A Study on Jamming Technique against Monopulse Type Missile

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Abstract— **Cross-eye is the best jamming technique against monopulse type missiles but it is difficult to implement. For effective jamming, especially against angle tracking, jamming must be performed according to internal radar parameters such as angle servo bandwidth. In this paper, the effectiveness of several jamming techniques is carried out through computer simulation using TESS (Tactical Engagement Simulation Software). The simulation results are shown that the noise jamming with SSW(swept square wave) technique which varies AM frequency with fixed duty rate of noise jamming signal is effective against monopulse missile with various angle servo bandwidth.**

***Keywords*— Monopulse, Jamming technique, TESS (Tactical Engagement Simulation Software).**

I. INTRODUCTION

In modern radar systems, the monopulse method is widely used to track the angle of the target. This method is robust to the jamming signal as compared with the conventional angle estimation method [1] [2]. An effective jamming technique for the monopulse method is a cross-eye that generates an estimation error by distorting a propagation surface received by a monopulse radar, but it has a disadvantage that it is very difficult to implement.

A jammer disturbs an enemy missile or a radar using electromagnetic waves, receives and analyzes the threat signal, identifies and transmits the optimum jamming technique that is stored in advance. In this case, the pre-stored jamming technique is acquired by collecting threat information with signal interception or hardware analysis. However, it is practically impossible to find the optimum jamming technique in advance by collecting all kinds of target threats. In addition, the jamming effectiveness also depends on the internal characteristics of the missile [3]. It is shown that noise jamming with the count-down technique which is on-off while decreasing the duty ratio can be effective against the monopulse missile [4].

In this paper, an effective compound jamming technique is proposed and analyzed with TESS. The internal characteristics of the missile, AGC and angle servo bandwidth, are also considered to analyze the jamming effectiveness.

II. BACKGOURND

A. Monopulse type RADAR

The monopulse system is not affected by the amplitude variation between pulses by estimating the angular error from one transmission pulse, as the name suggests. The most widely used amplitude comparison method among monopulse radars uses several antennas and feed horns so that the beam-oriented angles of the respective antennas are deflected in space and simultaneously transmitted and received. The angle measurement values in Fig. 1 are calculated from the sum pattern (Σ) and the difference pattern (Δ) for the received signal amplitudes of the adjacent beams included in the common detection area.

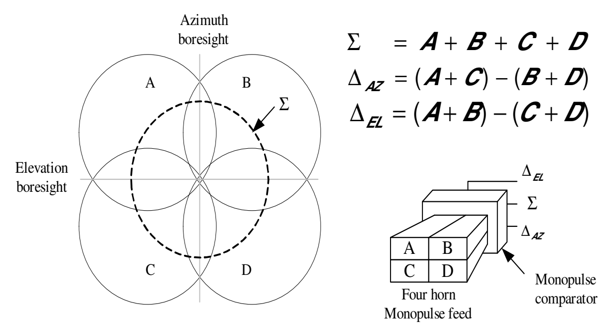

Figure 1. Concept of Monopulse.

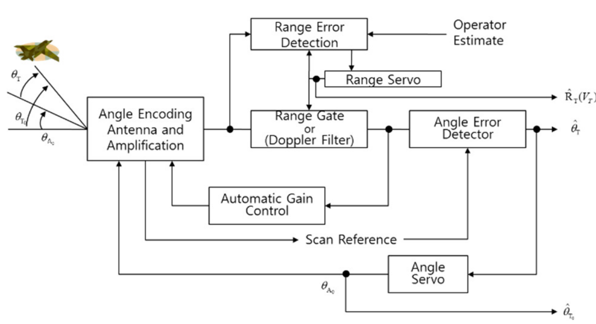

Figure 2. Basic elements of tracking radars.

B. Internal Structure of Tracking RADAR

Fig. 2 shows the internal structure of a typical tracking radar which has servos for angle and range tracking of the target. In general, these servos have characteristics of low-pass filter, and the tracking responses vary with the bandwidth [5]. TESS has some models of servo with range, angle and AGC which analyze the jamming effectiveness according to each servo bandwidth.

