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Unmanned Aircraft Systems (UAS) are rapidly gaining attention due to the increasing potential of their applications in the civil domain. UAS can provide great value performing environmental applications, during emergency situations, as monitoring and surveillance tools, and operating as communication relays among other uses. In general, they are specially well suited for the so-called D-cube operations (Dirty, Dull or Dangerous).

Most current commercial solutions, if not remotely piloted, rely on waypoint based flight control systems for their navigation and are unable to coordinate UAS flight with payload operation. Therefore, automation capabilities and the ability for the system to operate in an autonomous manner are very limited. Some motivators that turn autonomy into an important requirement include limited bandwidth, limits on long-term attention spans of human operators, faster access to sensed data, which also results in better reaction times, as well as benefits derived from reducing operators workload and training requirements.

Other important requirements we believe are key to the success of UAS in the civil domain are reconfigurability and cost-effectiveness. As a result, an affordable platform should be able to operate in different application scenarios with reduced human intervention.

To increase capabilities of UAS and satisfy the aforementioned requirements, we propose adding flight plan and mission management layers on top of a commercial off-the-shelf flight control system. By doing so, a high level of autonomy can be achieved while taking advantage of available technologies and avoiding huge investments. Reconfiguration is made possible by separating flight and mission execution from its specification.

The flight and mission management components presented in this thesis integrate into a wider hardware/software architecture being developed by the ICARUS research group. This architecture follows a service oriented approach where UAS subsystems are connected together through a common networking infrastructure. Components can be added and removed from the network in order to adapt the system to the target mission.

The first contribution of this thesis consists, then, in a flight specification language that enables the description of the flight plan in terms of legs. Legs provide a higher level of abstraction compared to plain waypoints since they not only specify a destination but also the trajectory that should be followed to reach it. This leg concept is extended with additional constructs that enable specification of alternative routes, repetition and generation of complex trajectories from a reduced number of parameters.

A Flight Plan Manager (FPM) service has been developed that is responsible for the execution of the flight plan. Since the underlying flight control system is still waypoint based, additional intermediate waypoints are automatically generated to adjust the flight to the desired trajectory.

In order to coordinate UAS flight and payload operation a Mission Manager (MMa) service has also been developed. The MMa is able to adapt payload operation according to the current flight

phase, but it can also act on the FPM and make modifications on the flight plan for a better adaption to the mission needs. To specify UAS behavior, instead of designing a new language, we propose using an in-development standard for the specification of state machines called State Chart XML.

Finally, validation of the proposed specification and execution elements is carried out with two example missions executed in a simulation environment. The first mission mimics the procedures required for inspecting navigation aids and shows the UAS performance in a complex flight scenario. In this mission only the FPM is involved. The second example combines operation of the FPM with the MMa. In this case the mission consists in the detection of hotspots on a given area after a hypothetical wildfire. This second simulation shows how the MMa is able to modify the flight plan in order to adapt the trajectory to the mission needs. In particular, an eight pattern is flown over each of the dynamically detected potential hot spots.

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