
illumination change on covariance matrix

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Without normalization

```
%crop img
img = imread('feature.jpg');
roi = rgb2gray(img(214:295,198:232,:));

%compute the covariance matrix
roifeature = FeatureMatrix(roi);
roifeature_vector = reshape(roifeature,[],7);
covmat = cov(roifeature_vector);

%scale the img
roi1 = round(1.2 * roi);

%compute the covariance matrix
roifeature1 = FeatureMatrix(roi1);
roifeature_vector1 = reshape(roifeature1,[],7);
covmat1 = cov(roifeature_vector1);

format short
disp('scale is 1.2')
disp('for whole matrix: ')
covmat1./covmat
disp('for diagonal elements: ')
diag(covmat1)./diag(covmat)
disp('for trace: ')
trace(covmat1)/trace(covmat)

%scale the img
roi2 = round(0.9 * roi);

%compute the covariance matrix
roifeature2 = FeatureMatrix(roi2);
roifeature_vector2 = reshape(roifeature2,[],7);
covmat2 = cov(roifeature_vector2);

disp('scale is 0.9')
disp('for whole matrix: ')
```

```
covmat2./covmat
disp('for diagonal elements: ')
diag(covmat2)./diag(covmat)
disp('for trace: ')
trace(covmat2)/trace(covmat)

scale is 1.2
for whole matrix:

ans =

    1.0000         NaN    1.1849    0.9208    1.4256    1.1278    1.3357
         NaN    1.0000    0.9883    0.8689    6.5587    0.9609    1.3142
    1.1849    0.9883    1.4022    0.9286    0.6135    0.8898    0.9539
    0.9208    0.8689    0.9286    1.4377    1.5209    1.4797    1.5855
    1.4256    6.5587    0.6135    1.5209    1.4428    1.5059    1.4984
    1.1278    0.9609    0.8898    1.4797    1.5059    1.4476    1.4944
    1.3357    1.3142    0.9539    1.5855    1.4984    1.4944    1.4502

for diagonal elements:

ans =

    1.0000
    1.0000
    1.4022
    1.4377
    1.4428
    1.4476
    1.4502

for trace:

ans =

    1.3458

scale is 0.9
for whole matrix:

ans =

    1.0000         NaN    0.9003    0.9043    0.8857    0.8827    0.8963
         NaN    1.0000    0.8970    0.8985    0.7909    0.8969    0.8920
    0.9003    0.8970    0.8103    0.8047    0.8068    0.7983    0.8072
    0.9043    0.8985    0.8047    0.8112    0.8091    0.8111    0.7971
    0.8857    0.7909    0.8068    0.8091    0.8106    0.8146    0.8112
    0.8827    0.8969    0.7983    0.8111    0.8146    0.8114    0.8169
    0.8963    0.8920    0.8072    0.7971    0.8112    0.8169    0.8091

for diagonal elements:

ans =
```

```
1.0000
1.0000
0.8103
0.8112
0.8106
0.8114
0.8091

for trace:

ans =

0.8386
```

Normalization applied

```
roi = rgb2gray(img(214:295,198:232,:));
roifeature = FeatureMatrix(roi);
roifeature_vector = reshape(roifeature,[],7);
roifeature_vector = roifeature_vector./
repmat(sqrt(sum(roifeature_vector,1)),size(roifeature_vector,1),1);
covmat = cov(roifeature_vector);

%scale the img
roi1 = round(1.2 * roi);

roifeature1 = FeatureMatrix(roi1);
roifeature_vector1 = reshape(roifeature1,[],7);
roifeature_vector1 = roifeature_vector1./
repmat(sqrt(sum(roifeature_vector1,1)),size(roifeature_vector1,1),1);
covmat1 = cov(roifeature_vector1);

format short
disp('scale is 1.2')
disp('for whole matrix: ')
covmat1./covmat
disp('for diagonal elements: ')
diag(covmat1)./diag(covmat)
disp('for trace: ')
trace(covmat1)/trace(covmat)

%scale the img
roi1 = round(0.9 * roi);

roifeature2 = FeatureMatrix(roi2);
roifeature_vector2 = reshape(roifeature2,[],7);
roifeature_vector2 = roifeature_vector2./
repmat(sqrt(sum(roifeature_vector2,1)),size(roifeature_vector2,1),1);
covmat2 = cov(roifeature_vector2);

format short
disp('scale is 0.9')
```

```
disp('for whole matrix: ')
covmat2./covmat
disp('for diagonal elements: ')
diag(covmat2)./diag(covmat)
disp('for trace: ')
trace(covmat2)/trace(covmat)

scale is 1.2
for whole matrix:

ans =

    1.0000         NaN    1.0837    0.8531    1.3171    1.0369    1.2298
         NaN    1.0000    0.9039    0.8050    6.0593    0.8834    1.2100
    1.0837    0.9039    1.1729    0.7868    0.5184    0.7482    0.8033
    0.8531    0.8050    0.7868    1.2341    1.3018    1.2604    1.3525
    1.3171    6.0593    0.5184    1.3018    1.2314    1.2791    1.2746
    1.0369    0.8834    0.7482    1.2604    1.2791    1.2237    1.2651
    1.2298    1.2100    0.8033    1.3525    1.2746    1.2651    1.2294

for diagonal elements:

ans =

    1.0000
    1.0000
    1.1729
    1.2341
    1.2314
    1.2237
    1.2294

for trace:

ans =

    1.1648

scale is 0.9
for whole matrix:

ans =

    1.0000         NaN    0.9487    0.9530    0.9339    0.9292    0.9448
         NaN    1.0000    0.9453    0.9469    0.8339    0.9441    0.9402
    0.9487    0.9453    0.8998    0.8936    0.8965    0.8855    0.8967
    0.9530    0.9469    0.8936    0.9009    0.8991    0.8998    0.8854
    0.9339    0.8339    0.8965    0.8991    0.9013    0.9042    0.9017
    0.9292    0.9441    0.8855    0.8998    0.9042    0.8991    0.9065
    0.9448    0.9402    0.8967    0.8854    0.9017    0.9065    0.8990

for diagonal elements:

ans =
```

```
1.0000  
1.0000  
0.8998  
0.9009  
0.9013  
0.8991  
0.8990
```

```
for trace:
```

```
ans =
```

```
0.9207
```

conclusion

normalization works

Published with MATLAB® R2016a