C. Jamming Techniques

In this paper, we proposed a jamming scheme that can be produced by a digital radio frequency memory (DRFM), stores received pulses, amplifies and retransmits after some time delays. Noise jamming with the SSW method which is on-off while changing the period of AM with fixed duty rate is proposed and analyzed the effectiveness with other jamming techniques. The Analyzed jamming techniques are shown in Fig. 3 to Fig. 6.

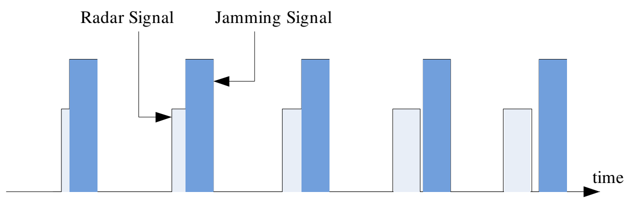

Figure 3. Range Gate Pull-Off

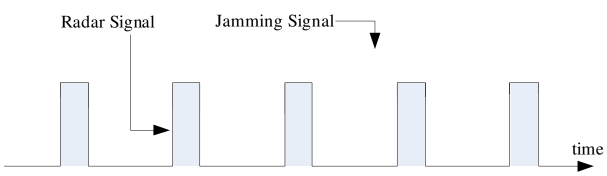

Figure 4. Noise Jamming

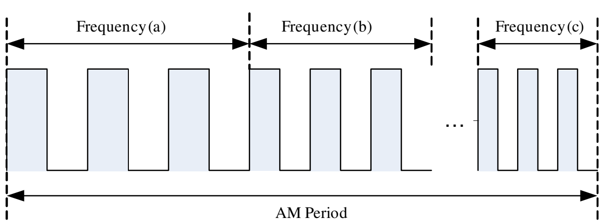

Figure 5. Swept Squre Wave(sawtooth type)

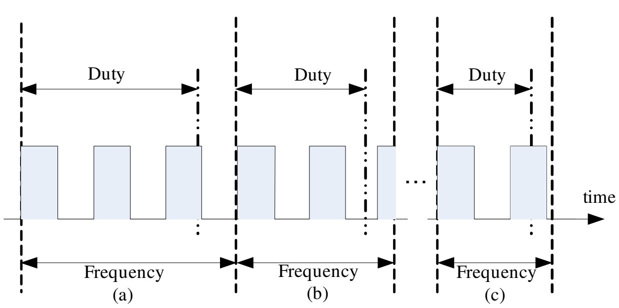

Figure 6. Noise Jamming with SSW

TABLE I. MAIN PARAMETERS AND VALUES

Parameters		Values
Frequency		9GHz
Pulse Repetition Intervval		0.33msec
Pulse Width		300nsec
Range Servo Bandwidth		2Hz
AGC Servo Bandwidth		50Hz
Proportional Navigation Guidance Coefficient	Azimuth	3
	Elevation	3

