SURVEILLANCE RADAR WAVEFORM FITTED FOR ANTI-STEALTHNESS AND FOR COUNTER-COUNTERMEASURES: EVALUATION.

N. Gonget[*], *P.Y. Arques*[*#], *L. Martinet*[*]

* DCN - CTSN / LSA / TTS. B.P. 28, 83800 Toulon Naval - France.
Tel: (33) 94162114 Fax: (33) 94162281
ISITV, Université de Toulon et du Var, B.P.32, 83957 La Garde cedex - France.
Tel: (33) 94142000

ABSTRACT

In the present context, the naval surveillance radar have to face important progress of both stealthness of the targets and electronic countermeasure (ECM) techniques. In order to resolve simultaneously the two problems of stealth targets and ECM techniques, we have proposed a new solution [1]. This one can be applied to the naval surveillance radar and its main characteristic is the use of a random waveform. We have presented the reception system and the simulation allowing to prove its validity [2].

In this paper, after a recall on the proposed simulation of the waveform, we discuss the performances of this naval surveillance radar waveform.

1. INTRODUCTION

In the present context, the naval surveillance radar have to face important progress of both stealthness of the targets and electronic countermeasure (ECM) techniques.

We have showed [1, 2] that most of proposed solutions are fitted either for anti-stealthness difficulties or for the robustness against the ECM techniques [3 - 6].

The improvement of radar techniques, such as digital pulse compression or Dirichlet Transform applied to a Doppler treatment on nonuniformly sampled signals [7], allows to propose a new random waveform for resolving conjointly the two present problems [1]. This waveform is a sequence of pulses which appears as a random emission without periodic characteristics. The random character derives from three random processes, the first for the instants of emission, the second for the transmitted frequencies and the last one for the pulse compression codes. The random sets building the waveform provide required ECCM capability and some anti-stealthness capabilities such as no range ambiguities, no fixed blind range, improved radar cross section and higher average power.

The waveform structure and characteristics, the reception structure and a simulation organization have been presented before [1, 2]. We present in this paper results of this simulation whose purpose is to verify the validity of the proposed concept of random waveform.

2. SIMULATION

The simulation is based on an example of a virtual coherent search radar with a maximum range equal to 150 km and a total observation time equal to 12 ms. In this frame, a classical unambiguous range waveform, containing 12 pulses equally spaced with three different frequencies, is used for comparison with the random waveform. This classical comparison radar allows detection with a signal to noise ratio close 13 dB.

The random waveform used in the simulation contains, in a 12 ms observation, seven different pulse compression codes, about seven different frequencies and a global average pulses number of about 60. We can remark that a random waveform characteristic is the possibility of a greater pulses density comparing to a classical unambiguous range waveform; this fact is generated by the random waveform capacity of ambiguities cancelling.

The successive pulses of the random waveform generally have not the same frequency. We call ‘pseudo burst’ a set of pulses having the same frequency in the 12 ms observation.

Three different integration processings of the random waveform are tried [2]:
- the ‘post integration’ (or incoherent integration);

- the ‘one burst integration’ (or coherent processing on the frequency with the greatest number of pulses);
- the ‘best burst integration’ (or combination of coherent processing and incoherent integration).

3. RESULTS

- The figures 1 to 6 present the input and the output of the three different integration processings. The gains of these treatments are:
  - ‘post integration’: 8.89 dB
  - ‘one burst integration’ with 14 pulses: 10.76 dB
  - ‘best burst integration’ with two bursts: 12.69 dB.

We can remark that these simulation values are equal or slightly lower than the theoretic ones:
- ‘post integration’: 8.89 dB
- ‘one burst integration’ with 14 pulses: 11.46 dB
- ‘best burst integration’ with two bursts: 14.06 dB.

The classical comparison radar has a corresponding gain of 8.4 dB.

With these values the random waveform can detect targets with some ‘dB’ lower than those of the classical comparison radar:
- ‘post integration’: about 0.5 dB
- ‘one burst integration’: about 2.4 dB
- ‘best burst integration’: about 4.3 dB.

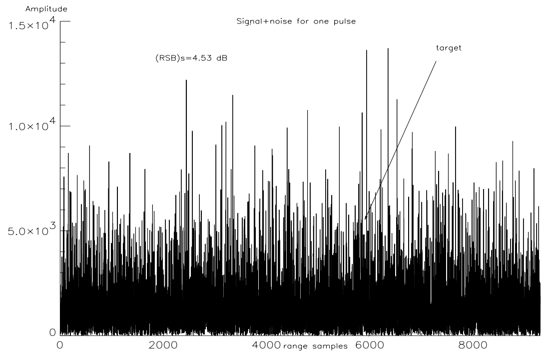

fig. 1: Input signal of the post integration treatment.

