

Assignment 2 Report

Project Instructions

All source code is contained within the file 'ght.py'. The program can be run through the command terminal, using Python 2.7. The source code uses cv2, numpy, scipy and matplotlib public modules.

All template and test images are found in the '\testimages' folder. Within this folder, the folder '\results' contains all edge maps and object detection images that have been generated and saved. Images of numerical representations of accumulator matrices can also be found in the '\results' folder.

block.tif

Methods were initially tested on the 'block.tif' image, with the template and test image being the same. The results are as follows:

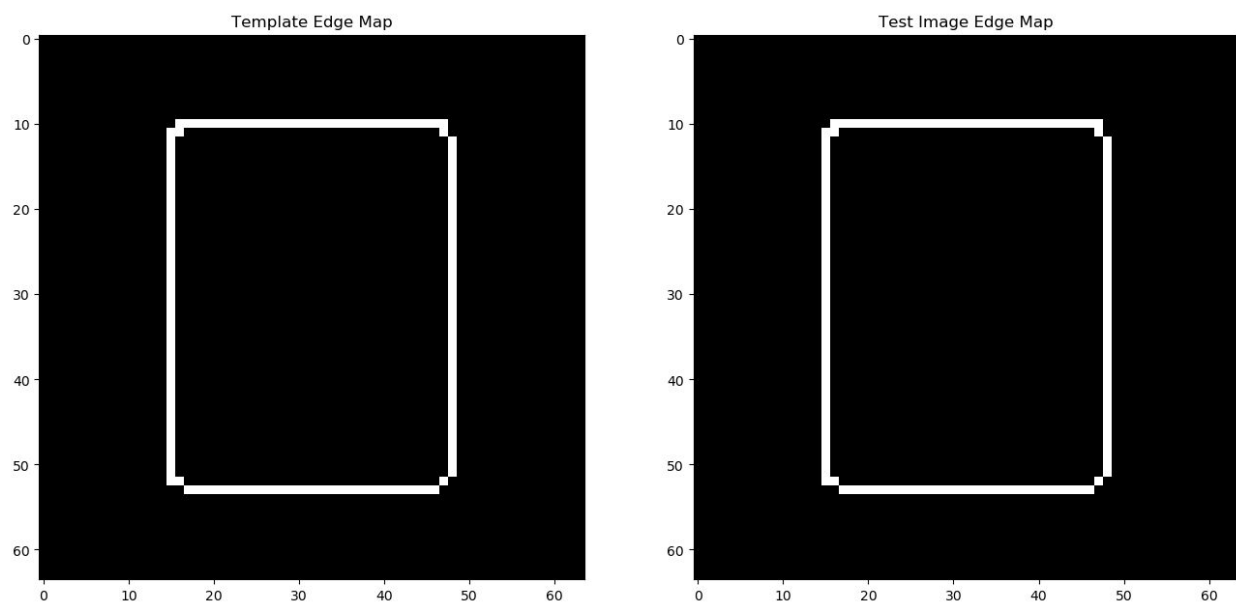


Fig. 1 Edge maps for the 'block.tif' image

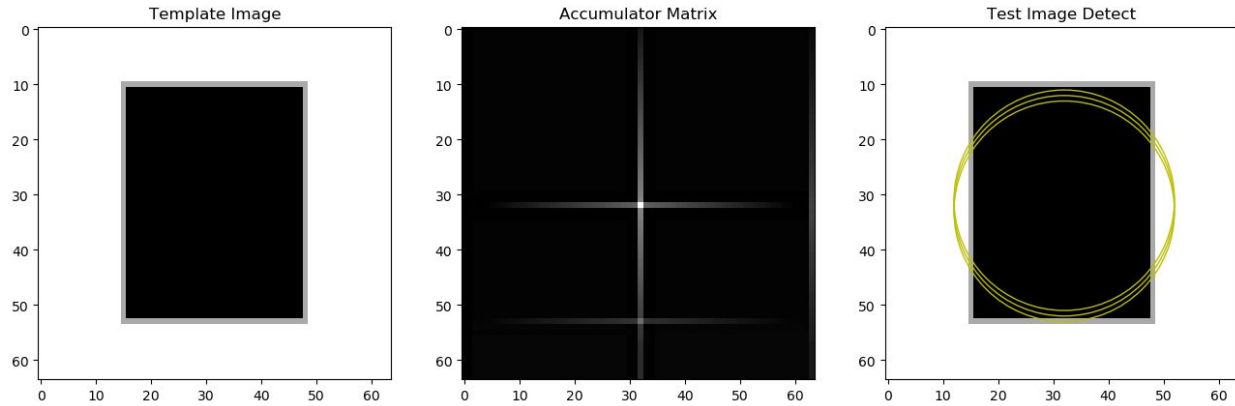


Fig 2. The accumulator matrix for 'block.tif', and the results of image detection

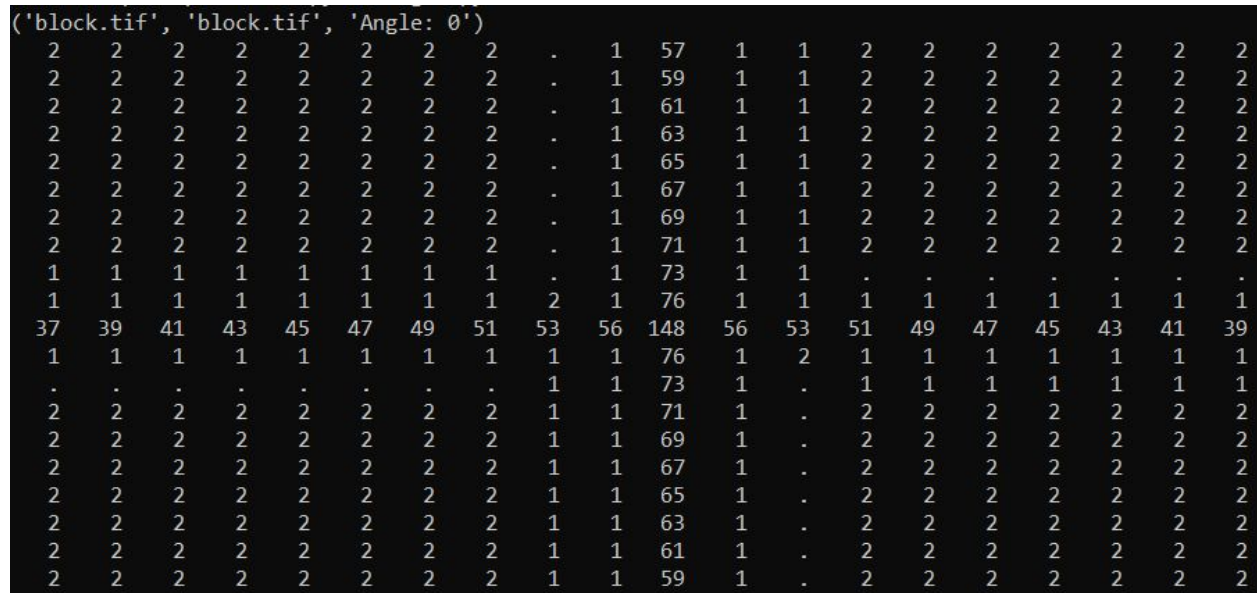


Fig 3. Numerical representation of the accumulator array for 'block.tif', peaking at 148

