UAV In-Flight Awareness Concept

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Abstract

This work proposes an innovative concept, called *In-Flight Awareness* (IFA), expanding the concept of *Sense And Avoid* and aiming situational awareness in both controlled and non-controlled airspace for unmanned aircraft. From events occurring either internally or externally to the aircraft, the proposed system checks symptoms (taking into account the capabilities of the platform), data from both environment and onboard sensors, nearby aerial traffic, and geopolitical issues to identify and prevent or mitigate accidents or simply to update the flight plan, through a decision analysis algorithm. The aim of this paper is to model internal and external factors taxonomy on UAVs in order to increase flight safety and situational awareness, called *In-Flight Awareness* (IFA), and generate a sample implementation in Simulink, based on an algorithm of decision obtained from a decision tree. Experiments were pursued using some small UAVs developed by ICMC and ITA.

Introduction

The growing use of unmanned aerial vehicles (UAV), also called Remotely Piloted Aircraft (RPA), developed discussions and questions about the risks involved in their operation on populated areas and for manned platforms, either in segregated air space or not. In this proposal, the term adopted will be VANT.

The common layers to avoid accidents involve radars ATC (*Air Traffic Control*), Sense and Avoid systems (TCAS, for example) and pilots on board as a final measure. Taking into account that UAVs are robotic platforms designed to carry payloads with the goal of performing missions in a changing environment, it is essential to establish ways to improve situational awareness beyond the perception of possible collisions. Taking into account that the security is the most important factor to ensure the integration of UAVs in the air space, it is essential to create ways to bring it back onboard what was eventually lost with the departure of pilots.

Due to the different aspects related to the necessary security during the operation, Douglas et al. [1] defined the term *In-Flight Awareness* (IFA), which may be understood as situational awareness in flight. Situational awareness can be defined as "the perception of elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future", [2] and [3]. To achieve an understanding of the situation during the execution of a task, an unmanned aircraft should realize broader aspects of identifying intruders on a collision course. In this context, concepts of *Sense And Avoid* (cooperative and uncooperative), although very important, are only part of the IFA and status data from mission sensors, geopolitical issues, weather forecast, the conditions of the platform, abnormal attitudes, level of autonomy platform and rules of air operations need to be obtained and processed to be inserted as an entry in the Flight Management System aiming the mission accomplishment. For a civil or military mission, a simple failure of a camera can be enough to compromise an entire flight.

Therefore, *In-Flight Awareness* involves realizing internal and external factors and their use in an algorithm, as part of the decision-making process, and acting in accordance with the current conditions and goals. In order to have a safe and efficient UAV flight, this paper proposes a process similar to that proposed by Endsley, [2], to achieve situational awareness in dynamic systems. In a first level (level 1), data from internal and external sources are collected and used in an algorithm developed and adapted to a specific situation, platform and to discover a present situation (level 2) and act accordingly (level 3). The Figure 1 shows this three levels structure for IFA.

- With the definition of aspects that must be taken into account to obtain situational awareness, one may identify the desired data as well as sensors and algorithms necessary and sufficient. The data collection using IFA's perspective involves: Cooperative (ACAS/TCAS, ADS-B) and Non-cooperatives Technologies (EO/Infrared, radar, acoustic), Data link (control

and video), Interface with autopilot, Level of autonomy, Certification aspects (safety), Air operations rules, Meteorology, Air traffic control instructions, Geopolitical issues and General operation conditions of both payload and aircraft systems.

Figure 1 - IFA requires a clear understanding of a multitude of data. Adapted from **[2]**.

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