QUASI-OPTIMAL DETECTORS FOR UWB SIGNALS

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UWB signal scattered from a target has an intricate shape, as shown

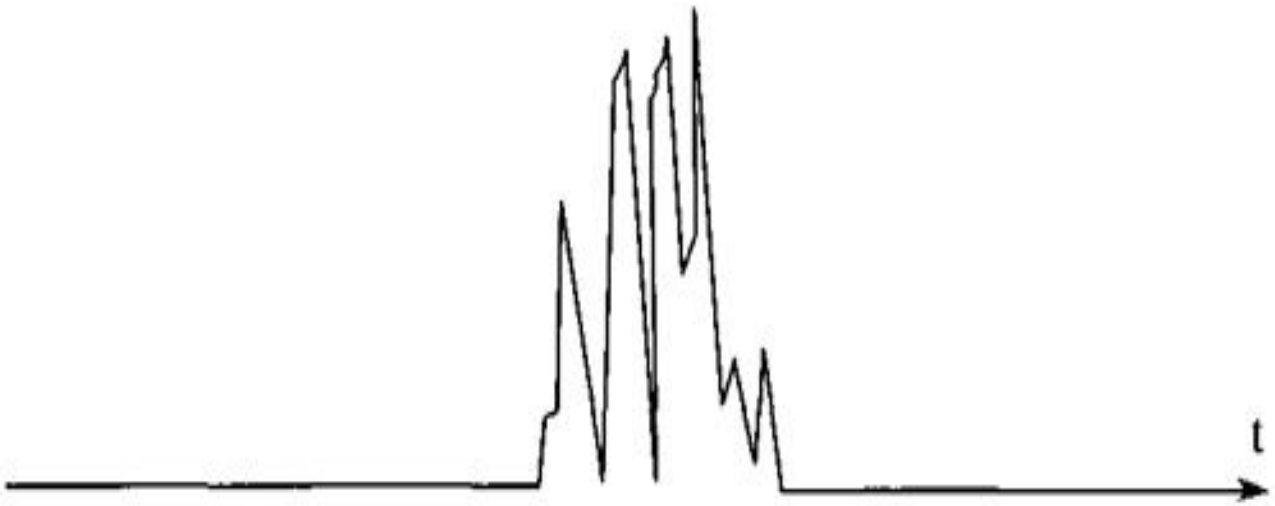


FIGURE 2.7 Power levels from an UWB signal scattered from a target when the range resolution is smaller than the target size. The target return becomes a series of low-energy returns from scattering centers. This concept differs from that of the usual target radar cross section models in which the resolution is considerably larger than the target.

Let us suppose that a target has the length *L* and occupies *N* resolution cells $x_1, x_2 x_N$ in space. The signals scattered by bright points are present in *K* cells, and the other cells are "empty." Processing all combinations from *N* elements on *K* bright points can provide optimal detection of the unknown signal. This algorithm realizes the detection of a fully known signal, as one of these combinations must coincide with a signal scattered from a target. The schematic diagram for such an optimal detector is described in Ref. 8 and shown

