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Enhancement of SNR for Radars

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ABSTRACT
RADAR (RAdio Detection and Ranging) use modulated waveforms and directive antennas to transmit electromagnetic energy into a specific volume in space to search for targets. The targets within the volume reflect echoes back to the radar which are further processed to extract target information. A better SNR (Signal to Noise Ratio) to for radar surveillance is achieved. The results are provided by Matlab simulation.
Key Words: *SNR (Signal to noise ratio).*

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I. Introduction

Radars are classified as ground based, airborne, space-borne or ship based radar systems. They are also classified based on the characteristics such as frequency band, antenna type, waveform utilized. Furthermore classification is based on functionality of the radar []. A ground based radar has a transmitting antenna and a receiving antenna. The transmitting antenna transmits a modulated signal towards the target and the target reflects back the signals. These reflected signals are then processed by the receiver antenna and the targets are detected. The extraction of the target information is done by the signal processing block [6]. First task is surveillance (search) of the target. This is done by continuously scanning a specified volume in space to search for the targets of interest and second task is accomplished of detection. Once detected the target information is extracted. Space borne radars are also one of the area for detection and imaging of targets where usually SAR (Synthetic Aperture Radars) are used. Where moving target localization has proven challenging in the case of single antenna conventional narrow-angle SAR utilizing conventional reconstruction methods such as the polar format and filtered-back-projection algorithms [2-3] due to an inherent ambiguity in target geo-location and velocity. The techniques for imaging moving targets with conventional SAR aim at focusing and detecting smeared targets in SAR imagery [2-6]. A number of techniques to handle moving objects explicitly have been developed. Space-time adaptive processing (STAP) [7] exploits multiple-phase center antennas to suppress clutter and produce a moving target indication image. But here we will be simulating a ground based radar to search and detect the targets.

II. Model Definition:

The Peak power density P_D is the peak transmitted power per unit area at any point in space.

$$P_D = \frac{peak\ power\ transmitted}{area\ of\ a\ sphere}$$

$$P_D = \frac{P_t}{4\pi R^2} \qquad 2.1$$

R- Radius of the sphere.
For our case R denotes the range of the radar.
The directive antennas are categorized by the antenna gain and the effective aperture.

$$G = \frac{4\pi A_e}{\lambda^2} \qquad 2.2$$

Where,
λ –Wavelength.
A_e- Effective Aperture.
G – Gain of the antenna.
The power density is related to the gain of the directive antenna by

$$P_D = \frac{P_t G}{4\pi R^2} \qquad 2.3$$

The radar radiated energy impinges on a target and the target reflects back the energy in all directions. This radiated energy is proportional to the radar cross section. The radar cross section is given as

$$\sigma = \frac{P_r}{P_D} \qquad 2.4$$

Where,

P_r – Power reflected from the target.

So, the total power delivered to radar signal processor by the antenna is,

$$P_{Dr} = \frac{P_t G \sigma}{(4\pi R^2)^2} A_e \qquad 2.5$$

Further,

$$P_{Dr} = \frac{P_t G^2 \lambda^2 \sigma}{(4\pi)^3 R^4} \qquad 2.6$$

If S_{min} is the detectable signal power then the maximum radar range is given by,

$$R_{max} = \left(\frac{P_t G^2 \lambda^2 \sigma}{(4\pi)^3 S_{min}}\right)^{\frac{1}{4}} \qquad 2.7$$

The Noise Figure F is,

$$F = \frac{(SNR)_i}{(SNR)_o} \qquad 2.8$$

$(SNR)_i$ and $(SNR)_o$ Are, Signal to Noise Ratios of input and output of the receiver.

The minimum output SNR is set equal to the radar detection threshold.

$$(SNR)_o = \frac{P_t G^2 \lambda^2 \sigma}{(4\pi)^3 k T_e B F R_{max}^4} \qquad 2.9$$

