Robust Control of a Quadrotor UAV with Cable-Suspended Load for Safe Transport and Delivery Applications

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Abstract. This work deals with the problem of controlling the transport of a load from one point to another through a cable connected to a quadrotor, and eliminating the oscillation generated by the suspended load. An ADRC controller is presented that asymptotically stabilises the desired position of the quadrotor while simultaneously limiting load oscillation and aligning it with the vertical position of the inertial reference frame. The proposed control scheme considers the dynamics generated by the suspended load to generate the control law. Unlike standard approaches in the scientific literature, feedback on the dynamics of the suspended load is not necessary since an extended state observer is designed to estimate it. The numerical simulation shows the effectiveness and stability of the proposed controller, thus contributing to the development of UAV-based sustainable mobility and safe transport applications such as purchased goods delivery, forest firefighting and aeromagnetic mapping.

1 Introduction

In recent years, unmanned aerial vehicles (UAVs) have become essential since we can classify them as mobile platforms capable of autonomously navigating various environments both indoors and outdoors. In a sustainable mobility sense, the challenge is to provide safe and accessible transport systems while minimising the environmental impact [10]. In particular, a UAV-based delivery system is taking a big boost since it is expected to revolutionise how customers receive purchased goods from urban or difficult access locations in a sustainable manner. Examples of suspended-load UAV-based transport applications include forest firefighting, aeromagnetic mapping, delivery of purchased goods and delivery of medical or first aid kits. Some advantages of using UAVs as delivery systems are the reduced shipping costs, less manual supervision and faster delivery times since they do not depend on the roadwork. Among other types of UAVs, the quadrotor has become the preferred aerial platform in aerial robotics due to its maneuverability, small size, hovering and landing/take-off ability. The technology involving

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