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VFR general aviation aircraft and UAV flights deconfliction

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Abstract[1]

Integrating UAV traffic into airspace requires that deconfliction of UAV flights from those of aircraft operating under Visual Flight Rules (VFR) can be achieved.

Today, the separation of two aircraft flying under VFR relies on the "see and avoid" principle but sometimes fails for reasons like high closing-in speed or pilot lack of vigilance.

Equipment can be considered to solve this problem and, providing they are fitted to most of flying vehicles, they could dramatically change the picture of UAVs incoming into the airspace.

Such an equipment, designed to provide assistance to light general aviation aircraft pilots in case of a risk of collision, delivers a voice message to the pilots giving them information to visually acquire each other. Once in visual contact, they both apply usual VFR to avoid collision.

Fitting UAV with a similar equipment would change the "see and avoid" concept into a "sense and avoid" concept. In case of a conflicting flight path between a UAV and a manned aircraft, the pilot of the aircraft would vocally get information enhancing his capability to visually acquire the UAV while the UAV would "numerically sense" the light aircraft. Both would then be able to modify their flight path to avoid collision.

Résumé[1]

L'intégration des UAV dans l'espace aérien exige qu'une dé-confliction entre leurs vols et ceux d'avions évoluant suivant les règles de vol à vue (VFR) puisse être réalisée.

Aujourd'hui, la séparation de deux avions volant en régime VFR est fondée sur le principe « Voir et Éviter » mais échoue parfois pour des raisons telles que des vitesses de rapprochement élevées ou le manque de vigilance du pilote.

Un équipement peut être envisagé pour résoudre ce problème moyennant le fait que tous les véhicules aériens en soient munis. Un effet indirect de l'utilisation d'un tel équipement est que le problème de l'intégration des UAVs dans l'espace aérien pourrait être radicalement changé.

Conçu pour fournir une aide aux pilotes d'aviation générale pour l'acquisition visuelle d'un autre avion en cas de risque de collision, il délivre un message vocal au pilote lui donnant l'information nécessaire pour cette acquisition. Une fois le contact visuel établi, les deux protagonistes appliquent les règles VFR habituelles pour éviter la collision.

L'intégration dans un UAV d'un équipement semblable transformerait le principe « voir et éviter » en un concept « détecter et éviter ». En cas de trajectoire conflictuelle entre un UAV et un avion équipé, le pilote de l'avion obtiendrait vocalement une information améliorant sa capacité d'acquisition visuelle de l'UAV tandis que ce dernier détecterait l'avion léger. Tous deux seraient alors capables de modifier leurs trajectoires pour éviter la collision.

Keywords: UAV integration into the airspace; Collision avoidance; TCAS; General aviation safety

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1. Introduction

Improving the security of aircraft flying in visual flight regime is not a new objective. According to the AOPA[2] Air Safety Foundation, eight of the 18 midair collisions that occurred in the USA during 2000 did not result in fatalities. The other 10 midairs were fatal. Midair collisions occur because it is easy for two aircraft to arrive at the same point in space at the same time despite the generous proportions of airspace. The sky is large where there are few aeroplanes to fill it, far from congested areas. But it is not so large around uncontrolled airports on nice weekend days.

In controlled areas, ATC may predict the potential for a collision and generate an alert, but controllers may also fail to communicate the alert to the pilot who may be able to manoeuvre to avoid the collision.

General Aviation community considers that we are in a time of transition with respect to decreasing the potential for midair collisions. See and avoid (S&A) technique has not to lose its number-one ranking on the list of collision avoidance tools, but electronic traffic surveillance devices will continue to evolve and become more accessible to small general aviation aircraft and, therefore, they may enhance the S&A pilot capability.

Dealing with "S&A" technique for a UAV is not a simple problem. The closer solution to usual VFR practice would be to consider that a UAV is an uninhabited vehicle having its pilot on the ground. The sensors on board would be the eyes of the ground pilot who would be able to take evasive action looking at the screens of a synthetic ground cockpit showing approaching traffic through images coming from the UAV via a data link.

This does not seem to be a practicable solution: the reliability of the total system (sensors + data link + ground pilot) would be difficult to assess and to guarantee. Moreover General Aviation pilots are considering that the S&A fails too often and are expecting some help from the technology to give them a better situation awareness.

Giving them this help through a "Converging Traffic Alert System" (CTAS) could really simplify the UAV integration into the airspace.

Such a system has been studied and designed in Onera in 1997. It has been patented in France in 1998 and in the US in 2001.[3]

[2] Aircraft Owners and Pilots Association.

[3] United States Patent # 6,438,492.

2. Collision alerting/avoidance systems

2.1. Requirements

The CTAS [1,2] has to be adapted to the piloting rules used by VFR pilots, without running the risk of changing their rules, customs and habits and whose guiding principle is: see and be seen.

To this end, the specific aeronautical constraints on light VFR aviation have to be taken into account.

Gliders in particular are subjected to the most stringent constraints because:

- available energy is limited to the use of battery;
- the space available to install the equipment is in the order of a few cubic decimetres;
- the maximum mass per square centimetre and the total mass are restricted due to the need to comply with certification constraints;
- the addition of external antennas to the fuselage would be detrimental, as would any change in the aerodynamics of the craft.

A system that would satisfy these constraints will generally be suitable to all the other categories of aircraft flying under VFR, in particular light aircraft, helicopters, ULM, ...

2.2. Current equipment

A number of anti-collision devices currently exist, co-operative or autonomous, which are used in aeronautical applications.

Two categories of autonomous devices may be cited:

1. Passive devices, which are generally optical and of the infrared sensor type, offer high performance in military applications where the targets have adapted infrared signatures.
2. Active devices, of the airborne radar type, require transmission and reception of a radar wave. The bandwidth of the signal determines the distance resolution performance. Other criteria, such as wavelength, determine the size of transmission and reception antennas.

Five categories may be cited among the co-operative devices:

1. Some devices are aimed at increasing the aircraft "optical signature" (anti-collision lights, coloured stripes painted or adhered to gliders, ...). These devices generally depend on the type of aircraft on which they are used. They do not significantly increase the pilot's ability to look at the right place at the right time.