- *Prof. Eli Brookner*
- **Lecture :**

MIMO RADAR DEMYSTIFIED AND ITS CONVENTIONAL EQUIVALENTS

Abstract: This talk is given in tutorial form. We give physical insight into MIMO and its conventional equivalents. We explain both. No heavy math used. It has been shown in the literature that MIMO radars can provide orders of magnitude better resolution and accuracy than conventional radars. We show how to use conventional radars to do as well. To achieve this advantage the MIMO radar uses a thin linear transmit array and a full linear receive array. The transmit thin array has N elements having a spacing between elements of $N\lambda/2$ where λ is the radar wavelength. The collocated parallel full receive linear array has N elements having a spacing between elements of $\lambda/2$. The combination is called a thin/full array. In the literature it is shown that this thin/full MIMO array is equivalent to a full array of N^2 elements having a spacing of $\lambda/2$ spacing and thus has N times better resolution and accuracy than a conventional full array of N elements and has no grating lobes. Thus the conclusion that a MIMO radar can provide N = 10 times, 100 times or 1000 times better resolution and accuracy than a conventional radar We show how the same MIMO thin/full array can be used as a conventional array to provide the same resolution and accuracy as the MIMO array. The conventional equivalent array also has no grating lobes, and uses exactly the same time and about the same energy for search. So the MIMO and conventional are equivalent performance wise. Whereas the MIMO thin/full array radar has a difficult waveform design issue that may require a noise like waveform for each transmit element for orthogonality the conventional equivalent can use the same simple standard chirp waveform for all elements.

Originally the author used a full/thin array for both. For the full/thin array the rolls are reversed with full array transmitting and thin array receiving. There were grating lobes for the conventional full/thin array system which had to be dealt with. Which is better depends on the details of the situation details.

It has been also shown that a MIMO airborne GMTI radar can provide a better minimum detectable velocity (MDV) than a conventional one. Here again a thin/full array was used for the

MIMO and full array for the conventional. We show how a thin/full array conventional system can be used for the GMTI system to provide the same advantages as the MIMO system relative to coherent dwell time and aperture size and should provide the same MDV.

We show that conventional equivalents to MIMO radar systems can do just as well as the MIMO systems in rejecting barrage-noise jammers, repeater jammers, hot-clutter jammers and main-lobe jammers.

The signal processing load for the MIMO radar system can typically be much larger than for its conventional equivalents. For example if a noise like waveform is required for the MIMO thin/full array then FN^2 matched filters (MFs) are required for the MIMO radar versus N for its conventional equivalent, where F is the number of matched filters needed to process a noise like orthogonal waveform's doppler shifted signal for the MIMO radar. For the conventional radar using a chirp waveform F=1, it typically being doppler tolerant. Thus for N=10 and F=30 we need 300,000 MFs for the MIMO radar versus 100 for the conventional radar, factor of 3,000 more MFs for the MIMO system. This result also holds for a monostatic MIMO full linear array of N elements versus its equivalent full conventional full array of N elements.