



Yıldız Technical University
Computer Engineering
2023-2024 Spring
BLM3620 Digital Signal Processing
Homework 2

Question 1)

- a) Create a Matlab code (in script or function form) that accepts angle of direction, phase value and normalized frequency (attention not normalized angular frequency) value as parameters and then constructs a 2D sinusoidal constant frequency planar wave on a 256 by 256 pixels canvas. Display your results for 3 different angle of direction values, 3 different phase values and 3 different normalized frequency values (total of 27 instances, you may display your results as 3 tables each of 3 rows by 3 columns). Is there a limit on normalized frequency value that does not cause aliasing?
- b) Create a Matlab code (in script or function form) that accepts phase value, normalized frequency value and origin x, y pixel values as parameters and then constructs a 2D sinusoidal constant frequency circular wave on a 256 by 256 pixels canvas. Display your results for 3 different phase values, 3 different normalized frequency values and 3 different origin values (total of 27 instances). Is there a limit on normalized frequency value that does not cause aliasing?
- c) Create a Matlab code (in script or function form) that accepts angle of direction, phase value, minimum frequency and maximum frequency values as parameters and then constructs a 2D sinusoidal linear sweeping frequency planar wave on a 256 by 256 pixels canvas. Display your results for 3 different angle of direction values, 3 different phase values and 3 different min-max normalized frequency values (total of 27 instances).
- d) Create a Matlab code (in script or function form) that phase value, origin x, y pixel values, minimum frequency and maximum frequency values as parameters and then constructs a 2D sinusoidal linear sweeping frequency circular wave on a 256 by 256 pixels canvas. Display your results for 3 different phase values, 3 different origin values and 3 different min-max normalized frequency values (total of 27 instances).

Question 2)

- a) Calculate and graph the frequency response of the following 2D FIR filter by means of magnitude response and phase response

$$\begin{aligned}h(n, m) = & \frac{1}{9} \delta(n, m) + \frac{1}{9} \delta(n, m - 1) + \frac{1}{9} \delta(n, m - 2) \\& + \frac{1}{9} \delta(n - 1, m) + \frac{1}{9} \delta(n - 1, m - 1) + \frac{1}{9} \delta(n - 1, m - 2) \\& + \frac{1}{9} \delta(n - 2, m) + \frac{1}{9} \delta(n - 2, m - 1) + \frac{1}{9} \delta(n - 2, m - 2)\end{aligned}$$

- b) Apply the filter in 2a to image from 1c with minimum normalized frequency =0.01, maximum normalized frequency = 0.3, angle value = 45 degrees and phase = 45 degrees.
- c) Apply the filter in 2a to image from 1d with minimum normalized frequency =0.01, maximum normalized frequency = 0.45, origin at (128,128) and phase =45 degrees.
- d) Comment on the behavior of the filter based on your findings at 2a, 2b and 2c.

Question 3)

- a) Calculate and graph the frequency response of the following 2D FIR filter by means of magnitude response and phase response

$$\begin{aligned}h(n, m) = & \frac{1}{16} \delta(n, m) - \frac{1}{8} \delta(n, m - 1) + \frac{1}{16} \delta(n, m - 2) \\& - \frac{1}{8} \delta(n - 1, m) + \frac{1}{4} \delta(n - 1, m - 1) - \frac{1}{8} \delta(n - 1, m - 2) \\& + \frac{1}{16} \delta(n - 2, m) - \frac{1}{8} \delta(n - 2, m - 1) + \frac{1}{16} \delta(n - 2, m - 2)\end{aligned}$$

- b) Apply the filter in 2a to image from 1c with minimum normalized frequency =0.01, maximum normalized frequency = 0.3, angle value = 45 degrees and phase = 45 degrees.
- c) Apply the filter in 2a to image from 1d with minimum normalized frequency =0.01, maximum normalized frequency = 0.45, origin at (128,128) and phase =45 degrees.
- d) Comment on the behavior of the filter based on your findings at 2a, 2b and 2c.