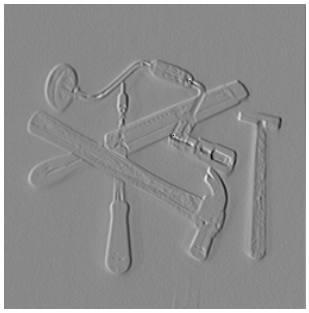
DD2423
Lab II
Alexandros Filotheou

1 Difference operators

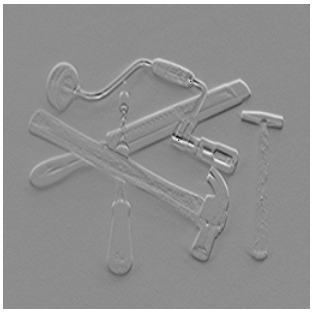
1.1 Question 1

Figure 1: Image `few256`.

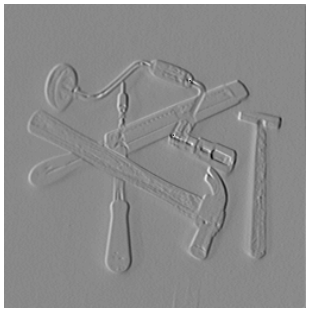
SDO: X-wise derivative



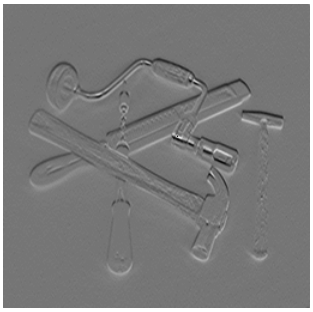
SDO: Y-wise derivative



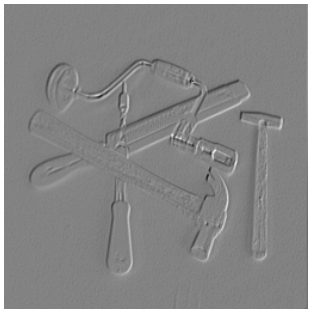
CDO: X-wise derivative



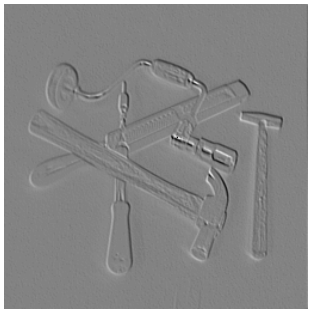
CDO: Y-wise derivative



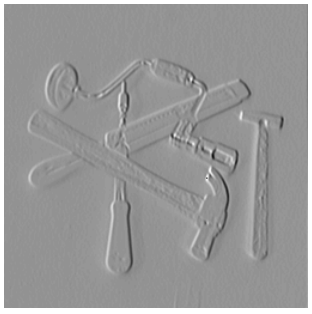
Roberts: X-wise derivative



Roberts: Y-wise derivative



Sobel: X-wise derivative



Sobel: Y-wise derivative

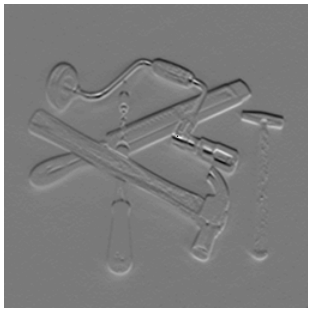


Figure 2: Derivatives of image `few256` in the x and y directions. The simple differences operator is featured in the first row, the central differences operator in the second, the Roberts cross operator in the third and the Sobel operator in the fourth.

operator / kernel size	x_wise	y_wise
SDO	1×3	3×1
CDO	1×3	3×1
Roberts	2×2	2×2
Sobel	3×3	3×3

Table 1: Kernel sizes for the 4 operators used, for taking derivatives in both x-wise and y-wise directions.

In the case of the simple differences operator, the kernel used has a size of 1×3 and 3×1 when considering the x-wise and y-wise derivatives respectively. Since *all* elements of the kernel have to be multiplied by a pixel value of a $N \times M$ image (parameter `SHAPE = valid`), the former kernel will fit exactly N times into the image x-wise (vertically), but only $M-2$ times y-wise (horizontally). In the general case where a kernel is of size $(2L+1) \times (2K+1)$, the output image's size will be $(N-L-1) \times (M-K-1)$. Table 1 shows the size of each kernel used by each operator for taking derivatives in both x-wise and y-wise directions. Tables 2 and 3 illustrate the size of the output images for the various operators used to deliver edge detection.

image	size_x	size_y
few256	256	256
SDO(few256)	256	254
CDO(few256)	256	254
Roberts(few256)	255	255
Sobel(few256)	254	254

Table 2: Image sizes for the origin image and the images of derivatives in the x-wise direction.

image	size_x	size_y
few256	256	256
SDO(few256)	254	256
CDO(few256)	254	256
Roberts(few256)	255	255
Sobel(few256)	254	254

Table 3: Image sizes for the origin image and the images of derivatives in the y-wise direction.

2 Point-wise thresholding of gradient magnitudes

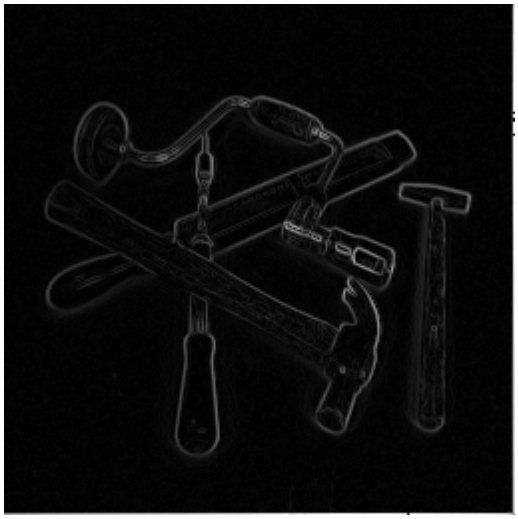
2.1 Without template `Lv`

2.1.1 `few256`

SDO

CDO

Roberts



Sobel

Figure 3: Approximation of the gradient magnitude for the simple differences, central differences, Roberts and Sobel operator.

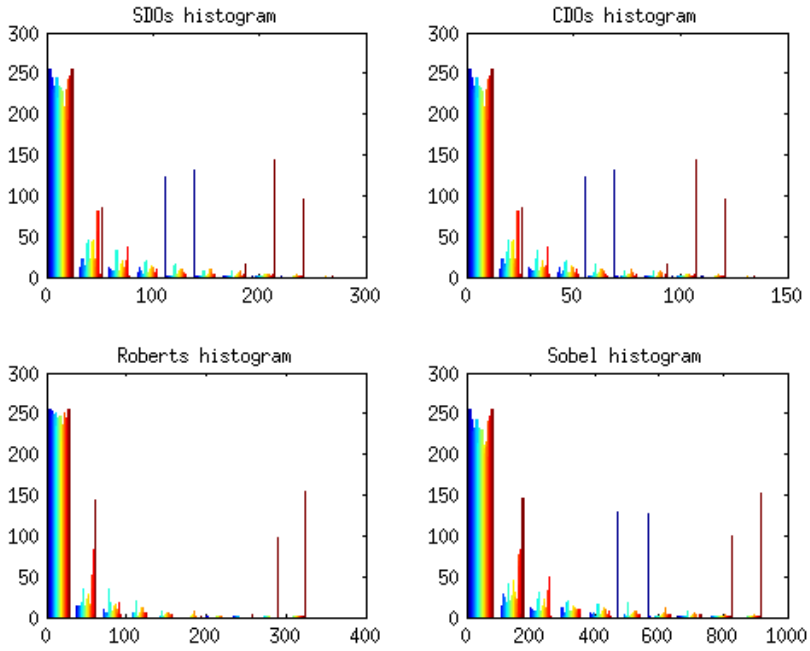


Figure 4: Histograms of the images seen in figure 3.

