```
%Create Gray-Level Co-occurrence Matrix for Grayscale Image
I0 = imread('dog.jpeg');
I = rgb2gray(I0);
imshow(I)
```

```
glcm = graycomatrix(I,'Offset',[2 0])
```

```
glcm = 8×8
        2173         734          81          34          17           4 ···
         694        4281        1245         230          79          20
         130        1266       11443        4880         762         129
          30         194        5064       67923       16884         820
          14          53         665       17655      235626       12383
           3          16         112         757       14762      276961
           0           9          19          76         193        3902
           0           0           2           0           3          17
```

```
%Create Gray-Level Co-occurrence Matrix Returning Scaled Image
I = [ 1 1 5 6 8 8; 2 3 5 7 0 2; 0 2 3 5 6 7]
```

```
I = 3×6
     1     1     5     6     8     8
     2     3     5     7     0     2
     0     2     3     5     6     7
```

```
[glcm,SI] = graycomatrix(I,'NumLevels',9,'GrayLimits',[])
```

```
glcm = 9×9
     0     0     2     0     0     0     0     0     0
     0     1     0     0     0     1     0     0     0
     0     0     0     2     0     0     0     0     0
     0     0     0     0     0     2     0     0     0
     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     2     1     0
```

```
     0     0     0     0     0     0     0     1     1
     1     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     1
SI = 3×6
     2     2     6     7     9     9
     3     4     6     8     1     3
     1     3     4     6     7     8
```

```
%Calculate GLCMs using Four Different Offsets
I0 = imread('dog.jpeg');
I = rgb2gray(I0);
imshow(I)
```

```
offsets = [0 1; -1 1;-1 0;-1 -1];
[glcms,SI] = graycomatrix(I,'Offset',offsets);
imshow(rescale(SI))
```

```
whos
```

```
  Name           Size                 Bytes  Class     Attributes

  I            602x1200              722400  uint8
  I0           602x1200x3           2167200  uint8
  SI           602x1200             5779200  double
  glcm           9x9                    648  double
  glcms          8x8x4                 2048  double
  offsets        4x2                     64  double
```

```
%Calculate Symmetric GLCM for Grayscale Image
I0 = imread('dog.jpeg');
I = rgb2gray(I0);
imshow(I)
```

```
[glcm,SI] = graycomatrix(I,'Offset',[2 0],'Symmetric',true);
glcm
```

```
glcm = 8×8
        4346        1428         211          64          31           7 ···
        1428        8562        2511         424         132          36
         211        2511       22886        9944        1427         241
          64         424        9944      135846       34539        1577
          31         132        1427       34539      471252       27145
           7          36         241        1577       27145      553922
           1          12          40         148         436        7745
           0           1           2           3           7          47
```

```
imshow(rescale(SI))
```

```
%extractLBPFeatures
gato = imread('gato.jpg');
gatobw=rgb2gray(gato)
```

gatobw = 750×750 uint8 matrix

85	88	91	91	88	86	87	88	89	90	91	92	91 ···
84	86	89	89	87	86	87	88	86	87	88	89	89
81	83	86	86	86	86	87	88	83	84	85	86	87
80	81	82	83	84	85	86	87	83	84	84	85	85
79	79	79	81	83	84	85	86	86	86	85	85	84
80	79	78	79	82	84	85	84	87	86	86	85	84
82	79	78	79	82	84	84	83	85	85	84	84	83
83	80	78	78	81	84	84	82	83	83	82	82	82
83	80	79	80	83	84	84	82	84	85	85	85	84
83	81	80	81	83	85	84	83	85	85	86	85	85
⋮												

```
rotatedcat = imread('rotatedcat.jpg');
rotatedcatbw=rgb2gray(rotatedcat)
```

rotatedcatbw = 750×750 uint8 matrix

29	28	28	28	28	28	28	28	28	28	28	29	30	30	29	28 ···
28	28	28	28	28	28	28	28	28	28	28	29	30	30	29	28
28	28	28	28	28	28	28	28	28	28	28	29	30	30	29	28
28	28	28	28	28	28	28	28	28	28	28	29	29	29	29	28
28	28	28	28	28	28	28	28	28	28	28	28	29	29	29	28
29	29	29	28	28	28	28	28	28	28	28	28	29	29	29	28
30	29	29	29	28	28	28	28	28	28	27	28	29	29	29	28
30	30	30	29	29	28	28	28	28	28	27	28	28	29	29	28
30	29	29	29	29	28	28	28	28	28	28	28	28	28	28	28
30	30	29	29	29	28	28	28	28	28	28	28	28	28	28	28

```
    ⋮
```