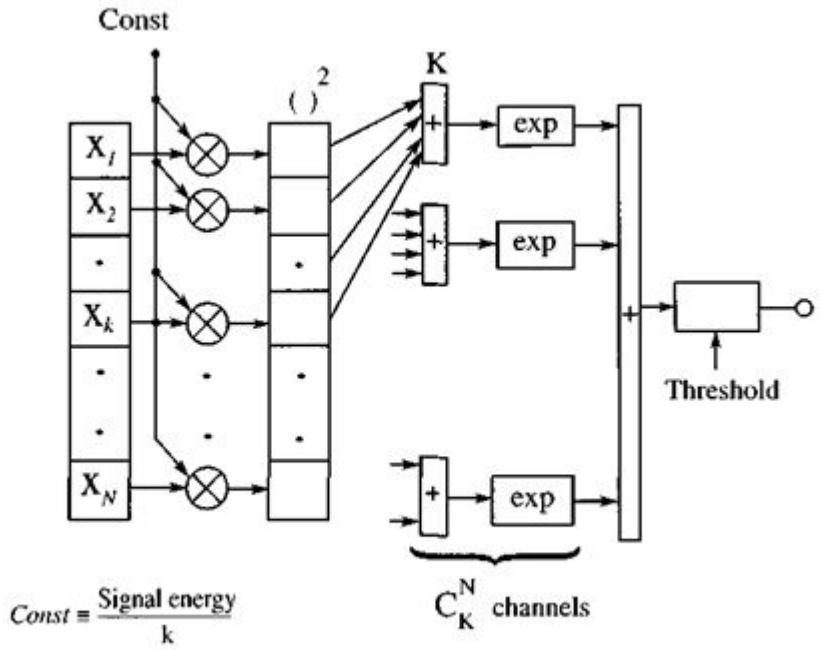


FIGURE 2.8 An optimal detector for a multiple-point scatterer target.[8]

The Table 2.1 shows the energy losses of threshold signal (dB) for three detection algorithms relative to the standard algorithm for detection probability D = 0.5 and false alarm rate $F = 10^{-3}$.

is modified into a quadratic detector with a linear integrator as shown

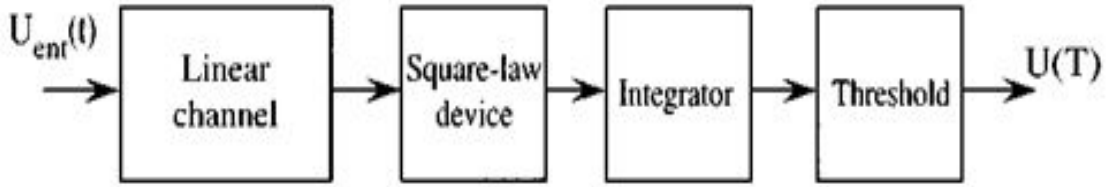
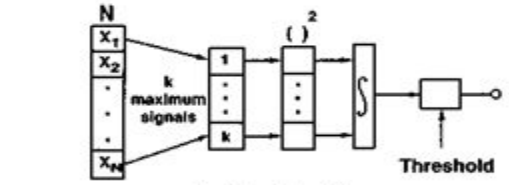


FIGURE 2.9 If a target is present within K cells within the observation interval, the detector of Figure 2.8 is modified into a quadratic detector with a linear integrator.

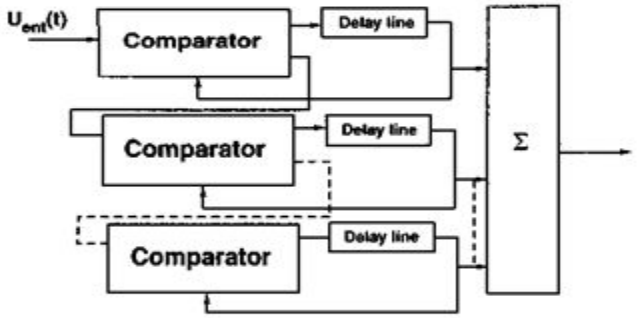
TABLE 2.1
Threshold Energy Signal Losses (dB) for Three Detection Algorithms for D = 0.5 and F = 10^{-3}

Algorithm	Number of "bright points"				
	1	4	8	16	32
Energy algorithm	7.5	8.1	5.2	3.0	2.1
Multichannel rank algorithm	2.7	4.8	3.0	1.6	1.5
"By-point" algorithm	2.5	5.6	4.2	3.8	4.7

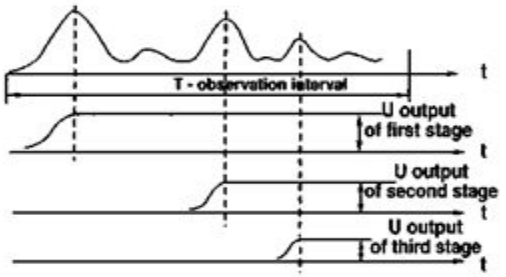
is the block diagram of an example single-channel rank detector. The procedure for selecting signal maximums for a target comprising three bright points is also shown here



a. Functional block diagram



b. Schematic diagram of the signal ranking process



c. Time sequencing of target signal maximum selection process

FIGURE 2.10 A single-channel rank detector.

Conclusion

“Energy detector" and the "by-point" detector can be operated effectively in the opposite situations, when the number of bright points is very small or very large. It would help to develop a two-channel detector that uses these two detectors operating simultaneously.