CMPEN/EE454: Computer Vision

Computer Project # 2

Region Properties, Shape Recognition, and Image Filtering

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A. OBJECTIVE

The objective of this project was to build a computer vision system to calculate image properties and then perform image analysis and shape recognition on a set of test images. Image filtering using mathematical morphology was also performed in this project.

B. METHODS

QUESTION 1:

This section contains details and descriptions of the algorithm. The main m-file is titled *main* and the additional files included are *shadow1scaled, shadow1, shadow1rotated, shadow1streaks, penn256, calculations, Shaperecog* and *zero*.

1. The input image "shadow1scaled" was read to construct the model database. The input image was first converted into a gray scale image and then to a binary image using thresholding. This binary image can then be used to label the image into different regions. Since there are three region of interests(ROI's), correspondingly three image matrices were initialized. The entire labeled image was analyzed, pixel by pixel, to find the appropriate pixel values of the three ROI's and saved into the pre-initialized matrices. These three matrices correspond to the three meaningful regions.

2. The properties of each region was calculated using the *calculations* function. This function loops through all the pixels to find the area, bounding box, position and four invariant moments of the region. A table is created to display all the properties calculated.

3. The test images include *shadow1, shadow1rotated, penn256, shadow1streaks*. Each of the first three images was converted into binary image in the same way as the database image. Now the pixel values for four ROI's are stored in the four pre-initialized image matrices which correspond to the four meaningful regions for recognition. The region properties for all three regions were calculated and displayed in a table accordingly. It can be seen that the labeled portions of *penn256* does not correspond to any of the desired ROI's.

4. For the fourth test image *shadow1streaks*, the image was initially filtered using a median filter to remove the effects of streak artifacts. The size of the filter was determined after various trials. A small sized filter did not remove the streaks properly and large sized filters resulted in over smoothening of the region boundaries. So we decided to use an optimum filter size of 5x5. After filtering, the four ROI's are separated using the same procedure which gives four meaningful regions for recognition. Calculation of properties were done and tabulated.

5. Shape recognition was done by computing the cost which is the difference between the invariant moments of the model database and the test images. If the difference is the smallest value, then that region corresponds to that particular ROI. While observing the database, except the first invariant moment, all the other moments are too small to affect the final value. So only the first invariant moment were considered for all the images.

C. RESULTS

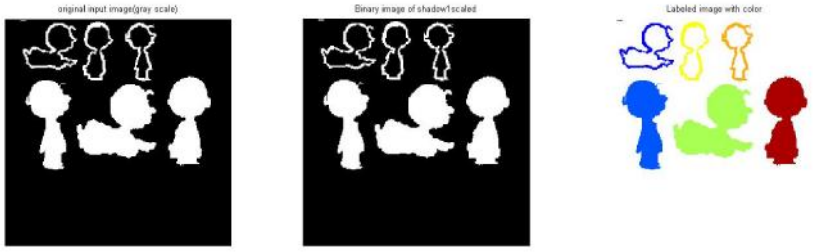

Fig.1: Original database image, Binary database image and labeled(RGB) database image

Fig.2: Three separated ROI's of the database image 'shadow1scaled'

	Upper left i	UL j	Bottom Left i	BL j	Upper Right i	UR j	Bottom Right i	BR j	Area/ Pixels	Position i	Position j	Invariant Moment #1	#2	#3
Region #1	24	70	24	170	75	70	75	170	2786	114.1106	51.5761	0.3276	0.0668	0.0059
Region #2	82	75	82	157	171	75	171	157	4255	120.3412	130.6428	0.2230	0.0074	0.0026
Region #3	185	63	185	165	233	66	233	165	3092	113.1779	207.4366	0.2984	0.0526	0.0013

Fig.3: Table with properties for the database image 'shadow1scaled'

