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SHORT COMMUNICATION

Design-By-Simulation: Antitorpedo Decoy

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ABSTRACT

Decoys and countermeasures in conjunction with the target are modelled as generic two-target problem. Design-by-simulation method is reported. Two-target problem relevant to a torpedo-submarine encounter is analysed using Monte' Carlo simulation. This illustrates the utility of the method in generating and verifying tactics of deployment of decoys to convert a threat into Buridon's donkey (who could not decide which stack of hay to choose). Extension to planning of countermeasures for missiles is indicated.

1. INTRODUCTION

The objective of countermeasures is two-fold: To camouflage and thereby conceal the target and to decoy thereby annul the threat. The art and science of camouflage lie in hiding a needle in needle stack. It mimics nature. Recourse is made to reduce and alter the signature (optical, infrared, radar cross-section, etc.) to merge the target with the background. The art and science of decoys lie in placing more attractive object by the side of the target. The weapon (enemy weapon, intelligence or surveillance) is made to believe that the decoy indeed is the genuine target. The weapon is diverted, or at least confused to choose between the target and the decoy, thus gaining precious time. Decoys thereby cause dilution, distraction, seduction and capture.

2. SCENARIO

Consider a torpedo-submarine encounter. The submarine propeller radiates noise. The homing head of torpedo has a passive sonar receiver. It senses whether the noise source is on its port or starboard, and turns towards it while moving forward under its own propulsion. With good guidance and speed advantage, it should collide with the submarine. Let T denotes the target and D a decoy, both radiating noise of similar power spectral density. Let D radiates signal of $+K$ dB over the target. Let L be a point away from the two, where the acoustic pressure of the target and the decoy are equal. Let the loci be called equi-bar (for want of a better term). On increasing K, the loci shrink around the target as shown in Fig. 1. The volume around the target T and decoy D is separated into two zones of influence, isolated by the equi-bar. Should the torpedo be located inside an equi-bar, the torpedo would receive signal from the target which is larger than the signal received from the decoy, and would home on to the target ignoring the decoy. Should the torpedo be outside the equi-bar within the zone of influence of the decoy, it would home on to the decoy, ignoring the target. In real life, the zones will not be so sharply defined. Incorporating the detection criteria of the

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receiver, where a decision is taken when the signal due to one target is in excess of the other, say 3 dB, one can find that the zones of influence are separated by a transit zone. In this zone, the torpedo transits as though neither target was present.

2.1 Monte'Carlo Simulation

The probability that a torpedo is decoyed as a function of the distance separating the two targets and the difference in the target strength is obtained through Monte' Carlo simulation. The procedure is similar to the classical method of evaluating π. The beam pattern of the receiver, and detection and decision criterion of a typical torpedo (3 dB excess signal to generate a control signal to steer towards the source of larger signal) are taken into account.

Typical simulation runs are shown in Figs 2,3 and 4. Figure 2 demonstrates the three zones of influence, while Figs 3 and 4 show the seduction and capture of the weapon by the decoys, respectively. Figure 5 illustrates the summary of the results of a large number of simulations. The following conclusions can be drawn from Fig. 5:

(a) For a given separation between the target *T* and the decoy *D*, as *K* increases, there is an increased assurance that the weapon is decoyed (i.e., increasing probability of first attack on the decoy and ignoring the true target). Beyond some value of K, one can be certain of capture.

(b) The *K-s* plane is divided into zones of assurance and safety (certainty of deception).

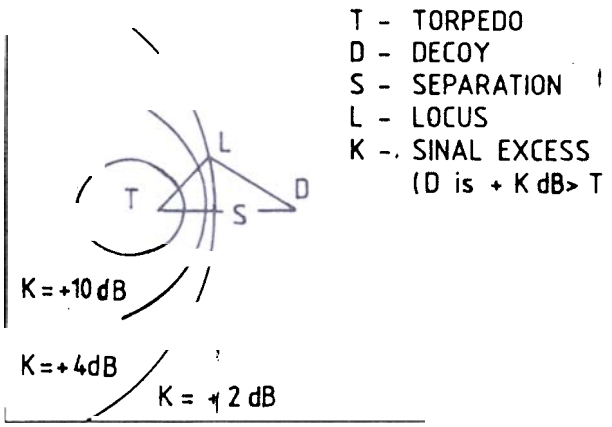

Figure 1. Equi-bars

Let the decoy possess a feature 9 dB in excess of the target. It is seen in Fig. 5 that a separation of 250 m assures that the weapon attacks the decoy first. At this separation, to be certain that the torpedo chases only the decoy and never attacks the target, the decoy should possess excess features strength of at least 27 dB.

2.2 Escape Manoeuvres

On perception of threat, if more than one decoy can somehow be positioned around the submarine/ship as shown in Fig. 6, then the submarine/ship can steal out of harms way, while the torpedo expends itself chasing decoys. Other tactical manoeuvres can be conceived and evaluated. Escape manoeuvres and tactics of deployment can be arrived at, knowing the dynamics of weapon. Reported results of simulation are generic and illustrate design-by-simulation. Missiles do not execute lost contact searches, unlike torpedoes. Decoying missiles is thus relatively simple. But this advantage is offset by the short time available between detection and deployment. Further, in a formation, coordinated action is necessary, as is evident from the experience in Falklands war.

