Overview of radars

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Types of Doppler Radar

- Continuous Wave (CW)
  - Simple
  - No range information
- Frequency Modulated CW, (FMCW)
  - Fine range resolution
  - Artifacts from target motion
- Pulse Doppler
  - Range and Doppler
  - No artifacts (except when pulse compression used)

FM Radar: Stationary target case

\[ f_d = 0 \]

\[ R = ct/2 \]

FM Radar: Moving target case

\[ f_d \neq 0 \]

Frequency difference, \( \Delta f \), between transmitter and received echoes is reduced by target's doppler frequency, \( f_d \). To find transit time, \( t_d \) must be added to \( \Delta f \).
How to find $f_d$ in Pulse Doppler Radar

Range Ambiguities

Range Resolution

$\Delta R = \frac{c\tau}{2}$

Unambiguous Range

$R_{\text{max}} = \frac{c}{2PRF} = \frac{cT_s}{2}$

Doppler Ambiguities

Nyquist frequency

$f_{d,\text{max}} = \frac{PRF}{2} = \frac{1}{2T_s}$

Nyquist Interval

(maximum radial velocity that can be measured)

$v_{\text{max}} = \frac{f_d\lambda}{2} = \frac{PRF\lambda}{4}$