

Emerging Software Paradigms in Autonomous Quadcopters

Introduction

The recent emergence of popularity and public adoption in remote controlled aerial vehicles such as programmable autonomous quadcopters (PAQ) accelerated the development of software suites which enable PAQs to coordinate amongst themselves to form swarms [1] [2]. The communications hardware required for PAQs to perform high-bandwidth communications with one another is already available on the radio frequency (RF) transmission systems of most modern high-end consumer drones with ranges of up to 7 kilometers [3]. With modern wireless communications systems and efficient quadrotor design, the primary challenge behind operating PAQs is in the development of advanced swarm control algorithms and extensive software integration. The primary purpose of this technical review is to explore current and potential approaches to software integration between PAQs, base station(s), and PAQ mounted sensor instrumentation allowing for PAQ swarm behavior.

Ground Station Software

Beyond hobbyist flying, PAQs are also increasingly used in professional applications such as aerial surveillance, cartography, and search and rescue operations. These professional PAQs applications for PAQs benefit greatly from PAQ swarms and paved way for the development of waypoint-based flight software and flight controller to ground control station communication standards such as the Micro Air Vehicle Communication Protocol (MAVLink) [1]. One example of a waypoint-based PAQ swarm management system is the UgCS Mission Planner which is a MAVLink compatible software development kit (SDK) allowing for the integration of individual unmanned vehicles into an intelligent swarm through a standardized communication protocol [4]. The UgCS Mission Planner, however, behaves more like a master remote control and will not support advanced swarm functionalities such as aerial docking and undocking amongst swarm drones. Advanced swarm clustering operations such as the aggregation of drones through aerial docking necessitate extensions to the UgCS SDK to further interface and integrate with the individual flight controller software of PAQ swarm units [2].

Flight Controller Software

Most drone and PAQ manufacturers produce proprietary flight controller software for their aircraft, but the proprietary nature of their software often means the controller software is locked to modification or enhancement for advanced swarm behavior. The exploration and development of advanced drone swarm operations in both academia and industry has led to the emergence of open-source flight controller software solutions such as the PX4 Professional Autopilot SDK and flight controller firmware allowing for full software extensibility and integration with swarm management systems such as UgCS [5]. Additionally, the PX4 SDK allows for the full customization of mounted sensory either through a PX4 compatible controller offered by solution partners such as Qualcomm, DJI, Intel, and Yuneec or from a PX4 Pro Controller distributed directly through the Dronecode Project which maintains the PX4 software suite.

Full System Integration

The purpose of this technical review is to evaluate and consider readily available software solutions to assist in the software integration of Skyisland, a modular, aerial self-docking and clustering, PAQ swarm. Few software solutions offer the total software integration between vehicle control systems, sensory instrumentation, vehicle ground station mission management systems, and inter-swarm-unit-module communications a next-generation aerial-docking PAQ swarm system requires [1]. Currently, only one PAQ solution trademarked as Airblock offers a similar level of total software integration which the Skyisland project requires. Airblock is a modularly configurable open source PAQ hardware and software suite which involves a single unified SDK tying together various PAQ modules such as motors, sensors, and RF modules as well as a simple ground station mission management system with an extensible application programming interface (API) [6]. However, the Airblock platform does not offer the hardware flexibility Skyisland requires. Thus, the PX4 SDK in conjunction with the UgCS platform is the most reasonable integration approach to efficiently achieve total software integration between Skyisland swarm-units and ground control manage systems.

References

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