1 Image Filtering

1. (a) With `valid` conditions,

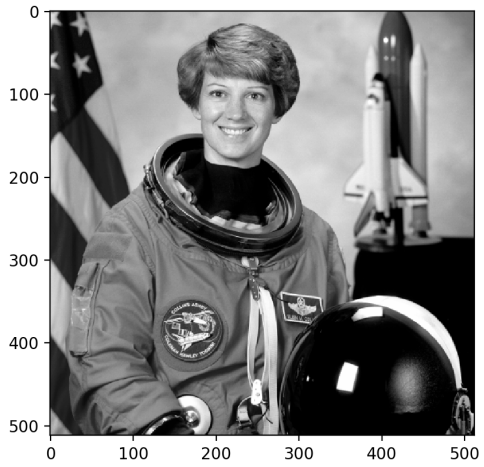
$$X * F = \begin{bmatrix} az + by + dx + ew & bz + cy + ex + fw \\ dz + ey + gx + hw & ez + fy + hx + iw \end{bmatrix}$$

   (b) With `same` conditions,

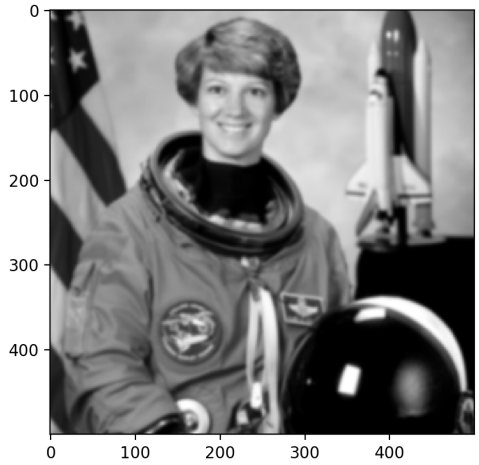
$$X * F = \begin{bmatrix} aw & ax + bw & bx + cw \\ ay + dw & az + by + dx + ew & bz + cy + ex + fw \\ dy + gw & dz + ey + gx + hw & ez + fy + hx + iw \end{bmatrix}$$

2. The output size should be $((h - i) + 1, (w - j) + 1)$.

3. Picture before applying the Gaussian kernel with kernel size 13:

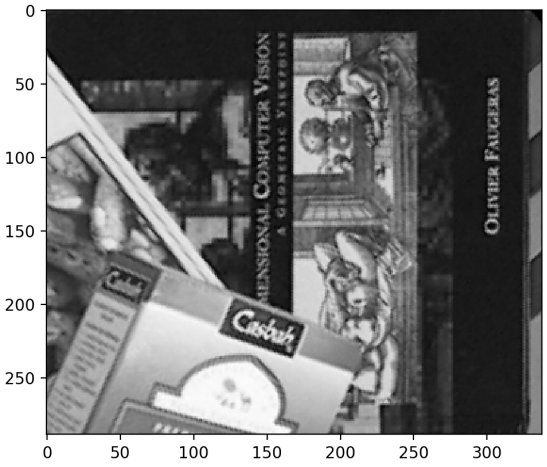


   picture after applying the Gaussian Kernel:

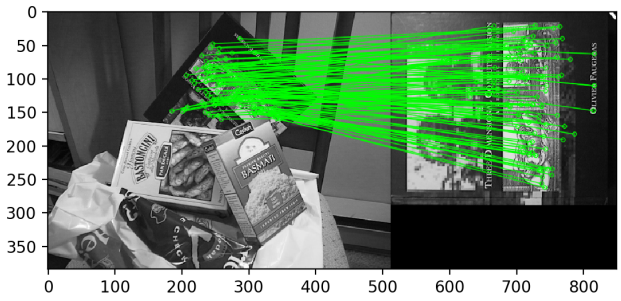


2 Image Alignment

The transformed image is in:



The inliers image is in:



The H matrix is:

$$H = \begin{bmatrix} 1.19333213e+00 & -1.34502240e+00 & 3.73811962e+01 \\ 1.27747147e+00 & 1.04462232e+00 & -3.41304188e+02 \\ 3.14546088e-04 & -5.46996078e-04 & 1.00000000e+00 \end{bmatrix}$$

3 Estimating the Camera Parameters

The matrix P is:

$$H = \begin{bmatrix} -1.27000127e-01 & -2.54000254e-01 & -3.81000381e-01 & -5.08000508e-01 \\ -5.08000508e-0 & -3.81000381e-01 & -2.54000254e-01 & -1.27000127e-01 \\ -1.27000127e-01 & -2.77555756e-17 & -1.27000127e-01 & 1.11022302e-16 \end{bmatrix}$$

The value of C is: [-0.5 0.5 0.5 -0.5]
Alternative route for c: [1. -1. -1.]

4 Structure from Motion

The following are the values for, both, M and T

```
/Users/taha_raslan/anaconda/bin/python3 /Users/taha_raslan/PycharmProjects/vision/ass1/motion.py
The matrix T is: [[[  5.49560397e-17   3.31216536e-17  -1.06118017e-16   4.27435864e-17
    -9.25185854e-19  -7.75305746e-17   1.22124533e-17   4.99600361e-18
    -9.43689571e-18  -2.08166817e-18]]

 [[ -7.03141249e-18   3.97029917e-18   1.24900890e-17  -1.85962357e-17
    -3.99217696e-17   8.83552490e-17   6.36527867e-17   2.71773345e-18
    -2.14643118e-17   3.85802501e-17]]]
********
The matrix M is [[-7.50914219  3.30837904 -3.71763726]
 [ 0.17858821 -8.56620251 -2.47587867]
 [ 8.25306132  2.16911022 -3.48212517]
 [-3.76826539 -8.34775199  1.20087007]
 [-0.73461099 -8.39784553 -2.88977146]
 [ 8.45690983 -2.56535708 -1.79392742]
 [-2.96665571 -7.78843781 -3.22986642]
 [-1.4368307  -8.62307292  3.07678742]
 [ 8.6277954  -2.12325785 -1.6361374 ]
 [ 7.44257036 -3.77728996  3.4002285 ]
 [-4.53754376 -1.57773527  7.74574759]
 [ 9.05169424  0.12603637  0.70587237]
 [-0.13132314 -7.68175234 -4.32518806]
 [ 8.27600638 -3.50666717  0.57004455]
 [-8.50036578  1.68529571 -2.55252838]
 [-3.28948312 -6.10374195 -5.44642826]
 [ 8.45107965 -1.64131526 -2.78078037]
 [-7.95142326 -0.23710514 -4.1742912 ]
 [-0.41749971  4.10544054 -8.14813897]
 [-5.22854825 -5.82482627  5.11580038]]

Process finished with exit code 0
```

The following is the 3D plot: