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1  %% TEST 1
2  clear all; close all; clc;
3  %% Import cam data
4  load('cam1_1.mat');
5  load('cam2_1.mat');
6  load('cam3_1.mat');
7  %% Get rows/columns and dimensions
8  [row1, col1, dim1_1, dim2_1] = size(vidFrames1_1);
9  [row2, col2, dim1_2, dim2_2] = size(vidFrames2_1);
10 [row3, col3, dim1_3, dim2_3] = size(vidFrames3_1);
11 %% Store the video by frames
12 for k = 1:dim2_1
13     img1{k} = vidFrames1_1(:, :, :, k);
14 end
15 for k = 1:dim2_2
16     img2{k} = vidFrames2_1(:, :, :, k);
17 end
18
19 for k = 1:dim2_3
20     img3{k} = vidFrames3_1(:, :, :, k);
21 end
22 %% Ideal Case
23 x1 = zeros(1, dim2_1);
24 y1 = zeros(1, dim2_1);
25 boxX1 = [300, 350];
26 boxY1 = [200, 250];
27 for k = 1:dim2_1
28     img = vidFrames1_1(:, :, 3, k);
29     box = double(img(boxY1(1):boxY1(2), boxX1(1):boxX1(2)));
30     [row, col] = find(box == max(max(box)));
31     y1(k) = mean(row) + boxY1(1);
32     x1(k) = mean(col) + boxX1(1);
33     boxX1 = [round(x1(k) - 20), round(x1(k) + 20)];
34     boxY1 = [round(y1(k) - 20), round(y1(k) + 20)];
35 end
36
37 x2 = zeros(1, dim2_2);
38 y2 = zeros(1, dim2_2);
39 boxX2 = [250, 300];
40 boxY2 = [250, 300];
41 for k = 1:dim2_2
42     img = vidFrames2_1(:, :, 3, k);
43     box = double(img(boxY2(1):boxY2(2), boxX2(1):boxX2(2)));
44     [row, col] = find(box == max(max(box)));
45     y2(k) = mean(row) + boxY2(1);
46     x2(k) = mean(col) + boxX2(1);
47     boxX2 = [round(x2(k) - 20), round(x2(k) + 20)];
48     boxY2 = [round(y2(k) - 20), round(y2(k) + 20)];
49 end
50
51 x3 = zeros(1, dim2_3);
52 y3 = zeros(1, dim2_3);
53 boxX3 = [310, 340];
54 boxY3 = [265, 295];
55 for k = 1:dim2_3
56     img = vidFrames3_1(:, :, 3, k);
57     box = double(img(boxY3(1):boxY3(2), boxX3(1):boxX3(2)));
58     [row, col] = find(box == max(max(box)));
59     y3(k) = mean(row) + boxY3(1);
60     x3(k) = mean(col) + boxX3(1);
61     boxX3 = [round(x3(k) - 15), round(x3(k) + 15)];
62     boxY3 = [round(y3(k) - 15), round(y3(k) + 15)];
63 end
64
65 % %% Video1

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66 % figure(1);
67 % for i = 1:length(img1)
68 %     imshow(img1{i});
69 %     hold on;
70 %     rectangle('position', [x1(i) - 10, y1(i) - 10, 20, 20], 'Linewidth', 2);
71 %     hold off;
72 %     pause(0.001);
73 % end
74 % %% Video2
75 % figure(2);
76 % for i = 1:length(img2)
77 %     imshow(img2{i});
78 %     hold on;
79 %     rectangle('position', [x2(i) - 10, y2(i) - 10, 20, 20], 'Linewidth', 2);
80 %     hold off;
81 %     pause(0.001)
82 % end
83 % %% Video3
84 % figure(3);
85 % for i = 1:length(img3)
86 %     imshow(img3{i});
87 %     hold on;
88 %     rectangle('position', [x3(i) - 15, y3(i) - 15, 30, 30], 'Linewidth', 2);
89 %     hold off;
90 %     pause(0.001)
91 % end
92
93 %% Force everything to be in the same size
94 x1; y1; % Reference
95 x2 = x2(11:dim2_1 + 10);
96 y2 = y2(11:dim2_1 + 10);
97 x3 = x3(1:dim2_1);
98 y3 = 480 - y3(1:dim2_1);
99 %% Plot
100 figure(4);
101 subplot(2,1,1);
102 plot(y1,'Linewidth', 3); hold on;
103 plot(y2,'Linewidth', 3)
104 plot(x3,'Linewidth', 3)
105 title('Y Coordinates of Can in Ideal Case');
106 xlabel('Timeframe');
107 ylabel('Displacement');
108 xlim([0 length(y1) + 50]);
109 legend('cam1(y1)', 'cam2(y2)', 'cam3(y3)');
110
111 subplot(2,1,2);
112 plot(x1,'Linewidth', 3); hold on;
113 plot(x2,'Linewidth', 3)
114 plot(y3,'Linewidth', 3)
115 title('X Coordinates of Can in Ideal Case');
116 xlabel('Timeframe');
117 ylabel('Displacement');
118 xlim([0 length(y1) + 50]);
119 legend('cam1(x1)', 'cam2(x2)', 'cam3(x3)');
120
121 %% Normalize the Data
122 figure(5)
123 subplot(2,1,1);
124 plot(y1 - mean(y1), 'Linewidth', 3); hold on;
125 plot(y2 - mean(y2), 'Linewidth', 3)
126 plot(x3 - mean(x3), 'Linewidth', 3)
127 title('Y Coordinates of Can in Ideal Case(Normalized)');
128 xlabel('Time');
129 ylabel('Displacement');
130 xlim([0 length(y1) + 50]);

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131 legend('cam1(y1)', 'cam2(y2)', 'cam3(y3)');
132
133 subplot(2,1,2);
134 plot(x1 - mean(x1), 'Linewidth', 3); hold on;
135 plot(x2 - mean(x2), 'Linewidth', 3);
136 plot(y3 - mean(y3), 'Linewidth', 3);
137 title('X Coordinates of Can in Ideal Case(Normalized)');
138 xlabel('Time');
139 ylabel('Displacement');
140 legend('cam1(x1)', 'cam2(x2)', 'cam3(x3)');
141 xlim([0 length(y1) + 50]);
142
143 %% SVD
144 X = [x1 - mean(x1); y1 - mean(y1); x2 - mean(x2); y2 - mean(y2); ...
145      x3 - mean(x3); y3 - mean(y3)];
146 [u, s, v] = svd(X, 'econ');
147
148 %% Plot
149 figure;
150 plot(diag(s)/sum(diag(s)), 'o', 'Linewidth', 2);
151 title('Importance of Singular Values For All Directions in Ideal Case');
152 xlabel('Singular values');
153 ylabel('Energy');
154 %%
155 %-----
156 %% TEST 2
157 clc; clear all; close all;
158 %% noisy case
159 load('cam1_2.mat')
160 load('cam2_2.mat')
161 load('cam3_2.mat')
162 %%
163 [row1, col1, dim1_1, dim2_1] = size(vidFrames1_2);
164 [row2, col2, dim1_2, dim2_2] = size(vidFrames2_2);
165 [row3, col3, dim1_3, dim2_3] = size(vidFrames3_2);
166 %%
167 for k = 1:dim2_1
168     img1{k} = vidFrames1_2(:, :, :, k);
169 end
170 for k = 1:dim2_2
171     img2{k} = vidFrames2_2(:, :, :, k);
172 end
173
174 for k = 1:dim2_3
175     img3{k} = vidFrames3_2(:, :, :, k);
176 end
177 %% case 2
178 x1 = zeros(1, dim2_1);
179 y1 = zeros(1, dim2_1);
180 boxX = [300 350];
181 boxY = [300 350];
182 for i = 1:dim2_1
183     img = vidFrames1_2(:, :, 3, i);
184     box = double(img(boxY(1):boxY(2), boxX(1):boxX(2)));
185     [row, col] = find(box == max(max(box)));
186     y1(i) = mean(row) + boxY(1);
187     x1(i) = mean(col) + boxX(1);
188     boxX = [round(x1(i) - 20), round(x1(i) + 20)];
189     boxY = [round(y1(i) - 20), round(y1(i) + 20)];
190 end
191
192 x2 = zeros(1, dim2_2);
193 y2 = zeros(1, dim2_2);
194 boxX = [290 340];
195 boxY = [330 380];

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196 for i = 1:dim2_2