I was able to successfully detect the image, with a clear accumulator peak and centred circles as shown by Fig. 2.

animals.jpg

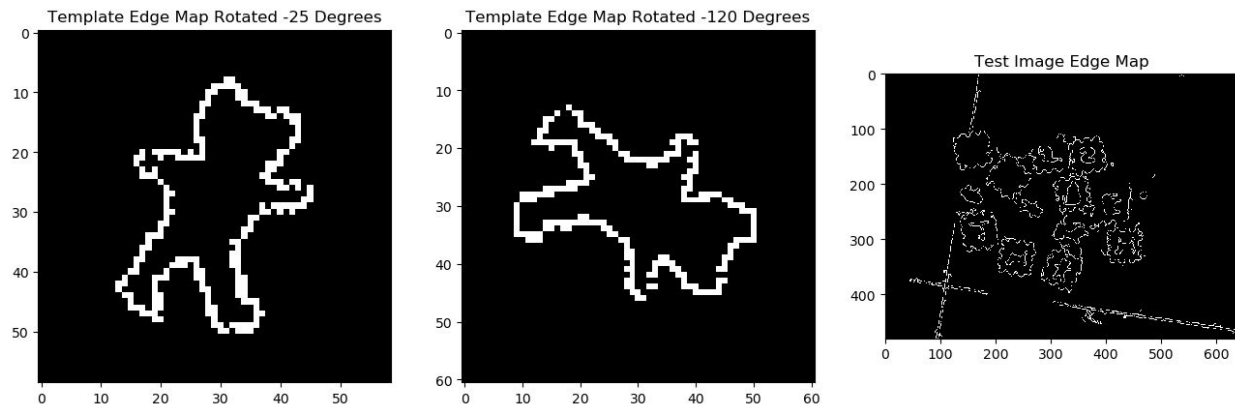


Fig. 4 Edge maps for 'template_bear.png' and 'animals.jpg', with the bear template rotated -25 degrees and -120 degrees

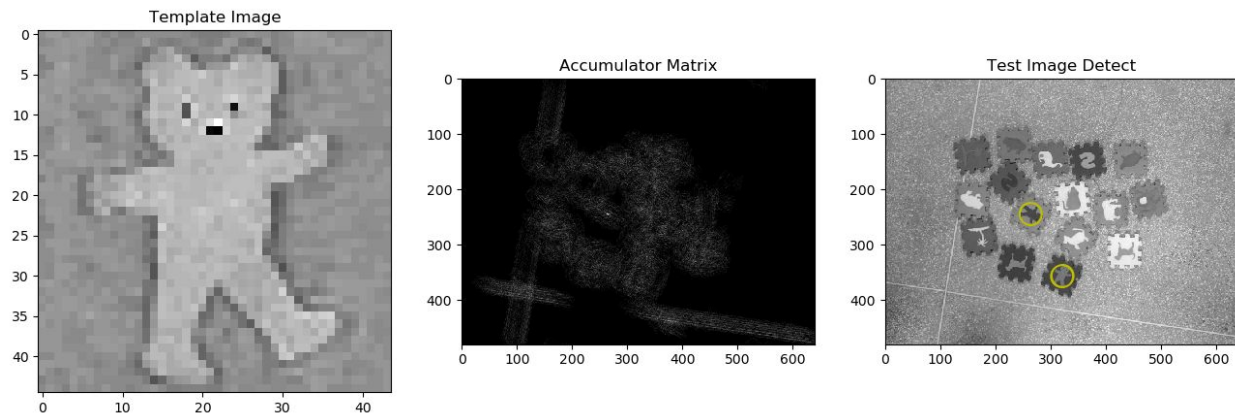


Fig. 5 The accumulator matrix for 'template_bear.png' and the results of image detection on 'animals.jpg'

('template_bear.png', 'animals.jpg', 'Angle: -25')

8	.	1	2	1	1	1	2	4	7	6	2	6	6	11	5	6	2	1	5
1	.	1	2	1	.	2	5	5	6	2	5	6	8	7	13	7	3	4	6
3	1	2	2	2	3	1	5	4	2	3	2	7	4	8	3	6	5	4	4
3	2	2	4	3	1	4	9	9	4	2	7	7	8	5	1	3	2	5	4
.	3	6	5	4	4	4	6	6	1	4	5	4	9	5	7	5	4	3	5
1	3	4	4	4	7	3	3	4	8	2	4	9	15	12	8	15	6	7	3
3	4	3	3	6	6	2	2	4	9	8	11	9	9	8	8	4	4	1	4
6	.	6	5	6	4	7	6	6	13	11	12	6	8	11	2	8	3	3	3
.	4	5	6	5	5	5	7	11	9	18	16	17	15	5	2	5	9	1	2
6	1	4	5	5	1	1	2	7	19	19	19	24	17	1	4	4	3	3	2
.	5	3	2	3	2	2	6	8	14	25	24	14	7	8	6	5	7	3	2
4	5	1	3	8	4	1	.	9	7	13	11	2	5	3	4	5	9	3	2
4	1	4	3	6	5	4	17	12	12	10	11	4	3	3	7	4	2	1	1
3	9	2	3	4	3	5	5	6	7	6	2	4	5	9	4	4	2	10	4
5	6	9	1	3	8	12	8	4	8	7	3	7	9	7	7	3	2	2	3
4	6	5	4	5	7	8	3	8	4	5	5	12	6	6	2	2	1	2	1
4	5	4	6	7	11	4	3	4	8	3	5	9	9	4	4	3	3	.	5
5	8	4	7	7	5	2	1	2	3	6	6	10	7	5	5	3	1	2	2
3	5	8	12	6	4	2	5	5	4	6	8	7	4	1	2	1	3	1	2
3	5	5	7	7	7	4	2	5	4	8	4	4	3	4	2	1	2	.	.

