

*******Draft*******

Principal component analysis (PCA)

08/31/19

*******Draft*******

Created a smaller set of images which were a cut from thumb0000yes1.pgm & thumb0000no1.pgm.
These were then used in example1.c.



Thumb0000yes1sm.pgm



Thumb0000no1sm.pgm

*****Draft*****

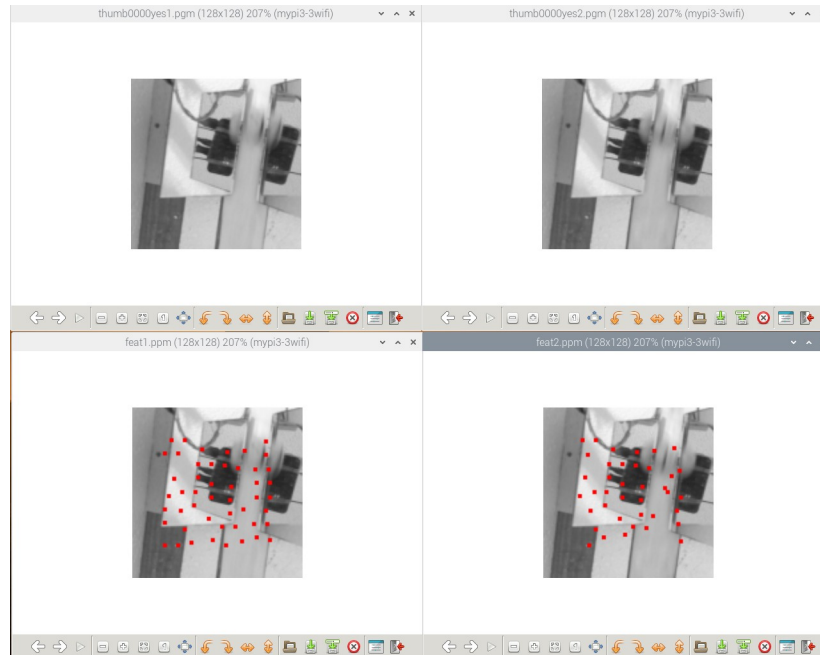
Principal component analysis (PCA)

08/31/19

*****Draft*****

Looking the feature extraction from ultibo_numlib/klt. Converted the 4 test images bmp images to pgm which was the format that was used.

Modified example1.c to use thumb0000yes1.pgm and thumb0000yes2.pgm



feat1.txt

Feel free to place comments here.

!!

!!! Warning: This is a KLT data file. Do not modify below this line !!!

KLT Feature List

nFeatures = 100

feature | (x,y)=val

-----+-----
0 | (59, 42)=12494

1 | (49, 52)=11437
2 | (71, 33)=11096
3 | (39, 91)=10412
4 | (59, 67)=10405
5 | (100, 77)= 9171
6 | (73, 69)= 8453
7 | (24, 86)= 8441
8 | (52, 31)= 7226
9 | (49, 42)= 5225
10 | (67, 89)= 3450
11 | (74, 59)= 3192
12 | (100, 35)= 2280
13 | (101, 87)= 2264
14 | (59, 57)= 1547
15 | (103, 99)= 1533
16 | (100, 25)= 1514
17 | (46, 73)= 1183
18 | (103, 67)= 1166
19 | (79, 45)= 1089
20 | (84, 32)= 1085
21 | (47, 63)= 906
22 | (102, 46)= 836
23 | (39, 24)= 757
24 | (34,103)= 730
25 | (69, 43)= 473
26 | (57, 83)= 468
27 | (31, 53)= 407
28 | (24, 34)= 270
29 | (24, 76)= 236
30 | (92, 46)= 210
31 | (73, 79)= 168
32 | (103, 56)= 145
33 | (27, 66)= 130
34 | (29, 24)= 97
35 | (93, 56)= 80
36 | (24,103)= 65
37 | (93, 97)= 52
38 | (36, 77)= 44
39 | (77, 89)= 40
40 | (44,101)= 28
41 | (60, 99)= 25
42 | (34, 34)= 21
43 | (93, 67)= 15
44 | (91, 87)= 13
45 | (70,103)= 5
46 | (82,100)= 4
47 | (83, 76)= 4
48 | (37, 63)= 1
49 | (-1, -1)= -1

