INNOVATION IN THE LASER WARNING SENSOR FIELD (i)

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Abstract

The more and more diffuse use of laser sources in the war scenario made necessary the introduction of systems capable to detect the presence of laser beams (Laser Warning Receivers). Such systems, in principle applicable not only to helicopters but to any kind of platform, flying sailing or in land, must warn the operators and eventually activate the countermeasures fitted to decoy the potential danger related to the laser threat. In this paper we describe a novel system of reception based on a suitable arrangement of a certain number of optical fibers. The device is patent pending. Trade-offs between the resolution regarding the incoming direction of the laser beam and amount of hardware and electronic information to be handled are also shown. We also illustrate different types of proposed solutions and other possible applications.

(*) Patent Pending

Introduction

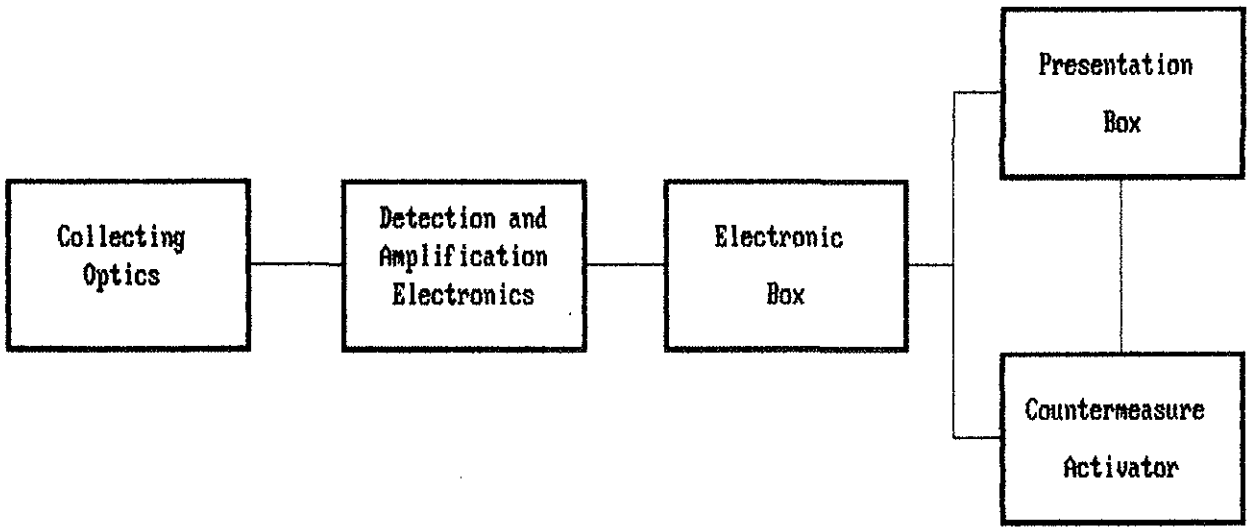
It is well known that lasers are used very often in war scenarios and helicopters are one of the main targets because of their tactical task and their ease to movement. Just for their agility, helicopters have good chances of survival if they are warned in time about the threat. Indeed, the fact that a helicopter is hit by a laser notifies the imminence of an attack. The most common types of laser threats in a battle are the following:

- laser rangefinders
- illuminators and designators for missile guide
- laser radars

Each of these kinds of lasers of course has different characteristics: spectral wavelength, pulse repetition rate, pulse length, intensity, kind of modulation. These parameters allow to define the kind of the laser and as a result the kind of the threat.

Requirements for a L.W.R. system

Beyond these parameters, a laser warning receiver system must be able to detect the laser incoming direction.
The more parameters are measured by the device, the more reliable and accurate is the detection of the laser beam and the subsequent countermeasure. The field of application of such systems, that is a battlefield, makes also other factors (ruggedness, reliability, maintenability, blind alarm possibility) very important.
A typical L.W.R. is usually formed by the elements shown in the following block diagram:

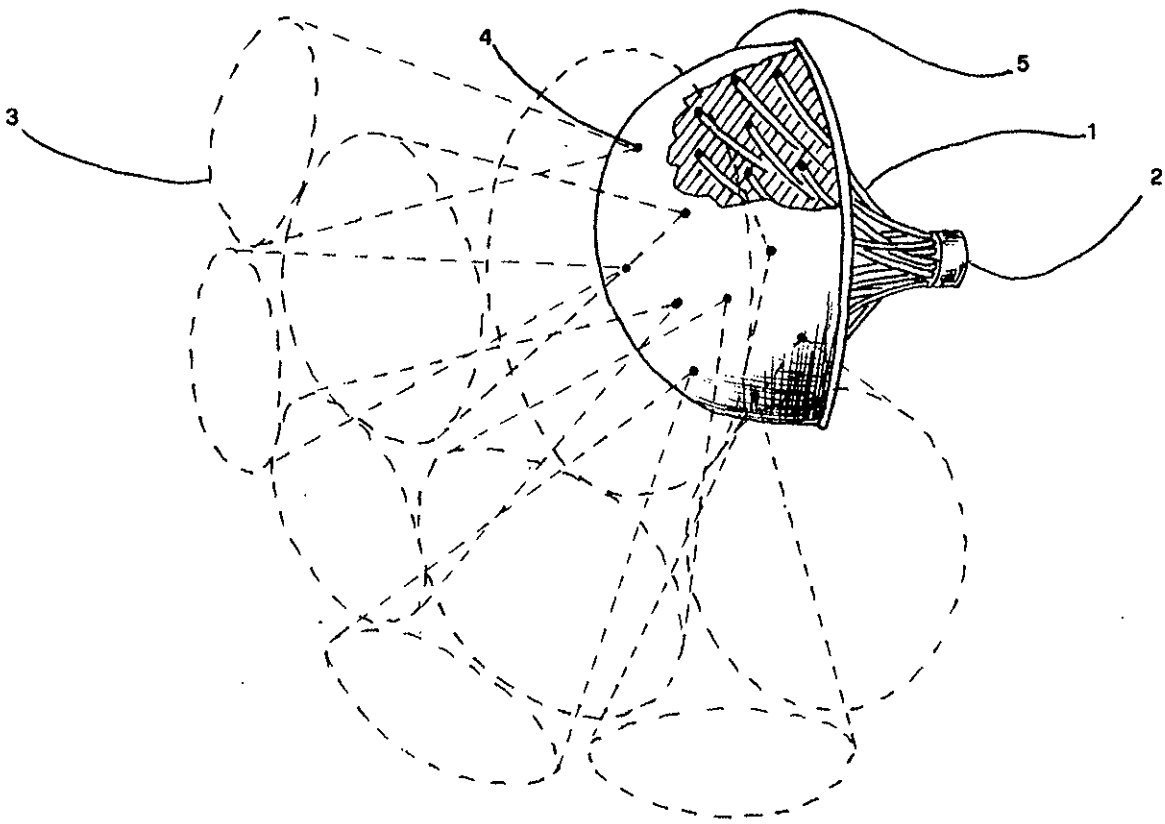


The collecting optics is located outside the platform, covering the solid angle necessary to protect it, catching the laser beam and maintaining the spatial information. According to the utilized technologies, the detection electronics may be located in the electronic box or together with the collection optics. The first solution allows a better defense against electromagnetic interferences, whereas the second one guarantees a better light efficiency. The electronic box processes the detected signal, points out the essential parameters, identifies the type of threat and interfaces the presentation box. Furthermore, it can decide the most suitable countermeasure or leave the decision to the operator. The presentation box displays in a suitable way the presence and the type of the threat and the countermeasures can be activated both automatically or by the operator.

Proposed solution

The scope of our work was to develope a new idea regarding the collecting optics, to design it and to build a prototype.
Two types of arrangements for L.W.R. have been devised: the first one has the sensors outside the platform surface and the electrical signal is brought to the inner electronic box via a conventional electric cable; in the second one the laser beam, collected by a lens, is brought to the inner sensor by an optical fiber.
What we propose is to replace the external boxes, cumbersome and fragile because of their optics and difficult to be assembled on any kind of platform and in particular on airborne ones, with a compact head, equipped with integrated optical fibers. The head will end with an optical fiber connector to make the assembly and disassembly easier, also without a further clamping, directly on the platform skin.
The following figure shows a typical configuration of an optical fiber head. It is possible to identify:

1: fiber optics
2: fiber optics connector
3: field of view of the single fiber
4: cablehead
5: outer cover



The incoming laser radiation that hits the head is collected only by one fiber, because the restricted acceptance angle of the single fiber does not allow the radiation to enter the other ones. The laser light is therefore conducted through the connector to the relative detector. In this way the information regarding the direction of the incoming beam can be kept and the accuracy and the resolution of the beam direction detection can be determined by choosing the appropriate acceptance angle of the fibers. The total number of fibers, their position and the degree of overlapping give the total field of view of the head. Normally it is convenient to put two or more heads on the helicopter to avoid shadowing from one side of the external scene. It is also possible, using fibers made by materials transparent in different spectral ranges, to see different kinds of laser. This can be done on the same heads, using fiber bringing the signal to detectors sensitive to different spectral ranges, or applying separate heads to the helicopter.
Using special types of fibers now available but every expensive and not yet very reliable, it is also possible to cover all the range from red (.7 microns) to far infrared (10.6 microns), that means to see every kind of laser likely to be used in a battlefield. The advantages of such a device compared with the previous one are obvious: reduced weigth, costs and dimensions, ease to assembly, improved ruggedness and durability, better angular resolution, possibility to use for communication or as a countermeasure actuator.
The presentation to the operator may be done on a dedicated display, on LEDs, by acoustic alarm or on account of the angular accuracy, directly on the radar display too, so that the operator can correlate the thread to the operational enviroment.

Other applications

Besides the application as a laser warning receiver, we can foresee other utilizations for such a sensor.
In fact the same enblock can be used in the countermeasure system, because through the same fiber collecting the incoming signal a laser jamming signal can be transmitted, that will cover the solid angle where the original signal came from, disturbing therefore the foe.
A further application of the head is as a two-way directional antenna in the infrared, visible or ultraviolet band. Finally it is possible to use the head for in flight communications.

Conclusions

We are sure that the new integrated fiber optic head shows a lot of advantages, and for these reasons we applied for a patent. After some compromises between amount of information to be handled and angular resolution were done, the design of a particular configuration has been finished and finally we are proceeding with the prototype construction.