Fig. 6 Numerical representation of the accumulator matrix for 'template_bear.png' rotated -25 degrees, peaking at 25

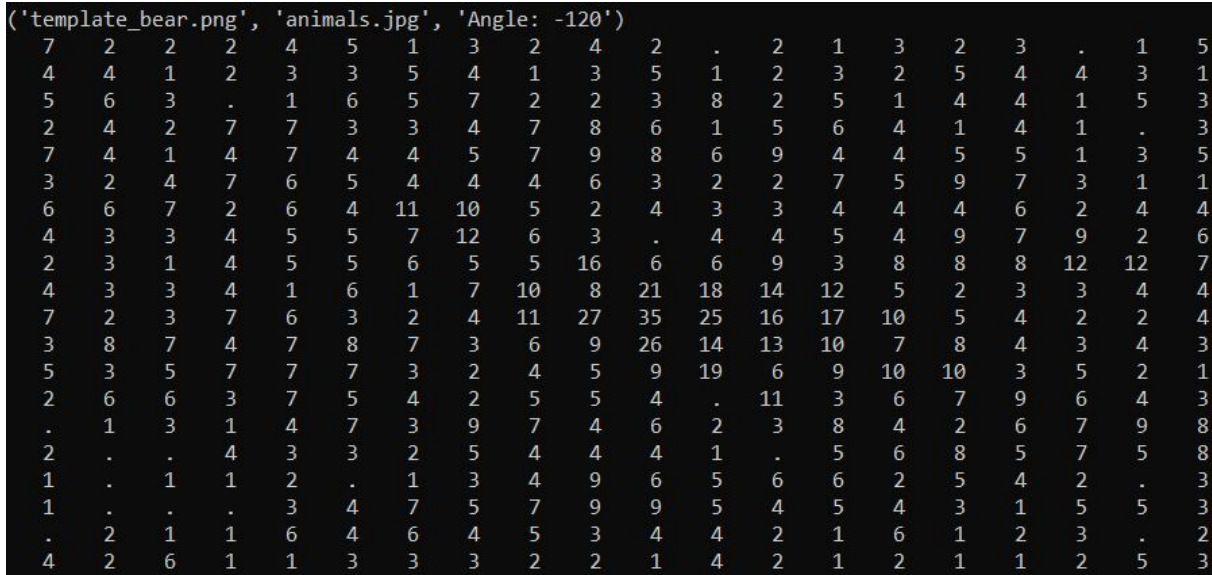


Fig. 7 Numerical representation of the accumulator matrix for 'template_bear.png' rotated -120 degrees, peaking at 35

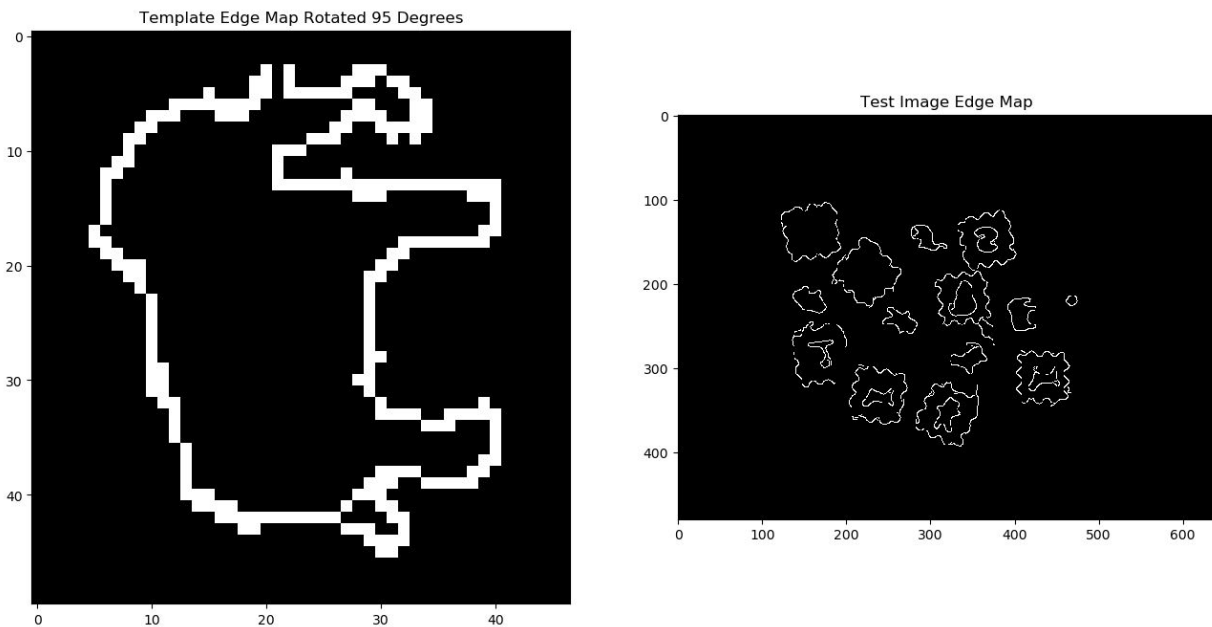


Fig. 8 Edge maps for 'template_elephant.png' and 'animals.jpg', with the elephant template rotated 95 degrees

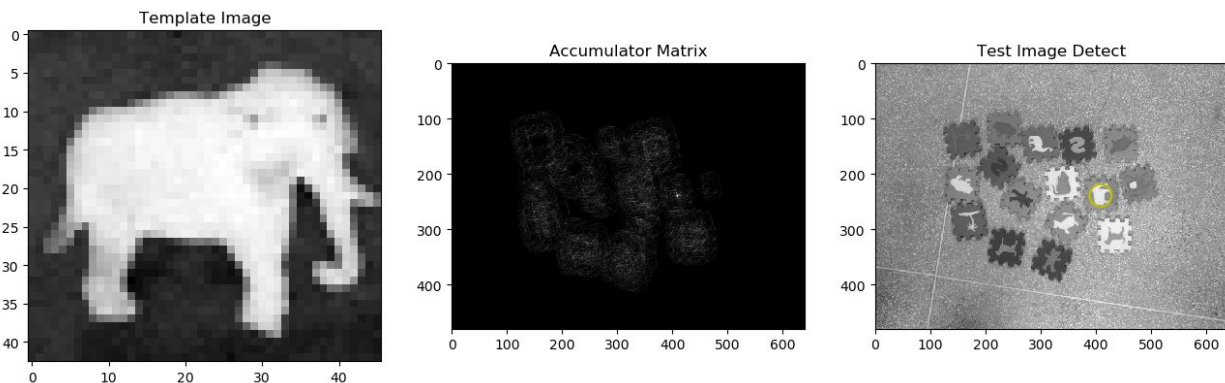


Fig. 9 The accumulator matrix for 'template_elephant.png' and the results of image detection on 'animals.jpg'