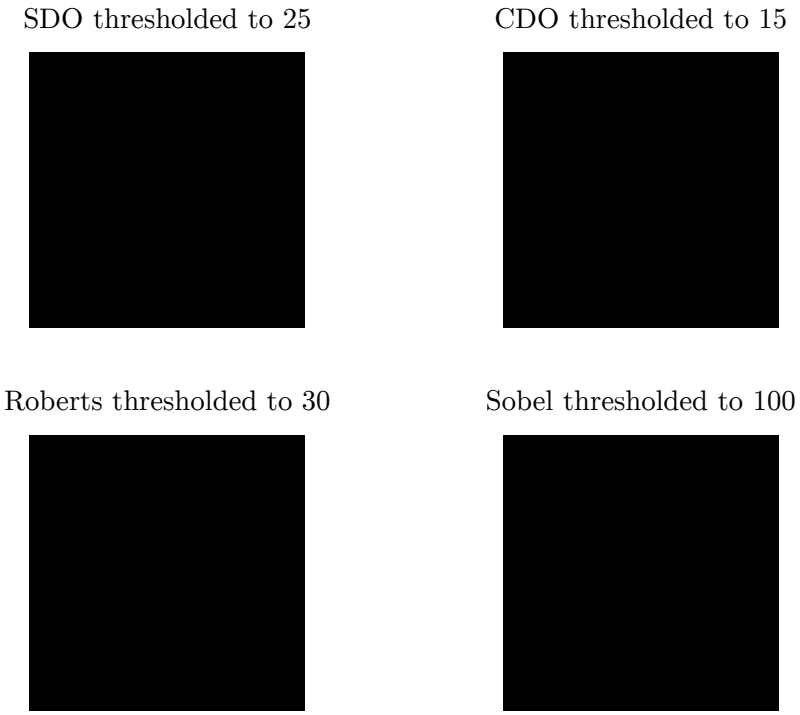


Figure 5: Thresholding of images in figure 3 with a threshold larger than the first major component of each histogram in figure 8.

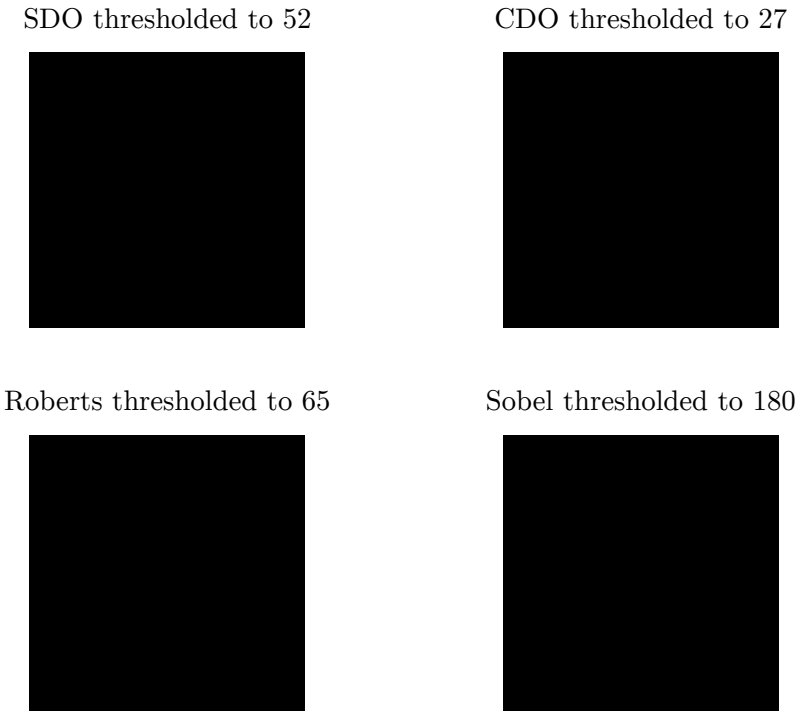


Figure 6: Thresholding of images in figure 3 with a threshold larger than the second major component of each histogram in figure 8.

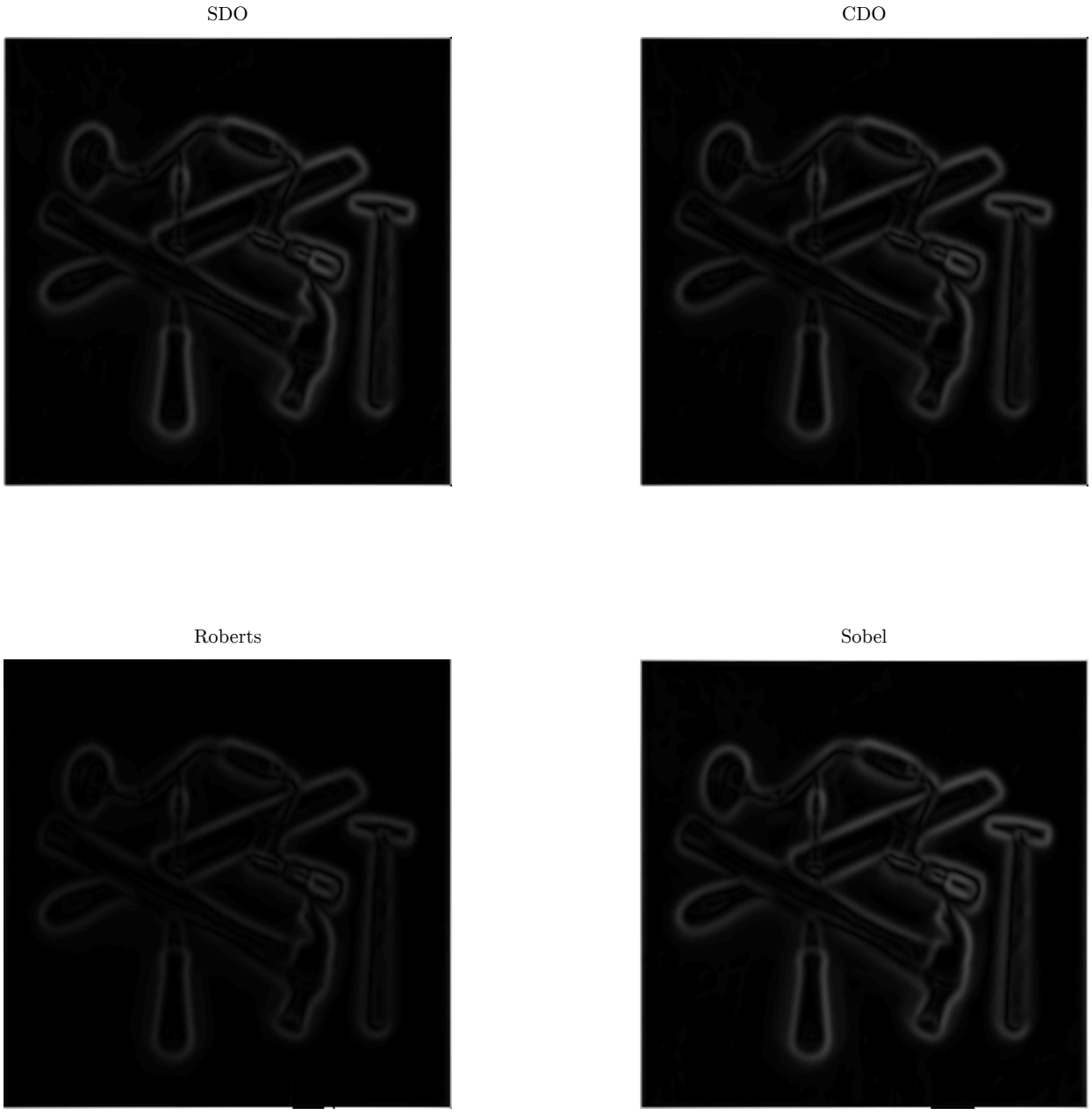


Figure 7: Smoothed approximation of the gradient magnitude for the simple differences, central differences, Roberts and Sobel operator. Smoothing was performed using a Gaussian filter with $\sigma^2 = 4$.