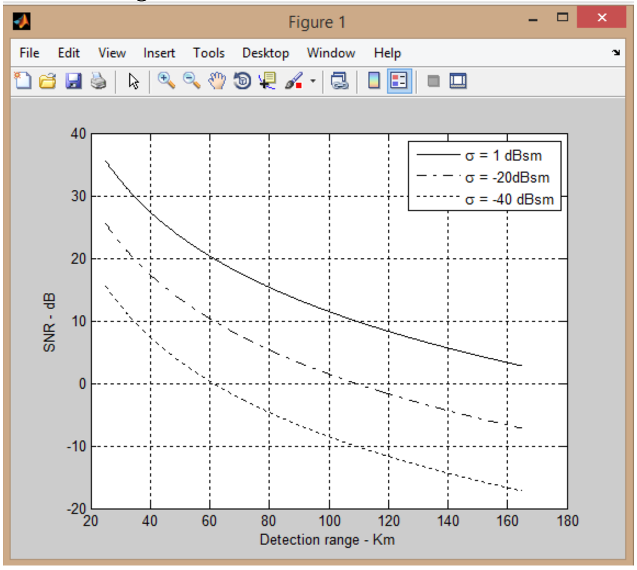
Now, considering the parameters for the design.

Table 2.1. Parameters and their respective quantities.

Parameter	Quantity
Peak power	4.5Mwatts
Operating Frequency	4GHz
Antenna Gain	35.0 dB
Radar cross section	0.3 square meters
Effective temperature	290.0 kelvin
Bandwidth	9MHz
Noise figure	3.0dB
Loss	4.0 dB

III. Simulation Results:

Figure3.1. SNR values vs detection range for the different radar cross section values.



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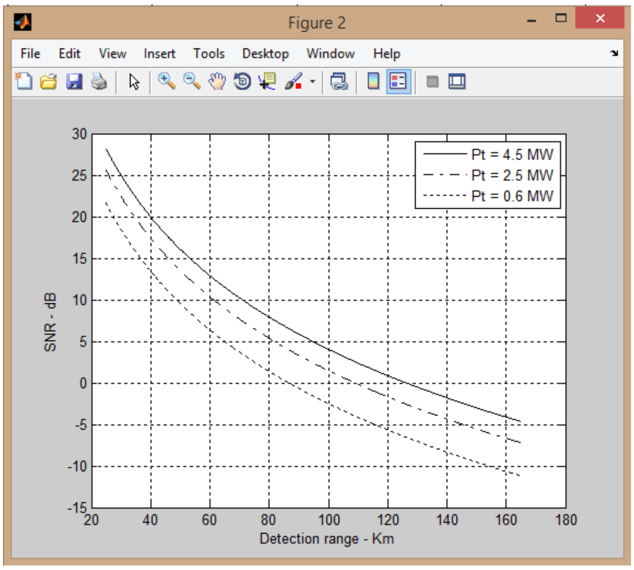

Figure3.2. SNR values vs detection range for the various transmitted power.

The Figure3.1 and Figure 3.2 show the SNR and detection range values for different values of the radar cross section and power transmitted by the radar.As the radar cross section increases from -40 dBsm to 1 dBsm the SNR values change from 15dB to 35 dB which is a considerable difference. The increase in the transmitted power increases the SNR from 22dB to 28dB with varying detection ranges

IV. Conclusion:

So with the above results we have much better SNR with the increase in the radar cross section and the transmitted power. Hence the power transmitted and the radar cross section play a key role in increasing the SNR of a radar.

References:

[1] C.V.Jakowatz, D.E. Wahl, and P.H. Eichel,"Refocus of constant-velocity moving targets in synthetic aperture radar imagery" *Algorithms for Synthetic Aperture Radar Imagery* V, vol.3370, no.1, pp, 85-89,1998.

[2] M. J. Minardi, L. A. Gorham, and E. G. Zelnio, "Ground moving target detection and tracking based on generalized SAR processing and change detection (invited paper)," *Algorithms for Synthetic Aperture Radar Imagery XII*, vol. 5808, no. 1, pp. 156–165, 200

[3] J. Fienup, "Detecting moving targets in SAR imagery by focusing," *Aerospace and Electronic Systems, IEEE Transactions on*, vol. 37, no. 3, pp. 794–809, July 2001.

[4] J. K. Jao, "Theory of synthetic aperture radar imaging of a moving target," *Geoscience and Remote Sensing, IEEE Transactions on*, vol. 39,no. 9, pp. 1984–1992, Sep 2001.

[5] C. Logan, H. Krim, and A. Willsky, "An estimation-theoretic technique for motion-compensated synthetic-aperture array imaging," *Image Processing, 1998 International Conference on*, vol. 1, pp. 9–13 vol.1, Oct 1998.

[6] Mahafza, Bassem R. MATLAB simulations for radar systems design, 2003.

[7] R. Klemm, *Space-time adaptive processing, principle and applications*. London, UK, Institution of Electrical Engineers, 1998.