50 | (-1, -1)= -1
51 | (-1, -1)= -1
52 | (-1, -1)= -1
53 | (-1, -1)= -1
54 | (-1, -1)= -1
55 | (-1, -1)= -1
56 | (-1, -1)= -1
57 | (-1, -1)= -1
58 | (-1, -1)= -1
59 | (-1, -1)= -1
60 | (-1, -1)= -1
61 | (-1, -1)= -1
62 | (-1, -1)= -1
63 | (-1, -1)= -1
64 | (-1, -1)= -1
65 | (-1, -1)= -1
66 | (-1, -1)= -1
67 | (-1, -1)= -1
68 | (-1, -1)= -1
69 | (-1, -1)= -1
70 | (-1, -1)= -1
71 | (-1, -1)= -1
72 | (-1, -1)= -1
73 | (-1, -1)= -1
74 | (-1, -1)= -1
75 | (-1, -1)= -1
76 | (-1, -1)= -1
77 | (-1, -1)= -1
78 | (-1, -1)= -1
79 | (-1, -1)= -1
80 | (-1, -1)= -1
81 | (-1, -1)= -1
82 | (-1, -1)= -1
83 | (-1, -1)= -1
84 | (-1, -1)= -1
85 | (-1, -1)= -1
86 | (-1, -1)= -1
87 | (-1, -1)= -1
88 | (-1, -1)= -1
89 | (-1, -1)= -1
90 | (-1, -1)= -1
91 | (-1, -1)= -1
92 | (-1, -1)= -1
93 | (-1, -1)= -1
94 | (-1, -1)= -1
95 | (-1, -1)= -1
96 | (-1, -1)= -1
97 | (-1, -1)= -1
98 | (-1, -1)= -1

99 | (-1, -1)= -1

feat2.txt

Feel free to place comments here.

!!

!!! Warning: This is a KLT data file. Do not modify below this line !!!

KLT Feature List

nFeatures = 100

feature | (x,y)=val

-----+-----
0 | (59.1, 42.1)= 0
1 | (49.2, 52.0)= 0
2 | (70.3, 33.2)= 0
3 | (38.9, 91.1)= 0
4 | (59.1, 66.9)= 0
5 | (100.0, 76.9)= 0
6 | (73.0, 68.8)= 0
7 | (-1.0, -1.0)= -4
8 | (52.2, 31.1)= 0
9 | (49.1, 42.1)= 0
10 | (66.9, 89.2)= 0
11 | (74.0, 58.9)= 0
12 | (-1.0, -1.0)= -4
13 | (101.0, 87.1)= 0
14 | (59.1, 56.9)= 0
15 | (102.8, 99.5)= 0
16 | (98.0, 29.9)= 0
17 | (46.2, 72.8)= 0
18 | (103.0, 66.9)= 0
19 | (79.3, 45.3)= 0
20 | (83.2, 32.1)= 0
21 | (47.2, 62.8)= 0
22 | (102.1, 47.5)= 0
23 | (39.2, 24.2)= 0
24 | (33.8,102.9)= 0
25 | (68.7, 43.5)= 0
26 | (57.5, 82.9)= 0
27 | (31.0, 52.1)= 0
28 | (-1.0, -1.0)= -4
29 | (-1.0, -1.0)= -4
30 | (95.9, 50.8)= 0
31 | (73.5, 80.0)= 0