197     img = vidFrames2_2(:,:,3,i);
198     box = double(img(boxY(1):boxY(2), boxX(1):boxX(2)));
199     [row, col] = find(box == max(max(box)));
200     y2(i) = mean(row) + boxY(1);
201     x2(i) = mean(col) + boxX(1);
202     boxX = [round(x2(i) - 30), round(x2(i) + 30)];
203     boxY = [round(y2(i) - 30), round(y2(i) + 30)];
204 end
205
206
207 x3 = zeros(1, dim2_3);
208 y3 = zeros(1, dim2_3);
209 boxX = [335 365];
210 boxY = [240 270];
211 %[335, 240, 20, 20]
212 count = 0;
213 for i = 1:dim2_3
214     count = count + 1;
215     img = vidFrames3_2(:,:,3,i);
216     box = double(img(boxY(1):boxY(2), boxX(1):boxX(2)));
217     [row, col] = find(box == max(max(box)));
218     y3(i) = mean(row) + boxY(1);
219     x3(i) = mean(col) + boxX(1);
220     boxX = [round(x3(i) - 30), round(x3(i) + 30)];
221     boxY = [round(y3(i) - 30), round(y3(i) + 30)];
222 end
223 %%
224 % figure(1);
225 % for i = 1:length(img1)
226 %     imshow(img1{i});
227 %     hold on;
228 %     rectangle('position', [x1(i) - 20, y1(i) - 20, 40, 40], 'Linewidth', 2);
229 %     hold off;
230 %     pause(0.001)
231 % end
232 %%
233 % figure(2);
234 % for i = 1:length(img2)
235 %     imshow(img2{i});
236 %     hold on;
237 %     rectangle('position', [x2(i) - 15, y2(i) - 15, 30, 30], 'Linewidth', 2);
238 %     hold off;
239 %     pause(0.001)
240 % end
241 %%
242 % figure(3);
243 % for i = 1:length(img3)
244 %     imshow(img3{i});
245 %     hold on;
246 %     rectangle('position', [x3(i) - 15, y3(i) - 15, 30, 30], 'Linewidth', 2);
247 %     hold off;
248 %     pause(0.001)
249 % end
250 %%
251 x1; y1;
252 x2 = x2(23:dim2_1 + 22);
253 y2 = y2(23:dim2_1 + 22);
254 x3 = x3(1:dim2_1);
255 y3 = y3(1:dim2_1);
256 %%
257 figure(2)
258 subplot(2,1,1);
259 plot(y1 - mean(y1), 'Linewidth', 3); hold on;
260 plot(y2 - mean(y2), 'Linewidth', 3)

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261 plot(x3 - mean(x3), 'Linewidth', 3)
262 title('Y Coordinates of Can in Noisy Case(Normalized)');
263 xlabel('Time');
264 ylabel('Displacement');
265 xlim([0 length(y1) + 50]);
266 legend('cam1(y1)', 'cam2(y2)', 'cam3(y3)');
267
268 subplot(2,1,2);
269 plot(x1 - mean(x1), 'Linewidth', 3); hold on;
270 plot(x2 - mean(x2), 'Linewidth', 3)
271 plot(y3 - mean(y3), 'Linewidth', 3)
272 title('X Coordinates of Can in Noisy Case(Normalized)');
273 xlabel('Time');
274 ylabel('Displacement');
275 legend('cam1(x1)', 'cam2(x2)', 'cam3(x3)');
276 xlim([0 length(y1) + 50]);
277 %% SVD
278 X = [x1- mean(x1); y1- mean(y1); x2- mean(x2); y2- mean(y2); y3- mean(y3); x3- mean(x3)];
279 [u, s, v] = svd(X, 'econ');
280 %%
281 figure(3)
282 plot(diag(s)/sum(diag(s)), 'o', 'Linewidth', 2);
283 title('Importance of Singular Values For All Directions in Noisy Case');
284 xlabel('Singular values');
285 ylabel('Energy');
286 %%
287 %-----
288 %% TEST 3
289 clc; clear all; close all;
290 %% horizontal displacement
291 load('cam1_3.mat')
292 load('cam2_3.mat')
293 load('cam3_3.mat')
294 %%
295 [row1, col1, dim1_1, dim2_1] = size(vidFrames1_3);
