Laser Surveillance System – John D. Myers - 1963

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Laser Surveillance System

Summary

An active infrared surveillance system is discussed which permits the angular scanning of previously acquired (by radar) targets at ranges up to ten kilometers for purposes of night-time discrimination and identification. At a range of ten kilometers, the system will scan 30 meters in azimuth, 20 meters in elevation, and have one meter resolution. The intensity modulated return signal will be displayed on a TV type raster or mosiac whose individual points correspond with the area being scanned. At shorter ranges, the area being scanned can be increased by the insertion of suitable optics so as to provide sufficient illumination to permit direct viewing with passive IR sensitive optical devices.

Introduction

This laser surveillance system is similar to a conventional TV camera - display system except that instead of collecting ambient light reflected or emitted by an object and building up an image by means of intensity modulation of a raster, the laser system selectively illuminates an object in a manner similar to a flying - spot scanner and builds up an image by reproducing the reflectivity of the object as a function of position on an appropriate display mosiac. A block diagram of the system is shown in Figure 1.

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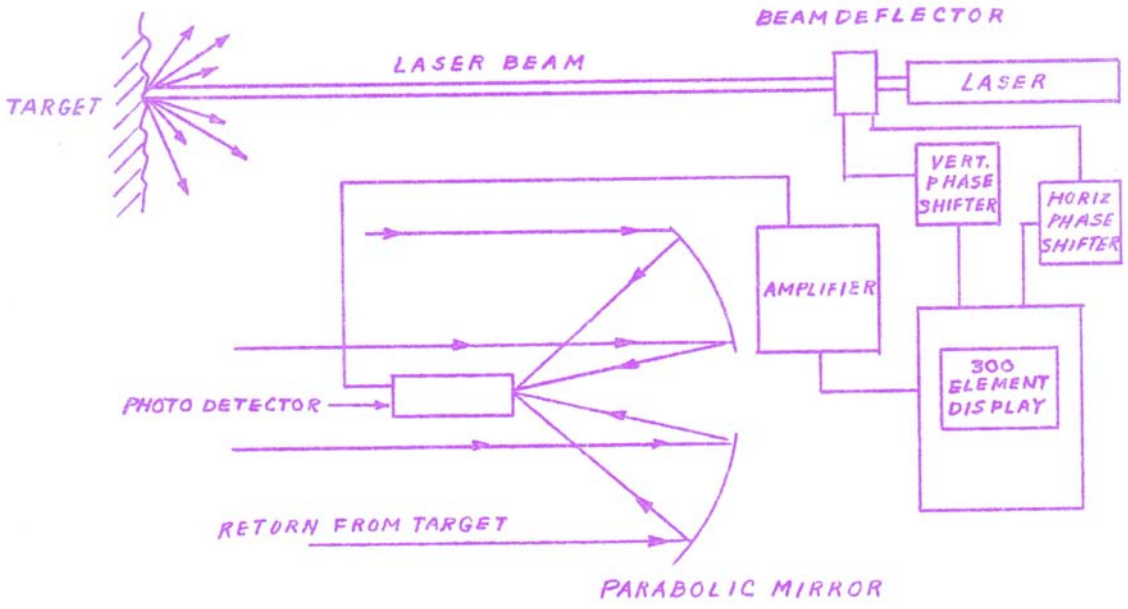

