Geometric Tracking Control of a Quadrotor UAV on SE(3)

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***Abstract*— Simple PID controllers are very good at following given trajectories but fail when the quadrotor has to perform aggressive maneuvers. This is where geometric controller work more efficiently. The aim of this paper project is to implement a geometric controller for crazylfie 2.0 bases upon the research paper [1].The quadrotor has four input degrees of freedom, namely the magnitudes of the four rotor thrusts, that are used to control the six translational and rotational degrees of freedom, and to achieve asymptotic tracking of four outputs, namely, three position variables for the vehicle center of mass and the direction of one vehicle body-fixed axis. A globally defined model of the quadrotor UAV rigid body dynamics is introduced as a basis for the analysis. A nonlinear tracking controller is developed on the special Euclidean group SE(3) and it is shown to have desirable closed loop properties that are almost global. Several numerical examples, including an example in which the quadrotor recovers from being initially upside down, illustrate the versatility of the controller.**

I. INTRODUCTION

A quadrotor unmanned aerial vehicle (UAV) consists of two pairs of counter-rotating rotors and propellers, located at the vertices of a square frame. It is capable of vertical take-off and landing (VTOL), but it does not require complex mechanical linkages, such as swash plates or teeter hinges, that commonly appear in typical helicopters. Due to its simple mechanical structure, it has been envisaged for various applications such as surveillance or mobile sensor networks as well as for educational purposes.

Geometric control is concerned with the development of control systems for dynamic systems evolving on nonlinear manifolds that cannot be globally identified with Euclidean spaces. By characterizing geometric proper- ties of nonlinear manifolds intrinsically, geometric control techniques provide unique insights to control theory that cannot be obtained from dynamic models represented using local coordinates. This approach has been applied to fully actuated rigid body dynamics on Lie groups to achieve almost global asymptotic stability.

In this paper, we try to implement a geometric controller for a quadrotor based upon [1]. The dynamics of a quadrotor UAV is expressed globally on the configuration manifold of the special Euclidean group SE(3). We construct a tracking controller to follow prescribed trajectories for the center of mass and heading direction. It is shown that this controller exhibits almost global exponential attractiveness to the zero equilibrium of tracking errors. Since this is a coordinate-free control approach, it completely avoids singularities and complexities that arise when using local coordinates. Compared to other geometric control approaches for rigid body dynamics, this is distinct in the sense that it controls an underactuated quadrotor UAV to stabilize six translational and rotational degrees of freedom using four thrust inputs, while asymptotically tracking four outputs consisting of its position and heading direction. We demonstrate that this controller is particularly useful for complex, acrobatic maneuvers of a quadrotor UAV, such as recovering from being initially upside down.

II. LIETRATURE REVIEW

III. QUADROTOR DYNAMICS

IV. CONCLUSIONS

REFERENCES

[1] Lee, Taeyoung, et al. ?http://Ieeexplore.ieee.org/Document/5717652/.? Geometric Tracking Control of a Quadrotor UAV on SE(3) - IEEE Conference Publication, 2010, ieeexplore.ieee.org/document/5717652/.