Original Image

Figure 1: Original Image

Frequency response of filters

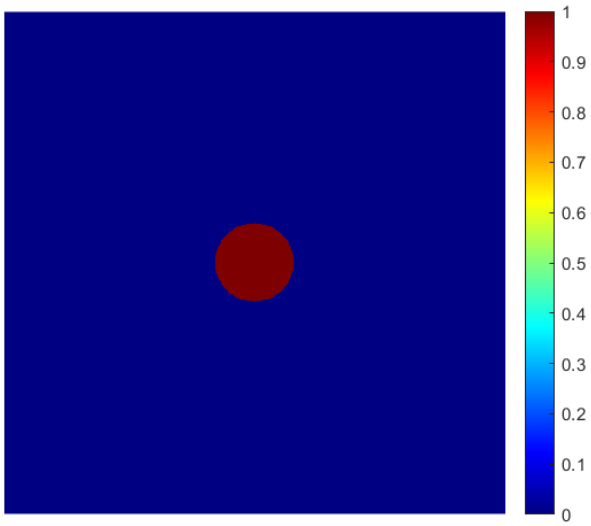

Figure 2: Ideal Filter (r=40)

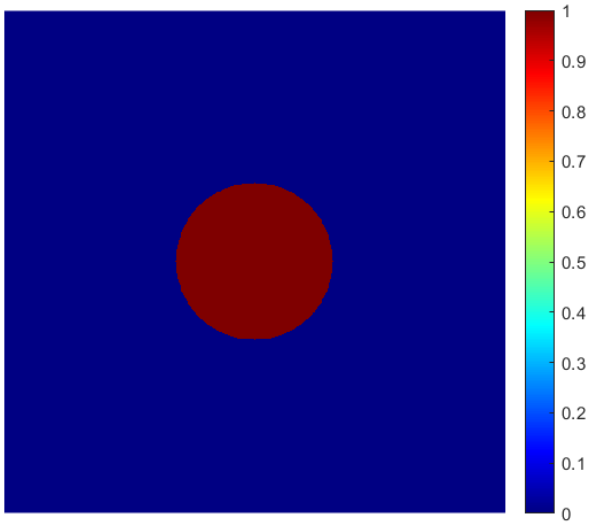

Figure 3: Ideal Filter (r=80)

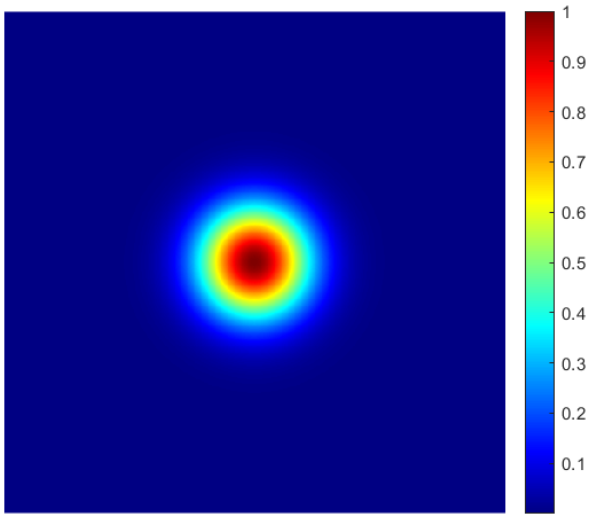

Figure 4: Gaussian Filter ($\sigma = 40$)

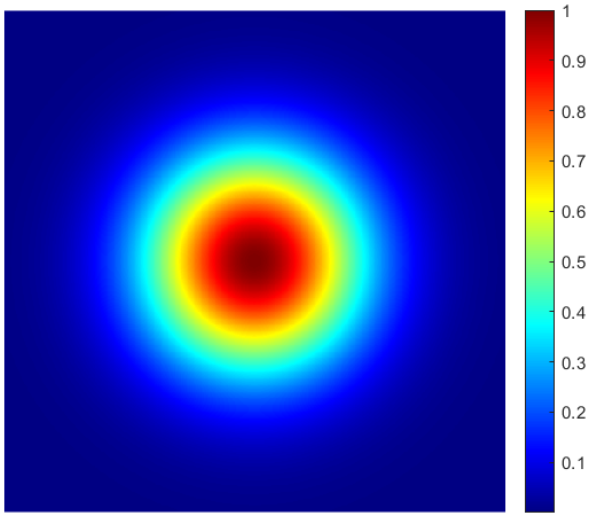

Figure 5: Gaussian Filter ($\sigma = 80$)

Filtered Images

Figure 6: Ideal Filtered Image (r=40)

Figure 7: Ideal Filtered Image (r=80)

Figure 8: Gaussian Filtered Image ($\sigma = 40$)

Figure 9: Gaussian Filtered Image ($\sigma = 80$)

Differences and Observations

- The ideal filter with r=40 blurs the image more than r=80 due to the fact that the upper frequency bound that can pass through the former is tighter and thus restricted low frequency components are allowed to pass. On the other hand, the r=80 filter allows more frequencies to pass through relatively.
- The $\sigma = 40$ gaussian filter blurs more than the $\sigma = 80$ due to the fact that in the spatial domain, the $\sigma = 40$ filter corresponds to a convolution over a larger spatial domain, naturally leading to more blurring.

- There are ripples and local circular effects while blurring with the ideal filter whereas in case of the gaussian filter there is no such effect seen. Thus, it looks like a better idea to use Gaussian filter for low pass filtering as it preserves the image texture and does not add any additional undesired effects.