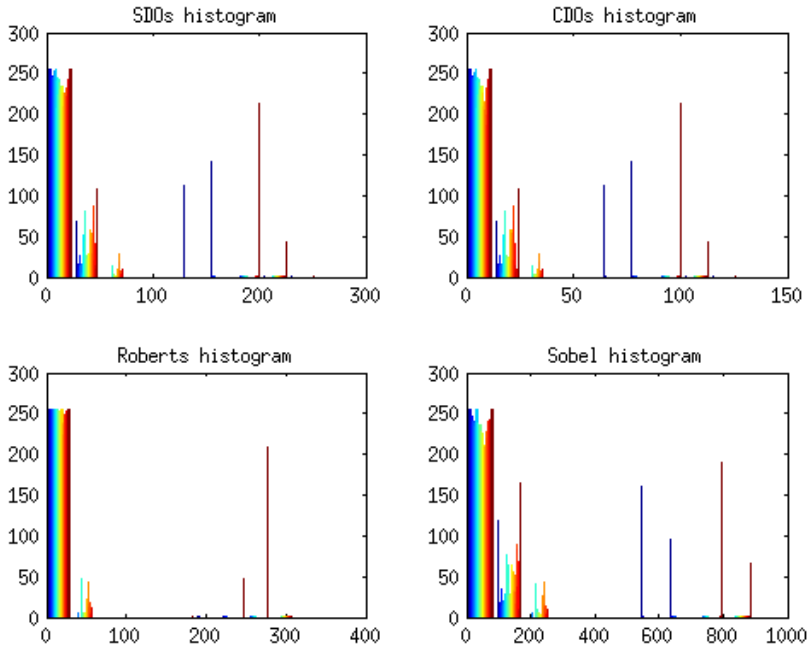


Figure 8: Histograms of the images seen in figure 7.

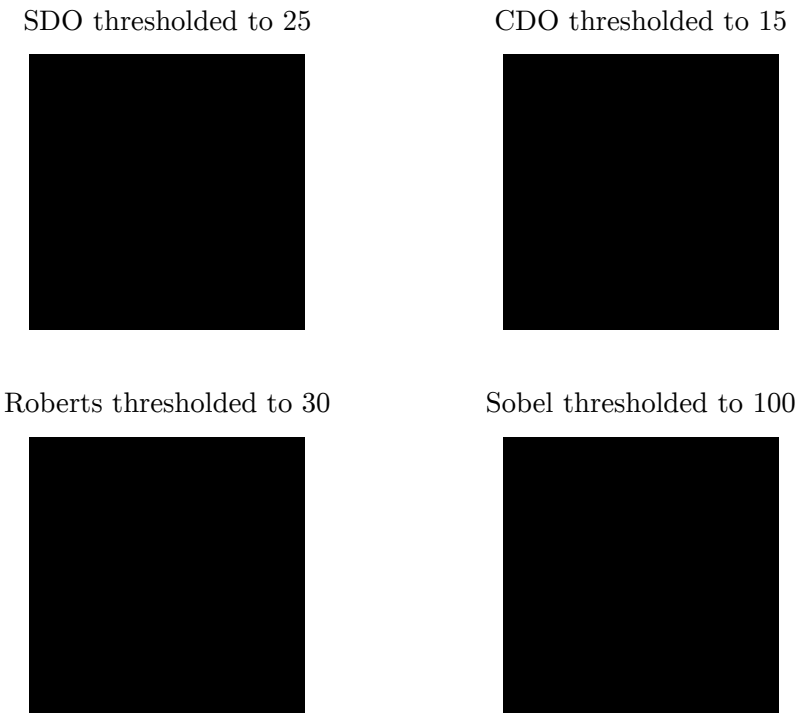


Figure 9: Thresholding of images in figure 7 with a threshold larger than the first major component of each histogram in figure 8.

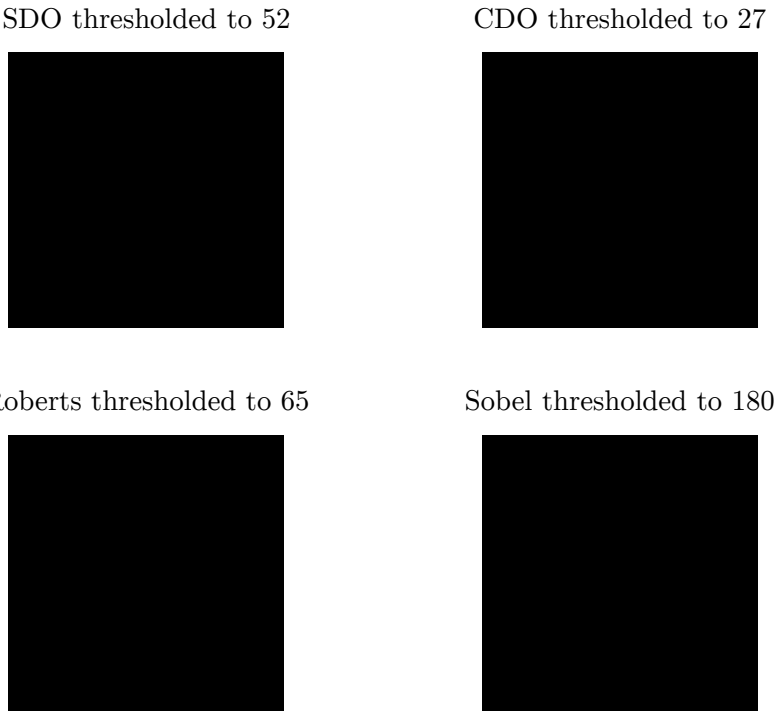


Figure 10: Thresholding of images in figure 7 with a threshold larger than the second major component of each histogram in figure 8.

2.1.2 `godthem256`

Figure 11: Approximation of the gradient magnitude for the simple differences, central differences, Roberts and Sobel operator.

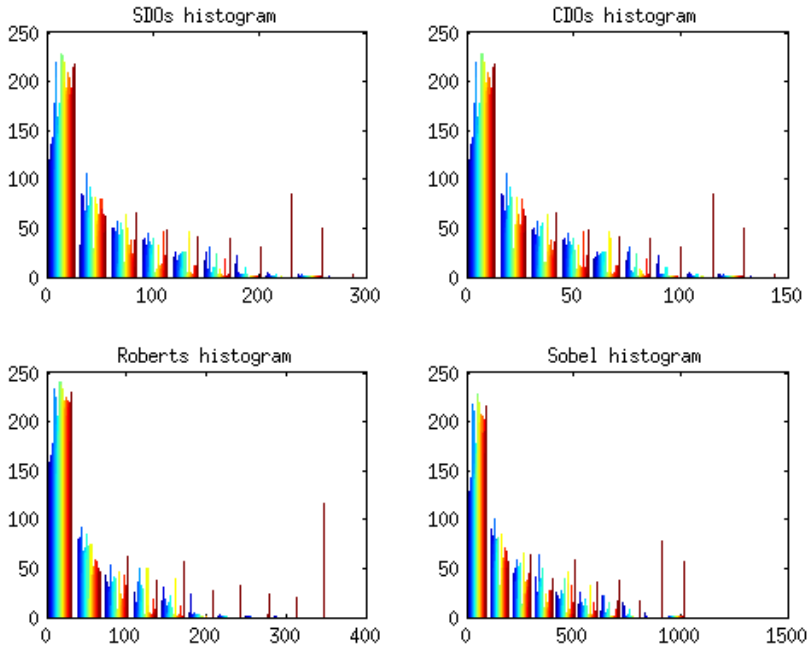


Figure 12: Histograms of the images seen in figure 11.