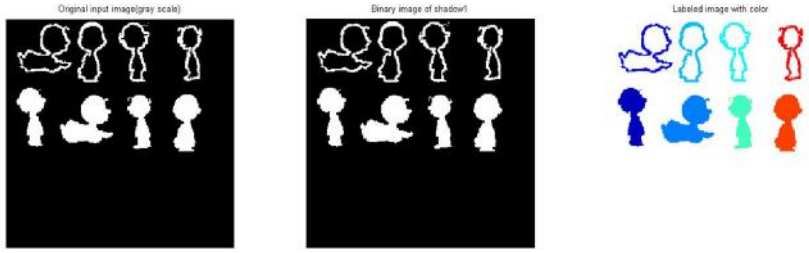

Fig.4: Original 'shadow1' image, Binary image and labeled(RGB) image

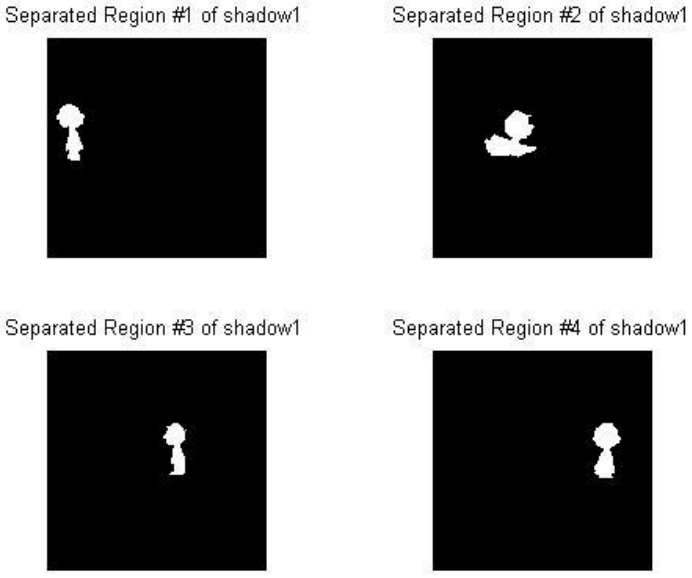

Fig.5: Four separated ROI's of the test image 'shadow1'

	Upper left i	UL j	Bottom Left i	BL j	Upper Right i	UR j	Bottom Right i	BR j	Area/ Pixels	Position i	Position j	Invariant Moment #1	#2	#3	#4
Region #1	13	78	13	143	45	73	45	143	1170	106.5726	30.3128	0.3269	0.0666	0.0061	0.0024
Region #2	62	86	62	139	120	88	120	139	1780	116.0680	92.5163	0.2214	0.0070	0.0026	5.0071e-05
Region #3	137	86	137	145	163	88	163	145	950	113.4389	152.1084	0.3553	0.0864	0.0030	0.0014
Region #4	188	85	188	148	219	85	219	143	1298	115.2227	202.5293	0.3005	0.0536	0.0012	4.9530e-04

Fig.6: Table with properties for the test image 'shadow1'

