A Method of Radar Protection from ARM with Active Decoys

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Abstract

This paper describes the technology on how to protect the radar from ARM attack with active decoys. When active decoys are set near the radar system and they generate similar signals as the radar, ARM attack the decoys instead of radar. The distance from radar to decoy is important for radar protection.

Keywords : Radar Decoy Protection ARM Target Antenna

1. Introduction

Radar is a very useful system to detect and identify targets day and night. ARM(anti radiation missile) is used to attack radar systems and disable its function. This paper describes the technology on how to protect the radar from ARM with active decoys. Active decoys are set near the radar system and they generate similar signals as the radar in radio frequency (RF), pulse width (PW), and pulse repeat interval (PRI). ARM remembers RF, PW, PRI of the radar. When ARM finds the same signal such as the radar, ARM traces the position of the signal and attacks the area. If radar decoys are activated near the radar and the radar is not working, ARM will attack the decoy instead of the radar in Figure 1.

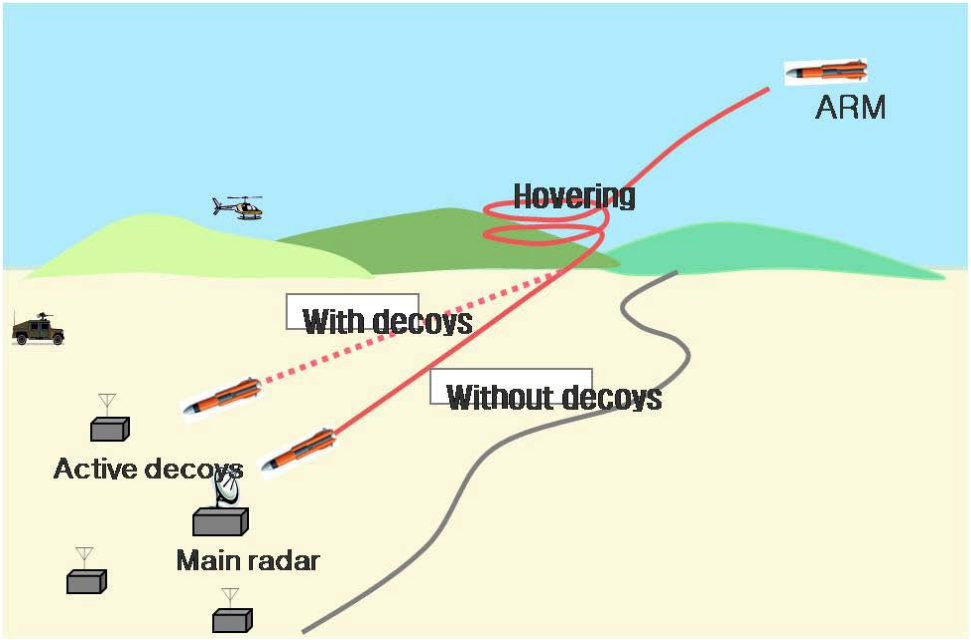

Figure 1: Radar protection from ARM attack with Decoys

2. Active decoy works with radar

An active decoy is set near the radar system and it radiates a similar signal as the radar's in RF, PW, and PRI, and leads the ARM to track the decoy instead of the radar. It has omni-directional antenna and transmits the same amplitude signal in all directions. If we use mono-static radar without ARM detector which is a kind of a radar using low radio frequency, active decoy works with the radar and the ARM detect the decoy signal with the radar's.

We simulate the power density of the radar signal and the decoy signal at ARM RF front-end according to the radar radio frequency and distance(D1) in Figure 2. Radar radiates the signal with high directional antenna but decoy radiates the signal with omni-directional antenna. In particular, the sum of radar's main-lobe signal and decoy signal is calculated, and the sum of radar's side-lobe signal and decoy signal also.

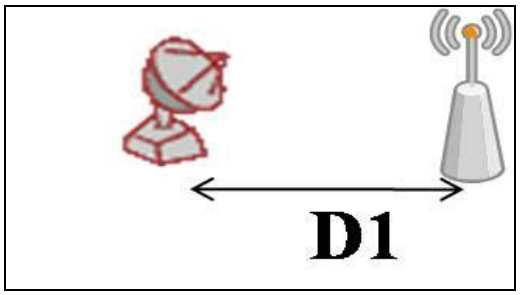

Figure 2: Active decoy is set on with radar.

