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10/16/2020

PHYS 331, HW08

1a.) The relevant feature of this plot is the slope. The plot is linear, demonstrating a power relationship between runtime and the scaling values of N. The slope is approximately 2, which is to be expected. Taking the form y = ax^k, the log-log plot becomes log(y) = k*log(x) + log(a), and thus the slope k corresponds to the complexity scaling with N as N^k. The expected scaling of the naïve discrete fourier transform is N^2. This implies we should have a slope of 2, which we do, thus our results are to be expected.

1b.) The relevant feature of this plot is the slope. The plot is linear, demonstrating a power relationship between runtime and the scaling values of N. The slope is approximately 1, which is to be expected. Taking the form y = ax^k, the log-log plot becomes log(y) = k*log(x) + log(a), and thus the slope k corresponds to the complexity scaling with N as N^k. The expected scaling of the fast fourier transform is Nlog(N). As graphically determined, on the order of 10^5, Nlog(N) is approximately N^1.4. On the order of 10^6, Nlog(N) is approximately N^1.3. On the order of 10^7, Nlog(N) is approximately 1.2. These are the orders of magnitude we plotted over, so averaging across these gives an approximation of x^1.3, and hence we expect a slope of ~1.3. This is a very approximate number, so it is reasonable to floor this to 1. Our slope is approximately 1, which matches this floored value, thus our results are to be expected.

2.) Peak 1 is at f = 0.85 Hz with an amplitude of roughly 0.6, Peak 2 is at f = 3.5 Hz with an amplitude of roughly 1.5, and Peak 3 is at f = 19 Hz with an amplitude of roughly 0.6. The engineers should be worried about bridge resonances, as there is a peak at f = 0.85 Hz, which is within the 0.1 Hz to 1 Hz range. This is below the threshold for noise due to traffic, and may be caused by the wind. This could pose great hazard.

3b.) The original image is an array of uint8, or an array of unsigned 8 bit integers, with size (1100,1100). The output image is an array of complex128, or an array of 128 bit complex numbers, with size (1100,1100).

3d.) The low pass version of the image is blurrier than the original image. It seems to form horizontal bands across the image, as if displayed on an old CRT display. The overall facsimile of the image remains unchanged, however.

3e.) For low passed images, a small aperture size of n = 10 produces a highly blurry image, bordering on distorted. The apparent horizontal bands are very thick and fuzzy, with a slight vertical ripple along the middle of the image. As the aperture size increases, the image becomes increasingly clear until it is indistinguishable from the original image. Similarly, the apparent horizontal bands grow thinner and thinner until they disappear entirely. For high passed images, a large aperture of n = 300 produces a very dark image, only allowing a few of the highest frequency signals to pass through, resulting in a dark and fuzzy image seeming to display the glare of the sun on the car. As the aperture size decreases, the image become brighter as more frequencies are allowed to pass through. These new frequencies fill in many of the vacancies of the higher aperture images, creating sharper, more distinct lines. For low pass images, sharpness increases with aperture size, while for high pass images, sharpness decreases with aperture size. For low pass images, this suggests that a high aperture lens allows for higher resolution, as it produces a clearer image as a result of this higher resolution.