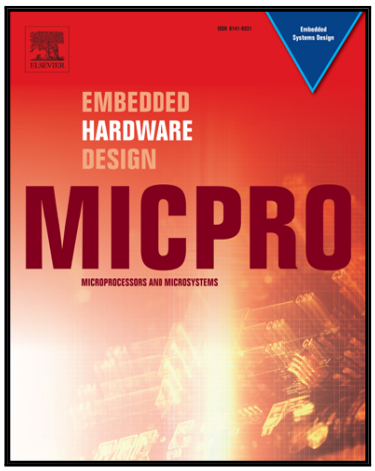

A Survey of Open-Source UAV Flight Controllers and Flight Simulators

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A Survey of Open-Source UAV Flight Controllers and Flight Simulators

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Abstract

The current disruptive innovation in civilian drone (UAV) applications has led to an increased need for research and development in UAV technology. The key challenges currently being addressed are related to UAV platform properties such as functionality, reliability, fault tolerance, and endurance, which are all tightly linked to the UAV flight controller hardware and software. The lack of standardization of flight controller architectures and the use of proprietary closed-source flight controllers on many UAV platforms, however, complicates this work: solutions developed for one flight controller may be difficult to port to another without substantial extra development and testing. Using open-source flight controllers mitigates some of these challenges and enables other researchers to validate and build upon existing research.

This paper presents a survey of the publicly available open-source drone platform elements that can be used for research and development. The survey covers open-source hardware, software, and simulation drone platforms and compares their main features.

Keywords: Unmanned Aerial Vehicle (UAV), Drones, Flight Controllers, Drone Simulators, Open Platforms, Survey.

1. Introduction

The current disruptive innovation in civilian drone (Unmanned Aerial Vehicle, UAV) applications and the associated growth in the drone industry has led to an increased need for research and development in UAV technology. While applications such as aerial filming, mapping, and inspection can be accomplished within the current legal framework and using technology already available on the market, the industry is pushing to break down the barriers which will enable entirely new markets in logistics, e-commerce, surveillance etc. Examples of these barriers are Beyond Visual Line of Sight (BVLOS) flights, which by many stakeholders is considered to be the next game-changer in the UAV business, autonomous operations not supervised by a pilot, and long range flights using small UAVs. Industry and academia are collaborating on solving the associated challenges, which are related to UAV platform properties such as functionality, reliability, fault tolerance, and endurance, which are all tightly linked to the UAV flight controller hardware and software. The lack of standardization of flight controller architectures and the use of proprietary closed-source flight controllers on many UAV platforms, however, complicates this work, as solutions developed for one flight controller may be difficult to port to another without substantial extra development and testing if at all legally possible. Using open-source flight controllers mitigates some of these challenges and enables other researchers to validate and build upon existing research.

In this work, we present a survey on open-source flight controllers designed for UAVs. The survey is based on 20+ flight controllers publicly available on the web. We relate flight controller hardware (Section 2) to flight controller software (Section 3) and compare features, specifications, license types etc. of each controller and software. Simulation is often used for software functionality experiments tests before performing actual flight tests, especially in flight controller research and development which can minimize the risk of loss of control during test flights and save time. We include a survey of open-source simulation systems (Section 4), some of which support hardware-in-the-loop or software-in-the-loop simulation. Currently, UAVs are under constant and rapid technological development, and the reader should note that the information described in this paper is as of February 2018.

1.1. Related work

In 2010 Cao et al. presented a survey of autopilot systems for small or micro UAVs systems with the objective of providing a summary of the available commercial, open-source and research autopilot systems in the market at that moment for potential users of small UAV [1]. In 2011 Mészarós surveyed open-source hardware and software for fixed-wing UAV platforms, including a design of a small fixed-wing UAV based on one of the presented systems with its first field test [2]. In 2012 Lim et al. surveyed publicly available open-source projects for quadrotor UAV systems, presenting eight quadrotors with descriptions of their avionics, sensor composition, analysis of attitude estimation and control algorithms, and comparison of their additional features [3]. In 2016 Sabikan and Nawawi presented a general view of the implementation of an open-source quadcopter platform to develop a quadcopter research testbed [4],

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