FIGURE 1

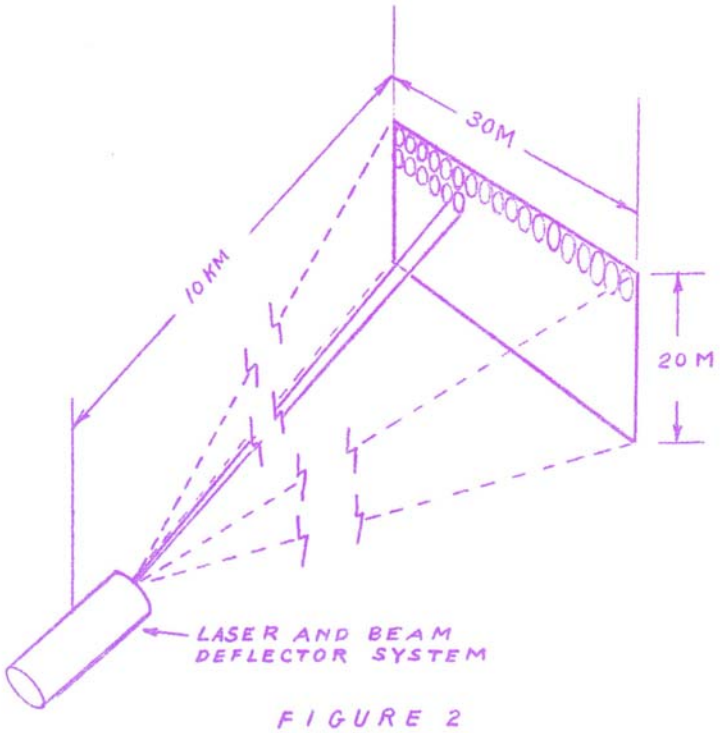

FIGURE 2

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The transmitter is composed of a pulsed gas laser and beam deflectors (azimuth and elevation). The particular laser to be used in this system is characterized by the following parameters and is commerically available.

pulse width	-	1 microsecond
peak power	-	100 watts (averaged over all lines)
pulse repetition frequency	-	10,000 pps
beam divergence	-	10^{-4} rad.
wavelength of radiation	-	11,177, 11,523, 11,614, and 12,066 Å (emitted simultaneously)

The beam deflectors can be either rotating mirrors or optical wedges. The total deflection in elevation will be .02 rad. and the total deflection in azimuth will be .03 rad. The resulting vertical scan will sweep at 16 cps while the horizontal scan will sweep at 320 cps. Since the divergence of the laser beam is approximately 10^{-4} rad, the spot size at 10 km will be about 1 meter in diameter. Therefore, with the laser operating at 10,000 pps, a raster will be produced at a range of 10 km which will cover a rectangular area of 600 m^2 as shown in Figure 2.

The receiver will be composed of a photo-detector and optical system which will be used to intensity modulate the element of a display which relates to the element of the raster in the scan area being illuminated. In this manner, a composite image of objects within the scan area will be built up and presented for viewing sixteen times a second.

The maximum effective range of this system is determined by atmospheric attenuation. This attenuation figure, in turn, sets the requirements on receiver aperature size for a given photo detector. The following discussion shows to what extent the atmosphere limits this system.

Attenuation of 11,000 Å radiation is due primarily to resonance absorption by water vapor. Absorption by carbon dioxide and ozone is negligible in comparison. Because of this fact, we shall consider only the attenuation due to water vapor when evaluating the laser surveillance system. Admittedly, our evaluation leaves much to be desired in that truly inclement weather (rain, snow, fog) is left out and the system is assumed to be generally ineffective in such weather.

The graph shown below shows the maximum effective range of a given laser surveillance system as a function of the relative humidity. This system is assumed to possess the following characteristics:

1.	peak power -	100 watts
2.	beam divergence -	10^{-4} rad.
3.	receiving aperature	1 m^2
4.	reflectivity of target	0.1
5.	minimum detectable signal	10^{-11} watts