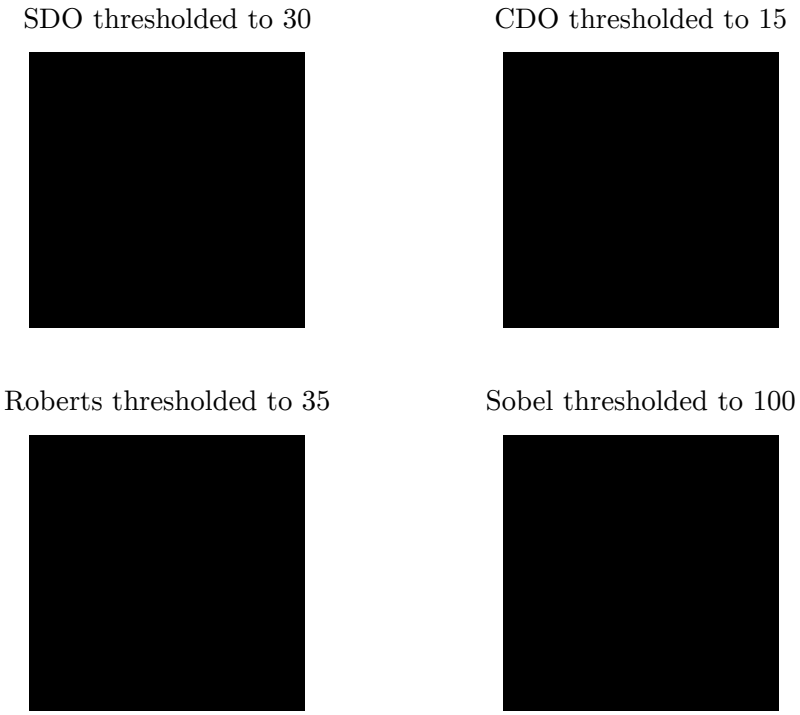


Figure 13: Thresholding of images in figure 11 with a threshold larger than the first major component of each histogram in figure 16.

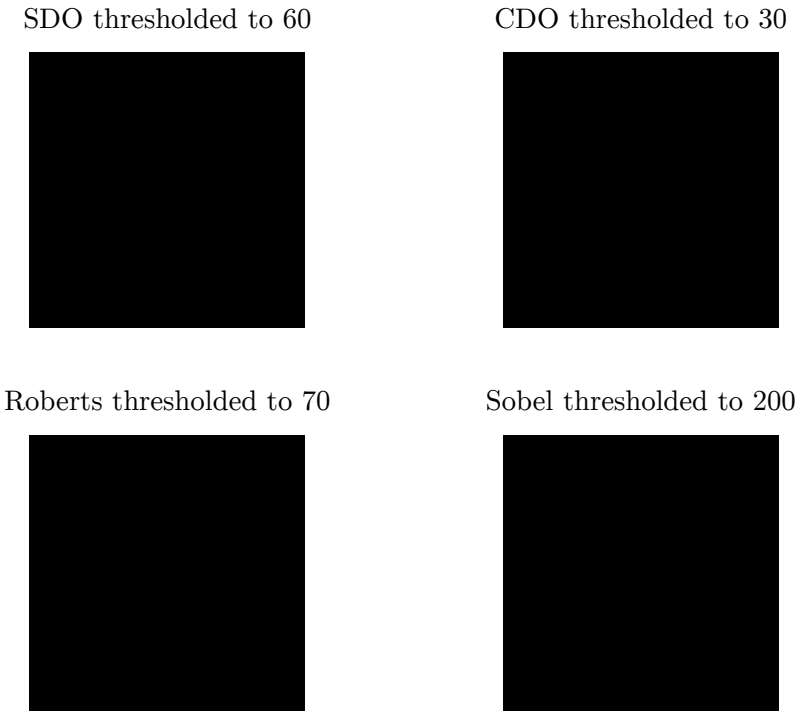


Figure 14: Thresholding of images in figure 11 with a threshold larger than the second major component of each histogram in figure 16.

SDO

CDO

Roberts

Sobel

Figure 15: Smoothed approximation of the gradient magnitude for the simple differences, central differences, Roberts and Sobel operator. Smoothing was performed using a Gaussian filter with $\sigma^2 = 4$.

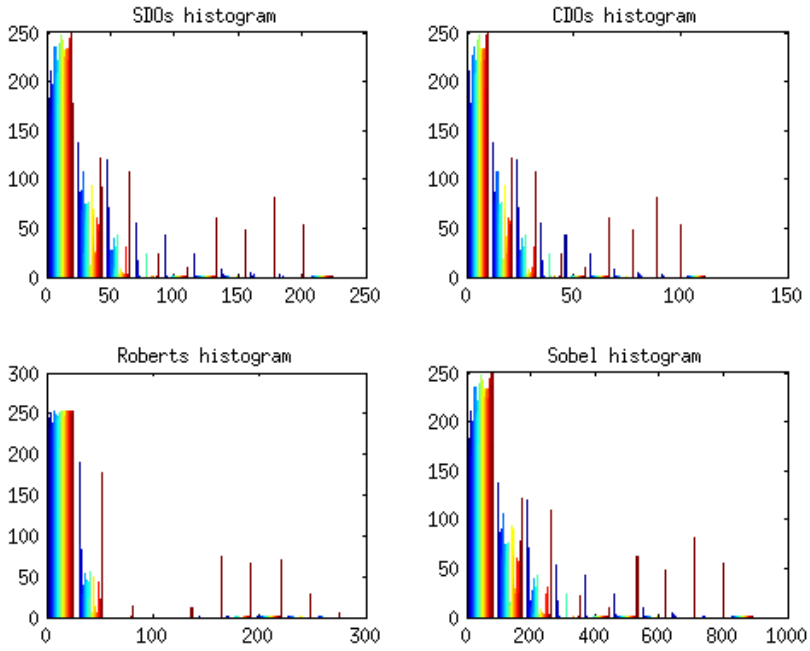
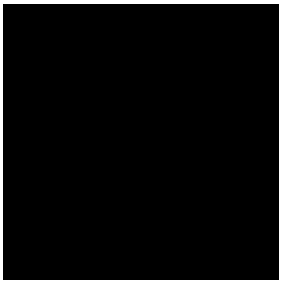


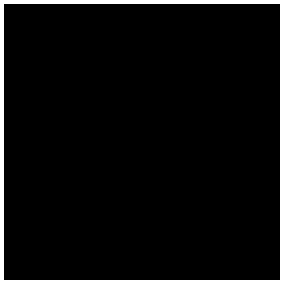
Figure 16: Histograms of the images seen in figure 15.

Figure 17: Thresholding of images in figure 15 with a threshold larger than the first major component of each histogram in figure 16.

