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I have scaled the image to be of size 0.3 times the original image, for faster processing.

1. a) Design a Gaussian filter kernel of size 9x9

- Gaussian with standard deviation = 1

1.791e-08 | 5.931e-07 | 7.226e-06 | 3.238e-05 | 5.339e-05 | 3.238e-05 | 7.226e-06 | 5.931e-07 | 1.791e-08

5.931e-07 | 1.964e-05 | 2.393e-04 | 1.072e-03 | 1.768e-03 | 1.072e-03 | 2.393e-04 | 1.964e-05 | 5.931e-07

7.226e-06 | 2.393e-04 | 2.915e-03 | 1.306e-02 | 2.154e-02 | 1.306e-02 | 2.915e-03 | 2.393e-04 | 7.226e-06

3.238e-05 | 1.072e-03 | 1.306e-02 | 5.855e-02 | 9.653e-02 | 5.855e-02 | 1.306e-02 | 1.072e-03 | 3.238e-05

5.339e-05 | 1.768e-03 | 2.154e-02 | 9.653e-02 | 1.592e-01 | 9.653e-02 | 2.154e-02 | 1.768e-03 | 5.339e-05

3.238e-05 | 1.072e-03 | 1.306e-02 | 5.855e-02 | 9.653e-02 | 5.855e-02 | 1.306e-02 | 1.072e-03 | 3.238e-05

7.226e-06 | 2.393e-04 | 2.915e-03 | 1.306e-02 | 2.154e-02 | 1.306e-02 | 2.915e-03 | 2.393e-04 | 7.226e-06

5.931e-07 | 1.964e-05 | 2.393e-04 | 1.072e-03 | 1.768e-03 | 1.072e-03 | 2.393e-04 | 1.964e-05 | 5.931e-07

1.791e-08 | 5.931e-07 | 7.226e-06 | 3.238e-05 | 5.339e-05 | 3.238e-05 | 7.226e-06 | 5.931e-07 | 1.791e-08

- Gaussian with std = 3

3.965e-03 | 5.850e-03 | 7.723e-03 | 9.124e-03 | 9.645e-03 | 9.124e-03 | 7.723e-03 | 5.850e-03 | 3.965e-03

5.850e-03 | 8.631e-03 | 1.139e-02 | 1.346e-02 | 1.423e-02 | 1.346e-02 | 1.139e-02 | 8.631e-03 | 5.850e-03

7.723e-03 | 1.139e-02 | 1.504e-02 | 1.777e-02 | 1.879e-02 | 1.777e-02 | 1.504e-02 | 1.139e-02 | 7.723e-03

9.124e-03 | 1.346e-02 | 1.777e-02 | 2.099e-02 | 2.219e-02 | 2.099e-02 | 1.777e-02 | 1.346e-02 | 9.124e-03

9.645e-03 | 1.423e-02 | 1.879e-02 | 2.219e-02 | 2.346e-02 | 2.219e-02 | 1.879e-02 | 1.423e-02 | 9.645e-03

9.124e-03 | 1.346e-02 | 1.777e-02 | 2.099e-02 | 2.219e-02 | 2.099e-02 | 1.777e-02 | 1.346e-02 | 9.124e-03

7.723e-03 | 1.139e-02 | 1.504e-02 | 1.777e-02 | 1.879e-02 | 1.777e-02 | 1.504e-02 | 1.139e-02 | 7.723e-03

5.850e-03 | 8.631e-03 | 1.139e-02 | 1.346e-02 | 1.423e-02 | 1.346e-02 | 1.139e-02 | 8.631e-03 | 5.850e-03

3.965e-03 | 5.850e-03 | 7.723e-03 | 9.124e-03 | 9.645e-03 | 9.124e-03 | 7.723e-03 | 5.850e-03 | 3.965e-03

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- Gaussian with std = 20

1.206e-02 | 1.217e-02 | 1.224e-02 | 1.229e-02 | 1.230e-02 | 1.229e-02 | 1.224e-02 | 1.217e-02 | 1.206e-02

1.217e-02 | 1.227e-02 | 1.235e-02 | 1.240e-02 | 1.241e-02 | 1.240e-02 | 1.235e-02 | 1.227e-02 | 1.217e-02

1.224e-02 | 1.235e-02 | 1.243e-02 | 1.247e-02 | 1.249e-02 | 1.247e-02 | 1.243e-02 | 1.235e-02 | 1.224e-02

