Salt-and-Pepper Noise

The purpose of this challenge is to illustrate that spectral filtering methods may not always be successful when the noise in the image is highly non-Gaussian.

We consider *salt-and-pepper noise*, for which a certain amount of the pixels in the image are either black or white (hence the name of the noise). Salt-and-pepper noise can, e.g., be used to model defects in the CCD or in the transmission of the image. Given the probability r (with $0 \leq r \leq 1$) that a pixel is corrupted, we can introduce salt-and-pepper noise in an image by setting a fraction of $r/2$ randomly selected pixels to black, and another fraction of $r/2$ randomly selected pixels to white. Simple de-noising of such images by means of low-pass filters was considered in Challenge 7 in section 3.3.

Consider now the deblurring problem with salt-and-pepper noise. We consider the realistic situation where the blurred image is corrupted *after* it is recorded on the CCD. In this model, we first create a blurred image represented by $\mathbf{b}_{\text{exact}} = \mathbf{A}\,\mathbf{x}$ (cf. section 1.4), and then we introduce salt-and-pepper noise into this image as described above, leading to the noisy image $\mathbf{b}$.

For your favorite grayscale test image, add Gaussian blurring to the image using `psfGauss` with `sigma` = `2`, and then corrupt 0.2 % of the pixels (i.e., $r = 0.002$) with salt-and-pepper noise. Then reconstruct the image using TSVD and/or Tikhonov regularization with threshold `tol` and regularization parameter `alpha` about 0.01.

You should observe severe "ringing effects" in the deblurred image around the corrupted pixels, similar to those shown in the figure below. Can you choose `tol` or `alpha` such that the "ringing effects" vanish?