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('template_elephant.png', 'animals.jpg', 'Angle: 95')
```

9	8	12	13	12	10	11	11	9	9	12	7	5	6	7	8	5	3	4	2
7	7	8	7	5	5	9	12	6	4	3	7	4	5	6	1	2	2	4	3
3	2	5	4	1	1	6	9	3	4	2	1	5	5	1	2	2	3	2	4
2	.	2	1	1	2	4	8	4	5	4	5	3	3	4	5	6	5	3	4
7	4	7	8	9	11	6	8	14	4	6	5	2	2	6	10	8	5	1	4
4	1	1	2	3	5	7	9	15	8	13	11	9	9	8	7	4	2	4	1
1	.	1	.	3	5	3	6	13	4	6	8	9	10	5	3	4	4	5	2
8	6	4	3	5	3	3	3	5	10	6	8	8	9	8	5	9	12	11	12
1	3	2	2	2	4	5	9	9	18	20	18	14	13	12	8	9	6	7	3
6	5	10	9	9	15	11	13	15	27	35	24	14	17	12	17	7	9	3	3
2	5	4	3	11	8	10	13	22	34	42	22	22	13	14	13	13	11	11	8
3	4	4	5	6	3	4	8	15	15	23	6	7	7	6	6	2	3	4	2
5	3	6	2	3	5	4	9	12	8	11	4	3	6	5	4	3	3	2	2
7	5	5	4	2	3	5	6	6	1	13	4	3	5	4	6	4	4	5	4
3	5	1	2	2	1	4	4	4	7	12	10	7	4	9	7	5	5	5	3
1	2	2	1	2	2	3	2	4	9	13	7	8	7	7	8	5	5	3	3
1	1	2	6	2	3	4	4	5	5	6	8	5	4	3	4	2	4	4	2
2	6	4	3	3	5	4	1	2	3	4	7	7	3	4	1	4	4	4	3
3	3	4	4	1	2	4	2	2	.	3	5	3	6	5	5	5	5	7	4
3	3	3	3	1	1	.	1	1	4	2	6	7	5	7	2	6	4	5	3

Fig 9. Numerical representation of the accumulator matrix for 'template_elephant.png', peaking at 42

After changing the angles of the template images, I was able to successfully detect all variations of the templates within 'animals.jpg'. The accumulator peaks were much lower with the bear template, as shown by Fig. 6 and Fig. 7, but it did not hinder image detection.

animals2.jpg

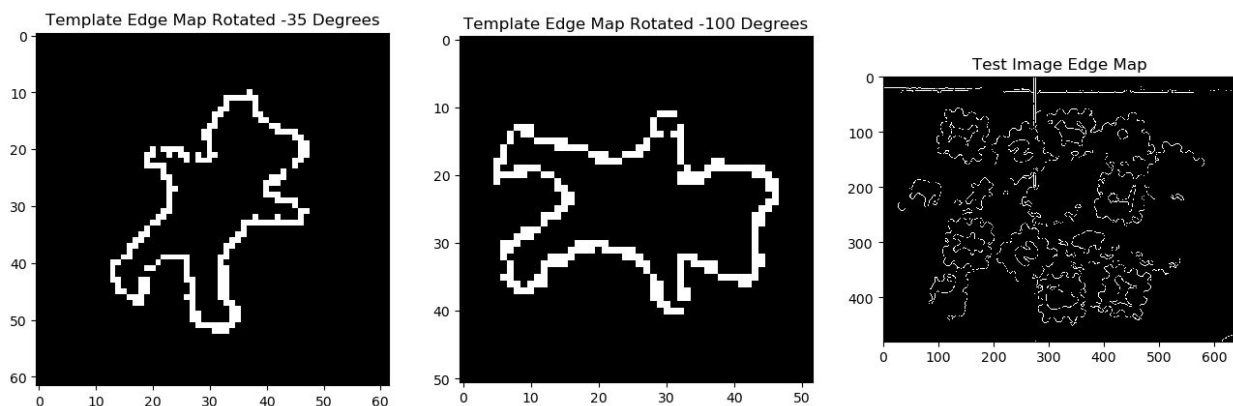


Fig 10. Edge maps for 'template_bear.png' and 'animals2.jpg', with the bear template rotated -35 degrees and -100 degrees

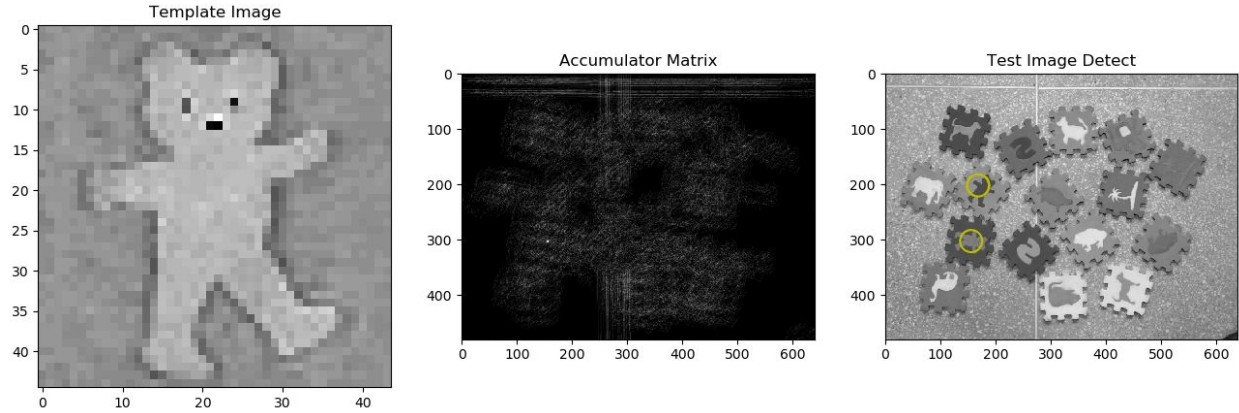


Fig. 11 The accumulator matrix for 'template_bear.png' and the results of image detection on 'animals2.jpg'

('template_bear.png', 'animals2.jpg', 'Angle: -35')

2	4	4	.	3	4	2	.	6	4	2	3	.	2	1	3	3	5	8	4
2	3	2	1	2	1	1	5	4	1	2	2	1	3	1	4	5	8	11	6
1	1	3	1	1	1	5	6	2	2	.	.	1	2	6	6	7	9	7	5
