# A Simple and Robust Fixed-Wing Platform for Outdoor Flying Robot Experiments

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## Abstract

In the last decades, the development of flying robots has made much progress. However, a flying platform for outdoor robot experiments, in particular research in collective systems, which fulfills the main criteria of safeness, ease of use, robustness and simplicity does not exist yet. Rather, current systems (e.g. the ones used in [1], [2] and [3]) tend to be dangerous in case of crash, are difficult to operate (requiring a technical staff and expert safety pilot) and expensive especially because they rely on complex sensors such as GPS, inertial measurement units (IMU), active range finders or complex vision processing.

Motivated by the so-called Swarming MAV project, currently under development in our laboratory (http://lis.epfl.ch/smavs), we are in need of a simple, cheap and robust aerial robotic platform, capable of completely autonomous flight. In the project, a swarm of flying robots will establish a communication network in the air: MAVs will interact and communicate with airborne fellows and ground stations. Being able to hover is not required, neither is the ability of absolute position detection. In order to develop a suitable aerial platform, we propose a concept that is different from the conventional approach: In terms of sensory modalities and flight control, instead of using an IMU and GPS, we aim at a system with a minimum number of sensors and simple, Braitenberg-like control laws based on direct input from the sensors. In this paper, we show the viability of such an approach.

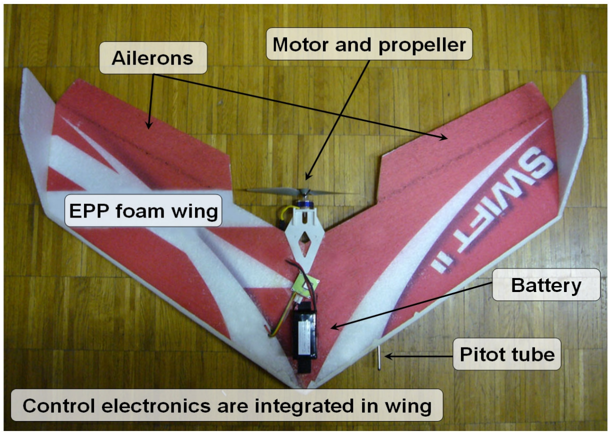


**Figure 1.** A simple and robust fixed-wing platform for robotic experiments (80 cm wing span, 350g weight - fully equipped -, 30min endurance)

In terms of platform hardware, and at the current stage of development, the chosen airframe is a very low-cost, commercially available flying wing made of expanded poly-propylene (EPP) foam (Fig. 1). It has been chosen for its resistivity to crash, good flight behavior in windy conditions, and reasonably low weight (max. 350g). The platform's control electronics consist of a tiny microcontroller (dsPIC) and no more than 4 sensors: a differential and an absolute pressure sensor permit to determine airspeed and altitude, 2 rate gyros measure the plane's rotational speed around the yaw and pitch axes. The basic flight control strategy uses the raw sensor values and is able to robustly steer the plane to autonomously take off, reach a predetermined altitude, circle with a constant turning rate, and land after a given time or when triggered.

An example of an autonomous flight is depicted in Fig.s 2a and 2b.

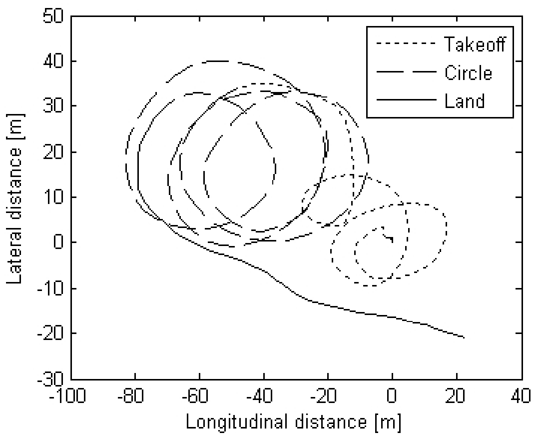


**Figure 2a.** Top-view of the trajectory for 3 autonomous flight phases. Switching between phases is done manually.

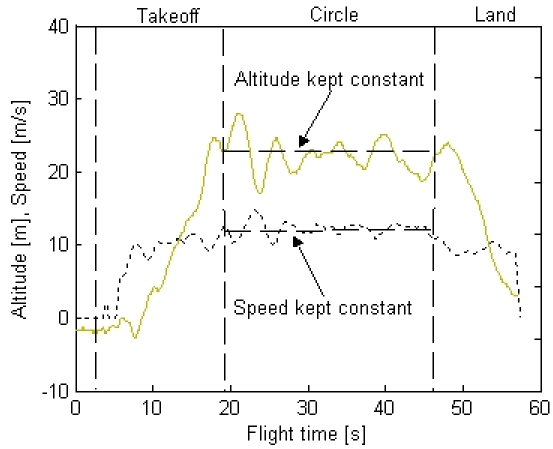


**Figure 2b.** Altitude and flight speed measured with the absolute and differential pressure sensors.

The main properties of this platform, i.e., ease of use, simplicity and robustness, make it ideal for real-world experiments in outdoor aerial robotics. Apart from its first application with the Swarming MAV project, it will particularly help to promote research in bio-inspired, collective and swarm aerial robotics.

## References


[1] Scherer, S., Singh, S., Chamberlain, L. and Saripalli, S. (April 2007) Flying Fast and Low Among Obstacles, *IEEE International Conference on Robotics and Automation*, Rome, Italy.

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[3] Cole, D. T., Göktogan, A. H. and Sukkarieh, S. (July 2006) The Demonstration of a Cooperative Control Architecture for UAV Teams, *International Symposium on Experimental Robotics*, Rio de Janeiro, Brazil.