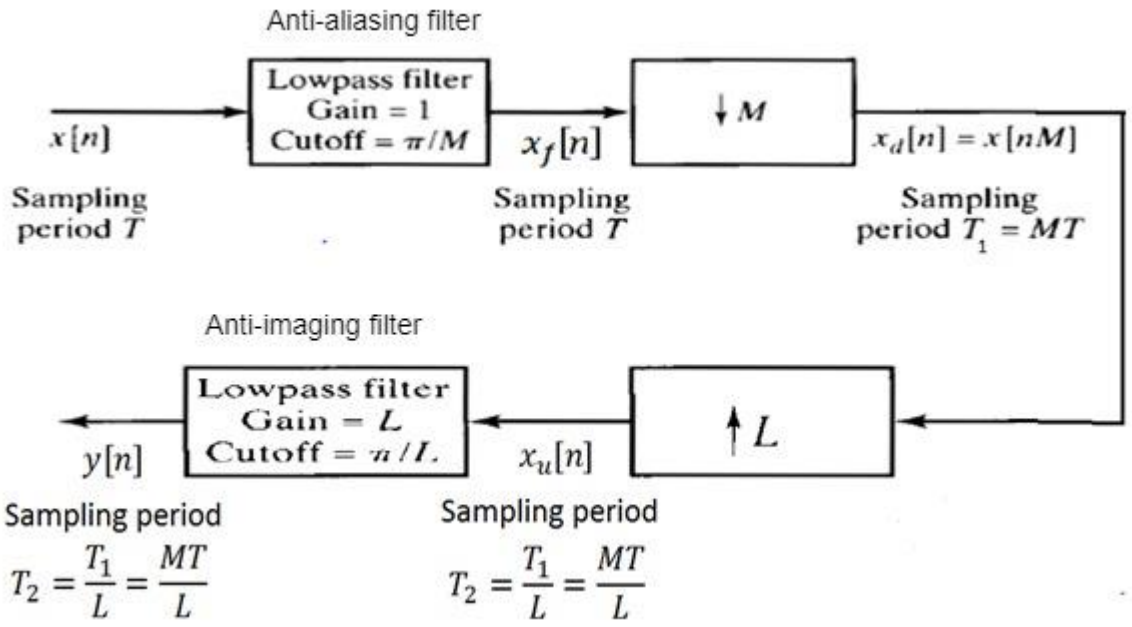
EE2801/EE5802: DSP Lab

Assignment 2

Problem:

Implementation of decimation and interpolation.

Technical details:



Input:

$$x[n] = \sin(2\pi f_0 n/f_s) + 0.5\sin(2\pi f_1 n/f_s) + 0.6\sin(2\pi f_2 n/f_s)$$

where, $f_0 = 100Hz$, $f_1 = 200Hz$, $f_2 = 300Hz$, $f_s = 2400\ Hz$

Generate 96 samples of input, where n= 0 to 95.

Downsampler: $\boldsymbol{x_d[n] = x[Mn]}$

Upsampler:

$$x_u[n] = \begin{cases} x_d[n/L], & \textit{if } n \textit{ is a multiple of } L \\ 0, & \textit{otherwise} \end{cases}$$

1. **Decimation and interpolation by factor 2 (M=L=2):**
   LPF(HBF) specifications
   - $Anti\ aliasing\ Gain = 1, Anti\ imaging\ Gain = L$
   - $Cutoff\ frequency\ (f_c) = 600\ Hz$
   - $Sampling\ frequency\ (f_s) = 2400\ Hz$
   - $Digital\ cutoff\ frequency\ (\omega_c) = \frac{\pi}{2}$
   - $Number\ of\ samples\ (N) = 101$
2. **Decimation and interpolation by factor 4 (M=L=4):**
   LPF specifications
   - $Anti\ aliasing\ Gain = 1, Anti\ imaging\ Gain = L$
   - $Cutoff\ frequency\ (f_c) = 300\ Hz$
   - $Sampling\ frequency\ (f_s) = 2400\ Hz$
   - $Digital\ cutoff\ frequency\ (\omega_c) = \frac{\pi}{4}$
   - $Number\ of\ samples\ (N) = 101$
3. **Decimation and interpolation by factor 8 (M=L=8):**
   LPF specifications
   - $Anti\ aliasing\ Gain = 1, Anti\ imaging\ Gain = L$
   - $Cutoff\ frequency\ (f_c) = 150\ Hz$
   - $Sampling\ frequency\ (f_s) = 2400\ Hz$
   - $Digital\ cutoff\ frequency\ (\omega_c) = \frac{\pi}{8}$
   - $Number\ of\ samples\ (N) = 101$

Instructions:

- Take input x[n] and decimate it first and then interpolate to get y[n].
- Compute the error vector e[n] = y[n]-x[n] and average error.

- Write generalized code for decimation and interpolation by any factor.
- Please take care of practical implementation of decimation and interpolation as present in lecture 3.

Submission Details:

- Write Matlab code to implement above system.
- **Coding format:** Write main code for calling functions like LPF, downsampler, upsampler and make separate functions for these operations.
- Write your understanding about decimation and interpolation in your own words in MS word or Latex.
- Upload the below files in a single zip file with your id, Example: EE21MTECH11010_**A3**.zip.
    1. Matlab code files (.m files)
    2. Plots of input x[n], decimated output $x_d[n]$, interpolated output y[n] and error vector e[n] for all 3 cases.
    3. Find out average error in all 3 cases.
    4. Pdf of your MS word or latex document.

Grading:

- Output - 50%
- coding format - 30%
- writting submission(pdf file) - 20%
- late submission - (-5)%