THE VULNERABILITY OF LASER-WARNING SYSTEMS AGAINST GUIDED WEAPONS BASED ON LOW-POWER LASERS—PART IV

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Abstract. The theory for a laser sensor model was presented in Part I of this four-part series, followed, in Part II, by the creation of a simulation employing MATLAB and Simulink. Part III detailed the verification of the laser sensor theory and simulation by laboratory based experimentation. This fourth and final part of the series outlines the results of extensive field trials of real laser systems in the UAE and compares these with those of the simulator. This paper then briefly looks at how to incorporate the effects of atmospheric turbulence within the simulator and finishes with a brief parametric study using the simulator.

INTRODUCTION

The value of any computer simulator rises significantly if its results can be validated using physical experimentation. Part III of this series showed that good correspondence was found between the theoretical and laboratory-based experimental results. Even greater value can be attributed to the simulation if its results can be further validated by comparison to real world systems in a full field trial. The results of such a trial are reported here.

An important factor affecting the performance of any laser-warning receiver is the level of atmospheric turbulence experienced as the laser beam propagates from the source to the receiver. This topic is briefly discussed here as well as how the turbulence effects are implemented in the model.

The paper concludes with a brief description of a parametric study to show how a full sensitivity analysis or optimisation of a particular system could easily be carried out.

FIELD TRIALS

Several well-known companies were invited to participate in a competitive bid process for the sale of laser warning systems to the UAE Land Forces. This was to be as part of a protection system comprising a laser-warning system, control unit and countermeasure system to be incorporated on UAE tanks and other armoured fighting vehicles (AFVs).

Part of the bid process involved full performance trialling of the laser-warning systems over an almost two-year period. The field trials were conducted on a military training ground for all types of weathers conditions, including the harsh summer conditions in the UAE between May and August. Various laser systems were used to stimulate the laser-warning receivers, including: laser rangefinders, laser designators and laser-beamrider guidance systems.

For commercial reasons it is not possible to identify the four particular companies that took part and the laser-warning systems fielded, hence the results are annotated as company A, B, C, and D.

There are clearly many results achieved from such an extensive trial. For ease of display therefore, we simply present the maximum detection ranges achieved in the various weather conditions (as previously defined in Part II) for the four laser warning systems trialed, against a particular Nd:YAG laser rangefinder (λ=1.06μm). These results are given in Table 1. The analysis of the results showed that, as expected, the weather conditions substantially influenced the performance efficiency of the laser warning systems and the trends experienced in the field trials are mirrored by the simulator results.

To model accurately the commercial systems with the simulator would require precise values of the components used in the laser-warning receivers. The companies involved are understandably reticent to give such full details of all of the parameters in their systems. However, company A, the provider of the best performing system, was persuaded to give sufficient details such that the simulator could be run with only a few engineering assumptions having to be made.

When the simulator results and the company A results are compared, Table 2, a significant degree of agreement can be seen, giving further credibility to the simulator as a predictive tool. (It is thought that the errors in measuring the atmospheric conditions during the trials more than encompass any differences).

ATMOSPHERIC TURBULENCE

Atmospheric turbulence can cause expansion, distortion, fluctuations in the angle of arrival (AoA) and fluctuations in the intensity of a laser beam as it propagates from its source to the receiver system. Atmospheric turbulence is caused by variations in temperature, humidity, and density of the air along the propagation path and these variations consequently alter the refractive index.

Company	Detection Range (m)				
	Good	Typ-1	Typ-2	Bad-1	Bad-2
A	4,500	4,100	3,300	2,100	1,950
B	4,300	4,000	3,200	2,000	1,900
C	3,900	3,800	2,950	1,950	1,890
D	3,800	3,500	2,500	1,830	1,700

Table 1. Trial results—maximum detection range.

	Detection Range (m)				
	Good	Typ-1	Typ-2	Bad-1	Bad-2
Company A	4,500	4,100	3,300	2,100	1,950
Simulator	4,300	4,200	3,500	2,000	1,900

Table 2. Comparison—maximum detection range.

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