1) General radar system design

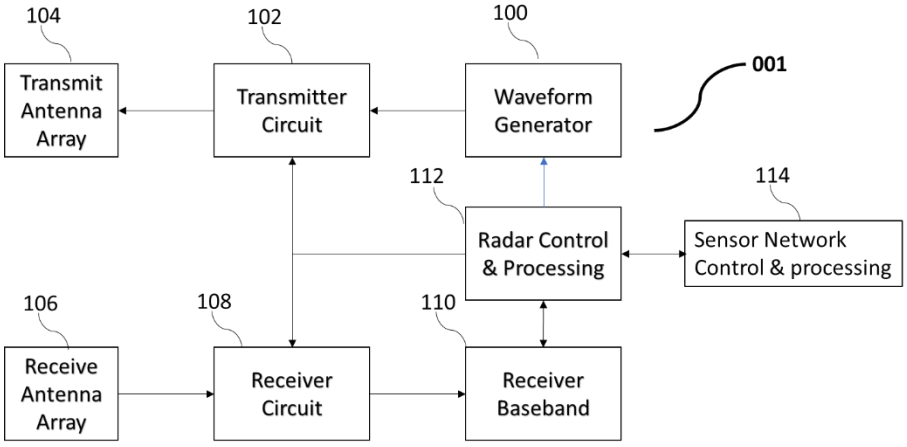
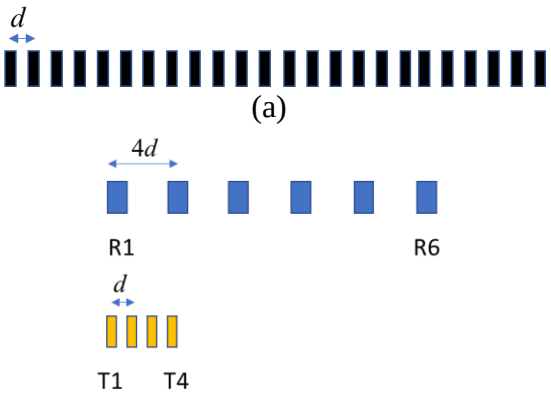


Figure-1: Radar system architecture

2) Dense ULA and its MIMO array configuration with four transmit (Tx) antennas and six receive (Rx) antennas.

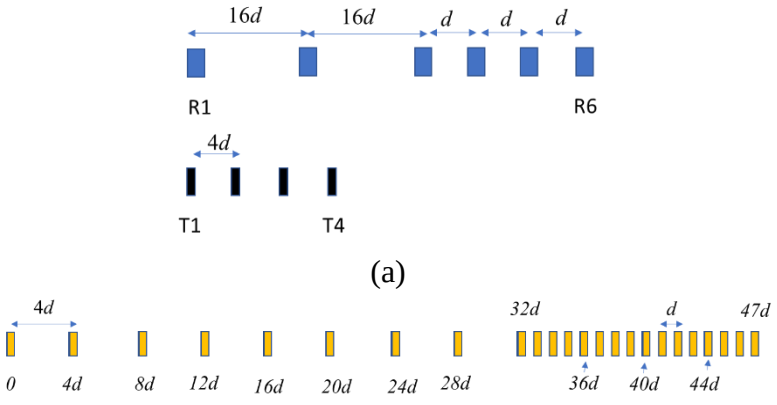


(a)

(b)

Figure-2: (a) ULA of half wavelength spacing with 24 elements, *d* is half wavelength; (b) MIMO radar that achieves equivalent 24-element ULA with four transmitters and six receivers.

3) Hybrid array design with MIMO configuration, four Tx antennas and six Rx antennas



(a)

(b)



(c)

Figure-3 (a) MIMO radar with 4 Tx antennas and 6 Rx antennas; (b) the virtual MIMO array of (a); (c) General configuration of array in (b).

4) 2D MIMO array configuration with hybrid antenna array design

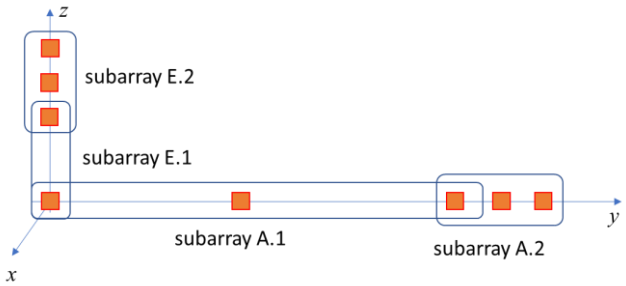


Figure-4: 2D generalization of the design in Figure-3.

5) Signal processing flowchart for radar with the hybrid array

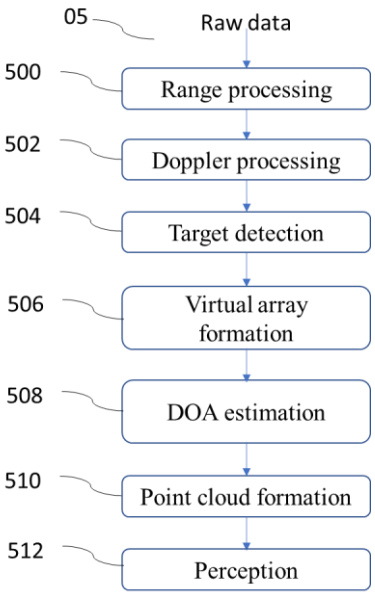


Figure-5 General signal processing flowchart

6) DOA estimation for 1D hybrid array

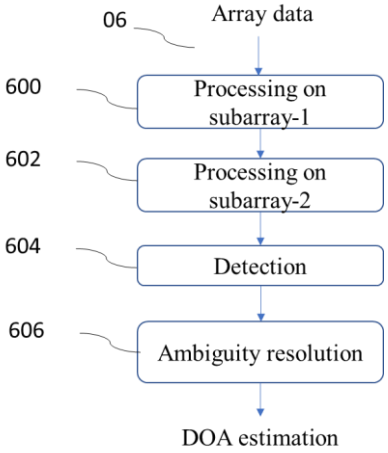


Figure-6: 1D DOA estimation

7) 2D DOA estimation for 2D hybrid array

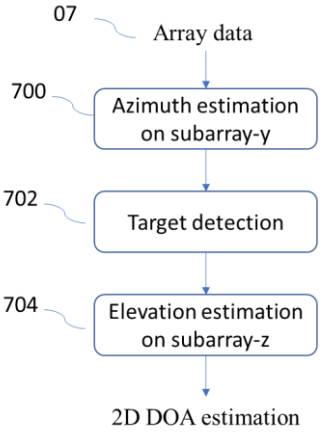


Figure-7: 2D DOA estimation

1) The hybrid array design illustrated in Figures 3,4 can be achieved via different antenna configuration design.
2) In the DOA estimation processing steps, although we illustrate the DOA estimation starting with azimuth, it can start with elevation estimation followed by azimuth estimation.
3) In the 1D DOA estimation, instead of using the two subarrays, the whole array can be used for DOA estimation in many cases with different DOA estimation method like MF.