Figure 3 displays the effect of decoy signal when ARM track the radar's main-lobe and the simulation radar frequency is 1.0 GHz, the decoy's distance from radar is 110 m, the phase difference between radar signal and decoy signal is 90 degrees.

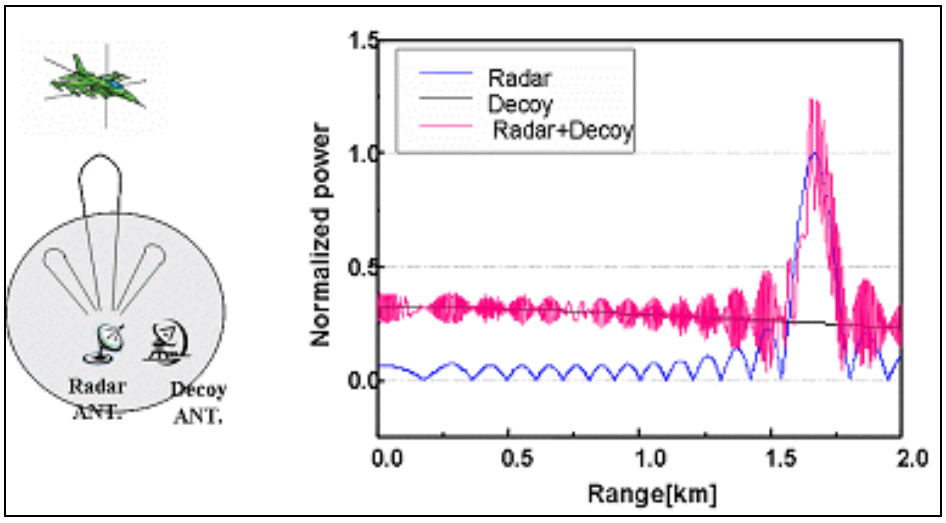

Figure 3: Decoy signal and radar's main-lobe signal at RF front end of ARM.

3. Active decoys work without radar signal

The probability to defend ARM attack is high in case of using ARM detector or bi-static radar. If we use active decoy together in this case, defense probability is increased. If we use more than 3 active decoys as in Figure 4 or Figure 5, the active decoys can be also protected from ARM attack. If we put the distance between active decoys D in Figure 5, D is related to the ARM's direction seeking accuracy.

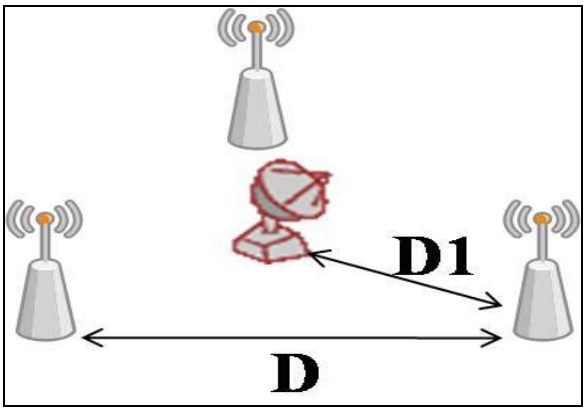

Figure 4: Three active decoys are set on with radar.