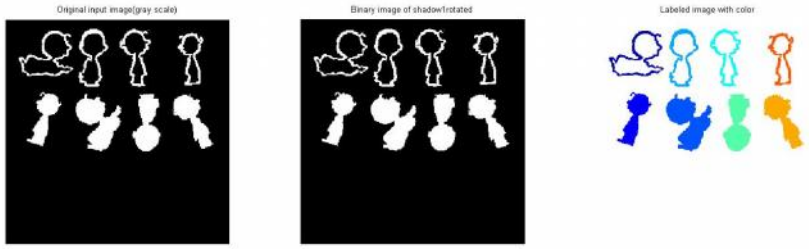

Fig.7: Original 'shadow1rotated' image, Binary image and labeled(RGB) image

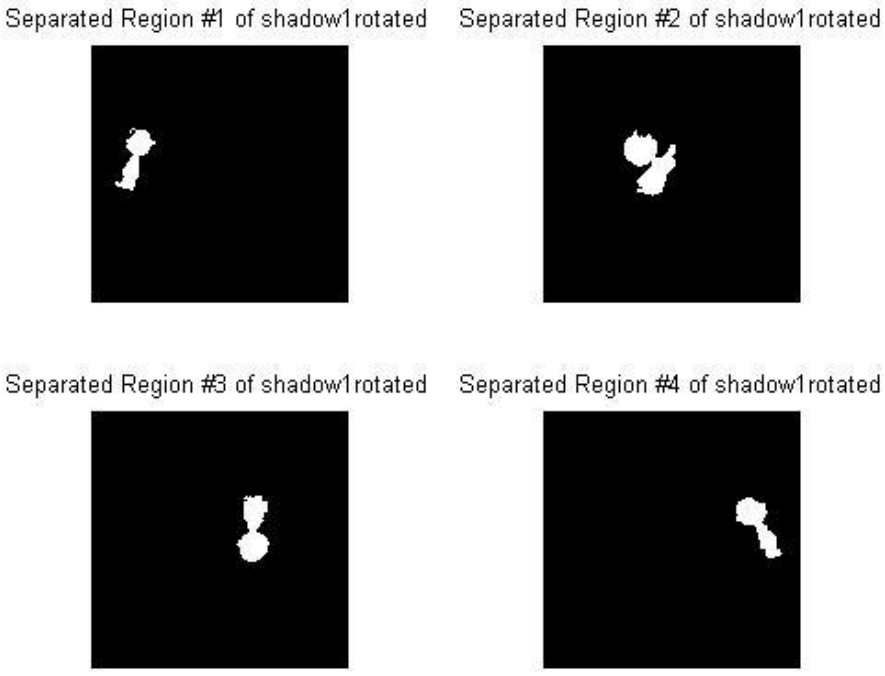

Fig.8: Four separated ROI's of the test image 'shadow1rotated'

	Upper left i	UL j	Ecttom Left i	BL j	Upper Right i	JR j	Bcttcm Right i	ER j	Area/ Pixels	Position i	Position_	Invariant Moment #1	#2	#3	#4
Regior #'	25	84	25	145	64	84	64	145	981	112.3690	45.0041	C.3577	0.C875	0.0033	0.0014
Regior #2	81	86	3'	150	'32	86	132	150	1803	117.2224	106.4565	C.2232	0.C073	0.0026	4.8734e-05
Regior #3	146	86	146	150	'77	86	177	150	1313	119.4752	162.6839	C.3023	0.C548	0.00'3	4.9186e-04
Regior #4	193	86	193	147	238	86	238	147	1'81	113.3472	214.4310	C.3333	0.C736	0.0064	0.0026

Fig.9: Table with properties for the test image 'shadow1rotated'

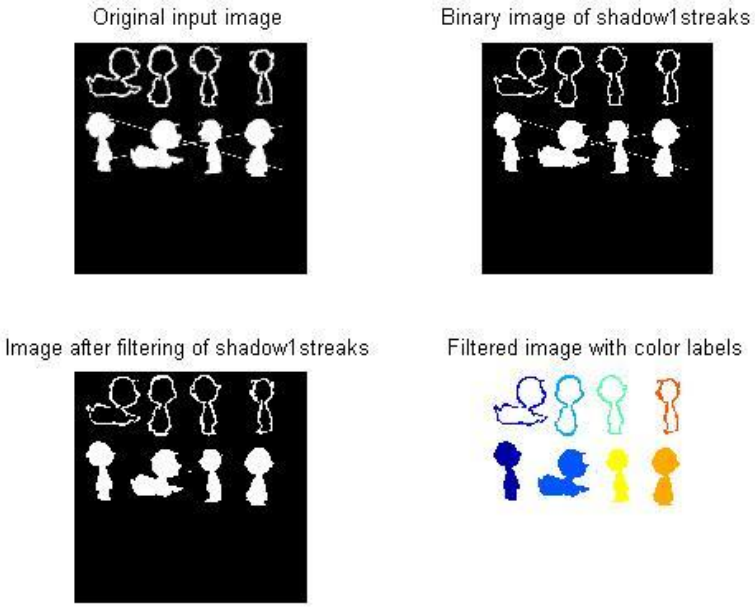

Fig.10: Original 'shadow1streaks' image, Binary image, Filtered image and labeled(RGB) image

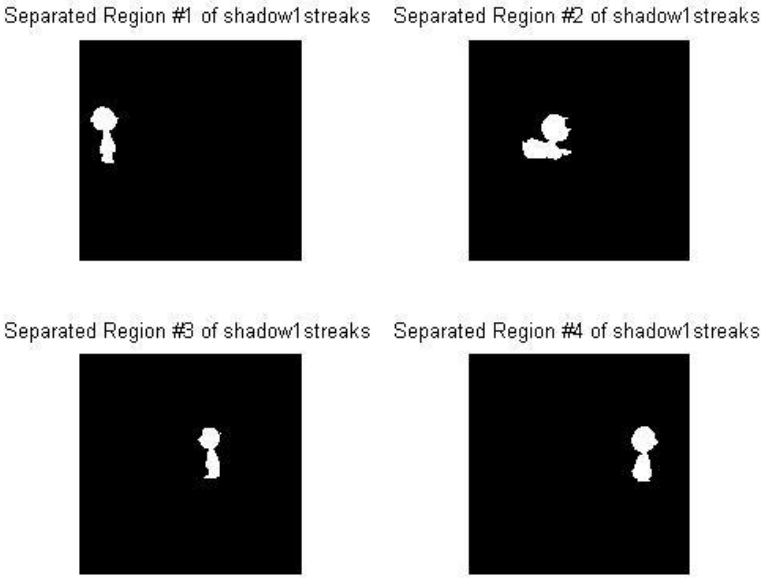

Fig.11: Four separated ROI's of the test image 'shadow1streaks'