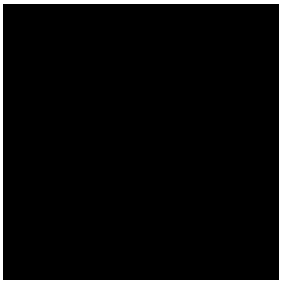
SDO thresholded to 45



CDO thresholded to 22



Roberts thresholded to 60



Sobel thresholded to 180

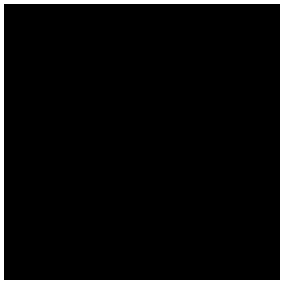


Figure 18: Thresholding of images in figure 15 with a threshold larger than the second major component of each histogram in figure 16.

2.2 With template function `Lv`

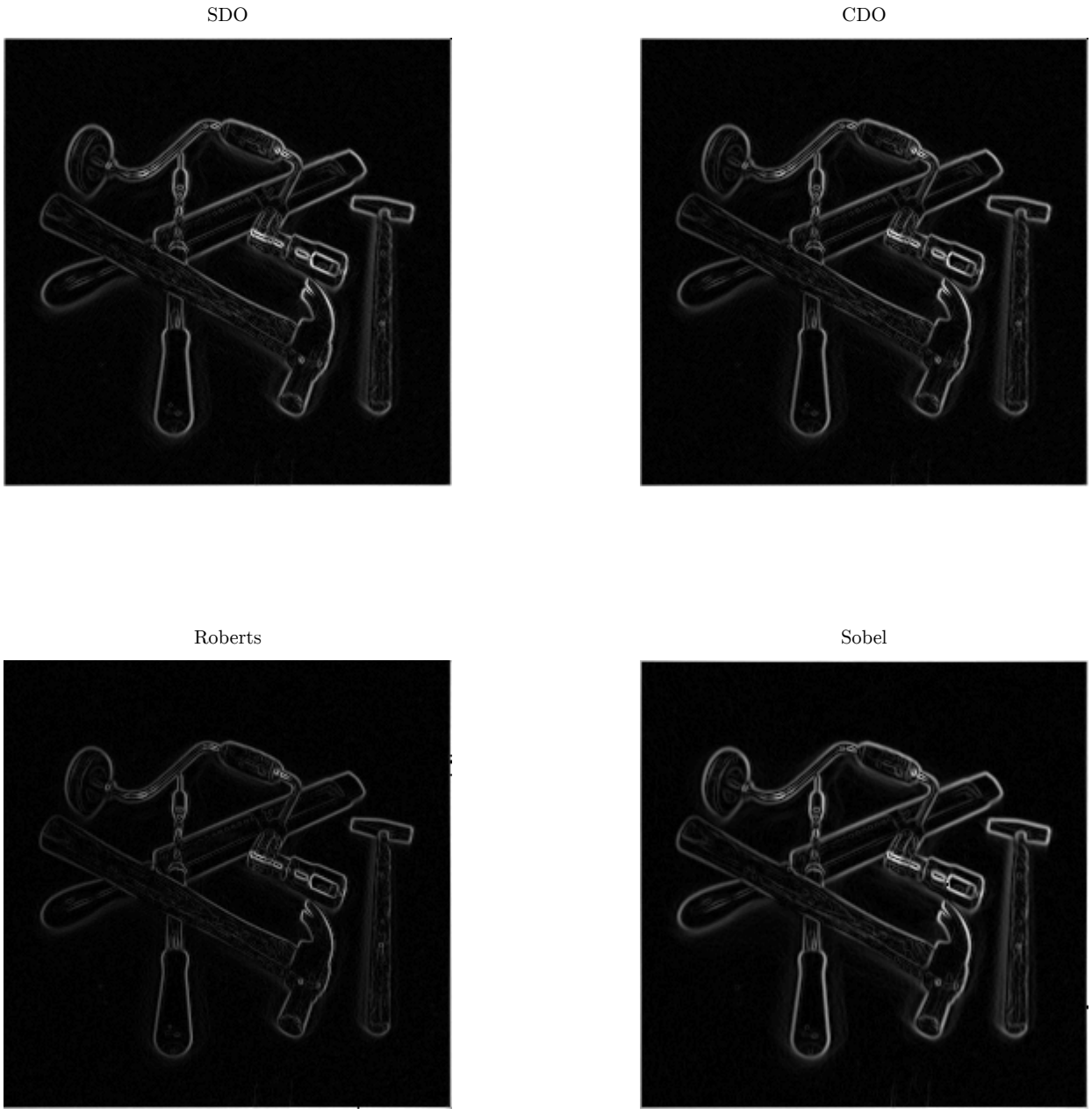


Figure 19: Approximation of the gradient magnitude for the simple differences, central differences, Roberts and Sobel operator.

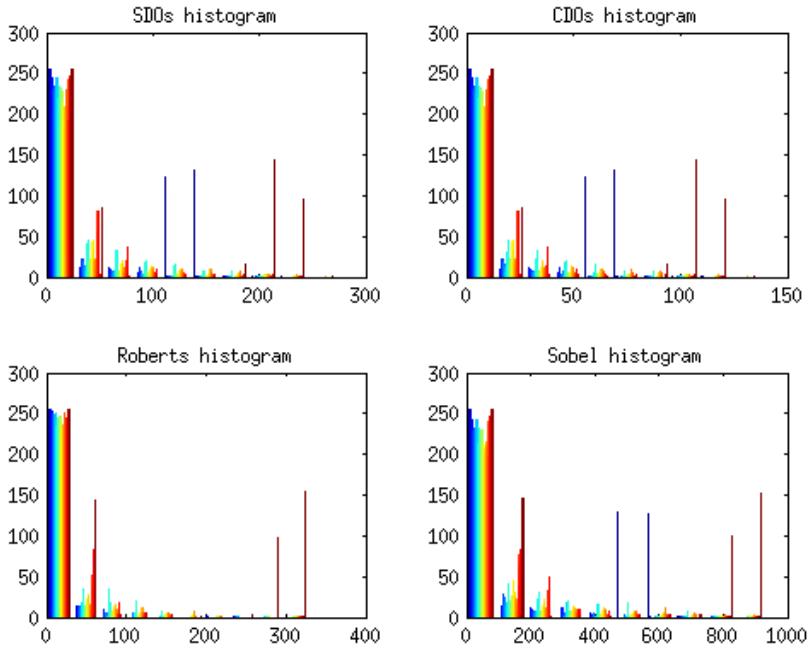


Figure 20: Histograms of the images seen in figure 3.