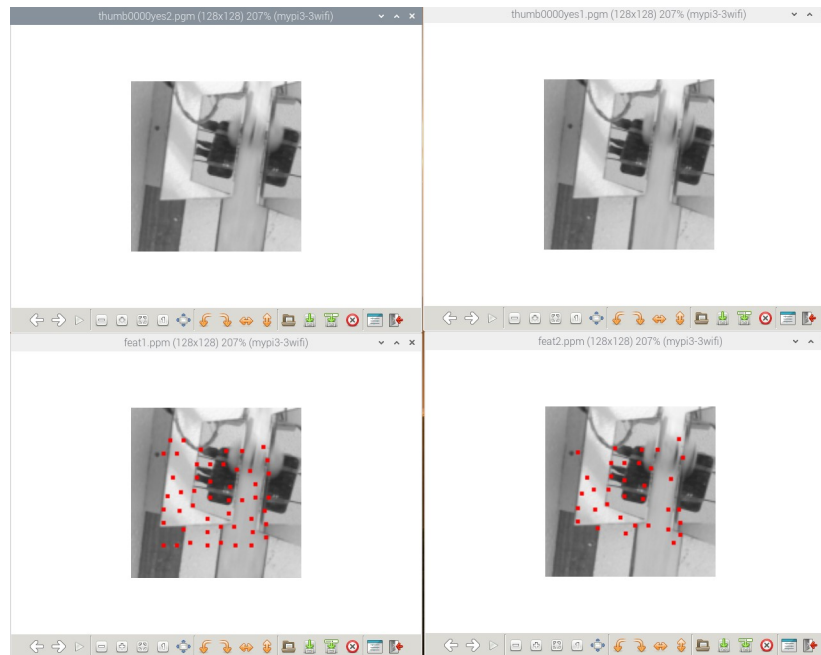
32 | (-1.0, -1.0)= -4
33 | (26.9, 66.3)= 0
34 | (28.9, 24.4)= 0
35 | (90.7, 59.8)= 0
36 | (-1.0, -1.0)= -4
37 | (-1.0, -1.0)= -3
38 | (35.3, 77.3)= 0
39 | (77.3, 89.6)= 0
40 | (44.9, 96.9)= 0
41 | (60.9, 95.4)= 0
42 | (33.3, 35.3)= 0
43 | (93.0, 62.8)= 0
44 | (-1.0, -1.0)= -3
45 | (-1.0, -1.0)= -4
46 | (-1.0, -1.0)= -4
47 | (81.6, 81.2)= 0
48 | (37.8, 63.2)= 0
49 | (-1.0, -1.0)= -1
50 | (-1.0, -1.0)= -1
51 | (-1.0, -1.0)= -1
52 | (-1.0, -1.0)= -1
53 | (-1.0, -1.0)= -1
54 | (-1.0, -1.0)= -1
55 | (-1.0, -1.0)= -1
56 | (-1.0, -1.0)= -1
57 | (-1.0, -1.0)= -1
58 | (-1.0, -1.0)= -1
59 | (-1.0, -1.0)= -1
60 | (-1.0, -1.0)= -1
61 | (-1.0, -1.0)= -1
62 | (-1.0, -1.0)= -1
63 | (-1.0, -1.0)= -1
64 | (-1.0, -1.0)= -1
65 | (-1.0, -1.0)= -1
66 | (-1.0, -1.0)= -1
67 | (-1.0, -1.0)= -1
68 | (-1.0, -1.0)= -1
69 | (-1.0, -1.0)= -1
70 | (-1.0, -1.0)= -1
71 | (-1.0, -1.0)= -1
72 | (-1.0, -1.0)= -1
73 | (-1.0, -1.0)= -1
74 | (-1.0, -1.0)= -1
75 | (-1.0, -1.0)= -1
76 | (-1.0, -1.0)= -1
77 | (-1.0, -1.0)= -1
78 | (-1.0, -1.0)= -1
79 | (-1.0, -1.0)= -1
80 | (-1.0, -1.0)= -1

