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A NEW LASER EQUIPMENT DESIGNED FOR AVIAN DISPERSAL IN AIRPORT ENVIRONMENT

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Abstract

This paper and the video associated, present a prototype of automatic runway protection system against bird strike using a laser light

Chronology of experiments, technical specifications, eye safety, results on different bird species on civil and military airfields related with meteorological conditions, benefits and drawbacks of this equipment are presented and discussed.

Key words: airport bird scare equipment, lasers

Introduction

The French Technical Service for Air Navigation is in charge of new scaring techniques against bird strike hazards. The main researches conducted in France since 1988 with different lasers equipment are presented below.

1988-1990

Bird frightening tests performed with an HeNe laser gun of 5 to 10 mW power. The initial bird frightening principle consists in impacting the bird's eye to cause flying-off. After multiple tests, it appears that the eye impact does not necessarily cause flying-off, but often an avoidance reaction by head movement. However, in favourable lighting conditions (twilight, mist, darkness, ...), a flying-off response is observed, when roughly aiming at the bird or the group of birds to be tested, whatever the species. The flying-off could have been caused by disturbance of the vigilance state necessary for the bird's safety. A first apprehension of what will later be called the "stick" effect is, however, felt: the flying-off could also be construed as the bird's fright due to the approach of a non identified intruder (in this case, the light beam materialised in air, and which has the appearance of a "stick"). Flying-off reactions were observed up to 300 m from the source.

1993

First contacts with the SYLAREC company. Several laser sources were tested:

- a continuous Argon laser emitting at 5 mW in the blue and green spectra
- a continuous HeNe laser of 30 mW, emitting in the red (633 nm)
- a diode - pumped State (DPSS) YAG laser of 100 mW, (532 nm)
- a continuous C02 laser of a few watts, emitting at 10,590 nm (thermal laser)
- a neodyme glass pulse laser, doubled in frequency, emitting at 530 nm (pulse duration of 26 ns).

These lasers are equipped with optical devices (afocal systems) which permit the diameter of the laser beam to be enlarged.

Multiple tests carried out on birds present on a garbage dump site allowed a high performance source to be selected: the DPSS (532 nm) YAG laser of 100 mW (photo 1). With this source, flying-off is obtained when approaching the enlarged beam: the "stick" effect is highlighted. However, these results are limited according to the ambient luminosity. The absence of the beam is felt, due to its small diameter, but the eye safety is not observed. The beam diameter is only 5 cm, in order to give a contrast which is sufficient to cause flying off.

1994

In order to maintain eye safety, a mock-up is developed, comprising a DPSS YAG laser of 200 mW (532 nm) and an afocal device permitting a 15-cm diameter beam to be created.

This system is mounted on a liquid head camera tripod, which easily allows the beam to be aimed at the targets (birds) to be tested. A VHS video camera collimated to the laser beam, enabled the experiments to be recorded (photo 2).
Results are observed in various luminosity conditions and on various bird species (Lapwings, gulls, ducks, waders, starling, pigeons...). A flying-off response of the birds is obtained up to distances in the order of one kilometre, under lighting conditions of less than 13,000 lux, provided that the beam is kept in motion. No habituation to the moving signal is detected, even on nesting birds, although they are strongly attached to the nesting site (Saint-Yan experiment on crows).

Eye Safety

The main risk associated with the use of the laser is the risk of eye injury due to the strong surface power density likely to hit the retina. The eye safety limit is the limit power threshold receivable by the eye, beyond which there can be irreversible retina damage. With a laser source emitting in continuous mode at 532 nm, the maximal acceptable lighting is 25.5 W/m2.

1995
Creation of an experimental laser robot mock-up for the automatic protection of an airfield runway. The mock-up allows the automatic sweeping motion of a laser beam over a half circle. The robot can be adjusted so that the beam is plunging and plots a half-circle of an approximate radius of 1,000 m on the ground.

An astronomic telescope (Celestron) is used as a focal device to enlarge the laser beam to more than the admitted value, in order to obtain eye safety. The resulting beam has a diameter of 157.5 mm. The emission power is assessed at 146 Mw (photo 3).

A first test campaign was conducted in the Veys Bay, using this mock-up. The results were quite disappointing. The birds only reacted to beam passage in very low lighting conditions (dawn and dusk). There was an obvious regression of the frightening power compared to the results obtained in 1994. After laboratory measurements, it appeared that the telescope used caused an excessive power loss in the output beam. On the one hand, a diagnosis showed that the laser power was reduced to only 100 mW (instead of the announced 200 mW), on the other hand, the central blanking of the telescope caused approximately 30 % of laser power losses at the device output.