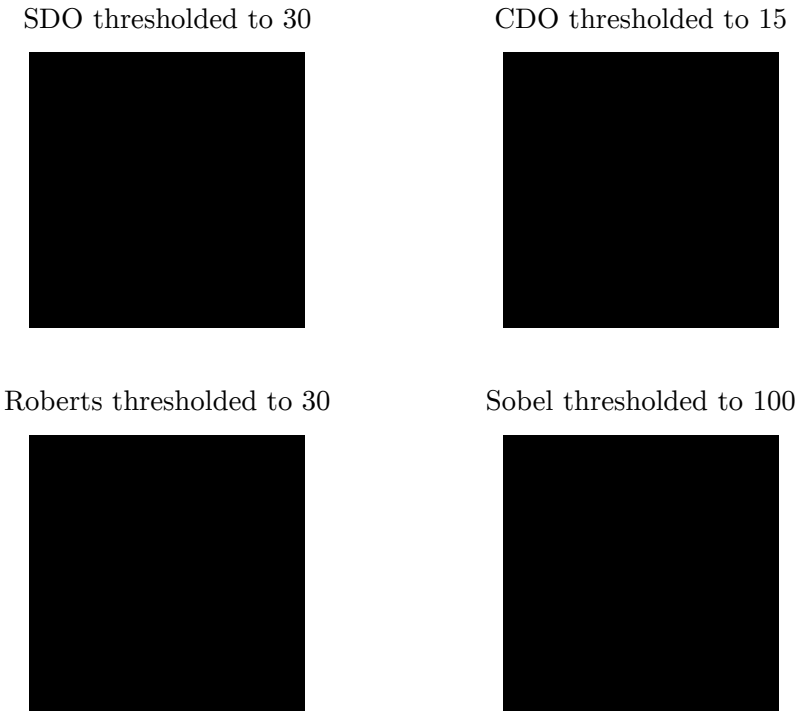
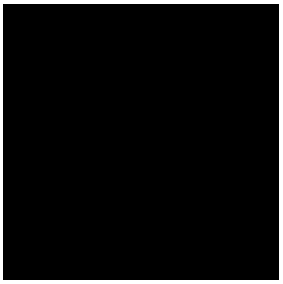
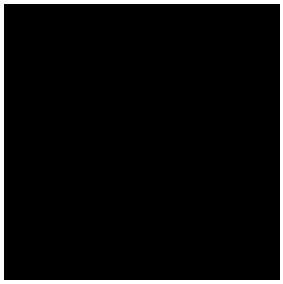


Figure 21: Thresholding of images in figure 3 with a threshold larger than the first major component of each histogram in figure 8.

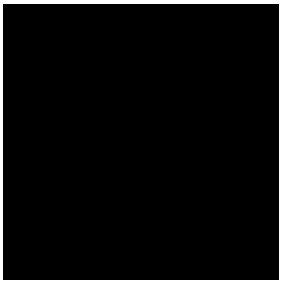
SDO thresholded to 50



CDO thresholded to 27



Roberts thresholded to 65



Sobel thresholded to 180

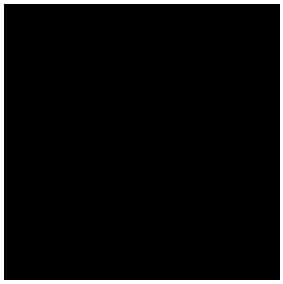


Figure 22: Thresholding of images in figure 3 with a threshold larger than the second major component of each histogram in figure 8.

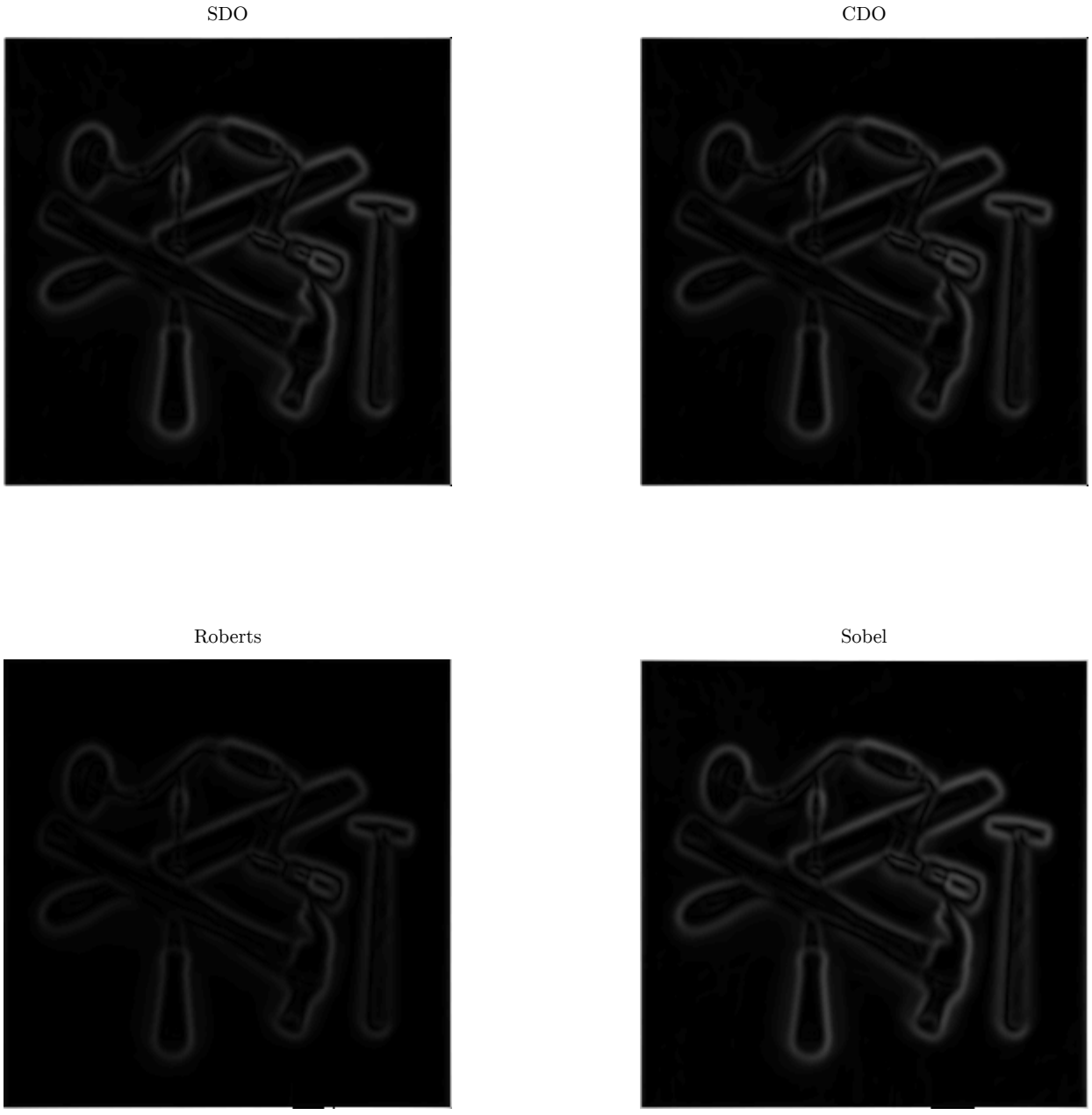


Figure 23: Smoothed approximation of the gradient magnitude for the simple differences, central differences, Roberts and Sobel operator. Smoothing was performed using a Gaussian filter with $\sigma^2 = 4$.

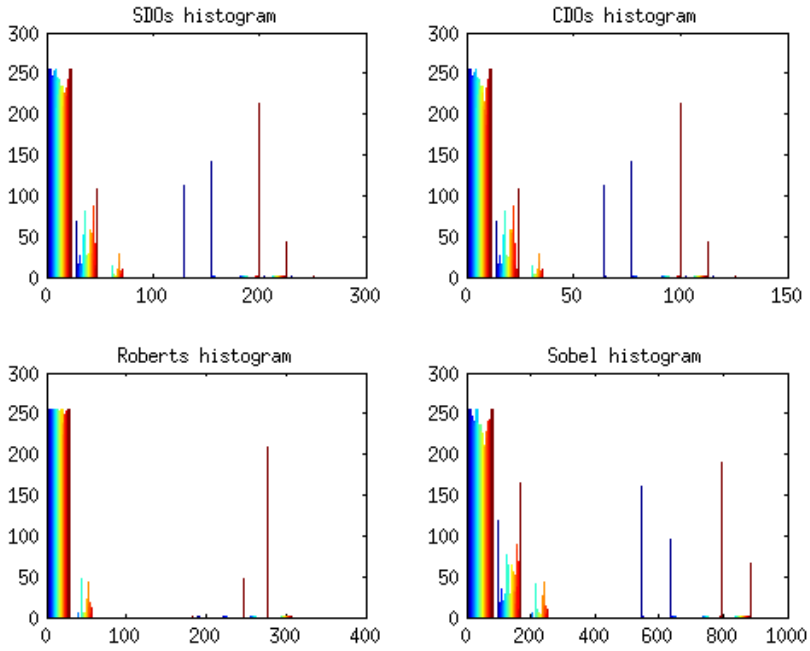


Figure 24: Histograms of the images seen in figure 7.