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81 | ( -1.0, -1.0)= -1
82 | ( -1.0, -1.0)= -1
83 | ( -1.0, -1.0)= -1
84 | ( -1.0, -1.0)= -1
85 | ( -1.0, -1.0)= -1
86 | ( -1.0, -1.0)= -1
87 | ( -1.0, -1.0)= -1
88 | ( -1.0, -1.0)= -1
89 | ( -1.0, -1.0)= -1
90 | ( -1.0, -1.0)= -1
91 | ( -1.0, -1.0)= -1
92 | ( -1.0, -1.0)= -1
93 | ( -1.0, -1.0)= -1
94 | ( -1.0, -1.0)= -1
95 | ( -1.0, -1.0)= -1
96 | ( -1.0, -1.0)= -1
97 | ( -1.0, -1.0)= -1
98 | ( -1.0, -1.0)= -1
99 | ( -1.0, -1.0)= -1

```

end of feat.txt



Modified example1.c to use thumb0000yes2.pgm and thumb0000yes1.pgm

feat1.txt

Feel free to place comments here.

!!

!!! Warning: This is a KLT data file. Do not modify below this line !!!

KLT Feature List

nFeatures = 100

feature | (x,y)=val

0	(59, 42)=12951
1	(71, 32)=11510
2	(49, 52)=11472
3	(59, 67)=10930
4	(39, 91)=10416
5	(100, 77)= 9166
6	(73, 69)= 8837
7	(24, 86)= 8779
8	(52, 31)= 7268
9	(49, 42)= 5364
10	(74, 59)= 3307
11	(67, 89)= 2881
12	(101, 87)= 2445
13	(83, 32)= 1920
14	(102, 39)= 1830
15	(101, 97)= 1785
16	(103, 49)= 1728
17	(59, 55)= 1637
18	(103, 67)= 1183
19	(46, 73)= 1097
20	(79, 46)= 1035
21	(69, 42)= 974
22	(47, 62)= 929
23	(89, 47)= 928
24	(99, 29)= 804
25	(39, 24)= 781
26	(34,103)= 731
27	(57, 83)= 470
28	(31, 52)= 415
29	(24, 34)= 256
30	(73, 79)= 253
31	(24, 76)= 232
32	(93, 57)= 121
33	(27, 66)= 121
34	(29, 24)= 93
35	(91, 93)= 60
36	(24,103)= 57
37	(36, 77)= 54
38	(77, 89)= 42
39	(67,101)= 33
40	(34, 34)= 24

41 | (44,101)= 23
42 | (90,103)= 23
43 | (78,103)= 19
44 | (93, 67)= 15
45 | (57, 93)= 8
46 | (90, 83)= 7
47 | (57,103)= 7
48 | (37, 63)= 2
49 | (83, 69)= 2
50 | (-1, -1)= -1
51 | (-1, -1)= -1
52 | (-1, -1)= -1
53 | (-1, -1)= -1
54 | (-1, -1)= -1
55 | (-1, -1)= -1
56 | (-1, -1)= -1
57 | (-1, -1)= -1
58 | (-1, -1)= -1
59 | (-1, -1)= -1
60 | (-1, -1)= -1
61 | (-1, -1)= -1
62 | (-1, -1)= -1
63 | (-1, -1)= -1
64 | (-1, -1)= -1
65 | (-1, -1)= -1
66 | (-1, -1)= -1
67 | (-1, -1)= -1
68 | (-1, -1)= -1
69 | (-1, -1)= -1
70 | (-1, -1)= -1
71 | (-1, -1)= -1
72 | (-1, -1)= -1
73 | (-1, -1)= -1
74 | (-1, -1)= -1
75 | (-1, -1)= -1
76 | (-1, -1)= -1
77 | (-1, -1)= -1
78 | (-1, -1)= -1
79 | (-1, -1)= -1
80 | (-1, -1)= -1
81 | (-1, -1)= -1
82 | (-1, -1)= -1
83 | (-1, -1)= -1
84 | (-1, -1)= -1
85 | (-1, -1)= -1
86 | (-1, -1)= -1
87 | (-1, -1)= -1
88 | (-1, -1)= -1
89 | (-1, -1)= -1

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90 | ( -1, -1)= -1
91 | ( -1, -1)= -1
92 | ( -1, -1)= -1
93 | ( -1, -1)= -1
94 | ( -1, -1)= -1
95 | ( -1, -1)= -1
96 | ( -1, -1)= -1
97 | ( -1, -1)= -1
98 | ( -1, -1)= -1
99 | ( -1, -1)= -1

```

feat2.txt

Feel free to place comments here.

