Image Processing 1 - Exercise 4 - WiSe 2012/13

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1

a

The grayvalues will be extended for 0 to 255. As the original values are equally spaced, so are the egalized values, which are 0, 85, 170, 255.

b

The optical effect is that the contrast becomes higher.

c

The image after histogram egalization will stay the same as the grayvalues are also equally spaced.

d

Please refer to source code in `src/egalize.py` and result images in `data/`.

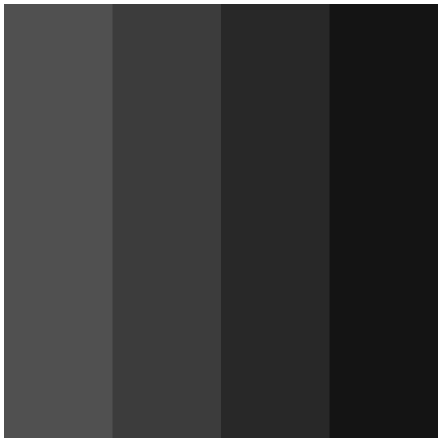
2

$$\begin{aligned}\sigma^2 &= E(g-\bar{g})^2 \\ &= Eg^2 - 2\bar{g}Eg + \bar{g}^2 \\ &= Eg^2 - (Eg)^2 \\ &= \frac{1}{N}\sum g^2 - (\frac{1}{N}\sum g)^2\end{aligned}$$

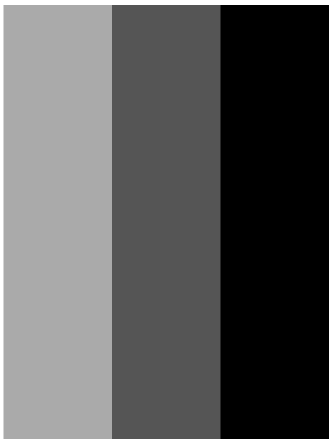
3

$$\begin{aligned}\bar{z} &= \sum w_i \bar{x_i} \\ &= m\sum w_i \\ &= m\end{aligned}$$

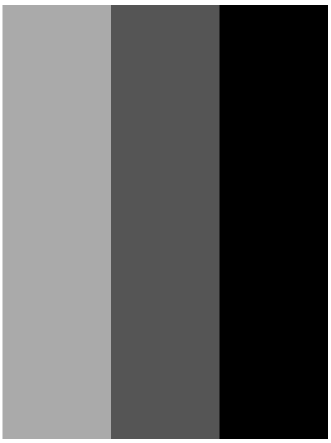
(a) Original Picture 1 (50, 100, 150, 200)



(b) Original Picture 2 (20, 40, 60, 80)



(c) Egalized Picture 1



(d) Egalized Picture 2

Figure 1: Result images of 1.

$$\begin{aligned}\sigma_z^2 &= \sum w_i^2 \sigma_{x_i}^2 \\ &= \sigma^2 \sum w_i^2\end{aligned}$$

The generalized mean inequality states

$$\frac{\sum w_i}{N} \leq \sqrt{\frac{\sum w_i^2}{N}}$$

in which the equality holds if and only if all w_i are equal. Therefore

$$\begin{aligned}\sigma_z^2 &\geq N\sigma^2 (\sum w_i)^2 \\ &= N\sigma^2.\end{aligned}$$

Thus, the optimal set of weight is $w_i = \frac{1}{N}$.

4

Apply median-filter using a 3 by 3 window, which includes the pixel itself and its 8 neighbors. The source code can be found in `src/removenoise.py`.

The images are shown below. Comparing the image after filtering the noise and the original image, the number of different pixels are `3125`.

