UDT 2019 – Confusion/dilution countermeasure

Abstract — In the field of the soft kill anti-torpedo defence, several types of countermeasure exist. In this paper, two types of countermeasure system will be presented and compared. Firstly, the combination of a jammer to hide the ship and a decoy to seduce the torpedo allowing the ship to escape. Secondly, a confusion/dilution countermeasure. It acts as a jammer and generates several credible false targets spread in space. False targets are permanently and randomly renewed. One will see what is the effect of both solutions on torpedo sonar guidance system.
.

1 Purpose / Objectives

This presentation aims to compare stationary jammers and mobile target emulators with confusion and dilution counter measure. The global effect on torpedoes acoustic head will be presented for both solutions.

2 Introduction

The sonar guidance systems of torpedoes are homing-in on the sounds that targets are making, with propellers for example, and echoes due to active pulses reflexion on target surface. To deceive the torpedo sensor, a possibility is to use the addition of a stationary jammer to mask the target noise and echoes plus a mobile target, which retransmit the received signals as false echoes on target. Another, choice is to use confusion and dilution counter measure. This system emits a signal that mask the target noise and echoes and simulated echoes of several possible targets spread in space.

3 Approach

To homing-in, the sonar guidance system needs first to determine the range and the bearing of the target. To establish range the sonar computes time difference between sonar pulse and echo reflected by the target (Δt), multiplies it by the celerity of sound in sea water (c) and divides this product by two as shown in figure 1.

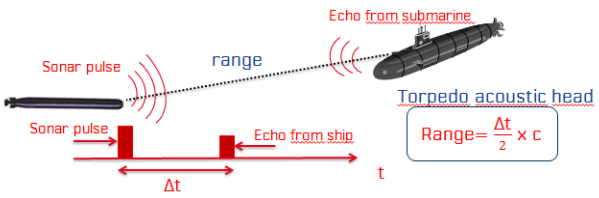

Fig. 1. Sonar range computation

To establish bearing of the target the sonar has to make a beamforming or spatial filtering. Nowadays, this is done digitally by combining elements of an antenna array. Several beams can be created covering different angle around the antenna as shown in figure 2. One can notice on the top image, when doing spatial filtering, a main lobe is created in the wanted direction. However, side attenuates lobes are also created in other directions.

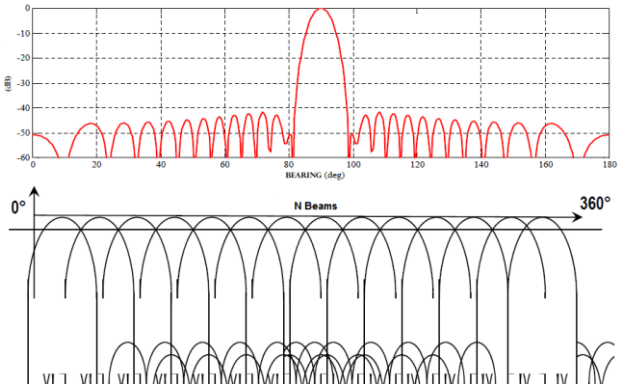

Fig. 2. Sonar beamforming example

3.1. Range ambiguity

In this paragraph, one will show what a torpedo will perceive in presence of both countermeasure concepts. If a mobile countermeasure is launched by the ship and repeats the ping received from the torpedo, the weapon will detect two potential targets at two different ranges as shown in figure 3. Indeed, the mobile target will create the ”green” echo and the submarine, the red echo. If the mobile is combined with a jammer situated in the same direction of the submarine, this could also hide the echo of the submarine (red echo will not be seen).

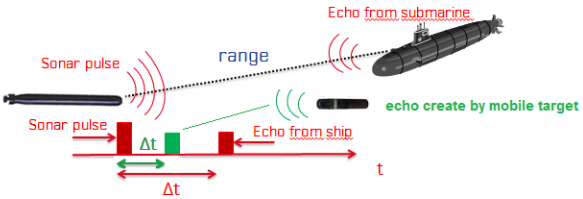

Fig. 3. Sonar range computation in presence of mobile countermeasure

If a confusion/dilution countermeasure is launched by the submarine and emits its signal, the weapon will detect several potential targets at several different ranges as illustrated in figure 4. One can see in this example that four echoes are detected. Three due to the countermeasure and one from the target. In this condition,

the weapon will see four potential targets and thus four different ranges. The system creates more range ambiguity.