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!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!! Warning: This is a KLT data file. Do not modify below this line !!!

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-----
KLT Feature List
-----

```

nFeatures = 100

```

feature | (x,y)=val
-----+-----
 0 | ( 58.8, 41.9)=  0
 1 | ( 71.7, 31.9)=  0
 2 | ( 48.8, 52.0)=  0
 3 | ( 58.9, 67.0)=  0
 4 | ( 39.1, 90.9)=  0
 5 | (100.0, 77.1)=  0
 6 | ( 73.0, 69.1)=  0
 7 | ( 24.1, 85.9)=  0
 8 | ( 51.9, 30.9)=  0
 9 | ( 49.0, 41.9)=  0
10 | ( 74.0, 59.1)=  0
11 | ( 67.1, 88.8)=  0
12 | (101.0, 86.9)=  0
13 | ( 83.7, 31.9)=  0
14 | (102.8, 38.2)=  0
15 | (101.3, 96.2)=  0
16 | ( -1.0, -1.0)= -4
17 | ( 58.9, 55.0)=  0
18 | ( -1.0, -1.0)= -4
19 | ( 45.9, 73.2)=  0
20 | ( 78.7, 45.7)=  0

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21 | (69.6, 41.8)= 0
22 | (46.9, 62.3)= 0
23 | (-1.0, -1.0)= -5
24 | (100.3, 24.0)= 0
25 | (-1.0, -1.0)= -4
26 | (-1.0, -1.0)= -4
27 | (56.4, 83.0)= 0
28 | (31.0, 52.9)= 0
29 | (24.1, 33.9)= 0
30 | (-1.0, -1.0)= -3
31 | (24.1, 75.6)= 0
32 | (93.8, 54.0)= 0
33 | (27.2, 65.4)= 0
34 | (-1.0, -1.0)= -4
35 | (92.4, 92.2)= 0
36 | (-1.0, -1.0)= -4
37 | (36.7, 76.6)= 0
38 | (76.7, 88.6)= 0
39 | (-1.0, -1.0)= -4
40 | (-1.0, -1.0)= -3
41 | (-1.0, -1.0)= -4
42 | (96.3,102.3)= 0
43 | (-1.0, -1.0)= -3
44 | (-1.0, -1.0)= -3
45 | (59.7, 94.7)= 0
46 | (91.6, 77.4)= 0
47 | (-1.0, -1.0)= -4
48 | (35.9, 62.4)= 0
49 | (-1.0, -1.0)= -3
50 | (-1.0, -1.0)= -1
51 | (-1.0, -1.0)= -1
52 | (-1.0, -1.0)= -1
53 | (-1.0, -1.0)= -1
54 | (-1.0, -1.0)= -1
55 | (-1.0, -1.0)= -1
56 | (-1.0, -1.0)= -1
57 | (-1.0, -1.0)= -1
58 | (-1.0, -1.0)= -1
59 | (-1.0, -1.0)= -1
60 | (-1.0, -1.0)= -1
61 | (-1.0, -1.0)= -1
62 | (-1.0, -1.0)= -1
63 | (-1.0, -1.0)= -1
64 | (-1.0, -1.0)= -1
65 | (-1.0, -1.0)= -1
66 | (-1.0, -1.0)= -1
67 | (-1.0, -1.0)= -1
68 | (-1.0, -1.0)= -1
69 | (-1.0, -1.0)= -1

