Towards a navigation system for an autonomous UAV in indoor environment

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1 Introduction

In recent years, research interest in unmanned aerial vehicles (UAVs) has emerged due to their potential use for a wide range of applications such as: smart flying sensor, formation control of unmanned ground vehicles (UGVs) using an UAV and habitat mapping. In order to accomplish the above mentioned missions, a prerequisite requirement is that the UAV should be able to implement real-time autonomous navigation. Whereas most of the proposed approaches are suitable for outdoors, only few techniques have been developed for indoor environments. In this paper, a solution using only onboard visual and inertial sensing which enables an UAV to operate indoors is proposed. The approach comprises three key components: pattern-based localization, IMU data process, designed path planning and controller. This methodology opens new possibilities for the UAV to perform autonomous navigation.

2 System setup

The proposed approach consists of three major components running on a laptop connected to the UAV (Ar. Drone 2.0) via wireless communication as shown in Figure 1. The first component is the pattern based localization which allows Ar. Drone 2.0 to determine its location and orientation in a working space. The second component is IMU data process which transmits and receives signals between Ar. Drone 2.0 and the ground station. The last component is a cascade control which guides the drone to follow the desired trajectories.

3 Path planning and control design

The paths are obtained base on modified A*, D* and Potential Fields algorithms. To perform experiments, a cascade control is designed (Figure 2) such that the drone follows the generated trajectories. There are two parts of the cascade controller: inner-loop controller and outer-loop controller. The inner-loop controller is performed inside the drone as a black-box. The outer-loop controller is designed to implement position control. The localization process provides the current the drone pose in world coordinate based on the ground patterns. The obtained free-collision path is sent to the controller by a list of way-points [1].

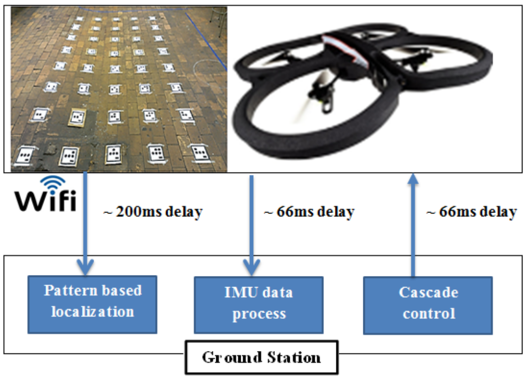

Figure 1: The proposed navigation approach of an AR.Drone 2.0

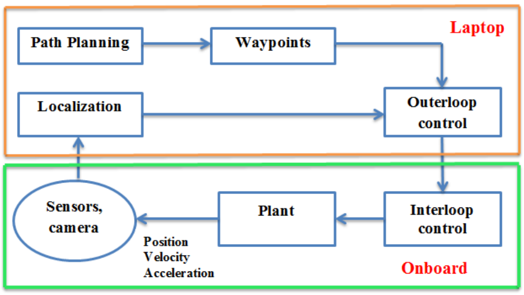

Figure 2: The proposed cascade controller of an AR.Drone 2.0

4 Conclusion

In this study, we have presented an indoor flight approach for a low-cost commercial AR. Drone 2.0 using only onboard visual and internal sensing. The real-time experiment demonstrates the feasibility of the proposed strategy which opens an autonomous navigation possibility for the drone in indoor environment.

References

[1] Mac. T.T, Copot. C, Hernandez. A, De Keyser R, Improved Potential Field Method for Unknown Obstacle Avoidance Using UAV in Indoor Environment, IEEE 14th International Symposium on Applied Machine Intelligence and Informatics, Herlany, Slovakia, pp. 345- 350, 2016.