Program of Research

The primary focus of this research is to design a new Frequency Modulated Continuous Wave (FMCW) radar system capable of tracking walkers and vehicles up to 2 km and 3 km, respectively. The radar's azimuth field of view (FOV) needs to be greater than 90 degrees. Besides developing new radar electronics, it will require testing different antenna designs at various power levels within the maximum allowed radiated power.

Equipment will include the following:

- Solid state radar panel containing all the radar electronics and antennas.
- Power supply.
- Cables.
- Tripod and mounting hardware.

Theory of Operation

The basic functionality of all types of radar systems is the same. Radar transmits a power signal directed towards a target and wait for it to return. The received signal is then processed to extract information about the target such as velocity, angle of arrival and distance.
The sinusoidal wave represented in Figure1 whose frequency increases linearly with time is a chirp signal in time domain.

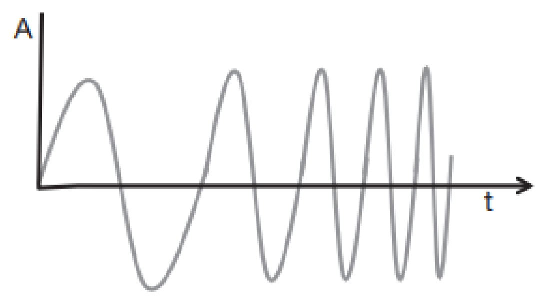

Figure 1: Frequency Modulated (FM) chirp in time domain

To have a better understanding of different features and functionality of chirp in an FMCW radar it is convenient to represent it in frequency - time plot as shown in Figure 2. The TX 1 chirp is characterized by frequency bandwidth (B) and modulation or ramp up time (T_m). The Slope (S) of the chirp defines the rate at which the chirp ramps up.The radar range resolution (d_{res}) is the ability to distinguish between two closely spaced targets. It depends on the chirp's bandwidth, wider the band finer the resolution as expressed below:

$$d_{res} = \frac{c}{2B}$$

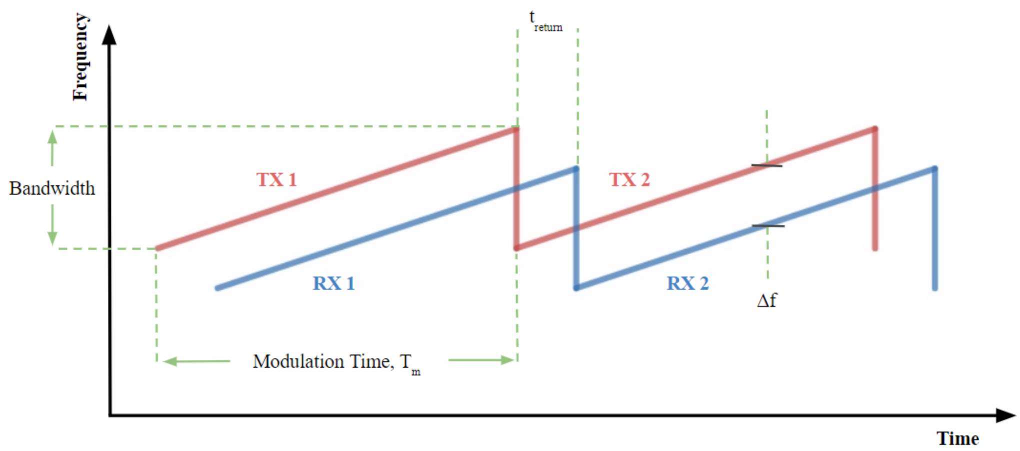

Figure 2: TX and RX chirps on frequency-time plot

Note that the RX 1 chirp is a delayed version of TX 1 chirp, which represents the round-trip time (t_{return}) between the radar and the target.

$$t_{return} = \Delta f \frac{T_m}{B}$$

Where, Δf is the frequency difference between the TX and RX chirps called the beat frequency or intermediate frequency (IF). The higher the beat frequency the greater the return time, which means farther the target is away from the radar as expressed mathematically:

$$d = \frac{c\, t_{return}}{2}$$

Where, d is the target's distance from the radar and a factor of 2 accounts for the round trip time.

In Figure 2, the duration between the first and second TX chirp is the pulse repetition interval (PRI) or sweep repetition period (SRP). Inverse of PRI is pulse repetition frequency (PRF). PRF is defined as the number of chirps transmitted in one second.

The advantage of the FMCW is radar versus pulsed radar is that because the energy is transmitted over a long period of time and accumulates coherently. It is possible to transmit at much lower power levels than pulsed radars, which reduces cost and complexity of the system and reduces overall power consumption.

SpotterRF LLC specializes in compact surveillance radars that provide perimeter security to nuclear facilities, oil refineries, electrical substations, power plants, and other critical infrastructure across the global.
Increased range and coverage will be instrumental in increasing the response time to counter any potential threat to the perimeter under surveillance.