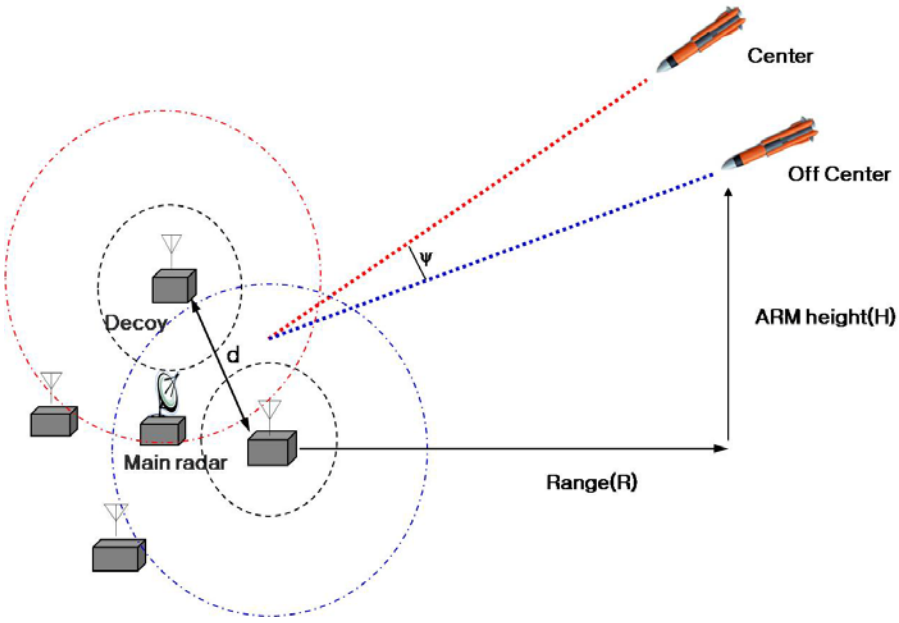

Figure 5: Four active decoys are set on with radar.

Most ARM uses amplitude-comparison or phase-comparison direction seeking technique. If azimuth error of ARM by D is smaller than direction seeking accuracy of the ARM, ARM tows at the center point of two active decoy intervals of Figure 5.

Fig. 6 shows the simulation results of ARM attack, when two active decoys act at 9GHz using D 110m or when they doesn't work(no decoys).

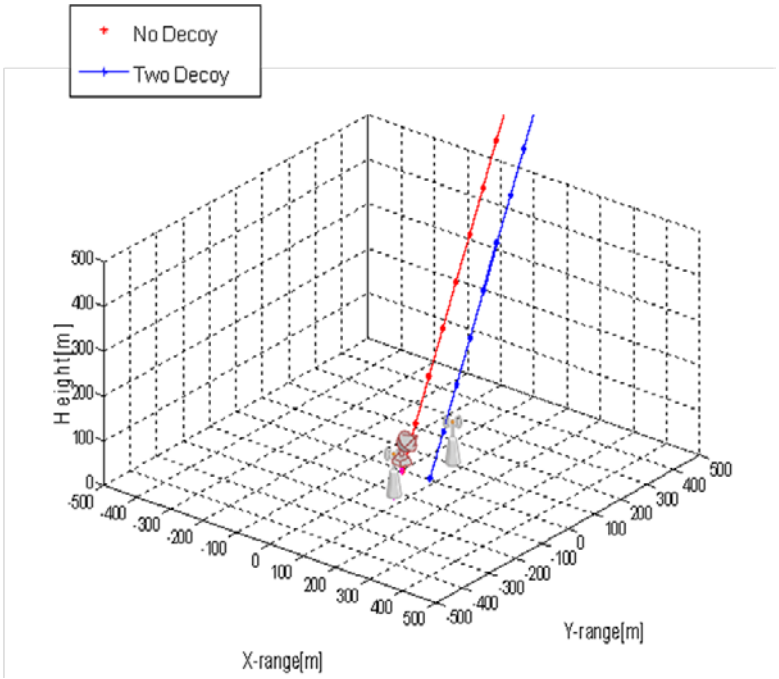

Figure 6: The result of ARM attack to radar with/without two decoys.

4. Conclusions

An active decoy is one of good methods to protect the radar from ARM. The interference signal of radar and a decoy near the radar is analyzed at the RF front end of ARM and the interference signal of two decoy signals is also analyzed at the RF front end of ARM. In this case, the decoy distance from radar and the distance between decoys are dependent on the direction seeking accuracy of ARM. If these distances are smaller than the distance which is made of ARM's direction seeking error, ARM shall attack on a centre between two decoys.

References

[1] Joong-Soo Lim, *A Radar's Electronic Protection from ARM Attack Using Active Decoy*. PIERS 2009 Moscow, Proceedings, p 15, 18-21, Aug. 2009.
[2] Leroy B. Van Brunt, *Applied ECM, volume 3*, EW engineering, Inc., 1995
[3] Stephen E. Lipsky, *Microwave Passive Direction Finding*, John Wiley & Sons, 1987.
[4] D. Curtis Schleher, *Electronic Warfare in the Information Age*, Artech House, 1999.
[5] Wang Fan, He RuiLong, Sha Xiang, *"Anti-ARM Technique: Feature Analysis of ARM Warning Radar"* CIE International Conference, Proceedings, pp293-296, 15-18 Oct. 2001.