Campbell, Stephen Ansel

From: Panahi, Issa
Sent: Thursday, November 11, 2021 12:15 PM
To: Panahi, Issa
Cc: Kovalyov, Anton
Subject: FW: Question CLASS PROJECT-EESC6360-Fall 2021

Categories: Purple category

Few comments regarding the class project for those who chose to do it:

- Review the project carefully.
Consider how the transmitted signal was created;
what were the bandwidths of the signals at every stage ?
how were they used for modulations ?
what was sampling rates for the signals at different stages
and how were they made for transmission ?
Then, the reverse process, in appropriate order, at the receiver can
be done to recover the original signals of the male and female sounds.

- Also ask the questions:
what is really needed to be done at the receiver?
Was there any up-sampling, and any post-filtering ?
Is the down-sampling needed, and pre-filtering needed too ?

FYI. Matlab has a routine that can be called to down-sample , or up-sample a signal.
NOTE 1: Down-sampling and up-sampling is the time-scaling of signal in time-domain:

- Down-sampling increases the sampling time interval of the signal by a factor = decreasing the sampling frequency by the inverse of that factor.

Down-sampling CAN cause aliasing in frequency domain, if signal bandwidth IS NOT SMALLER THAN THE HALF OF THE NEW/DECREASED sampling frequency .

Thus, it often requires a **low-pass pre-filtering** to be done first, which is part of the Matlab routine too.

If such low-pass filter is not specified by the user, Matlab uses its own default pre-filter, which should be fine in many cases too.

Down-sampling must be done carefully to avoid aliasing in frequency domain. The pre-filtering is done to avoid any such aliasing.

- Up-sampling decreases the sampling time interval of the signal by a factor = increasing the sampling frequency by the inverse of that factor.

Up-sampling does not cause any aliasing in frequency domain, but creates multiple images of the signal spectrum.

Up sampling also requires a **low-pass post-filtering**, which is part of the Matlab routine too. Post-filtering selects the spectrum of the signal from
its multiple spectrum images.

If such low-pass filter is not specified by the user, Matlab uses its own default filter, which should be fine in many cases too.

NOTE 2: The MATLAB routines are "downsample" and "upsample".
Detailed documentation can be found with examples for any MATLAB routine online,

e.g., https://www.mathworks.com/help/signal/ref/downsample.html. It is possible that an extra MATLAB toolbox/API may need to be installed to use these routines. Note that the downsampling routine specific to this project is rather simple and can be written without the need for additional APIs.

Issa Panahi.