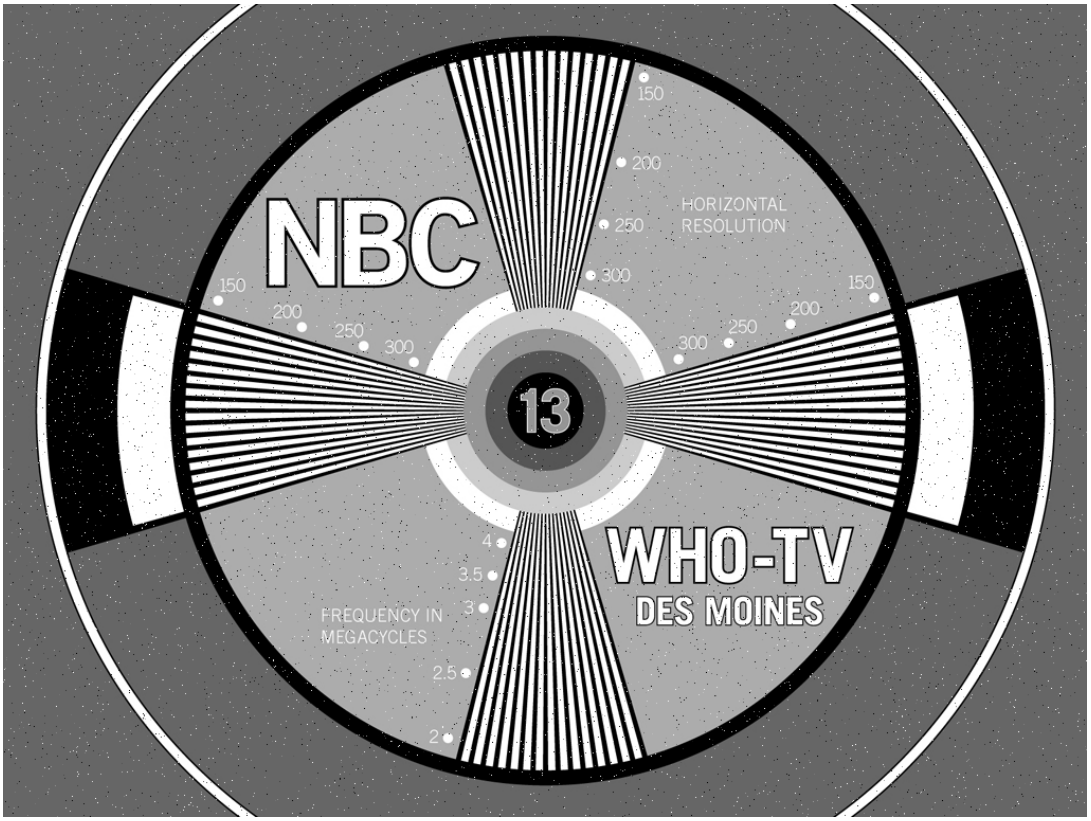


Figure 2: Picture with "salt and pepper" noise.