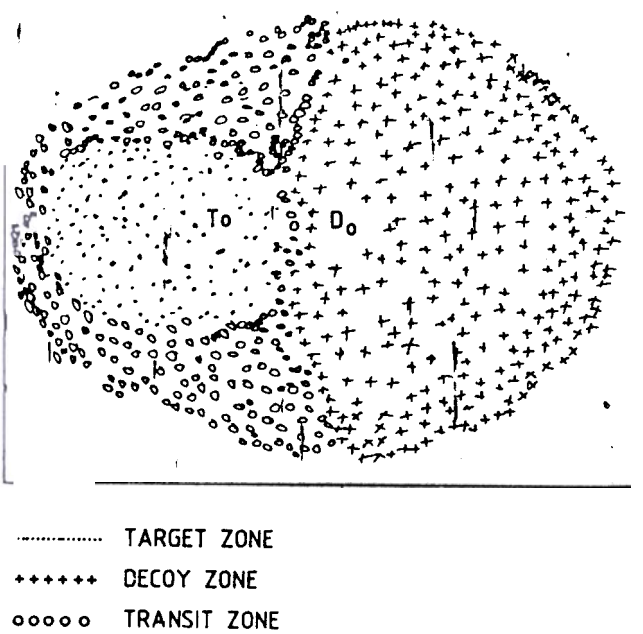

Figure 2. Zones of influenc

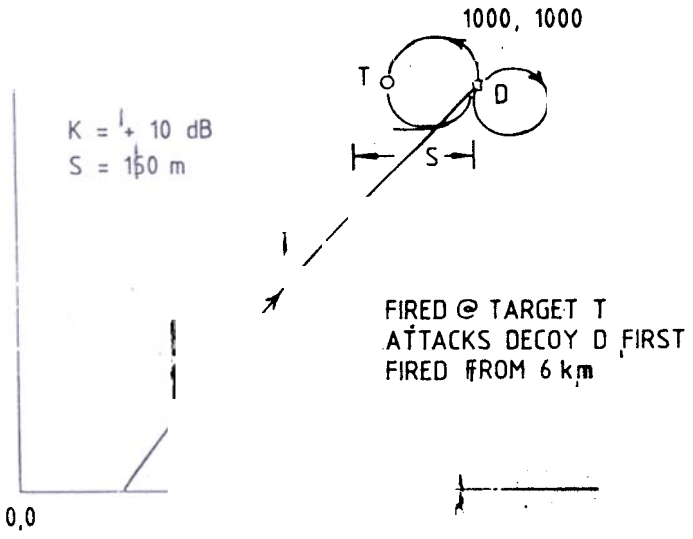

Figure 3. Trajectory of torpedo

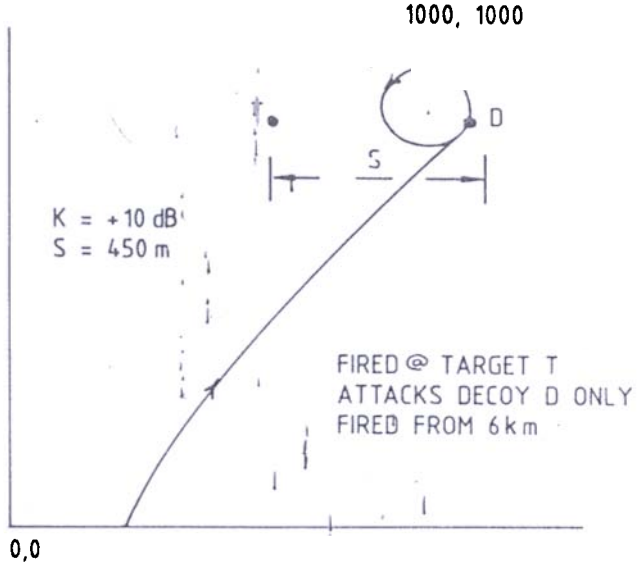

Figure 4. Trajectory of torpedo

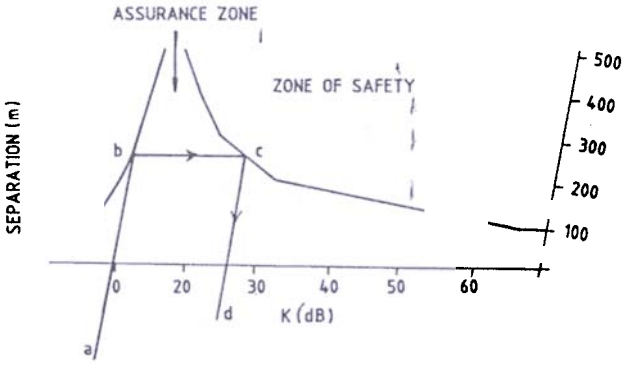

Figure 5. Deployment strategy

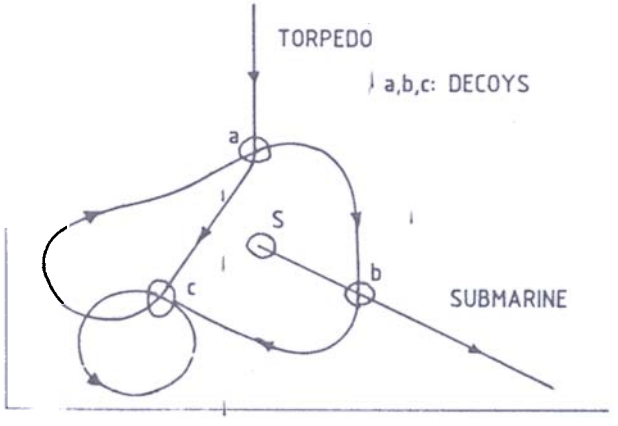

Figure 6. Deployment tactics

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