Performance Evaluation of Radar Systems in Noise Jamming Environments

Francisco Novillo[1], Juan Romero-Arguello[1], Esteban Guerrero[2], Jennifer Figueroa[1], Cristhian Suarez[1]
Facultad de Ingenieria en Electricidad y Computacion (FIEC)
[1]Escuela Superior Politecnica del Litoral (ESPOL)
Km 30.5 via Perimetral, Guayaquil, Ecuador
{fnovillo, manurome, jsfiguer, criasuar}@espol.edu.ec
[2]COS1-COAD, Fuerza Area Ecuatoriana (FAE)
Av. Predro Menendez Gilbert, Guayaquil, Ecuador
eguerrero@fae.mil.ec

***Abstract*—Radar systems are widely used for military, transportation and scientific purposes. For radars, the ability of the device to mitigate the effects of noise and interference is of great importance because it will determine its performance. Radars may suffer from attacks aimed to hinder their performance, known as jamming attacks. In this context, noise jamming attacks are a very common type of attack, thus reducing their effect is fundamental. Due to this fact, simulation and analysis of radar performance in different scenarios could help decrease possible threats. For this reason, in this paper the performance of radars in noise jamming environments is evaluated. To achieve this, a radar system, jammer attacks and anti-jamming algorithm are modelled and evaluated through simulations. The models and algorithms developed in this work could aid in the process of performance test and analysis of radars and could be used as a design platform of radars and jammers to reduce developing and implementation time.**

***Keywords*—Radar, noise jamming, anti-jamming, targets, MTI.**

I. Introduction

Radar sytems are widely used for military, transportation and scientific purposes [1] due to their ability to detect and locate targets of interest. A key feature of a radar is its capability to filter out the noise and interference coming from internal and external sources that may detriment its performance, i.e. its targets detection capability. In a military scenario, external sources may alter the normal operation of a radar to hinder its performance. This situation could have a severe impact, contaminate the received signal and prevent the detection of targets, which is a mayor concern. These external sources are known as jammers and the action of altering the normal operation and performance of a radar is known as a *jamming attack*. There are different types of jamming attacks: noise jamming and deception jamming. Noise jamming is a common scenario in electronic warfare [2] and because of that this work will focus on it.

Noise jamming attacks use noise to alter the signal received by the radar. In the design of jamming systems, a Gaussian distribution is normally used, therefore, noise can be assumed to be Gaussian. Several noise jamming techniques are available, such as: Broad-Band Noise (BBN), Partial-Band Noise (PBN), and Narrow-Band Noise (NBN). BBN adds noise to the entire spectrum frequency of operation of the radar, but is impractical and requires considerable power. PBN adds noise to specific frequency operation channels of the radar, consequently reducing the power required and being more practical if compared to BBN. NBN adds noise to a single frequency operation channel of the radar and saves more power than PBN [3].

As a result, the performance of a radar may be affected not only by weather conditions, ambient noise, interference, number and size of targets but also by intentional jamming attacks. This situation calls for the need to evaluate and test the performance of a radar under different and varying conditions so that vulnerabilities in the system could be found and actions taken to revert this situation. However, most of the time this is not feasible since the device is currently being used, very expensive or the test conditions difficult to replicate. Therefore, a tool to simulate, test and evaluate the performance of a radar under different conditions could be very useful. Given these points, this paper models a radar system, jammer attacks, and anti-jamming algorithm through simulation.

A configurable model of a radar system, different types of noise jammers and anti-jamming algorithm capable of filtering interference are simulated and implemented to evaluate the performance of a radar under different conditions. The method used allows to accurately replicate a real radar and provides a tool for tests and performance analysis of different types of radars, including surveillance 2D and 3D radars. The current work could also be used together with software defined radio units to simplify the developing time and quickly create and test radar systems, jammers and analyse their effect.

The rest of the document is organized in the following way: section II is the state of the art and introduces the concept of jamming and anti-jamming techniques, section III presents the simulation model used for the radar and jammer, section IV explains the anti-jamming algorithm used, section V is the performance evaluation where the radar is tested under different conditions, and section VI summarizes the conclusions.

978-1-5090-1629-7/16 $31.00