296 [row2, col2, dim1_2, dim2_2] = size(vidFrames2_3);
297 [row3, col3, dim1_3, dim2_3] = size(vidFrames3_3);
298 %%
299 for k = 1:dim2_1
300     img1{k} = vidFrames1_3(:, :, :, k);
301 end
302 for k = 1:dim2_2
303     img2{k} = vidFrames2_3(:, :, :, k);
304 end
305
306 for k = 1:dim2_3
307     img3{k} = vidFrames3_3(:, :, :, k);
308 end
309 %% case 2
310 x1 = zeros(1, dim2_1);
311 y1 = zeros(1, dim2_1);
312 boxX = [310 330];
313 boxY = [280 300];
314 for i = 1:dim2_1
315     img = vidFrames1_3(:, :, 3, i);
316     box = double(img(boxY(1):boxY(2), boxX(1):boxX(2)));
317     [row, col] = find(box == max(max(box)));
318     y1(i) = mean(row) + boxY(1);
319     x1(i) = mean(col) + boxX(1);
320     boxX = [round(x1(i) - 10), round(x1(i) + 10)];
321     boxY = [round(y1(i) - 10), round(y1(i) + 10)];
322 end
323
324 x2 = zeros(1, dim2_2);
325 y2 = zeros(1, dim2_2);

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326 boxX = [230 260];
327 boxY = [280 310];
328 for i = 1:dim2_2
329     img = vidFrames2_3(:,:,3,i);
330     box = double(img(boxY(1):boxY(2), boxX(1):boxX(2)));
331     [row, col] = find(box == max(max(box)));
332     y2(i) = mean(row) + boxY(1);
333     x2(i) = mean(col) + boxX(1);
334     boxX = [round(x2(i) - 10), round(x2(i) + 10)];
335     boxY = [round(y2(i) - 10), round(y2(i) + 10)];
336 end
337
338
339 x3 = zeros(1, dim2_3);
340 y3 = zeros(1, dim2_3);
341 boxX = [345 375];
342 boxY = [220 250];
343 count = 0;
344 for i = 1:dim2_3
345     count = count + 1;
346     img = vidFrames3_3(:,:,3,i);
347     box = double(img(boxY(1):boxY(2), boxX(1):boxX(2)));
348     [row, col] = find(box == max(max(box)));
349     y3(i) = mean(row) + boxY(1);
350     x3(i) = mean(col) + boxX(1);
351     boxX = [round(x3(i) - 20), round(x3(i) + 20)];
352     boxY = [round(y3(i) - 20), round(y3(i) + 20)];
353 end
354 %%
355 % figure(1);
356 % for i = 1:length(img1)
357 %     imshow(img1{i});
358 %     hold on;
359 %     rectangle('position', [x1(i) - 10, y1(i) - 10, 20, 20], 'Linewidth', 2);
360 %     hold off;
361 %     pause(0.001)
362 % end
363 %%
364 % figure(2);
365 % for i = 1:length(img2)
366 %     imshow(img2{i});
367 %     hold on;
368 %     rectangle('position', [x2(i) - 10, y2(i) - 10, 20, 20], 'Linewidth', 2);
369 %     hold off;
370 %     pause(0.001)
371 % end
372 %%
373 % figure(3);
374 % for i = 1:length(img3)
375 %     imshow(img3{i});
376 %     hold on;
377 %     rectangle('position', [x3(i) - 10, y3(i) - 10, 20, 20], 'Linewidth', 2);
378 %     hold off;
379 %     pause(0.001)
380 % end
381 %%
382 x1 = x1(8:177 + 7);
383 y1 = y1(8:177 + 7);
384 x2 = x2(36:177+35);
385 y2 = y2(36:177+35);
386 x3 = x3(1:177);
387 y3 = 480 - y3(1:177);
388 %%
389 figure(2)
390 subplot(2,1,1);

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```

391 plot(y1 - mean(y1), 'Linewidth', 3); hold on;
392 plot(y2 - mean(y2), 'Linewidth', 3)
393 plot(x3 - mean(x3), 'Linewidth', 3)