4	2	4	1	.	4	4	1	.	1	2	1	2	3	5	8	9	7	6	2
3	4	4	1	4	4	2	.	1	3	4	4	4	4	5	7	10	5	4	4
4	2	2	3	5	1	2	1	2	1	5	3	7	6	6	12	10	4	1	8
2	1	6	5	3	1	1	1	3	4	4	5	7	7	12	9	5	4	3	6
1	3	2	3	4	1	1	2	1	3	7	4	13	13	10	5	5	3	5	4
1	2	4	2	1	3	5	6	7	4	6	10	14	11	9	4	5	6	4	3
5	4	2	.	2	2	1	2	6	5	10	10	19	9	9	5	8	4	2	1
1	1	1	1	1	2	2	3	1	5	20	12	17	9	6	7	6	2	2	3
3	3	3	3	2	4	4	5	8	16	17	17	14	10	13	11	6	3	5	6
3	3	2	.	4	3	1	7	9	8	9	7	7	11	8	3	3	3	1	3
5	5	5	5	5	3	6	7	9	12	8	7	11	9	10	5	6	4	3	6
3	2	3	5	2	5	7	9	7	3	6	4	8	9	5	7	4	1	3	3
5	3	4	2	3	5	6	5	4	4	4	4	2	3	2	1	7	5	4	3
2	5	3	9	7	5	5	4	5	4	2	5	3	1	4	5	7	5	4	2
7	5	6	5	4	5	4	5	1	4	5	4	2	2	4	6	5	3	2	1
6	5	4	6	4	2	2	1	.	4	5	4	2	5	5	3	5	3	1	2
4	7	4	3	3	2	6	3	3	4	6	3	5	5	8	4	5	1	3	3

Fig. 12 Numerical representation of the accumulator matrix for 'template_bear.png' rotated -35 degrees, peaking at 20

('template_bear.png', 'animals2.jpg', 'Angle: -100')

2	1	1	5	4	1	2	4	6	2	1	2	3	4	2	1	1	1	1	3
4	2	3	3	2	5	6	6	5	6	4	4	2	2	.	2	.	2	2	2
7	2	4	4	5	8	7	5	2	7	8	5	5	3	1	3	.	2	3	7
2	2	6	3	4	4	6	4	1	5	5	2	5	2	1	3	6	6	5	7
8	3	6	8	6	2	4	3	3	6	2	1	.	2	4	4	5	3	4	4
6	5	6	4	2	6	3	4	3	6	3	3	2	1	6	4	7	8	4	6
2	2	5	5	6	4	2	4	1	8	5	1	2	4	3	3	5	5	4	3
7	7	4	5	3	2	2	4	1	8	5	6	7	7	6	7	2	2	4	3
4	6	4	5	4	6	3	6	5	7	8	7	10	7	10	8	4	4	4	5
2	2	7	3	9	5	3	4	11	8	13	16	10	9	8	4	3	4	8	4
5	3	8	3	3	2	4	8	7	22	25	17	7	7	4	4	7	5	5	4
3	4	7	5	4	3	6	10	11	15	21	14	9	8	4	7	5	2	6	5
2	1	3	4	4	6	7	8	13	11	15	13	5	6	6	8	8	6	7	6
6	1	1	4	3	8	4	3	8	9	3	3	4	3	4	3	5	6	8	7
1	4	4	7	5	1	2	5	3	4	2	1	2	2	3	3	2	7	3	3
1	4	4	5	4	.	5	5	5	2	3	3	2	6	1	.	4	6	1	4
8	4	4	3	3	2	2	2	1	.	2	1	1	4	2	5	7	1	4	3
2	3	4	2	.	3	2	5	4	1	3	.	4	1	3	5	5	5	5	3
3	1	3	1	3	4	4	2	.	.	.	1	2	3	7	7	5	2	.	4
1	2	2	3	2	1	3	1	.	1	.	5	3	5	4	1	1	4	2	3

Fig. 13 Numerical representation of the accumulator matrix for 'template_bear.png' rotated -100 degrees, peaking at 25

