Lab 1

- Generate a chirp

![Chirp Waveform](image1)

- Play and record chirp

![Chirp Frequency Response](image2)

- Auto-correlation of a chirp - pulse compression

![Chirp Auto-correlation](image3)

- Auto-correlation of constant freq

![Constant Frequency Auto-correlation](image4)
Lab I part II - Sonar

- Generate a pulse - analytic
- Use real part for pulse train
- Transmit and record

Sent and recorded:

Lab I part II - Sonar

- Extract a pulse

Lab I part II - Sonar

- Matched Filtering

Lab I part II - Sonar

- Display echos vs distance

Matched Filter:

```markdown
\text{samples} \quad t = \text{samp} / \text{fs} \quad d = \text{samp} / \text{fs} \cdot v_s
```
Lab I part II - Sonar

- def sonar(Npulse, f0, f1, fs, Nseg, Nrep, T=20, maxDist=400, vmax=0.2):
  - Play with different parameters: f0-f1 10,000 - 19000 Npulse = 300
    - change range of frequencies, change pulse length

SDR Stuff

- Samples you measure from the SDR are COMPLEX! WHY?
- Aren’t physical signals real??????

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Aren’t physical signals real??????

With the SDR we look at part of the spectrum
Example:
>> rtl_sdr -f 94e6 -s 5e5
samples represent this freq. band
• How is it implemented?

\[ e^{-i2\pi f_0 t} = \cos(2\pi f_0 t) - i \sin(2\pi f_0 t) \]

• How is it physically implemented?

\[ e^{-i2\pi f_0 t} = \cos(2\pi f_0 t) - i \sin(2\pi f_0 t) \]
Lab I part III - SDR

- Get samples around 162MHz
  - Compute DFT 8000

- Compute average DFT of many windows size 800

Lab I part III - SDR

- Compute spectrum of FM radio around 88.3MHz

HD radio
NPR radio

ADS-B

ADS-B enhanced ATC system
1030MHz interrogation
1090MHz reply
ADS-B In
1090MHz ADS-B squitter

ADS-B mode S Packet

Preamble 8.0 us  Data, 56/112 us

rti-sdr measured ADS-B mode S packet
ADS-B

• Acquire 1 seconds

• Extract 1 packet

Detect Preamble

• Energy:
  – Median and MAD to estimate noise
  – Set threshold based on noise

• Using cross correlation

\[ \rho_{xy}(k) = \frac{\sum_{n=0}^{N-1} x(n) y(n+k) - \bar{x} \bar{y}}{\sqrt{\sum_{n=0}^{N-1} x(n)^2 - \bar{x}^2} \sqrt{\sum_{n=0}^{N-1} y(n)^2 - \bar{y}^2}} \]

• Using Logic
  1’s bigger than 0’s