The first step in the development of the novel platform concentrates on the airframe and a flight controller board, with focus on the criteria of low cost (simple and off-the-shelf components), safety (light-weight, small), ease-of-use (fly behind the office) and versatility (connectivity to external modules, sufficient processing power). A control strategy using a minimum of sensors and simple control laws is implemented and investigated in flight experiments.

In order to cope with some of today’s difficulties in aerial robotics, propose a novel fixed-wing autonomous platform. Compared to helicopters, fixed-wing vehicles offer a particularly good lift to propulsion ratio (long endurance and high payload) and are able to land without causing damage in case of a control or propulsion system failure (gliding landing).

**Limitations of existing platforms**

- Expensive + complex: airframe, flight computer, sensors
- Big + heavy
- Difficult to operate
- Limited user-access

**Benefits of the new platform**

- Low cost
- Safe
- Easy-to-use
- Versatile

**Approach**

The first step in the development of the novel platform concentrates on the airframe and a flight controller board, with focus on the criteria of low cost (simple and off-the-shelf components), safety (light-weight, small), ease-of-use (fly behind the office) and versatility (connectivity to external modules, sufficient processing power). A control strategy using a minimum of sensors and simple control laws is implemented and investigated in flight experiments.

**Current Platform Hardware**

**Airframe (flying wing)**

- size: 80cm wingspan
- weight: 350g
- flight speed: ~10m/s
- custom flexible foam
- brushless electric motor
- propeller mounted behind
- all electronics inside wing
- long endurance with LiPo-Battery: 30min
- cheap: 250€

**Flight Controller**

- 2 Micro-controllers
- 4 sensors (altimeter, airspeed, pitch-yaw rate gyros)
- 15g, 150€
- expandable (interface connectors for ext. CPU, wireless network adapter, extra sensors)
- Flight Control Computer (FCC, flight stabilisation)
- Navigation Control Computer (NCC, communication to ground station PC and high level navigation)

**Flight control strategy and experiment**

**Flight control with few sensors, is that possible?**

Simple control laws based on proportional error feedback have been implemented for holding altitude, speed and yaw turn rate, and to guide through automatic takeoff (gain altitude at constant speed), automatic landing (descent at constant speed, motor off).

We tested a flight experiment composed of the sequence “takeoff, circling, land” of autonomous flight, except for manual switching between flight phases. Yaw turn rate is predefined to 30°/s for takeoff and cruise flight (circling), and to 0°/s for landing. When switching from takeoff to circling, current altitude and speed are saved and maintained constant.

**Results**

The controllers manage to keep altitude within 3m and speed within 1m/s around the desired values. Turn rate is kept well during circling. Influence of wind (drift) visible.

**Conclusion**

The first steps towards a novel aerial robotic platform with the unique combination of being low cost, safe and easy-to-use in an out-of-the-box package have shown promising results in autonomous flight tests. A solution using only few sensors seems viable for control in combination with the chosen flying wing airframe.

**Future Work**

- Increase the integration level of the components
- Implement safety features (parachute, flight envelope monitor)
- Develop a user-interface and pre-programmed flight behavior primitives
- Design an external CPU and WLAN adapter module
- Use simulation results for controller design
- Integrate in Swarming Micro Air Vehicles project

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