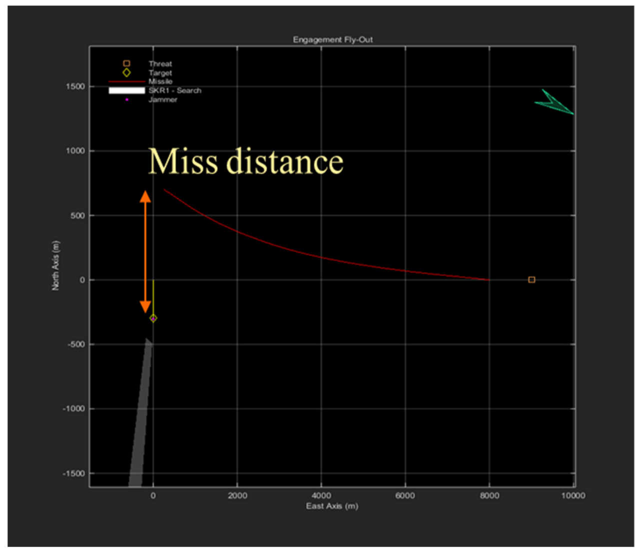

Figure 7. Miss distance in TESS simulation

III. SIMULATIONS

A. Conditions

In this paper, TESS is used to measure the jamming effectiveness of the jamming technique according to the internal angle servo bandwidth of the monopulse type missile. The scenario is that anti-air missile is launched toward the aircraft from 5 km away at the ground. The directions of aircraft and missile are shown in fig. 7.

The value of AGC servo bandwidth of missile is set to 50Hz that is a maximum value in general [4]. The other main radar signal parameters and values are in Table I.

The effectiveness of jamming is assessed by miss distance like in Fig. 7. Results are presented for each jamming technique according to various values of angle servo bandwidth.

B. Result and Analysis

1) Noise Jamming and RGPO

When RGPO and noise jamming are used respectively, miss distance was 0 regardless of the radar internal servo bandwidth. The results show that there is no jamming effectiveness against the monopulse type missile.

2) *Noise Jamming with SSW technique*

The miss distance when noise jamming with the SSW technique is performed, is shown in Fig. 8 and Fig. 9. Though the angle servo bandwidth is between 0.1Hz and 10Hz, noise jamming with SSW, varies from 1Hz to 7Hz, 8Hz and 9Hz of maximum frequency with 2Hz/sec frequency rate and 70 % of duty rate, is an effective way to avoid the missile's tracking.

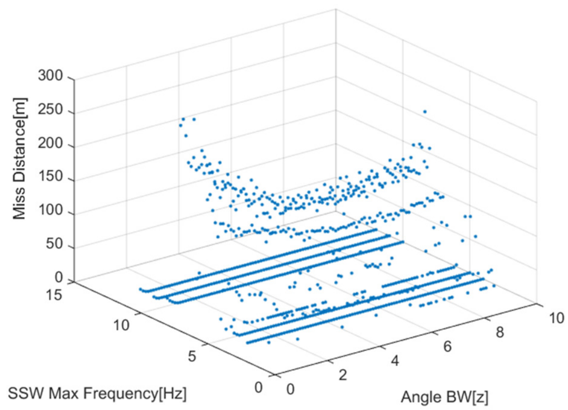

Figure 8. Simulation result of noise jamming with SSW(3D plot)

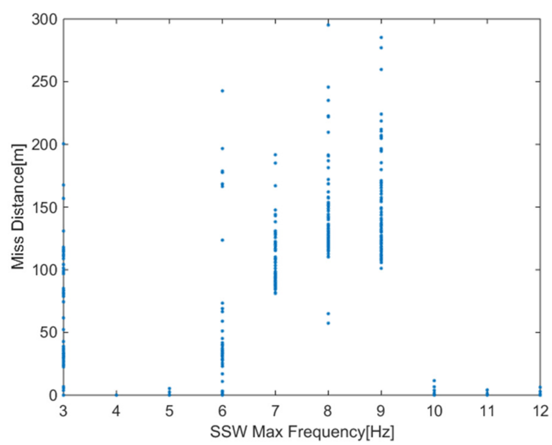

Figure 9. Simulation result of noise jamming with SSW(2D plot)

IV. CONCLUSION

In this paper, jamming effectiveness of three jamming techniques are compared with the miss distance through TESS simulation, according to the value of angle servo bandwidth in the monopulse type missile. It is shown that noise jamming with the SSW technique is effective regardless of any value of the angle servo bandwidth inside the monopulse missile. It is also shown that the monopulse missile can be jammed without using the crosseye technique, known as the optimal jamming technique against the monopulse type missile. This shows that the conventional jammer can be used without cross eye jammer which is difficult to be implemented.

For the future work and application to real jammer, the theoretical analysis of the correlation between the internal structure of the missile and the jamming technique is needed. And verification through the hardware is also needed.

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