1.229e-02 | 1.240e-02 | 1.247e-02 | 1.252e-02 | 1.254e-02 | 1.252e-02 | 1.247e-02 | 1.240e-02 | 1.229e-02

1.230e-02 | 1.241e-02 | 1.249e-02 | 1.254e-02 | 1.255e-02 | 1.254e-02 | 1.249e-02 | 1.241e-02 | 1.230e-02

1.229e-02 | 1.240e-02 | 1.247e-02 | 1.252e-02 | 1.254e-02 | 1.252e-02 | 1.247e-02 | 1.240e-02 | 1.229e-02

1.224e-02 | 1.235e-02 | 1.243e-02 | 1.247e-02 | 1.249e-02 | 1.247e-02 | 1.243e-02 | 1.235e-02 | 1.224e-02

1.217e-02 | 1.227e-02 | 1.235e-02 | 1.240e-02 | 1.241e-02 | 1.240e-02 | 1.235e-02 | 1.227e-02 | 1.217e-02

1.206e-02 | 1.217e-02 | 1.224e-02 | 1.229e-02 | 1.230e-02 | 1.229e-02 | 1.224e-02 | 1.217e-02 | 1.206e-02

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b) Perform Gaussian filtering on an image

- Filtering with Gaussian filter with std = 1

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- Filtering with Gaussian filter with std = 3

- Filtering with Gaussian filter with std = 20

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2. a) Design a DoG (Difference of Gaussians) filter of size 11x11 and standard deviations of your choice.

4.172e-04 | 8.571e-04 | 1.501e-03 | 2.238e-03 | 2.845e-03 | 3.082e-03 | 2.845e-03 | 2.238e-03 | 1.501e-03 | 8.571e-04 | 4.172e-04
8.571e-04 | 1.761e-03 | 3.082e-03 | 4.592e-03 | 5.817e-03 | 6.285e-03 | 5.817e-03 | 4.592e-03 | 3.082e-03 | 1.761e-03 | 8.571e-04
1.501e-03 | 3.082e-03 | 5.379e-03 | 7.837e-03 | 9.276e-03 | 9.506e-03 | 9.276e-03 | 7.837e-03 | 5.379e-03 | 3.082e-03 | 1.501e-03
2.238e-03 | 4.592e-03 | 7.837e-03 | 9.403e-03 | 3.583e-03 | -2.726e-03 | 3.583e-03 | 9.403e-03 | 7.837e-03 | 4.592e-03 | 2.238e-03
2.845e-03 | 5.817e-03 | 9.276e-03 | 3.583e-03 | -3.296e-02 | -6.532e-02 | -3.296e-02 | 3.583e-03 | 9.276e-03 | 5.817e-03 | 2.845e-03
3.082e-03 | 6.285e-03 | 9.506e-03 | -2.726e-03 | -6.532e-02 | -1.196e-01 | -6.532e-02 | -2.726e-03 | 9.506e-03 | 6.285e-03 | 3.082e-03
2.845e-03 | 5.817e-03 | 9.276e-03 | 3.583e-03 | -3.296e-02 | -6.532e-02 | -3.296e-02 | 3.583e-03 | 9.276e-03 | 5.817e-03 | 2.845e-03
2.238e-03 | 4.592e-03 | 7.837e-03 | 9.403e-03 | 3.583e-03 | -2.726e-03 | 3.583e-03 | 9.403e-03 | 7.837e-03 | 4.592e-03 | 2.238e-03
1.501e-03 | 3.082e-03 | 5.379e-03 | 7.837e-03 | 9.276e-03 | 9.506e-03 | 9.276e-03 | 7.837e-03 | 5.379e-03 | 3.082e-03 | 1.501e-03
8.571e-04 | 1.761e-03 | 3.082e-03 | 4.592e-03 | 5.817e-03 | 6.285e-03 | 5.817e-03 | 4.592e-03 | 3.082e-03 | 1.761e-03 | 8.571e-04
4.172e-04 | 8.571e-04 | 1.501e-03 | 2.238e-03 | 2.845e-03 | 3.082e-03 | 2.845e-03 | 2.238e-03 | 1.501e-03 | 8.571e-04 | 4.172e-04

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b) Perform filtering on an image using DoG filter designed in part 2(a)

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c) Detect zero crossings and generate a binary image highlighting the zero crossings on the DoG filtered image.

Here I used a kernel that looks at 4 neighbors and if the pixel that it is looking at is +ve and if any of the neighbors are -ve than the pixel is turned to value 255, and all the rest of the pixels are set to 0. Below is the result.