394 title('Y Coordinates of Can in Horizontal Displacement Case(Normalized)');
395 xlabel('Time');
396 ylabel('Displacement');
397 xlim([0 length(y1) + 50]);
398 legend('cam1(y1)', 'cam2(y2)', 'cam3(y3)');
399
400 subplot(2,1,2);
401 plot(x1 - mean(x1), 'Linewidth', 3); hold on;
402 plot(x2 - mean(x2), 'Linewidth', 3)
403 plot(y3 - mean(y3), 'Linewidth', 3)
404 title('X Coordinates of Can in Horizontal Displacement Case(Normalized)');
405 xlabel('Time');
406 ylabel('Displacement');
407 legend('cam1(x1)', 'cam2(x2)', 'cam3(x3)');
408 xlim([0 length(y1) + 50]);
409 %% SVD
410 X = [x1- mean(x1); y1- mean(y1); x2- mean(x2); y2- mean(y2); y3- mean(y3); x3- mean(x3)];
411 [u, s, v] = svd(X, 'econ');
412 %%
413 figure(3)
414 plot(diag(s)/sum(diag(s)), 'o', 'Linewidth', 2);
415 title('Importance of Singular Values For All Directions in Noisy Case');
416 xlabel('Singular values');
417 ylabel('Energy');
418 %%
419 %-----
420 %% TEST 4
421 clc; clear all; close all;
422 %% horizontal displacement and rotation
423 load('cam1_4.mat')
424 load('cam2_4.mat')
425 load('cam3_4.mat')
426 %%
427 [row1, col1, dim1_1, dim2_1] = size(vidFrames1_4);
428 [row2, col2, dim1_2, dim2_2] = size(vidFrames2_4);
429 [row3, col3, dim1_3, dim2_3] = size(vidFrames3_4);
430 %%
431 for k = 1:dim2_1
432     img1{k} = vidFrames1_4(:, :, :, k);
433 end
434 for k = 1:dim2_2
435     img2{k} = vidFrames2_4(:, :, :, k);
436 end
437
438 for k = 1:dim2_3
439     img3{k} = vidFrames3_4(:, :, :, k);
440 end
441 %%
442 boxX = [430 460];
443 boxY = [260 290];
444 for i = 20:70
445     img = vidFrames1_4(:, :, 3, i);
446     box = double(img(boxY(1):boxY(2), boxX(1):boxX(2)));
447     if (max(max(box)) == max(max(img)))
448         [row, col] = find(box == max(max(box)));
449         y1(i) = mean(row) + boxY(1);
450         x1(i) = mean(col) + boxX(1);
451         boxX = [round(x1(i) - 15), round(x1(i) + 15)];
452         boxY = [round(y1(i) - 15), round(y1(i) + 15)];
453     end
454 end
455

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456 boxX = [340 370];
457 boxY = [320 350];
458 for i = 150:200
459     img = vidFrames1_4(:,:,3,i);
460     box = double(img(boxY(1):boxY(2), boxX(1):boxX(2)));
461     if (max(max(box)) == max(max(img)))
462         [row, col] = find(box == max(max(box)));
463         y1(i) = mean(row) + boxY(1);
464         x1(i) = mean(col) + boxX(1);
465         boxX = [round(x1(i) - 15), round(x1(i) + 15)];
466         boxY = [round(y1(i) - 15), round(y1(i) + 15)];
467     end
468 end
469 x1 = x1(y1>0);
470 y1 = y1(y1>0);
471
472 %%
473 boxX = [255 285];
474 boxY = [180 210];
475 for i = 152:200
476     img = vidFrames2_4(:,:,3,i);
477     box = double(img(boxY(1):boxY(2), boxX(1):boxX(2)));
478     if (max(max(box)) == max(max(img)))
479         [row, col] = find(box == max(max(box)));
480         y2(i) = mean(row) + boxY(1);
481         x2(i) = mean(col) + boxX(1);
482         boxX = [round(x2(i) - 15), round(x2(i) + 15)];
483         boxY = [round(y2(i) - 15), round(y2(i) + 15)];