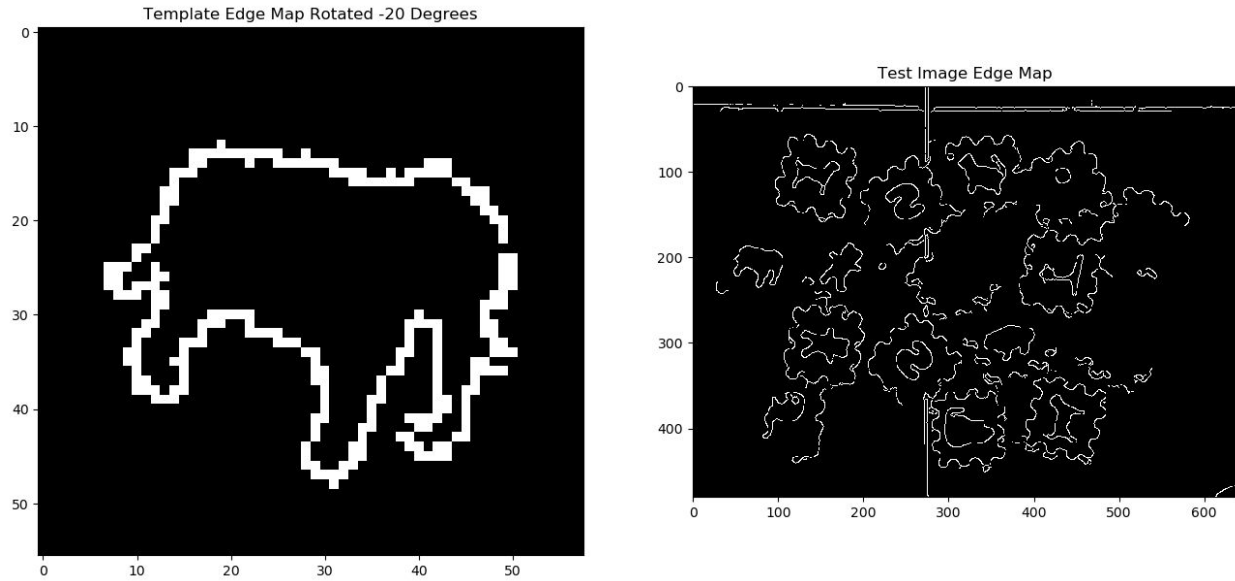


Fig. 14 Edge maps for 'template_elephant.png' and 'animals2.jpg', with the elephant template rotated -20 degrees

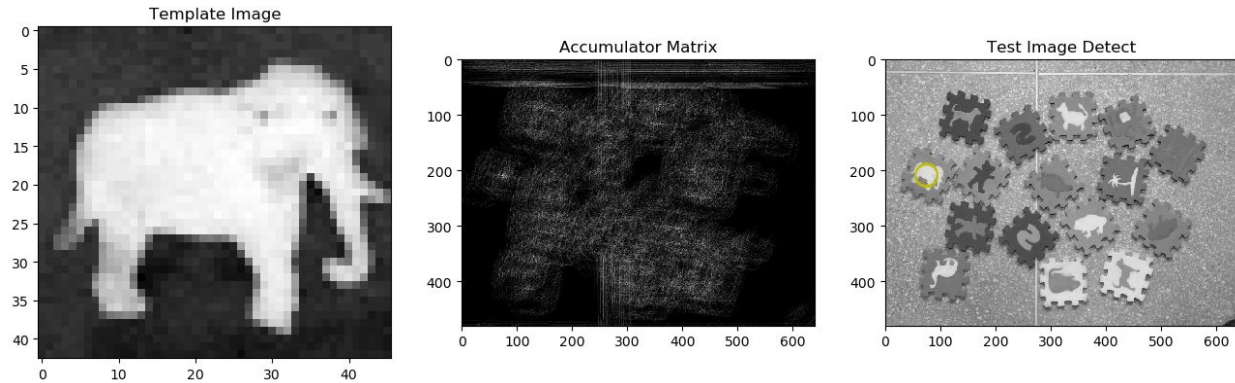


Fig. 15 The accumulator matrix for 'template_elephant.png' and the results of image detection on 'animals2.jpg'

('template_elephant.png', 'animals2.jpg', 'Angle: -20')

1	.	4	3	2	2	1	3	5	4	3	3	2	5	3	4	2	.	4	3
1	2	4	.	1	3	2	3	2	.	2	3	3	6	5	10	2	3	6	4
4	2	1	1	4	3	4	5	3	2	2	3	1	3	7	.	4	7	1	2
3	2	2	1	3	9	6	5	2	2	3	2	4	2	6	3	5	5	2	2
2	2	2	2	3	7	5	3	1	3	3	2	6	7	6	5	5	2	4	4
1	1	3	2	9	8	4	1	5	3	2	5	9	7	5	8	2	3	4	3
1	2	4	2	6	5	2	2	4	1	2	6	10	8	9	4	3	3	5	3
3	4	2	8	8	6	3	1	3	.	8	6	7	5	5	2	2	7	5	5
2	6	8	7	5	7	4	1	2	8	9	9	13	9	8	4	3	4	7	8
2	2	4	4	7	2	3	4	5	9	13	10	8	5	5	2	3	5	8	9
7	12	9	6	8	3	3	3	8	8	21	12	14	5	5	7	6	7	4	4
2	5	8	7	5	6	5	5	12	13	13	12	11	12	10	6	6	6	8	3
4	8	7	6	5	2	6	9	10	21	16	9	9	12	5	8	12	12	5	4
4	13	5	3	4	4	7	6	9	19	21	13	11	14	12	9	5	10	8	7
4	2	6	3	1	2	4	3	7	6	18	9	7	6	12	6	6	4	8	11
11	5	3	3	6	5	5	8	12	11	15	12	7	9	5	5	11	7	5	5
2	3	3	5	7	3	5	6	13	6	11	5	6	4	8	3	7	2	5	6
5	2	1	2	3	2	3	5	4	4	4	6	4	4	5	5	9	4	3	2
3	6	1	2	.	3	2	10	4	4	4	6	5	4	6	5	.	1	3	1
1	3	4	1	4	7	2	7	1	6	5	5	3	3	3	6	4	3	2	3

Fig. 16 Numerical representation of the accumulator matrix for 'template_elephant.png' rotated -100 degrees, peaking at 21

The accumulator matrix peaks for the templates applied to 'animals2.jpg' was significantly lower, as shown by Fig. 12, Fig. 13, and Fig. 16. This is likely due to requiring both rotation and scaling, which relied on observation. However, image detection was still successful at finding all variations of the templates in the test image.

letters.png

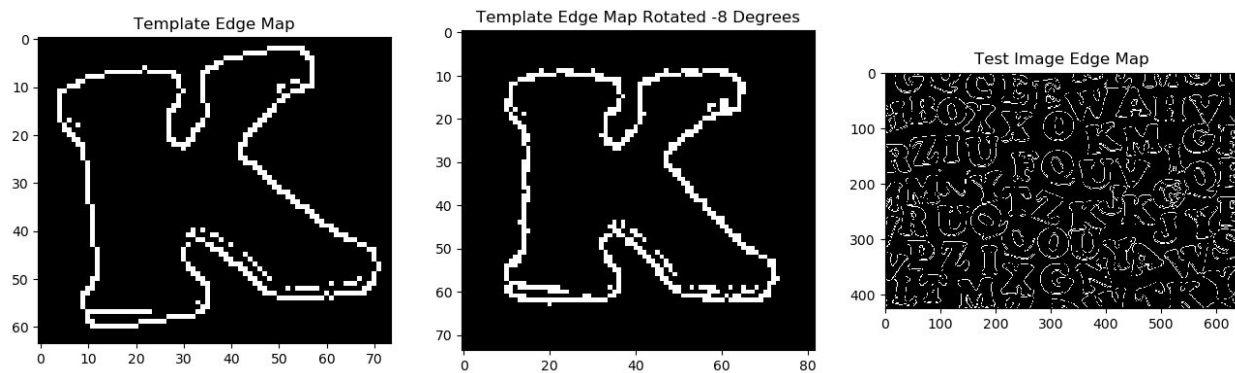


Fig. 17 Edge maps for 'template_K.png' and 'letters.png', with the original K template as well as the K template rotated -8 degrees