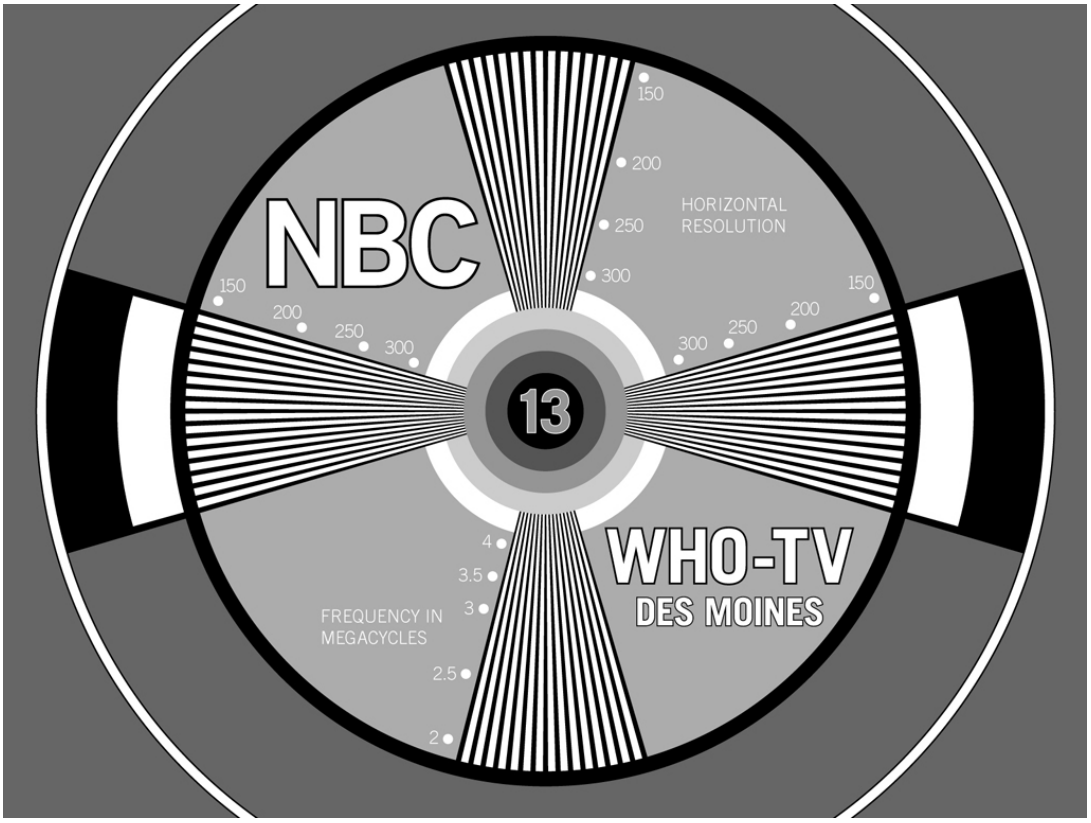


Figure 3: Original picture.

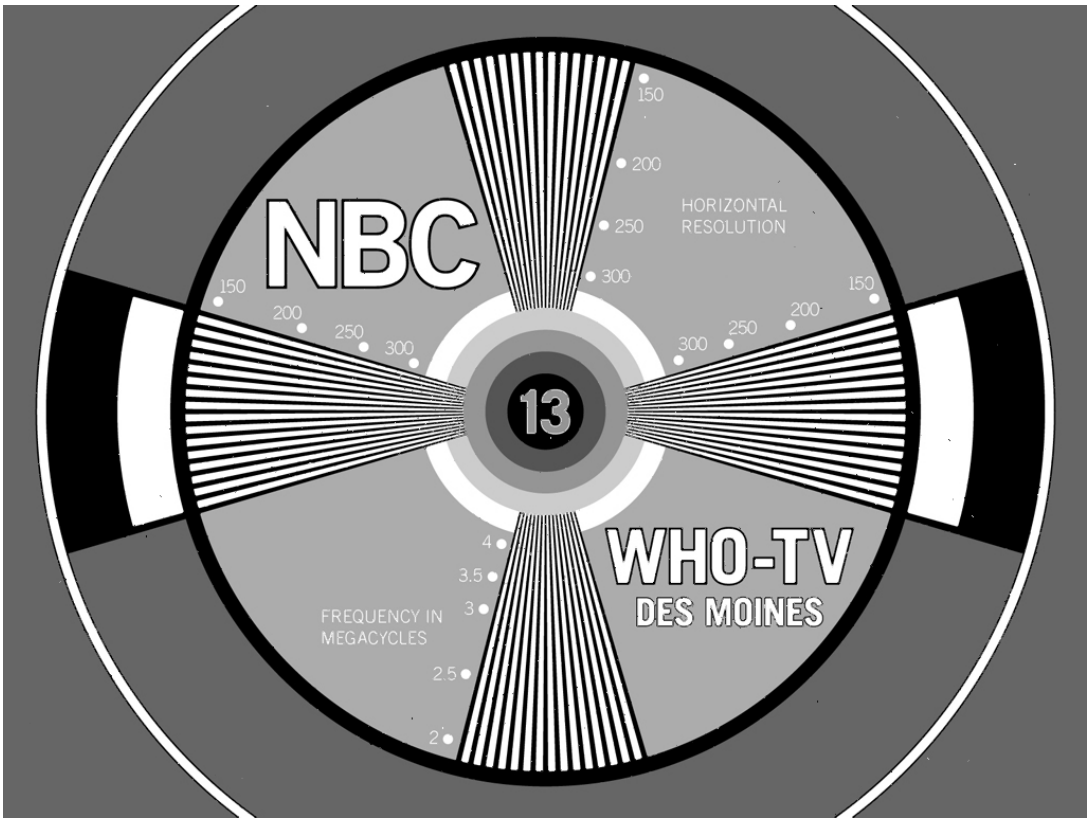


Figure 4: Picture after removing noise.