70 | (-1.0, -1.0)= -1
71 | (-1.0, -1.0)= -1
72 | (-1.0, -1.0)= -1
73 | (-1.0, -1.0)= -1
74 | (-1.0, -1.0)= -1
75 | (-1.0, -1.0)= -1
76 | (-1.0, -1.0)= -1
77 | (-1.0, -1.0)= -1
78 | (-1.0, -1.0)= -1
79 | (-1.0, -1.0)= -1
80 | (-1.0, -1.0)= -1
81 | (-1.0, -1.0)= -1
82 | (-1.0, -1.0)= -1
83 | (-1.0, -1.0)= -1
84 | (-1.0, -1.0)= -1
85 | (-1.0, -1.0)= -1
86 | (-1.0, -1.0)= -1
87 | (-1.0, -1.0)= -1
88 | (-1.0, -1.0)= -1
89 | (-1.0, -1.0)= -1
90 | (-1.0, -1.0)= -1
91 | (-1.0, -1.0)= -1
92 | (-1.0, -1.0)= -1
93 | (-1.0, -1.0)= -1
94 | (-1.0, -1.0)= -1
95 | (-1.0, -1.0)= -1
96 | (-1.0, -1.0)= -1
97 | (-1.0, -1.0)= -1
98 | (-1.0, -1.0)= -1
99 | (-1.0, -1.0)= -1
end of feat.txt

*****Draft*****

Principal component analysis (PCA)

08/29/19

*****Draft*****

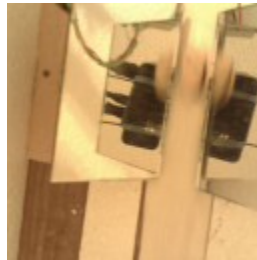
Principal component analysis (PCA) is a statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables (entities each of which takes on various numerical values) into a set of values of linearly uncorrelated variables called principal components.

Machine Learning — Singular Value Decomposition (SVD) & Principal Component

Analysis (PCA)

Analysis of 4 images 2 cracked and 2 not cracked. The (SVD) or (PCA) does appears to track that pistachios that are cracked do have a higher (PCA) than pistachios that are not cracked.

Thumb0000yes1.bmp



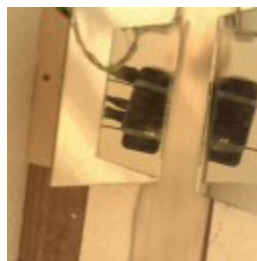
thumb0000no1.bmp



Thumb0000yes2.bmp



thumb0000n2.bmp



thumb0000yes1.bmp thumb0000no1.bmp thumb0000yes2.bmp thumb0000n2.bmp
pca1(1:20)
ans =

2.5118e+04	2.4510e+04	2.5212e+04	2.4252e+04
4.1047e+03			
1.7342e+03			
1.3414e+03			
1.3223e+03			
1.0863e+03			
8.6049e+02			
7.6984e+02			
6.8771e+02			
6.0650e+02			
5.2599e+02			
4.5459e+02			
4.4436e+02			
3.8315e+02			
3.7725e+02			
3.3203e+02			
3.1981e+02			
2.7991e+02			
2.7412e+02			
2.5770e+02			

pca2(1:20)
ans =

2.0217e+04	1.9552e+04	2.0434e+04	1.9248e+04
3.8104e+03			
1.5775e+03			
1.3825e+03			
1.1628e+03			
1.0376e+03			
7.8174e+02			
7.4592e+02			
6.8873e+02			
5.8089e+02			
5.1885e+02			
4.6897e+02			
4.5024e+02			
4.0410e+02			
3.6088e+02			
3.2620e+02			
3.0089e+02			
2.8690e+02			
2.6073e+02			

2.4677e+02

pca3(1:20)
ans =

1.3455e+04	1.2802e+04	1.3600e+04	1.2537e+04
2.7543e+03			
1.2505e+03			
1.0014e+03			
8.8897e+02			
7.7139e+02			
6.2903e+02			
5.8134e+02			
5.3249e+02			
4.6860e+02			
4.0902e+02			
3.9088e+02			
3.6356e+02			
3.4791e+02			
3.0013e+02			
2.6766e+02			
2.5222e+02			
2.3809e+02			
2.1705e+02			
2.0159e+02			

thumb0000no1.bmp
pca1(1:20)
ans =

2.4510e+04
4.0433e+03
1.9649e+03
1.4272e+03
1.3475e+03
9.9684e+02
8.2375e+02
7.9589e+02
6.8341e+02
5.8102e+02
5.0413e+02
4.6857e+02
4.2710e+02
4.0367e+02
3.7746e+02
3.4601e+02
3.3557e+02
2.9683e+02
2.8394e+02