484     end
485 end
486
487 boxX = [248 278];
488 boxY = [198 228];
489 for i = 235:274
490     img = vidFrames2_4(:,:,3,i);
491     box = double(img(boxY(1):boxY(2), boxX(1):boxX(2)));
492     if (max(max(box)) == max(max(img)))
493         [row, col] = find(box == max(max(box)));
494         y2(i) = mean(row) + boxY(1);
495         x2(i) = mean(col) + boxX(1);
496         boxX = [round(x2(i) - 15), round(x2(i) + 15)];
497         boxY = [round(y2(i) - 15), round(y2(i) + 15)];
498     else
499         y2(i) = y2(i-1);
500         x2(i) = x2(i-1);
501         boxX = [round(x2(i) - 50), round(x2(i) + 50)];
502         boxY = [round(y2(i) - 50), round(y2(i) + 50)];
503     end
504 end
505 x2 = x2(y2>0);
506 y2 = y2(y2>0);
507 %%
508 boxX = [310 340];
509 boxY = [210 240];
510 for i = 50:100
511     img = vidFrames3_4(:,:,2,i);
512     box = double(img(boxY(1):boxY(2), boxX(1):boxX(2)));
513     [row, col] = find(box == max(max(box)));
514     y3(i) = mean(row) + boxY(1);
515     x3(i) = mean(col) + boxX(1);
516     boxX = [round(x3(i) - 15), round(x3(i) + 15)];
517     boxY = [round(y3(i) - 15), round(y3(i) + 15)];
518 end
519 boxX = [365 395];
520 boxY = [220 250];

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521 for i = 120:170
522     img = vidFrames3_4(:,:,2,i);
523     box = double(img(boxY(1):boxY(2), boxX(1):boxX(2)));
524     [row, col] = find(box == max(max(box)));
525     y3(i) = mean(row) + boxY(1);
526     x3(i) = mean(col) + boxX(1);
527     boxX = [round(x3(i) - 15), round(x3(i) + 15)];
528     boxY = [round(y3(i) - 15), round(y3(i) + 15)];
529 end
530 y3 = x3(x3>0);
531 x3 = x3(x3>0);
532 y3 = [y3(10:40) y3(63:end)];
533 x3 = [x3(10:40) x3(63:end)];
534 %%
535 x1 = x1(5:length(x3));
536 y1 = y1(5:length(x3));
537 x2 = x2(1:length(x3) - 4);
538 y2 = y2(1:length(x3) - 4);
539 x3 = x3(5:length(x3));
540 y3 = 480 - y3(1:length(x3));
541 %%
542 figure(2)
543 subplot(2,1,1);
544 plot(y1 - mean(y1),'Linewidth', 3); hold on;
545 plot(y2 - mean(y2),'Linewidth', 3)
546 plot(x3 - mean(x3),'Linewidth', 3)
547 title('Y Coordinates of Can in Horizontal Displacement and Rotation Case(Normalized)');
548 xlabel('Time');
549 ylabel('Displacement');
550 xlim([0 length(y1) + 10]);
551 legend('cam1(y1)', 'cam2(y2)', 'cam3(y3)');
552
553 subplot(2,1,2);
554 plot(x1 - mean(x1),'Linewidth', 3); hold on;
555 plot(x2 - mean(x2),'Linewidth', 3)
556 plot(y3 - mean(y3),'Linewidth', 3)
557 title('X Coordinates of Can in Horizontal Displacement and Rotation Case(Normalized)');
558 xlabel('Time');
559 ylabel('Displacement');
560 legend('cam1(x1)', 'cam2(x2)', 'cam3(x3)');
561 xlim([0 length(y1) + 10]);
562 %% SVD
563 X = [x1- mean(x1); y1- mean(y1); x2- mean(x2); y2- mean(y2); y3- mean(y3); x3- mean(x3)];
564 [u, s, v] = svd(X, 'econ');
565 %%
566 figure(3)
567 plot(diag(s)/sum(diag(s)), 'o','Linewidth', 2);
568 title('Importance of Singular Values For All Directions in Noisy Case');
569 xlabel('Singular values');
570 ylabel('Energy');

```