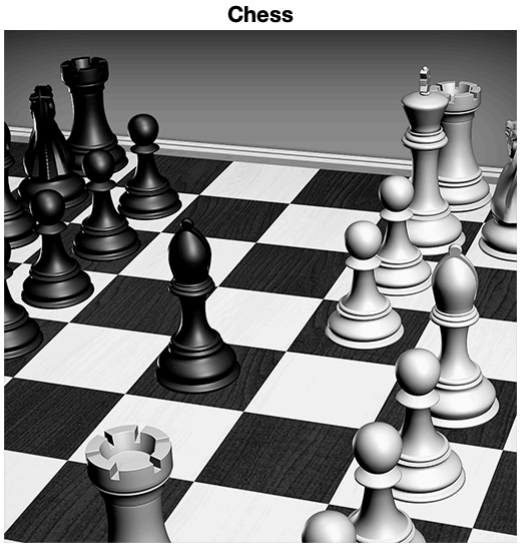
```
chess = imread('chess.png');
chessbw=rgb2gray(chess)
```

```
chessbw = 512×512 uint8 matrix
   40   43   43   43   43   44   44   44   44   44   45   45   45   45   45   45 ···
   46   46   46   47   47   47   47   48   48   48   49   48   48   49   49   50
   45   47   47   48   48   48   49   48   49   49   49   50   50   50   50   51
   45   48   49   49   49   49   50   50   51   50   50   51   51   51   51   52
   46   49   49   49   50   50   51   51   51   51   51   51   51   52   52   52
   47   50   50   50   51   51   51   51   51   51   51   52   52   52   52   53
   48   51   51   51   52   52   52   52   52   53   53   53   53   54   54   54
   49   52   52   52   52   53   52   53   53   54   54   54   54   55   55   55
   50   53   53   53   53   54   54   54   54   55   55   55   55   56   56   57
   51   54   54   54   54   55   55   55   55   56   56   57   57   57   57   58
    ⋮
```

```
figure
imshow(gatobw)
title('cat')
```

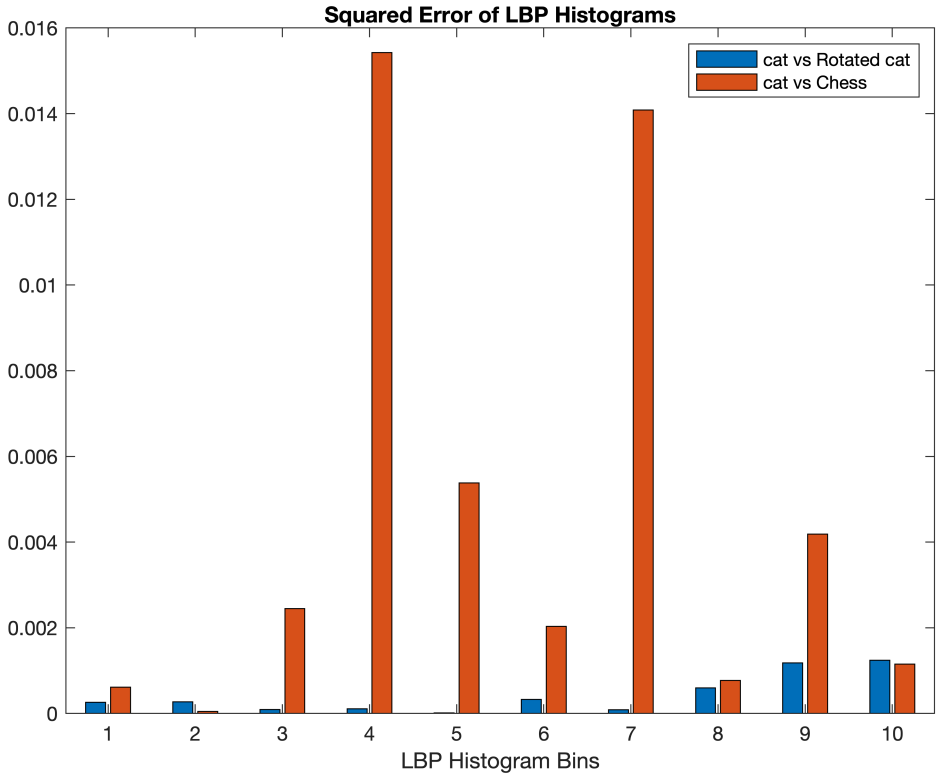

```
figure
imshow(rotatedcatbw)
title('Rotated cat')
```


```
figure
imshow(chessbw)
title('Chess')
```




```
lbpBricks1 = extractLBPFeatures(gatobw,'Upright',false);
lbpBricks2 = extractLBPFeatures(rotatedcatbw,'Upright',false);
lbpCarpet = extractLBPFeatures(chessbw,'Upright',false);
```

```
brickVsBrick = (lbpBricks1 - lbpBricks2).^2;
brickVsCarpet = (lbpBricks1 - lbpCarpet).^2;
figure
bar([brickVsBrick; brickVsCarpet]','grouped')
title('Squared Error of LBP Histograms')
xlabel('LBP Histogram Bins')
legend('cat vs Rotated cat','cat vs Chess')
```




```
I = imread('gato.jpg');
I = im2gray(I);
lbpFeatures = extractLBPFeatures(I,'CellSize',[32 32],'Normalization','None');
numNeighbors = 8;
numBins = numNeighbors*(numNeighbors-1)+3;
lbpCellHists = reshape(lbpFeatures,numBins,[]);
lbpCellHists = bsxfun(@rdivide,lbpCellHists,sum(lbpCellHists));
lbpFeatures = reshape(lbpCellHists,1,[]);
```