Collision-free formation control of quadcopters on leader-follower topology

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1 Introduction

Quadcopters are versatile **VTOL** (**V**ertical **T**ake **O**ff and **L**anding) **UAV** (**U**nmanned **A**erial **V**ehicle) with a wide range of applications (surveillance, exploration, fire-fighting, etc). Due to their size, hovering and slow flight capabilities, quadcopters are widely-used aerial robots for formation flights to perform missions [1].
Formation control of networks has been widely investigated with formulations such as swarming, flocking, foraging, consensus and rendezvous. The main motivation of this formation control comes from the fact that using multiple (low-cost) agents to perform a task is usually more effective than a single (high-tech) agent especially for difficult tasks such as rescue missions, combats, mapping, etc [3]. Networks are composed of several agents (UAV) called nodes which interact to each other through a communication protocol (Wi-Fi, Bluetooth, XeeBee, etc) to exchange some states information.

2 Formation Control

In this study, a formation control of quadcopters is considered on a directed leader-follower topology using a distributed approach (i.e all the followers contribute in achieving the control goal). The leader has a prescribed path and the followers should track the leader while maintaining a specified formation shape.
Although the quadcopter dynamics is represented by a complex and strongly non-linear model, a linear formation control law is designed for each quadcopter resulting from a feedback linearisation scheme (Fig. 1) [2]. This control law has an extra term with a *sign* function, comparable to a relaxed Sliding Mode Control (SMC) scheme to deal with bounded disturbances. We assume in this work that all the quadcopters are equipped with an appropriate autopilot being capable of controlling the copter's attitude and position. The collision avoidance problem between vehicles is tackled by constructing a edge-tension function and finally, the impact of the network topology (communication graph) on the performance of the system is investigated to consider possible communication failure between quadcopters during real operations.

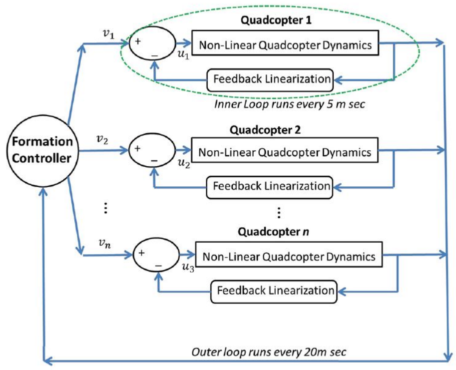

Figure 1: Formation control applied to global linear system

References

[1] R. Thien and Yoonsoo Kim, "Decentralized formation flight via PID and Integral Sliding mode control," Aerospace Science and Technology, 2018.

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[3] Y. Pan, H. Werner, Z. Huang and M. Bartels, "Distributed cooperative control of leaderfollower multi-agent systems under packet dropouts for quadcopters," Systems and Control Letters, 2017.