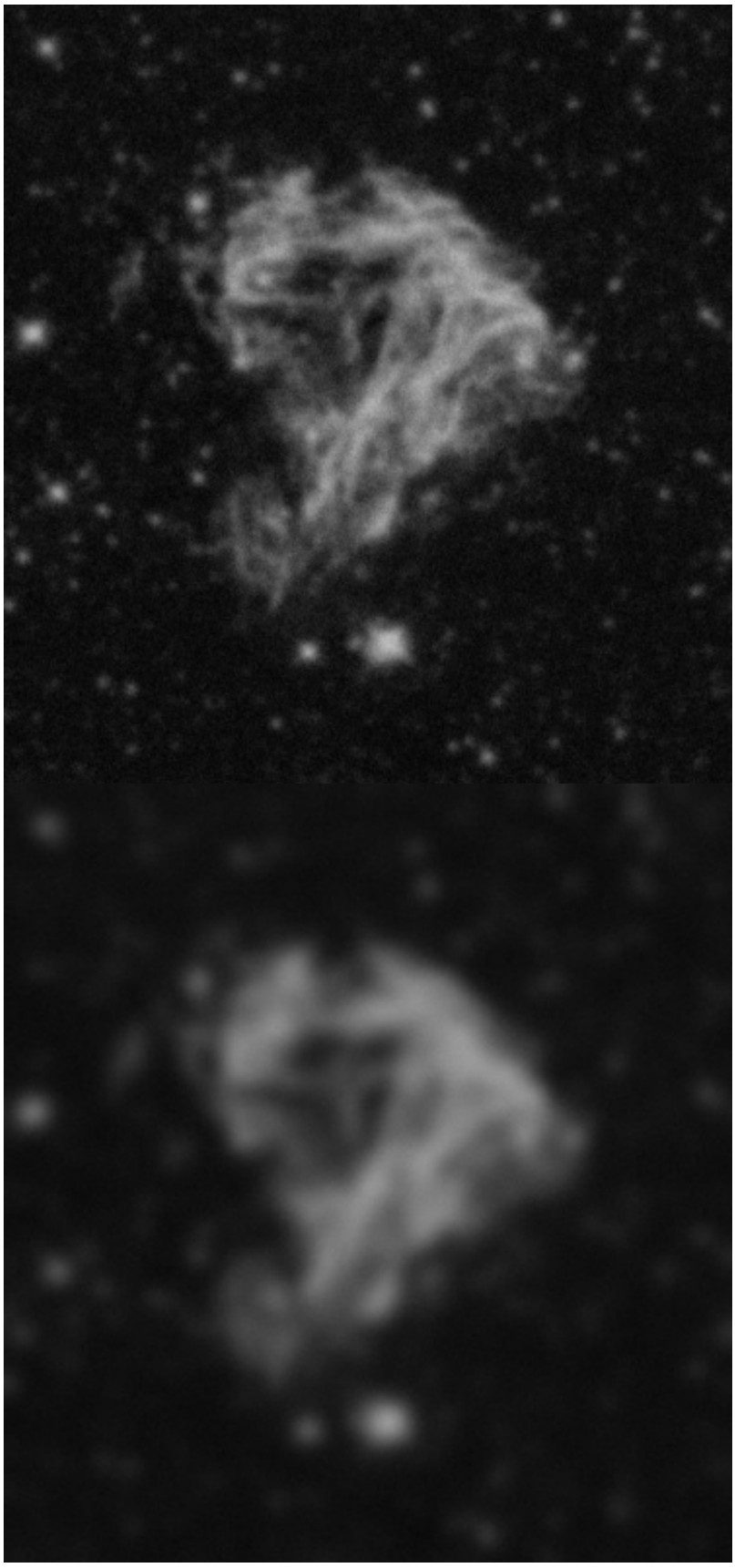