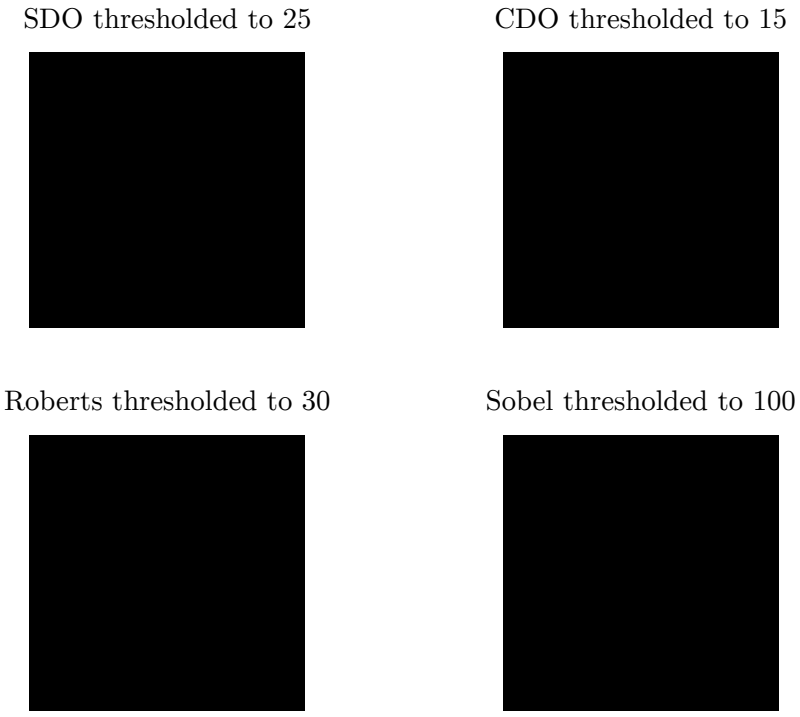
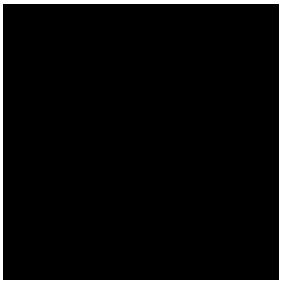
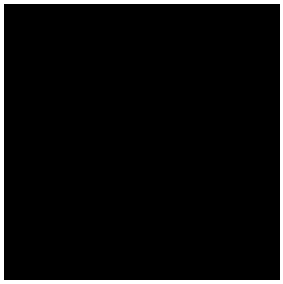


Figure 25: Thresholding of images in figure 7 with a threshold larger than the first major component of each histogram in figure 8.

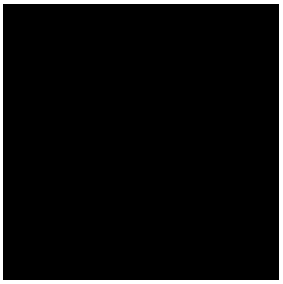
SDO thresholded to 52



CDO thresholded to 27



Roberts thresholded to 65



Sobel thresholded to 180

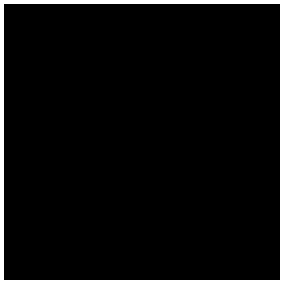


Figure 26: Thresholding of images in figure 7 with a threshold larger than the second major component of each histogram in figure 8.

2.2.1 `godthem256`

SDO

CDO

Roberts

Sobel

Figure 27: Approximation of the gradient magnitude for the simple differences, central differences, Roberts and Sobel operator.

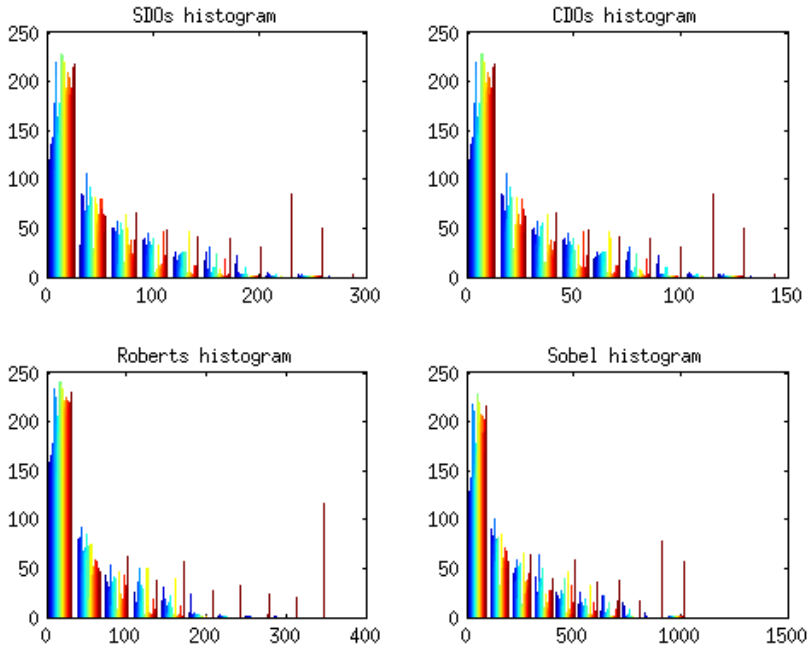


Figure 28: Histograms of the images seen in figure 11.

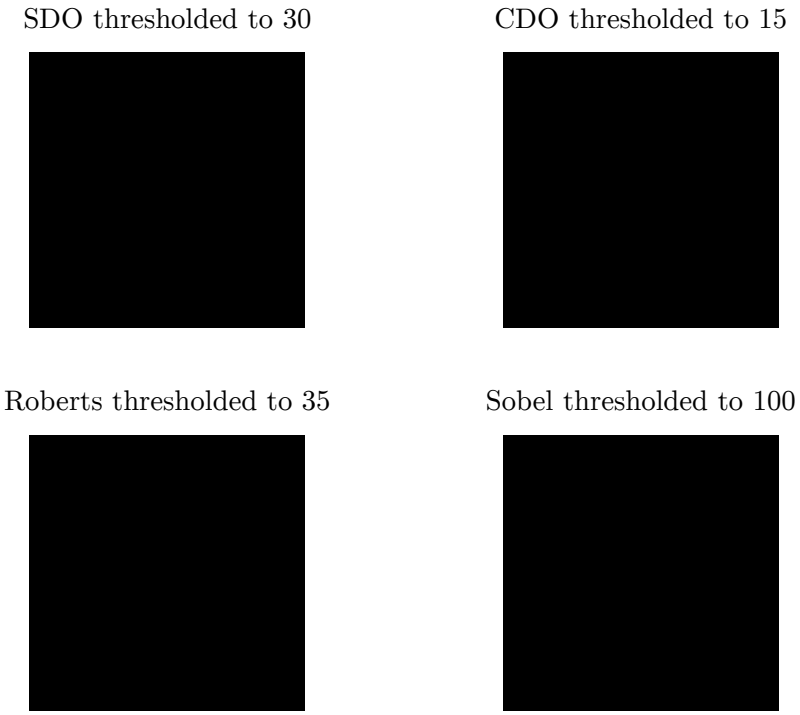
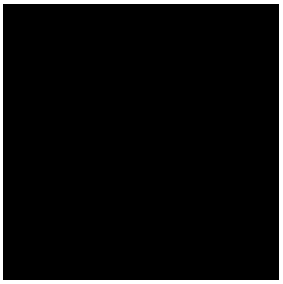
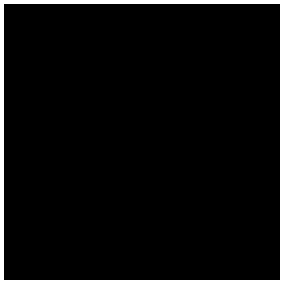


Figure 29: Thresholding of images in figure 11 with a threshold larger than the first major component of each histogram in figure 16.