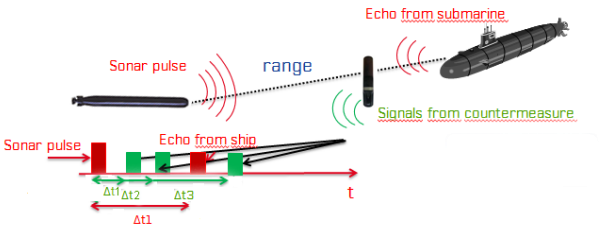

Fig. 4. Sonar range computation in presence of confusion/dilution countermeasure

3.2. Bearing ambiguity

Facing first concept of countermeasure, with a jammer in the same beam than the submarine, the torpedo using active ping will only see the mobile countermeasure in one beam and perhaps sometimes the real target hidden by the jammer (due to a non-continuous signal). Otherwise, if not in the same beam because of the submarine's escape, the weapon can discriminate two targets using beamforming.

Confronting a confusion dilution torpedo, the potential targets spread in ranges will also be spread in bearing due to side lobes created during beamforming computation as shown in figure 2. When making spatial filtering, the sonar creates what is called a sonar view on figure 5. It gives information of energy distribution in circular and elevation. On the example of figure 5, one can observe that even if the countermeasure is situated in one main beam at zero degree, energy can be seen on the other direction with, in this example, fifteen dB less. The same reflexion is true for other directions. Thus, with its high acoustic sound level confusion/dilution countermeasure can also create bearing ambiguity in several directions.

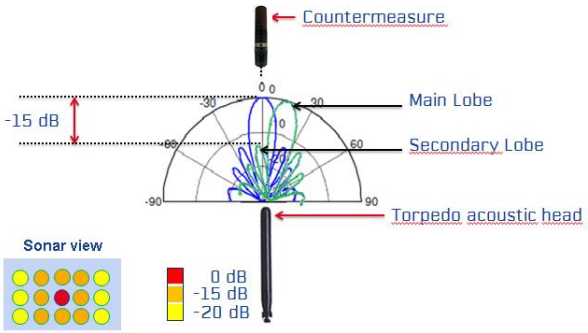

Fig. 5. Bearing ambiguity due to side lobe

4 Results and Discussion

Both solutions create target ambiguity for the torpedo. The first creates two potential targets and potentially hides the real one using a jammer. The second creates several targets spread in space and makes the attack's choice confusing for the torpedo. The use of dilution, by emitting high broadband noise level, hides the real target.

5 Future work

New generation of torpedoes are becoming more powerful in term of spatial filtering, acoustic sensitivity and tracking possibilities. Both domains try continuously to counter the other. In order to become more efficient and have a flexible solution, torpedo defence industry starts to work on acoustic communications links to connect separate countermeasures devices. This system presented in [1] will permit to change tactics in response to changing tactical or environmental conditions. Counter-measures will work together against torpedo using communication. It will include the ability to classify the torpedo and its sensors will operate in full duplex. The use of new technology of transducer called single crystal is also considered. This will permit a better acoustic output efficiency keeping the same countermeasure volume.

[1]https://www.militaryaerospace.com/articles/2018/09/acoustic-countermeasure-for-submarine-torpedo-defense.html

6 Conclusions

Confusion/dilution countermeasure is one of the solution proposed by the industry to counter old and actual modern torpedoes. As technology evolved quickly, torpedoes are also evolving. Countermeasure industry has to adapt its counter philosophy to face torpedoes evolution using countermeasure network [1] for example.

7 Author/Speaker Biographies

Sebastien COLSON, Underwater Weapons Systems Acoustic Engineer, Naval Group – BU Armes Sous Marines – Saint-Tropez - France

S. COLSON graduated as an Electronic Engineer in 2006 in the Engineer school ISEN (Toulon – France) with additional "Signal Processing" diploma in Toulon University (Toulon –France) in 2006 as a speciality.
He started his career working for TNO Defence in the Hague working in the R&D acoustic department. He then came back in the south of France, still working in acoustic domain and integrate Naval Group in 2012 working as acoustic engineer for underwater weapon system as Heavy Weight Torpedo, Countermeasure and torpedo target.