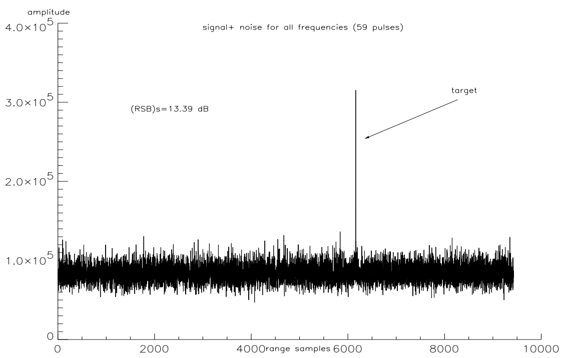

fig. 2: Output signal of the post integration treatment.

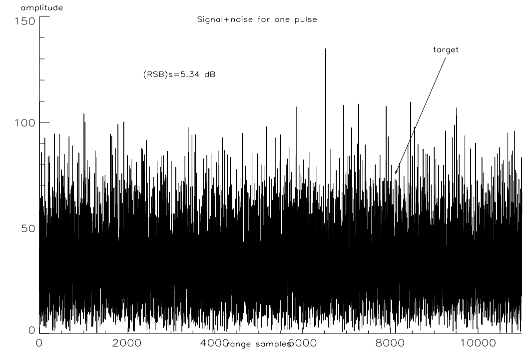

fig. 3: Input signal of the one burst integration.

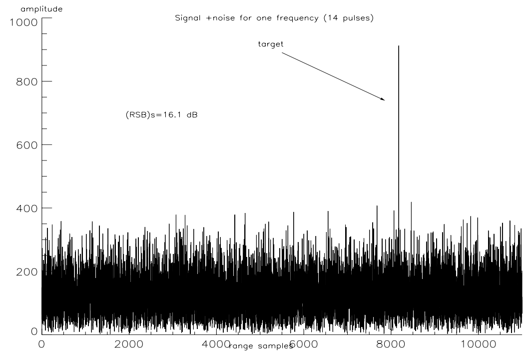

fig. 4: Output signal of the one burst integration.

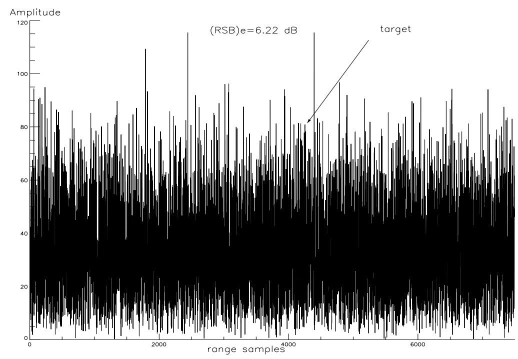

fig. 5: input signal of the Best burst integration.

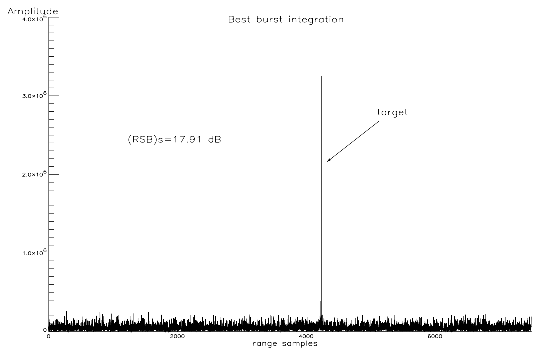

fig. 6: Output signal of the Best burst integration (2 bursts).

• The figure 7 presents the detection probability versus false alarm probability of the three different integration processings and of the classical comparison radar.

We keep the order of the previous results: the performances of ‘post integration’ and ‘classical’ are about the same, but are lower than those of ‘one burst’ and especially ‘best burst’.

Some values of the couple ‘false alarm probability and detection probability’ are:
- ’post integration’: (10^{-6}, 0.54),
- ‘one burst’ integration’: (10^{-6} , 0.71),
- ‘best bursts’ integration’: (10^{-6}, 0.80).

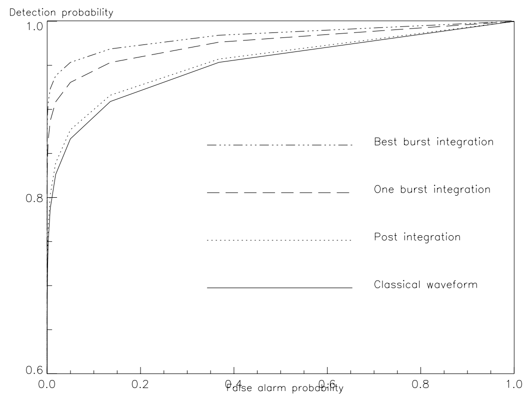

fig. 7: Detection probability versus false alarm probability at the integration processing: comparison with the classic unambiguous range waveform.

4. CONCLUSION

It is difficult for the naval surveillance radar to face the important improvements of both stealthness of the target and ECM techniques. Also, in order to improve radar systems, we have proposed a new solution [1] characterised by the use of random waveform. The results of the simulation show the validity of the proposed concept in both anti-stealthness and counter countermeasures.

5. REFERENCES

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