2.5602e+02

pca2(1:20)
ans =

1.9552e+04
3.6803e+03
1.6822e+03
1.4549e+03
1.1840e+03
9.1180e+02
7.5005e+02
7.1683e+02
6.8642e+02
5.3968e+02
4.8279e+02
4.4007e+02
4.3046e+02
4.0756e+02
3.5801e+02
3.3369e+02
3.1684e+02
2.8013e+02
2.6143e+02
2.4284e+02

pca3(1:20)
ans =

1.2802e+04
2.6358e+03
1.2603e+03
1.1070e+03
8.7383e+02
7.0593e+02
5.8519e+02
5.8225e+02
5.2708e+02
4.2259e+02
3.9897e+02
3.7471e+02
3.5758e+02
3.3290e+02
3.1216e+02
2.7739e+02
2.5960e+02
2.3723e+02
2.1209e+02
2.0476e+02

thumb0000yes2.bmp

pca1(1:20)

ans =

2.5212e+04

4.0210e+03

1.8347e+03

1.4258e+03

1.3558e+03

1.0733e+03

8.3836e+02

7.6427e+02

6.8187e+02

6.1109e+02

5.2345e+02

4.8893e+02

4.5993e+02

4.1018e+02

4.0371e+02

3.5510e+02

3.3618e+02

2.9982e+02

2.6943e+02

2.5862e+02

pca2(1:20)

ans =

2.0434e+04

3.7564e+03

1.6314e+03

1.4176e+03

1.2380e+03

1.0131e+03

7.6505e+02

7.4708e+02

6.7221e+02

5.7194e+02

5.2257e+02

4.7293e+02

4.6234e+02

4.2547e+02

3.7508e+02

3.3221e+02

3.3095e+02

2.8798e+02

2.6839e+02

2.5635e+02

```
pca3(1:20)  
ans =
```

```
1.3600e+04  
2.7226e+03  
1.2751e+03  
1.0553e+03  
9.2998e+02  
7.9118e+02  
6.0423e+02  
5.9610e+02  
5.1626e+02  
4.6031e+02  
4.2646e+02  
4.0938e+02  
3.8739e+02  
3.5952e+02  
3.1919e+02  
2.8066e+02  
2.6825e+02  
2.4342e+02  
2.2798e+02  
2.1238e+02
```

```
thumb0000n2.bmp
```

```
pca1(1:20)  
ans =
```

```
2.4252e+04  
4.3798e+03  
1.6566e+03  
1.4539e+03  
1.2313e+03  
9.4545e+02  
8.6362e+02  
7.0752e+02  
6.3207e+02  
5.8339e+02  
5.0927e+02  
4.6314e+02  
4.3968e+02  
3.7103e+02  
3.2726e+02  
3.1503e+02  
2.9399e+02  
2.7929e+02  
2.6932e+02
```

2.6126e+02

```
>> pca2(1:20)  
ans =
```

1.9248e+04
3.8751e+03
1.6063e+03
1.3434e+03
1.0795e+03
8.8676e+02
7.6481e+02
6.9949e+02
5.9415e+02
5.6022e+02
4.9497e+02
4.3213e+02
4.0966e+02
3.5401e+02
3.1833e+02
2.9621e+02
2.8560e+02
2.7431e+02
2.5903e+02
2.4629e+02

```
>> pca3(1:20)  
ans =
```

1.2537e+04
2.7423e+03
1.2570e+03
1.0034e+03
7.9929e+02
6.7685e+02
5.8549e+02
5.6615e+02
4.7492e+02
4.3317e+02
4.0130e+02
3.5044e+02
3.3603e+02
3.0458e+02
2.7552e+02
2.5449e+02
2.4492e+02
2.2631e+02
2.1090e+02
2.0487e+02