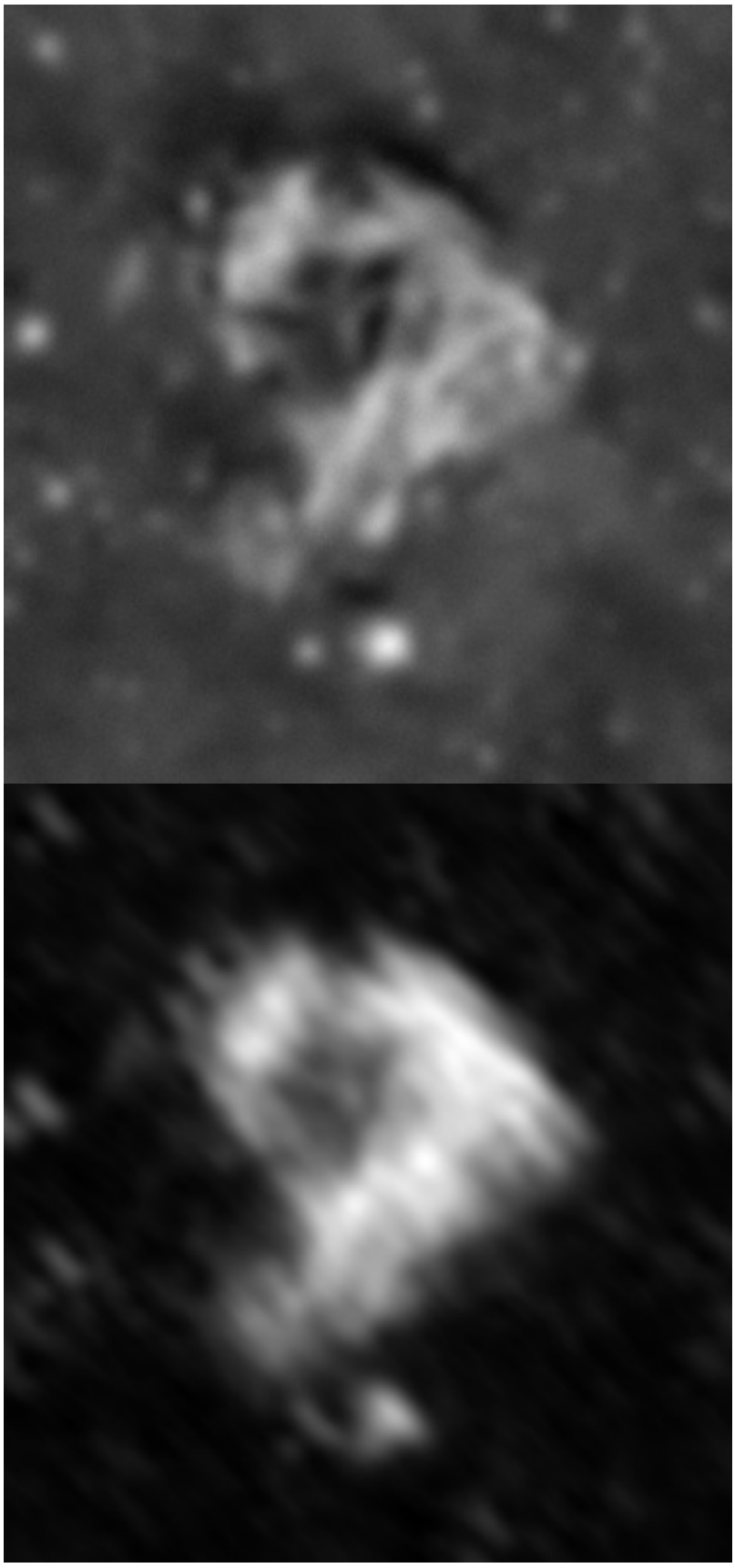
Changes for the use of C++11