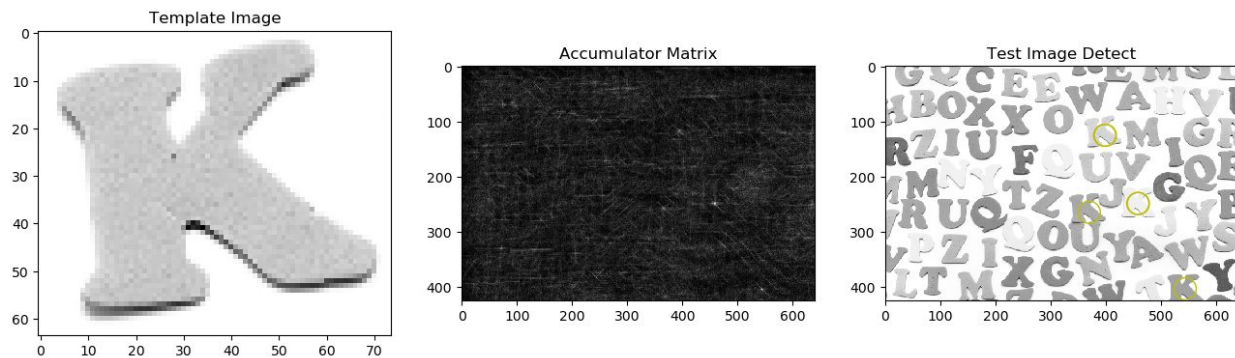


Fig. 18 The accumulator matrix for 'template_K.png' and the results of image detection on 'letters.png'

('template_K.png', 'letters.png', 'Angle: 0')

11	9	7	2	3	4	4	2	7	20	5	4	7	6	3	4	4	4	4	7
4	3	6	5	5	9	4	7	5	19	3	8	4	7	1	6	6	4	3	4
20	6	4	7	5	7	6	6	9	18	3	6	1	6	3	4	5	13	7	2
14	19	15	7	8	3	6	10	9	16	5	7	3	8	5	4	9	13	6	1
7	7	24	22	5	5	8	5	6	20	10	3	6	7	6	6	16	9	4	2
7	8	8	14	24	8	10	5	2	12	13	5	6	5	8	20	11	5	4	1
5	10	10	9	13	37	15	9	7	11	16	5	5	12	13	10	10	4	5	6
3	4	5	4	5	17	29	20	15	20	33	21	24	28	24	18	18	21	18	10
11	13	11	15	17	19	25	41	46	35	52	31	27	15	13	11	11	7	9	10
13	13	11	15	14	11	10	13	26	51	50	35	25	18	22	30	32	34	32	23
6	8	11	13	16	22	30	44	48	74	258	84	47	41	26	23	20	15	12	12
23	23	32	26	24	27	21	20	23	21	55	51	19	9	7	9	10	8	7	10
8	10	13	8	12	8	13	15	19	30	39	26	38	34	18	13	14	11	12	10
4	7	15	19	17	12	14	15	20	18	23	23	14	24	31	15	10	5	5	3
5	7	9	8	10	6	6	7	10	4	12	20	6	8	10	28	14	8	8	5
5	1	5	7	6	10	8	6	10	9	12	17	8	3	6	11	25	13	12	13
5	3	4	8	6	9	6	4	6	5	7	18	8	7	16	10	8	25	23	14
7	5	6	11	5	3	3	7	5	9	4	22	7	5	8	5	4	9	13	15
2	5	3	9	8	2	4	5	3	5	3	21	8	10	5	6	4	9	4	11
3	3	4	3	3	1	4	6	4	7	2	18	8	5	6	7	3	6	7	8

Fig. 19 Numerical representation of the accumulator matrix for 'template_K.png', peaking at 258

('template_K.png', 'letters.png', 'Angle: -8')

16	16	13	7	5	9	11	10	10	17	6	15	6	8	7	4	7	3	4	9
8	12	15	7	13	9	11	9	6	13	5	20	7	11	6	6	7	1	5	6
11	13	12	15	7	12	10	7	4	10	8	15	9	9	9	4	7	6	6	7
9	14	9	11	14	10	10	6	9	15	7	14	8	8	6	9	10	8	12	6
8	8	7	9	17	13	10	6	8	12	7	21	4	8	8	7	14	9	9	12
9	13	7	5	9	19	15	10	8	12	9	17	9	11	9	8	5	15	8	8
7	6	8	4	7	12	17	22	14	15	5	19	7	11	8	7	9	10	8	5
11	7	11	4	10	12	14	18	18	24	12	14	10	7	5	15	6	10	5	7
7	7	10	15	15	18	26	21	32	35	37	36	22	22	23	19	17	16	15	15
14	16	19	12	16	17	25	25	37	59	50	41	28	24	23	19	17	13	15	17