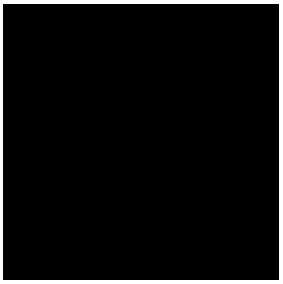
SDO thresholded to 60



CDO thresholded to 30



Roberts thresholded to 70



Sobel thresholded to 200

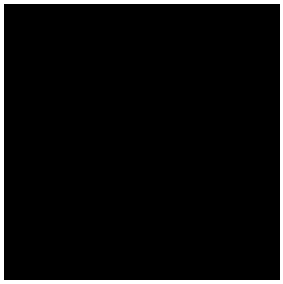


Figure 30: Thresholding of images in figure 11 with a threshold larger than the second major component of each histogram in figure 16.

SDO

CDO

Roberts

Sobel

Figure 31: Smoothed approximation of the gradient magnitude for the simple differences, central differences, Roberts and Sobel operator. Smoothing was performed using a Gaussian filter with $\sigma^2 = 4$.

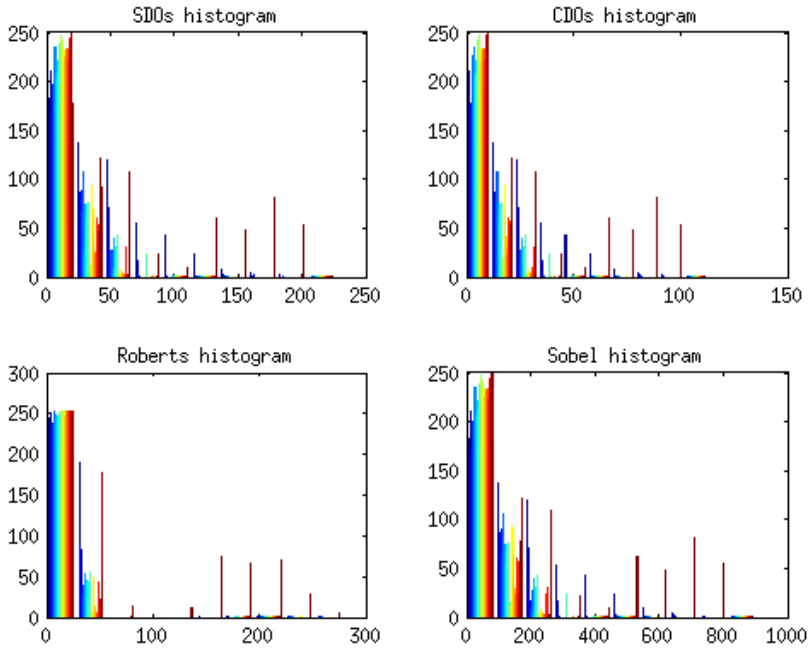


Figure 32: Histograms of the images seen in figure 15.

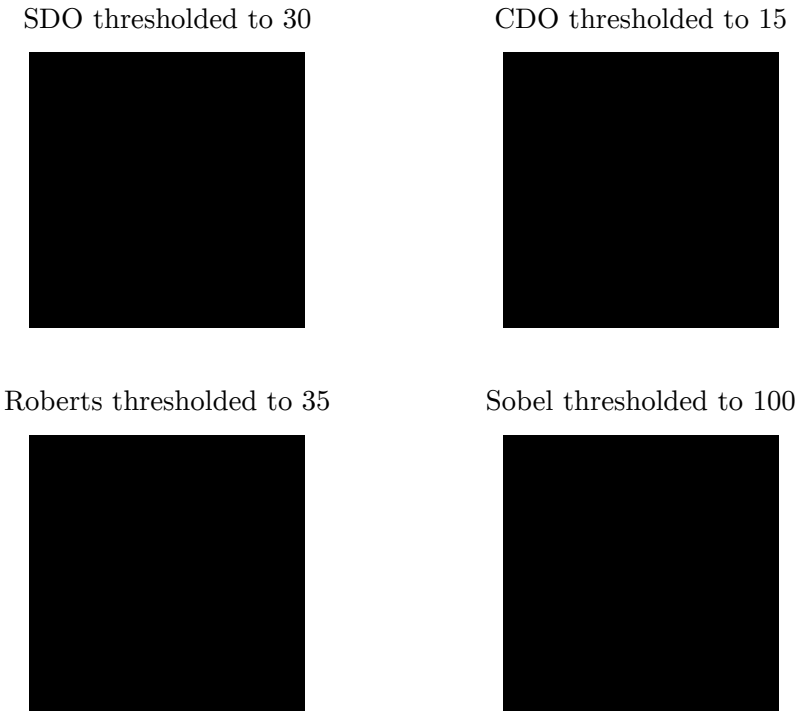


Figure 33: Thresholding of images in figure 15 with a threshold larger than the first major component of each histogram in figure 16.

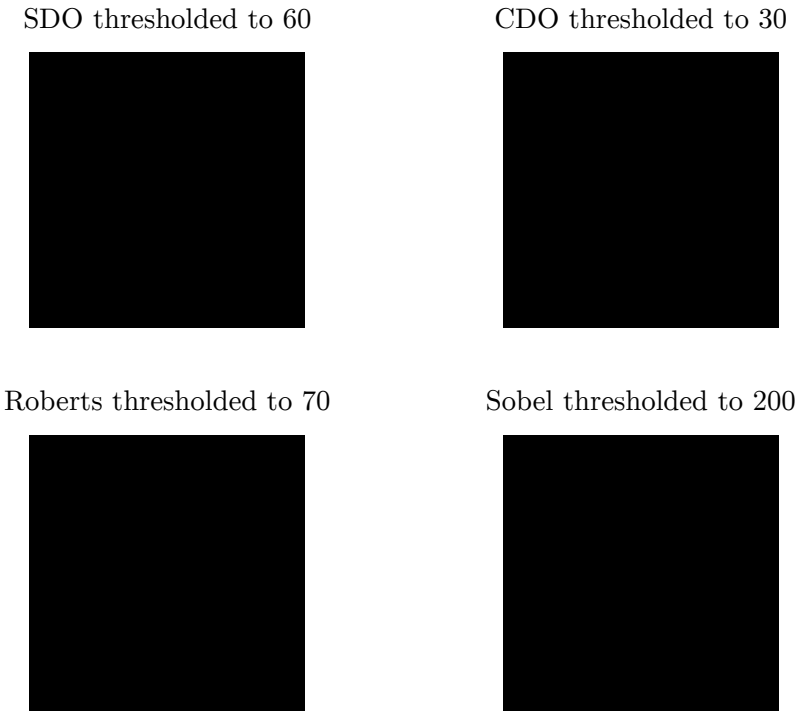


Figure 34: Thresholding of images in figure 15 with a threshold larger than the second major component of each histogram in figure 16.