1996
Further to observations made in 1995, it was decided that a 400 mW laser source would be used in order to compensate for the power loss in the optic equipment. This type of source was installed on the existing test mock-up. Eye safety at the system output was maintained.

A new test campaign was conducted in the Veys Bay. The automatic scanning of the bay caused flying-off when the birds saw the beam pass above or below them (h < 2 m), for luminosity levels up to 15,000 lux (photo 4). However, it appeared that the surface covered, in terms of bird frightening, was limited by the impossibility of controlling the beam in elevation angle.

After this test campaign, the mock-up was installed on the Brétigny-sur-Orge military (CEV = In Flight Test Center) airfield platform, in order to detect the possible disturbance caused to the pilots or the various users of the platform, in the case of direct or reflective vision of the beam. Therefore, the system was mounted at 400 m laterally, to the South of runway 05/23, at approximately 1,100 m from the threshold 23.

After adjusting the beam and masking the critical zones, the various possible disturbance levels for the platform users (air traffic controllers, meteo operators, vehicles on the ground...) were cancelled. Runs on the runway, during take-off and landing phases, or in level over flight at a height of a few metres, were performed with a light aircraft from the CEV. The system was either in automatic, or in manual operating mode. When in manual, the beam is fixed (spraying the runway threshold end) or follows the aircraft on its run. The pilot was not dazzled by the beam at any time.

An inquiry was then conducted with the CEV pilots, whatever the aircraft used. The system was in operation during daytime flying hours. After three months of tests performed under various weather conditions (winter and spring 1997), no complaint was filed with the airfield's operations office, either by the pilots or by the other airfield users. No bird strikes where registered during this period on this airfield except during the days when the laser was out of service. Most of the birds (gulls, lapwings) where observed at rest behind the prototype when it was working.

The Bretigny experiment demonstrated the operational feasibility of an automatic airfield runway protection system against bird strikes by means of a laser device.

2000
Design of a new prototype, whose scanning speed and beam routing are programmable, in order to ensure the protection of the runway and surroundings, whatever the profile of the site to be covered. This prototype is operational in an airport environment, without disturbing the existing installations, and in diversified weather conditions.

This equipment is tested on a civil airport (Tarbes-Ossun-Lourdes) during the winter 2000 and give very good results especially on lapwings: no birds staying in front of the prototype on the part of the runway covered by the laser beam during cloudy days and sometimes during sunny days (birds remember the disturbing area?). No habituation after three months experiments.

2001-2003

Drawing and achievement of an industrial prototype by “Lord Ingienierie company” with professional components and respect of eye safety. A remote control and monitoring function enable the system to be survey by internet and allow the control of failures from the ATC office (photos 5 et 6).
Tested on a military base (Mont de Marsan) during the 2003 winter, this equipment give the same results as in previous experiments when the speed of the laser beam (and the illumination period where respected (the system must start very soon in the morning until the sunset to be effective on the birds).

No complaint was noticed with the pilots flying on this airfield during daytime and at night.

Conclusion

This equipment seems to be promising and can be used without any safety problem on civil and military airfields. It must be looked as an additional scaring system to equipment used manually (distress calls, pyrotechnics, hunting) in order to help bird patrols during hard meteorological conditions (dawn and dusk, raining and foggy days etc…). More attempts will be achieved on a French civil airport during night.
Inefficient on birds flying over the runway and during sunny days are the main drawbacks of this system.

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Photo 1


Photo 2


Photo 3

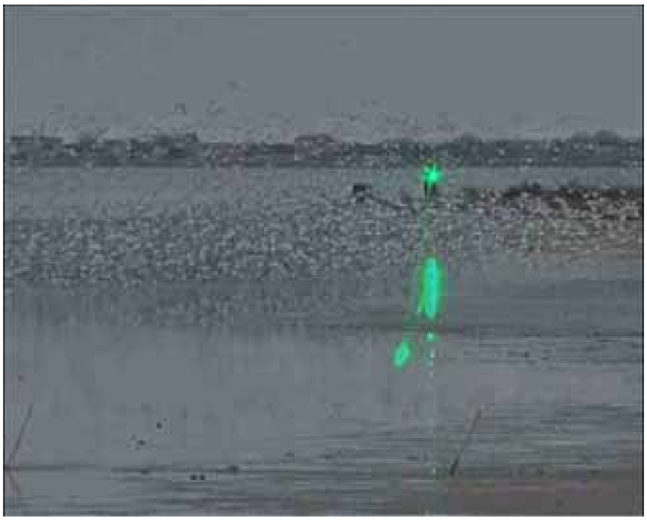
Photo 4


Photo 5


Photo 6