	Upper left i	UL j	Bottom Left i	B_j	Upper Right i	JR j	Bottom Right i	BR j	Area/Pixels	Position i	Position j	Invariant Moment #1	#2	#3	#4
Region #1	29	172	29	314	99	172	99	314	5420	234.2705	67.2533	0.3369	0.0721	0.0068	0.0028
Region #2	137	189	137	306	264	189	264	306	8317	255.5453	205.2682	0.2250	0.0077	0.0027	5.9301e-05
Region #3	303	189	303	319	360	189	360	319	4352	249.5556	336.2371	0.3666	0.0946	0.0032	0.0016
Region #4	415	167	415	326	484	187	484	326	6041	253.3693	447.4051	0.3079	0.0573	0.0015	5.9697e-04

Fig.12: Table with properties for the test image 'shadow1streaks'

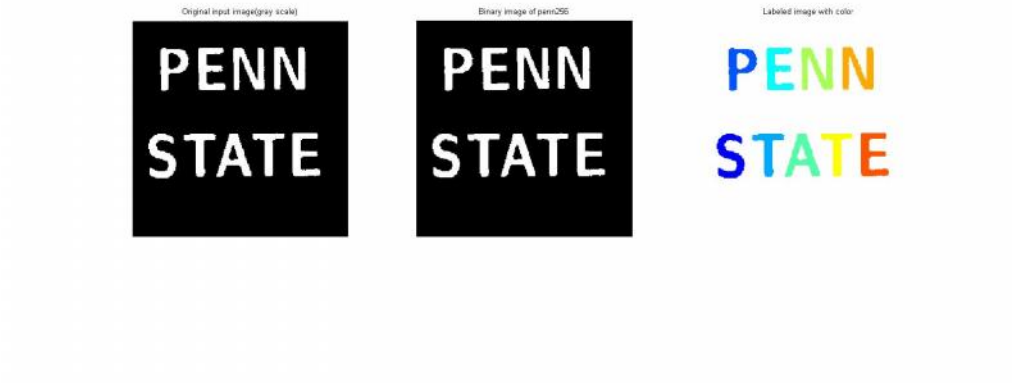

Fig.13: Original 'penn256' image, Binary image and labeled(RGB) image

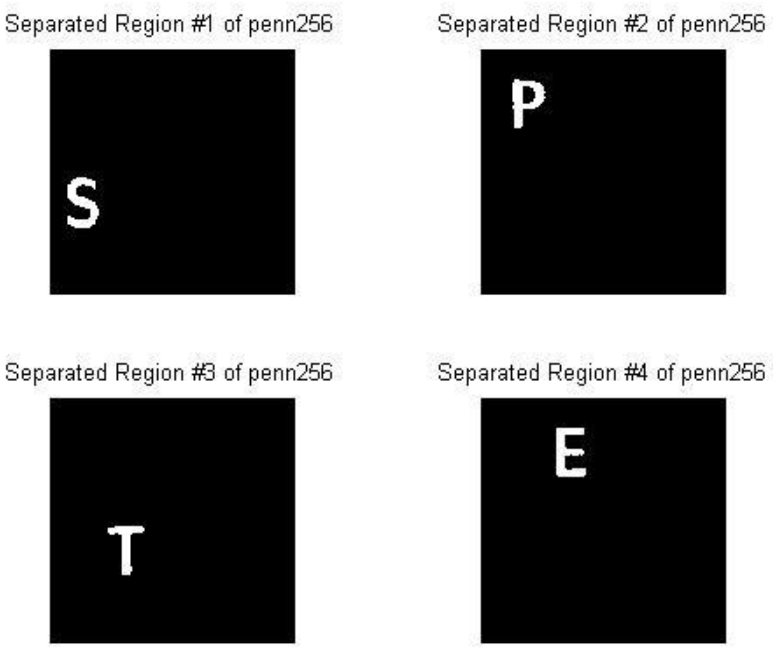

Fig.14: Four separated ROI's of the test image 'penn256'

As it can be seen that none of the four separated regions of the test image 'penn256' correspond to any of the desired ROI's

