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# Autonomous landing for a fixed-wing drone on a dynamic vehicle \\using neurocontrol strategies with theoretical guarantees

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Unmanned aerial vehicles (UAVs) have been taking significant developments in robotics systems due to their capability to perform different tasks. However, numerous challenges are presented in these systems, and the scientific community is looking for improved solutions. These solutions often require a robust control system due to the complexity of the systems that have nonlinear dynamics. Now, with the evolution of neural networks is possible to integrate them with some nominal controllers allowing better responses in closed loop systems.

In this study, a safe landing method for a fixed-wing drone in a reduced area is proposed using a recovery system assisted by a ground vehicle. This work is inspired by missions where the landing gear is removed for operational reasons in order to increase flight durability. However, the landing process is a critical stage due to external factors that made unsettled this process. Some recovery methods have been designed, but they could damage the aircraft, making essential the needed of precise manoeuvrers for a successful landing.

The primary objective is to guide an aerial vehicle toward the location of a moving target to ensure that the ground vehicle arrives at the same location as the drone at a predetermined distance. This control strategy is divided into two independent tasks for each vehicle. The aerial vehicle's controller is designed to track a soft-descending trajectory, allowing the kinetic energy absorption of the fixed-wing drone,and the ground vehicle's control is responsible to the capture task.

My PhD subject is based on this subject and previous works were developed considering ideal cases \cite{c2}\cite{c3}. We designed a control strategy to follow a predefined trajectory to reduce the speed of the fixed-wing drone for ensuring better synchronization between the systems. This is essential because the drone exhibits significantly faster dynamic responses compared to the ground vehicle.

We proposed first solutions of a PhD project with the goal to land a FWD in a mobile target. First developed studies focus on proposing hybrid control algorithms for autonomous adapting gains in a control simple algorithm. The adaptation was done using a neural network. Later, we worked in designed a control strategy to follow a trajectory
to reduce the speed of the FWD. The next phase of this research is to test in real time, the behaviour of the proposed results based on simulations.

As a test of the neuro-control theory, we propose a backpropagation neural network to adjust the gains of a PD controller for the $x$-position of a UAV when its mass is varying. Our neural network is composed by a hidden layer of three neurons. However, it is possible to adjust the network with more neurons or even with more hidden layers in order to solve other kind of problems. This signify that for our application a simple hidden layer performs well.

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Références :

[1] Lozano, R. (John Wiley & Sons) 2013. Unmanned Aerial Vehicles: Embedded Control.

[2] Lozano, R., Alatorre, A., & Castillo, P. (2023). Cooperative control strategy for an airplane landing on a mobile target. Journal of Intelligent & Robotic Systems, 107 (1).

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