

HW #4 Solutions

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1. Calculate the minimum sampling frequencies needed for a perfect reconstruction for the above image $I(x,y)$.

Ans: The minimum sampling frequency required is 8 in the x-direction and 10 in the y-direction.

2. Do the results agree with what is stated in the sampling theorem?

Ans: Even sampling frequencies as high as (13, 15) do not seem to give perfect reconstruction though they give much better reconstruction compared to the frequencies under the sampling frequency. Therefore, the observed results do not completely agree with the sampling theorem.

3. In which case do you have aliasing?

Ans: In all the cases $\{(13, 15), (10, 12), (7, 6), (5, 4)\}$ aliasing is observed.

4. What can you notice in the images sampled with a frequency that satisfies the Nyquist constraint (pay attention to the phase...)?

Ans: In the images reconstructed using frequencies satisfying the Nyquist criterion there seems to be an occurrence of phase shift such that the patterns in the reconstructed image seem to be offset compared to the patterns in the original image.

5. The reconstruction formula given by the sampling theorem requires an infinite number of samples, but in our implementation we are forced to use a finite number of samples: how is the reconstruction affected (pay attention to the quality of the reconstructed image near the boundaries...)?

Ans: The effect of not having an infinite number of samples is that there is "blob formation" predominantly at the ends of the white bars at the boundaries of the image along with blurring. Also the reconstructed bars are not straight any more showing the induction of new frequency components.