17	9	15	19	32	31	32	35	38	62	69	51	39	24	24	24	22	20	15	18
13	11	15	12	11	10	24	17	17	46	57	43	17	18	19	12	15	13	15	13
5	12	5	8	11	15	17	22	23	24	21	29	30	9	17	14	8	4	8	12
9	8	11	9	14	12	10	14	20	26	17	28	23	32	15	15	10	7	6	11
9	2	9	8	9	9	10	7	14	19	6	10	19	21	23	9	7	6	3	8
5	9	8	6	4	7	7	8	9	10	10	9	4	21	21	21	6	4	1	2
9	3	8	2	4	5	3	4	7	10	13	9	7	5	11	21	20	8	7	6
5	3	5	4	6	5	6	8	11	7	7	9	8	6	7	19	29	18	10	8
8	7	5	6	7	2	4	5	10	8	10	12	10	6	8	3	16	29	17	15
5	6	10	9	7	4	6	8	10	6	9	5	5	6	10	7	9	14	26	18

Fig. 20 Numerical representation of the accumulator matrix for 'template_K.png' rotated -8 degrees, peaking at 69

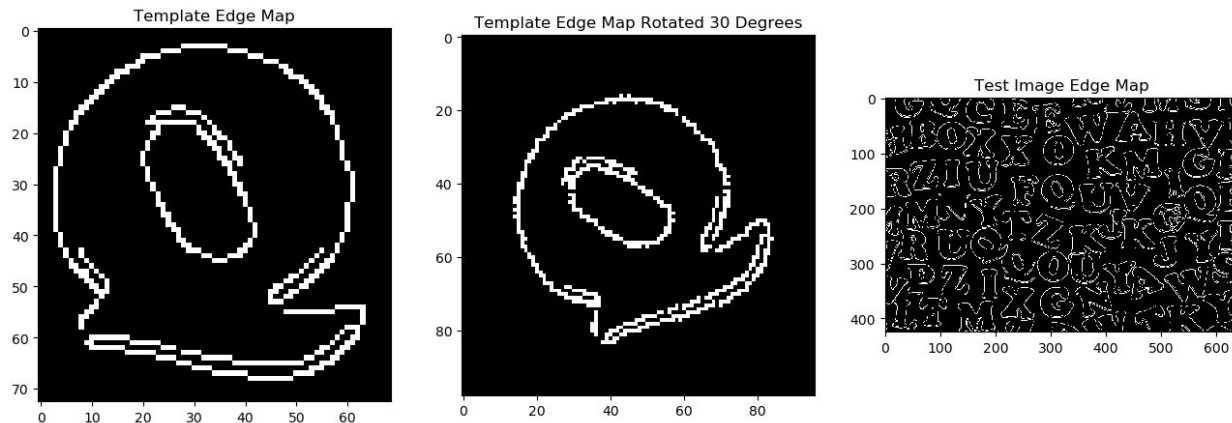


Fig. 21 Edge maps for 'template_Q.png' and 'letters.png', with the original Q template as well as the Q template rotated 30 degrees

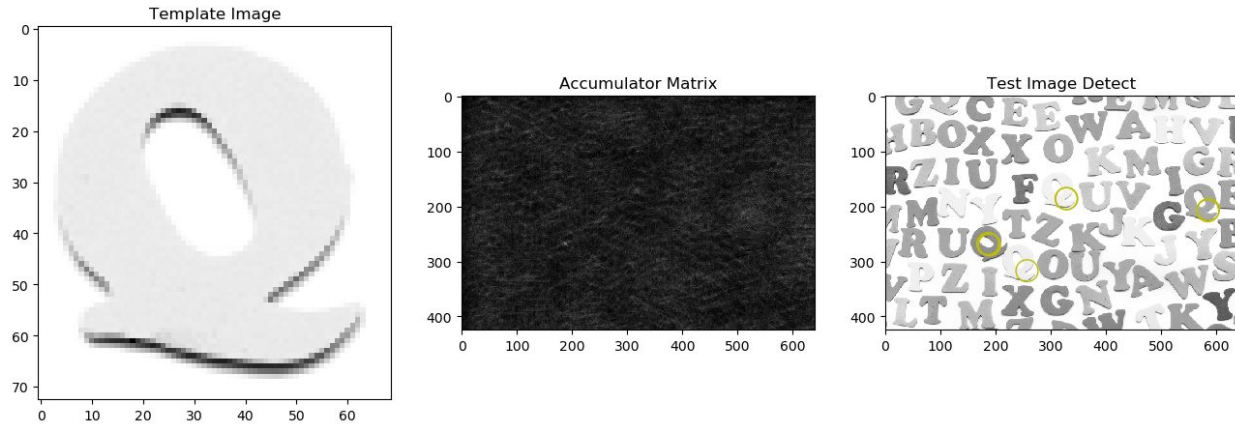


Fig. 22 The accumulator matrix for 'template_Q.png' and the results of image detection on 'letters.png'

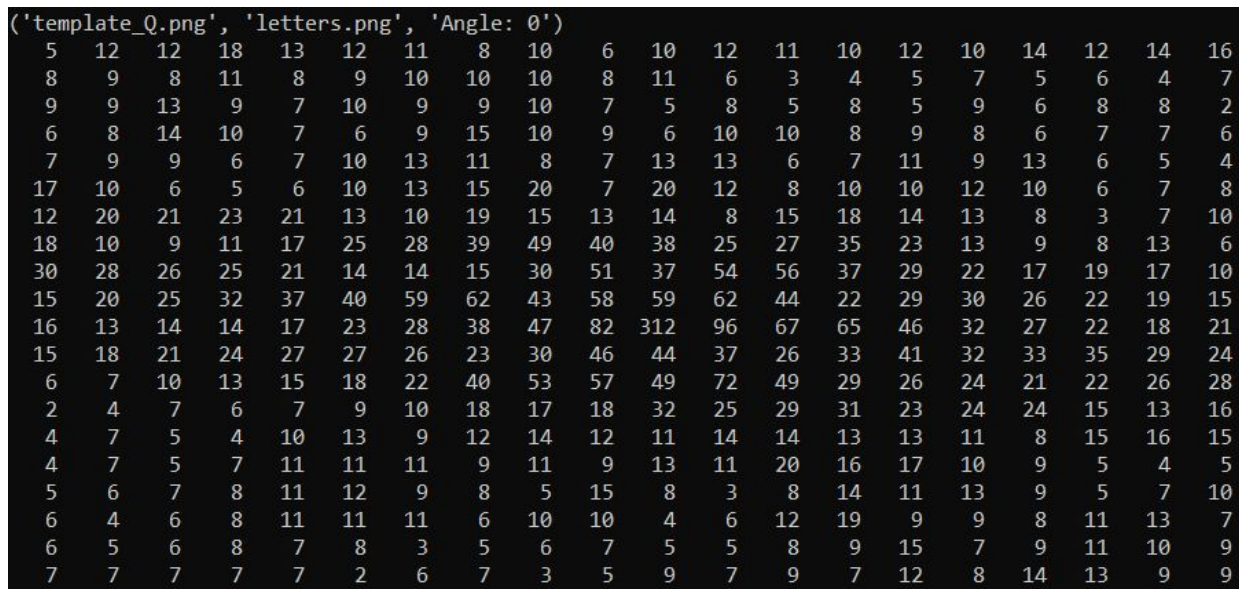


Fig. 23 Numerical representation of the accumulator matrix for 'template_Q.png', peaking at 312

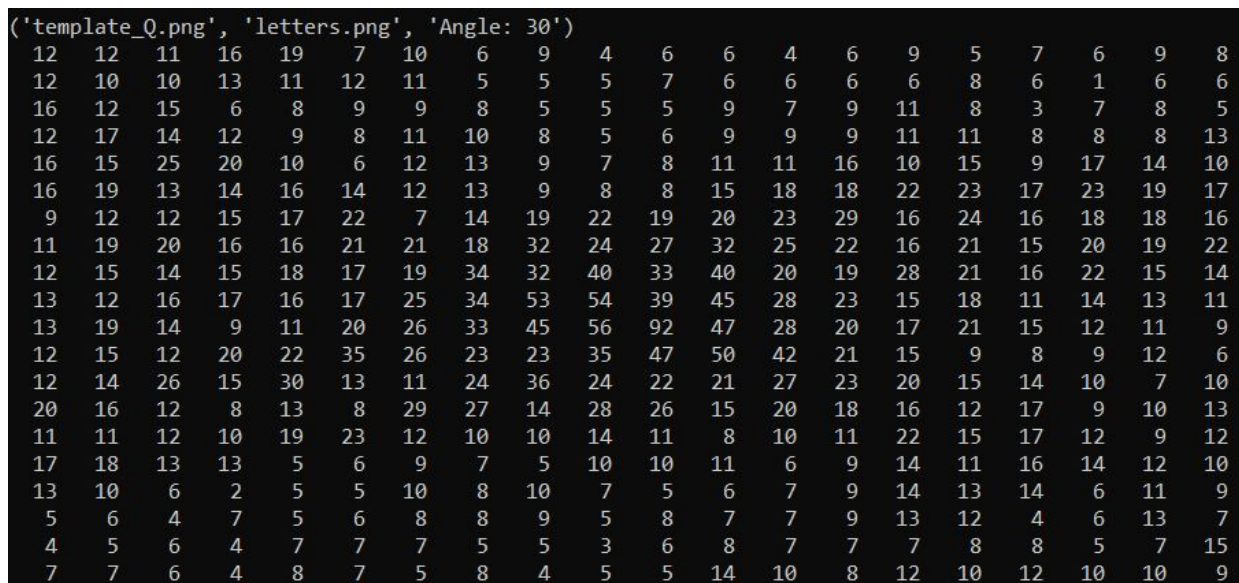


Fig. 24 Numerical representation of the accumulator matrix for 'template_Q.png' rotated 30 degrees, peaking at 92

The accumulator peaks for image detection on 'letters.png' was significantly higher than other images, as shown by Fig. 19, Fig. 20, Fig. 23, and Fig. 24. This is likely due to the lower amounts of noise in the test image, where median filters were not needed to be applied in order to obtain clean edge maps, as well as scaling not being required for image detection. As a result, the letter templates were easily detected in the test images. However, the 'Q' found in the top left border of the test image was not detected, due to a portion of it being cropped out of the image.