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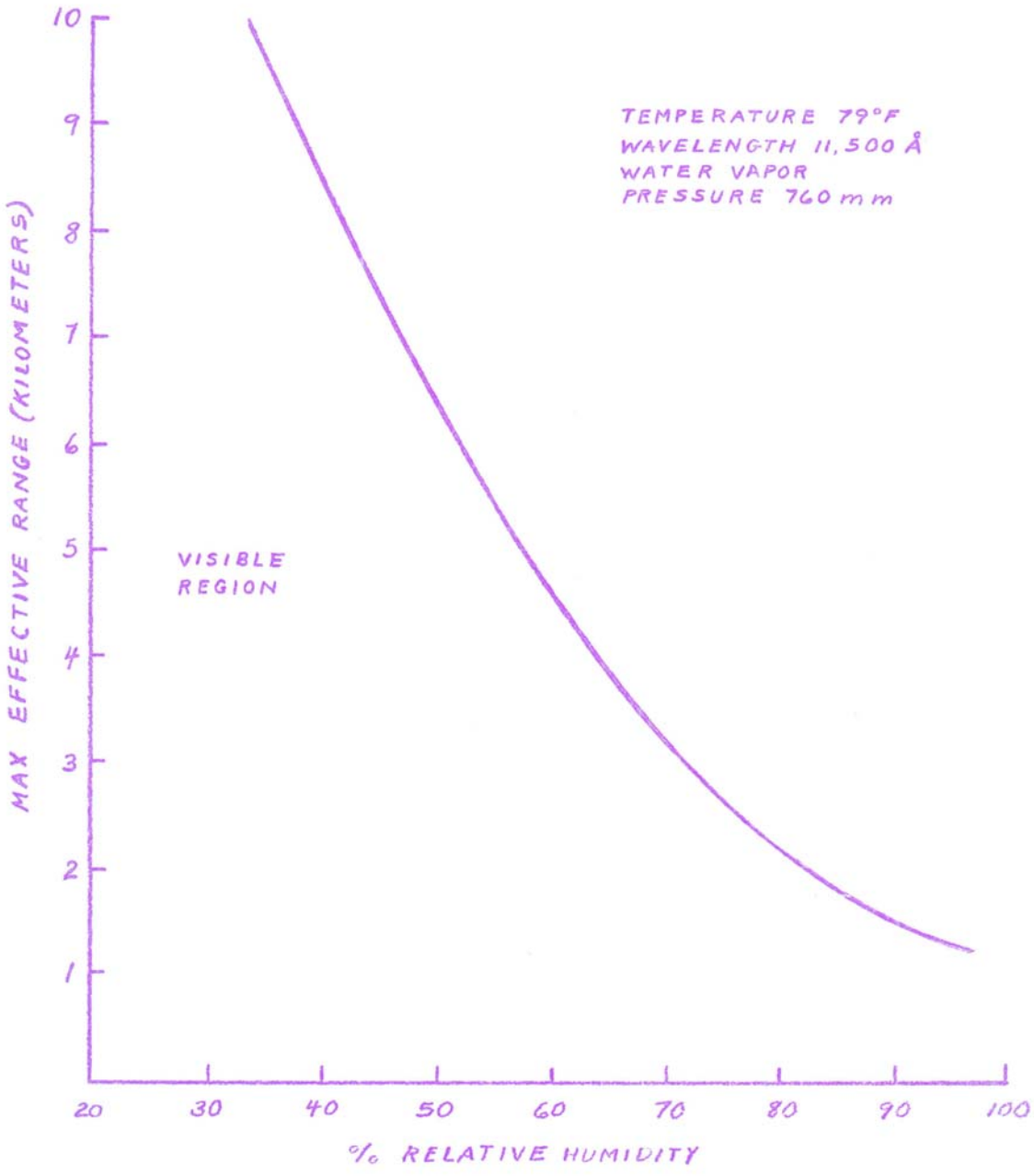

FIGURE 3

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The data used in obtaining this graph was extrapolated from measurements[1] taken at the Antenna Laboratory at Ohio State University.

Summarizing, this laser surveillance system will permit night-time identification of small objects such as PT boats, surfaced submarines, and patrol craft at ranges up to 10 km, atmospheric conditions permitting. At shorter ranges (approx. 1 km) the system will provide IR illumination for mapping or observing coastal areas using passive IR optical systems.

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(1) "Lasers and Applications", Edited by W. S. C. Chang, Engineering Experiment Station, The Ohio State University, Columbus, Ohio, SR-27, 1963, p. 209.