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Mission planning and simulation of unmanned aerial vehicles with a GIS-based framework

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Mission Planning software uses Geographic Information Systems (GIS) sources and dynamic aggregation of geo-referenced data to provide an information-rich context for human-directed creation of missions that are, for the most part, vehicle-independent. This requires a connection between the universal Mission Planner and an heterogeneous groups of unmanned aerial vehicles (UAVs), payloads and associated software tools. The developed abstraction mechanism is the Aerial Vehicle Control Language (AVCL), in which the missions are expressed. The ultimate goal is the easy integration of vehicles developed by different research groups with existing systems. It has been tested with our real-time small helicopter simulator.

I. Introduction

Typical development of unmanned aerial vehicles follows a bottom-up approach: low-level control is developed first, and high-level command last. This is patent when reviewing articles related to UAV-platforms published in the past decades: most of them deal with modelling, attitude control and low-level trajectory tracking, while mission planning and other high-level functionality received little or no attention. This is a reasonable, even natural, approach, but usually the design of the *top* control hierarchy is conditioned by the low-level controller's capabilities and design-time choices. Furthermore, outside military-related research[1] there is no driving force for the use of applicable standards and technologies to ease integration of heterogeneous vehicles with existing systems.

Our research team has developed two autonomous helicopters, bought two commercial UAVs and is working on an autonomous indoors blimp. Therefore the higher levels of the software hierarchy must be vehicle-independent and designed with a top-down approach: as the framework moves *down* it will need flexible adaptors to connect vehicles with different capabilities and design compromises. This is also true for different payloads and software tools (e.g. simulators, path planners). An additional goal will be the use of applicable standards whenever possible and cost-effective.

The bridge between the GIS-based tools for mission planning and simulation (MP-S) is the run-time interpreted Aerial Vehicle Control Language (AVCL). This language represents a move toward vehicle-independent missions (akin to the MDLe[2]). Both the MP-S and the AVCL interpreter were designed with an heterogeneous groups of vehicles and systems in mind, and try to establish an platform open to future vehicles at our university.

In other words: the AVCL is the abstraction layer that allows the human operator to express mission goals and parameters as vehicle/payload-independent commands. The AVCL is also a mission-storage medium and a good tool for rapid prototyping because new functionality may be programmed using existing commands.

A. GIS data as a world-model

Because UAV development has been driven mostly by military-funded research[3] scientists and engineers have focused on threat avoidance, target acquisition and unknown-space navigation. Nevertheless the DoD's

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