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.