Because we wanted to use `C++11`, we added `set(CMAKE_CXX_FLAGS "${CMAKE_CXX_FLAGS} -std=c++11")` to the `CMakeCLists.txt`.

Exercices

The results of the filters do not look like that they are working correctly, I couldn't figure out why.





inverse filter

```
// be sure not to touch them
  degraded = degraded.clone();
  filter = filter.clone();

  Mat tempA = Mat::zeros(degraded.size(), CV_32FC1);
```

```
// convert to frequency spectrum
Mat degradedFreq = degraded.clone();
Mat filterFreq = Mat::zeros(degraded.size(), CV_32F);

// add Border
for (int x = 0; x < filter.rows; x++) for (int y = 0; y < filter.cols; y++) {
  filterFreq.at<float>(x, y) = filter.at<float>(x, y);
}

filterFreq = circShift(filterFreq, -1, -1);

// transform to complex
Mat planes[] = {degradedFreq, Mat::zeros(degraded.size(), CV_32F)};
Mat planesFilter[] = {filterFreq, Mat::zeros(filterFreq.size(), CV_32F)};

merge(planes, 2, degradedFreq);
merge(planesFilter, 2, filterFreq);

dft(degradedFreq, degradedFreq, DFT_COMPLEX_OUTPUT); // degradedFreq == S
dft(filterFreq, filterFreq, DFT_COMPLEX_OUTPUT); // filterFreq == P

// create Q

split(filterFreq, planes);

Mat Re = planes[0];
Mat Im = planes[1];

// calculate Threshold
double thresholdFactor = 0.5, threshold;
double max = 0;

Re.copyTo(tempA);
abs(tempA);
minMaxIdx(tempA, 0, &max, 0, 0, Mat());

threshold = thresholdFactor * max;

for (int x = 0; x < filterFreq.rows; x++) for (int y = 0; y < filterFreq.cols; y++) {

  if (Re.at<float>(x, y) >= threshold) {

    float resq = Re.at<float>(x, y) * Re.at<float>(x, y);
    float imsq = Im.at<float>(x, y) * Im.at<float>(x, y);

    // complex numbers need special attention

    Re.at<float>(x, y) = Re.at<float>(x, y) / (resq + imsq);
    Im.at<float>(x, y) = Im.at<float>(x, y) / (resq + imsq);

  } else {
```

```
      Re.at<float>(x, y) = 1/threshold;
      Im.at<float>(x, y) = 1/threshold;
    }

  }

  Mat Q = Mat::zeros(filterFreq.size(), CV_32F);

  merge(planes, 2, Q);

  Mat original;

  mulSpectrums(degradedFreq, Q, original, 1);
  dft(original, original, DFT_INVERSE + DFT_SCALE);
  split(original, planes);

  original = planes[0];

  if (original.channels() == 1) {
    normalize(original, original, 0, 255, CV_MINMAX);
    original.convertTo(original, CV_8UC1);
  } else {
    original.convertTo(original, CV_8UC3);
  }

  return original;
}
```

wiener filter

```
Mat Dip4::wienerFilter(Mat& degraded, Mat& filter, double snr){

  // be sure not to touch them
  degraded = degraded.clone();
  filter = filter.clone();

  // Q_k = conjugate_transpose(P_k) / | P_k | ^2  + 1/SNR^2

  Mat filterFreq = filter.clone();
  Mat planesFilter[] = {filterFreq, Mat::zeros(filterFreq.size(), CV_32F)};
  merge(planesFilter, 2, filterFreq);

  dft(filterFreq, filterFreq, DFT_COMPLEX_OUTPUT); // filterFreq == P

  // create Q

  split(filterFreq, planesFilter);

  Mat Re = planesFilter[0];
  Mat Im = planesFilter[1];

  Mat QRe = Re.clone();
```

```
  Mat QIm = Im.clone();

  for (int x = 0; x < filterFreq.rows; x++) for (int y = 0; y < filterFreq.cols; y++) {

    // A*_ij = Ã_ji
    float reConjugateTranspose = filterFreq.at<float>(y, x);
    float imConjugateTranspose = -filterFreq.at<float>(y, x);
    float resq = Re.at<float>(x, y) * Re.at<float>(x, y);
    float imsq = Im.at<float>(x, y) * Im.at<float>(x, y);
    float ReAbs = Re.at<float>(x, y) / (resq + imsq);
    float ImAbs = Im.at<float>(x, y) / (resq + imsq);

    QRe.at<float>(x, y) = reConjugateTranspose / ((ReAbs * ReAbs) + 1/(snr * snr));
    QIm.at<float>(x, y) = imConjugateTranspose / ((ImAbs * ImAbs) + 1/(snr * snr));

  }

  Mat Q = Mat::zeros(filterFreq.size(), CV_32F);

  Mat qplanes[] = {QRe, QIm};

  merge(qplanes, 2, Q);

  Mat original;

  dft(Q, Q, DFT_INVERSE + DFT_SCALE);
  split(Q, planesFilter);
  Q = planesFilter[0];

  filter2D(degraded, original, -1, Q);

  if (original.channels() == 1) {
    normalize(original, original, 0, 255, CV_MINMAX);
    original.convertTo(original, CV_8UC1);
  } else {
    original.convertTo(original, CV_8UC3);
  }

  return original;

}
```

circShift

```
Mat Dip3::circShift(Mat& in, int dx, int dy){

  // sanitze input

  dx = dx % in.cols;
  dy = dy % in.rows;

  Mat out = Mat::zeros(in.rows, in.cols, CV_32FC1);
```

```
    for (int x = 0; x < out.rows; x++) for (int y = 0; y < out.cols; y++) {

        int newX = (x + dx) % out.cols;
        int newY = (y + dy) % out.rows;

        newX = newX < 0 ? out.cols + newX : newX;
        newY = newY < 0 ? out.rows + newY : newY;
        out.at<float>(newX, newY) = in.at<float>(x, y);

    };

    return out;

}
```