	Upper left:	UL	Bottom Left i	EL j	Upper Right i	UR j	Bottom Right i	BR j	Area/ Pixels	Position i	Position j	rvarian: Momen: #1	#2	#3	#4
Region #1	20	135	20	136	52	135	52	135	387	16'.19'7	35.5006	0.3748	0.0419	3.8877e-04	3.0C14e-C5
Region #2	34	33	34	33	67	33	67	33	365	53.0786	46.7896	0.3155	0.0167	0.0117	9.8221e-C4
Region #3	62	135	62	135	99	135	99	135	702	153.9031	8C.4345	0.4219	0.0312	0.3382	C.0039
Region #4	78	33	79	32	110	33	110	32	904	57.7976	9C.7312	0.3720	0.0432	0.2018	9.2662e-C4

Fig.15: Table with properties for the test image 'penn256'

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MATLAB Command Window                                          Page 1

>> main
The A ROI is in region #1 in the Image 1

The B ROI is in region #2 in the Image 1

The C ROI is in region #4 in the Image 1

The A ROI is in region #4 in the Image 2

The B ROI is in region #2 in the Image 2

The C ROI is in region #3 in the Image 2

The A ROI is in region #1 in the Image 3

The B ROI is in region #2 in the Image 3

The C ROI is in region #4 in the Image 3

None of the regions correspond to desired ROIs in the Image 4
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Fig.16: Results for Shape Recognition

QUESTION 2:

This section contains details and descriptions of the algorithm. The main m-file is titled *main* and the additional files included are *dilation, erosion, One* and *zero1*.

1. The image 'shadow1' which has the outlined figures in it was read. The input image was eroded initially which results in elimination of the outlined figures. But the sizes of the solid figures have reduced significantly

2. Next dilation process was done on the eroded image which results opening of the input image. The dilation process restores the sizes of the solid figures back to original. The border effects are also depicted in the final image.

3. The major task in this process was to find the mask which could ultimately regenerate an image which would be closest similar to the original image with the outlined figures eliminated. We choose a shape which is rectangular because the alignment of all the figures is either horizontal or vertical.

D. RESULTS

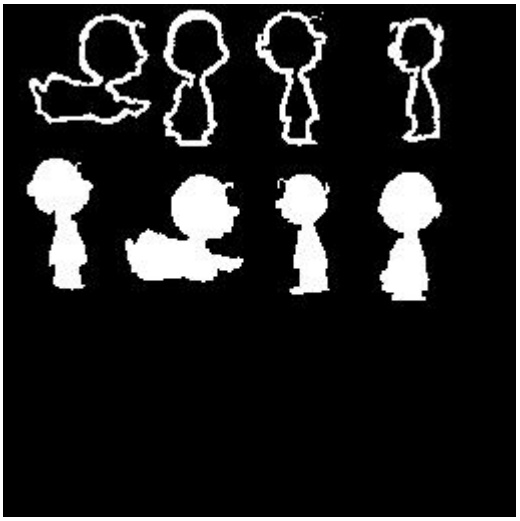

Fig 1.a) Shadow1

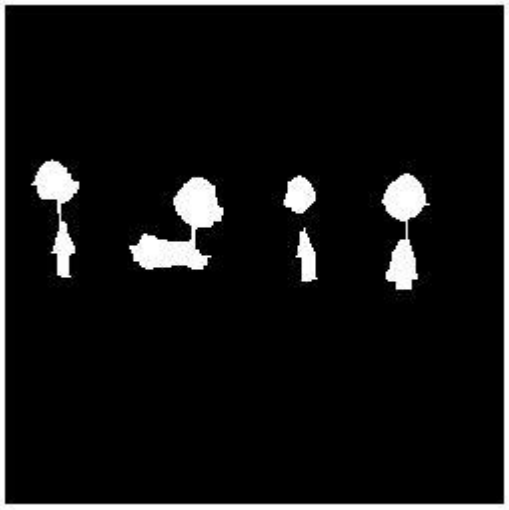

Fig 1.b) 3x3Erosion of Shadow 1

Fig 1.c) Dilation of Fig 1.a (Opening)

This figure shows a first successful case with the thinnest 3x3 window based opening . Figure also shows border effects due to erosion/dilation operations. This is a the most basic window and results in an opening of the original image. As it can be seen some of the details are missing in the final image.

