Embedded Software

CS 145/145L

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Announcements (2022-05-26)

● Monday is a holiday!
  ○ No labs!

● We won’t get to have Saehanseul as a guest speaker…

● Please submit the official department evaluations!
  ○ Completely anonymous, give your honest feedback :)  
  ○ Extra credit on Project 5 demo
  ○ Make sure to submit evaluations for the instructor (CS145) and your TAs (CS145L)
  ○ [https://evaluations.eee.uci.edu/](https://evaluations.eee.uci.edu/)
Agenda

- Recap
- Aliasing
- Low Pass Filters
- Complete Input Pipeline
- Digital-to-Analog Converter
- Playback Path
- Examples
Recap
Recap

Problem 1: not using all the range possible.

Solution: increase gain.
Recap

Problem 2: signal is biased to positive or negative range.

Solution: remove DC bias (e.g., add a capacitor)
Recap

Problem 3: missing important information.

Solution: sample faster!

*But might not solve all problems!*
Aliasing

We sample based on the 0~20KHz range
But faster noises will also show up in this range!
Low Pass Filter

Ideal filter: pass *only* frequencies below our maximum.

Real filter: tries to pass *only* frequencies below our maximum.
Filter eliminates these frequencies before we even sample the signal!
Complete Input Pipeline

- Mic.
- Bias Correction
- Low Pass Filter
- Amplifier (Gain = 1000)
- 16-bit ADC (40 KHz)
DSP Pipeline

Mic. → Bias Correction → Low Pass Filter → Amplifier (Gain = 1000) → 16-bit ADC (40 KHz)

?
This is the playback path!
Output Pipeline

- Speaker
- Bias Correction
- Amplifier
- Low Pass Filter
- 16-bit ADC 40 KHz
We do the inverse now:
- The DAC will sample our signal
- Process the input based on its range
- Adjust the range of output
Example DAC


https://rocelec.widen.net/view/pdf/32o8jkrciq/ANDIS07385-1.pdf
Example DAC
When you fast forward or slow down a video you change its playback time.

This changes the pitch of the audio…

So there is a limit up to which this can be done as it results in data loss.

Stream platforms are usually limited by a small factor (0.25x to 2x).
Fourier Transform

Consider A as temp of room in whole day
Consider B temp of space with people coming and leaving
Fourier Transform
Fourier Transform

Three sine waves of different frequencies and amplitudes

The sum of the three sine waves

Frequency Spectrum of the above signal separates the three components
5G Internet

https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=8873669
Optical Fiber Communication

https://www.mdpi.com/2076-3417/9/19/4192
Low-Precision Deep Learning on FPGAs

Genome Classification

Fig. 2 Canada goose (blue, 16,760 bp) vs. European beaver (red, 16,722 bp) - comparison between the DFT phase spectra of their full mtDNA genomes

See you next time :) 

Q & A