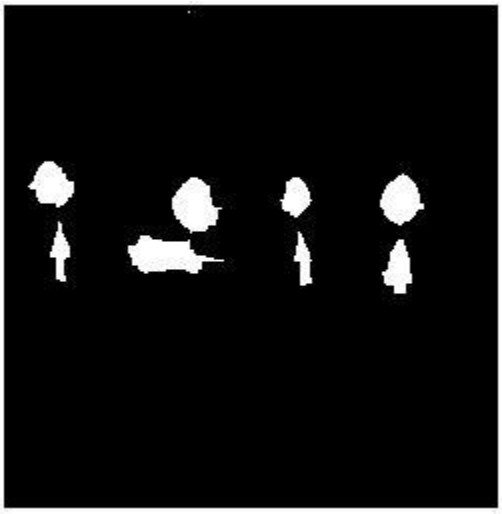

Fig 2.a) 2x4 Erosion of shadow1

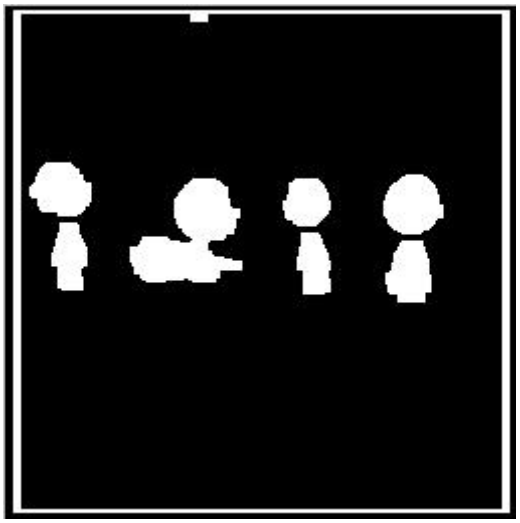

Fig 2.b)Dilation of Fig 2.a (Opening)

The opening applied on Fig 2 has a 2x4 window which removes the neck part from the images. It creates new regions of interest and is hence a failure as three images totally change.

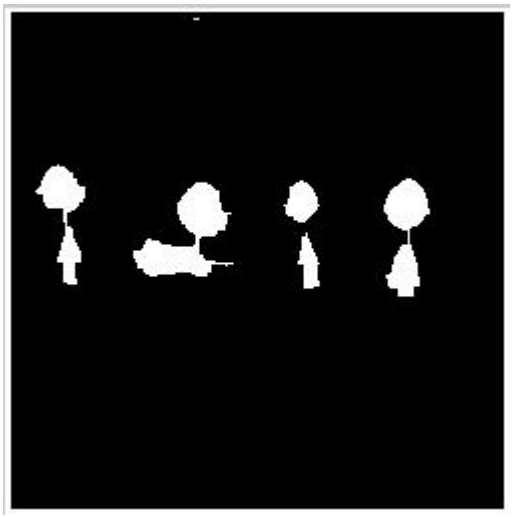

Fig 3.a) 2x3 Erosion of shadow1

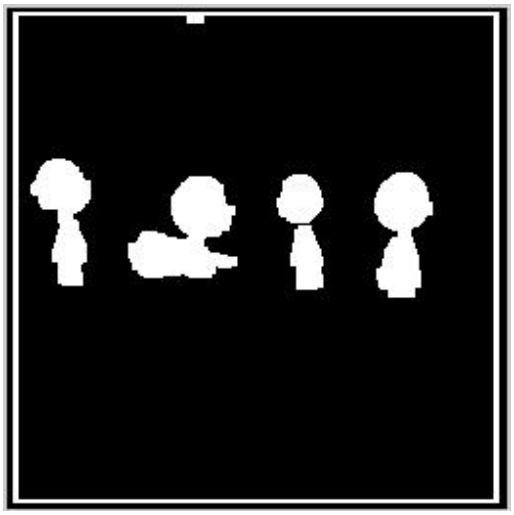

Fig 3.b) Dilation of Fig 3.a (Opening)

With the filter size of 2x3, the opening of the image gives the closest to the original ones which eliminates the outlined figures while largely preserving the solid figures.

E. CONCLUSION

For shape recognition, it can seen that rotation of the image causes very little change in the value of the invariant moments. Also the artifacts corrupting the 'shadow1streaks' image was recognized without much difficulty since most of the streak effects were removed by an appropriate filter size. The image 'penn256' did not contain any corresponding region of interest in it and so it cannot be recognized.

For image filtering, opening of the 'shadow1' image was successful which preserved most of the solid figures and eliminated the outlined figures. The success of this process was completely depended on the size of the filter (2x3) used. This process failed when an inappropriate filter size was used (2x4).